TM 11-896

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

RADIO RECEIVING SET AN/FRR-12

DEPARTMENT OF THE ARMY • OCTOBER 1948

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TM 11-896, Radio Receiving Set AN/FRR-12, is published for the information and guidance of all concerned.

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CONTENTS

DESTRUCTION NOTICE

WHY—To prevent the enemy from using or salvaging this equipment.

WHEN—When ordered by your commander.

HOW—1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.
2. Cut—Use axes, handaxes, machetes.
3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.
4. Explosives—Use firearms, grenades, TNT.
5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT—1. Smash—Relays, controls, panels.
2. Cut—Cables and wiring.
3. Burn—Resistors, capacitors, all technical manuals, instruction books, tube charts.
4. Bury or scatter—Any or all of the above pieces after destroying their usefulness.

DESTROY EVERYTHING

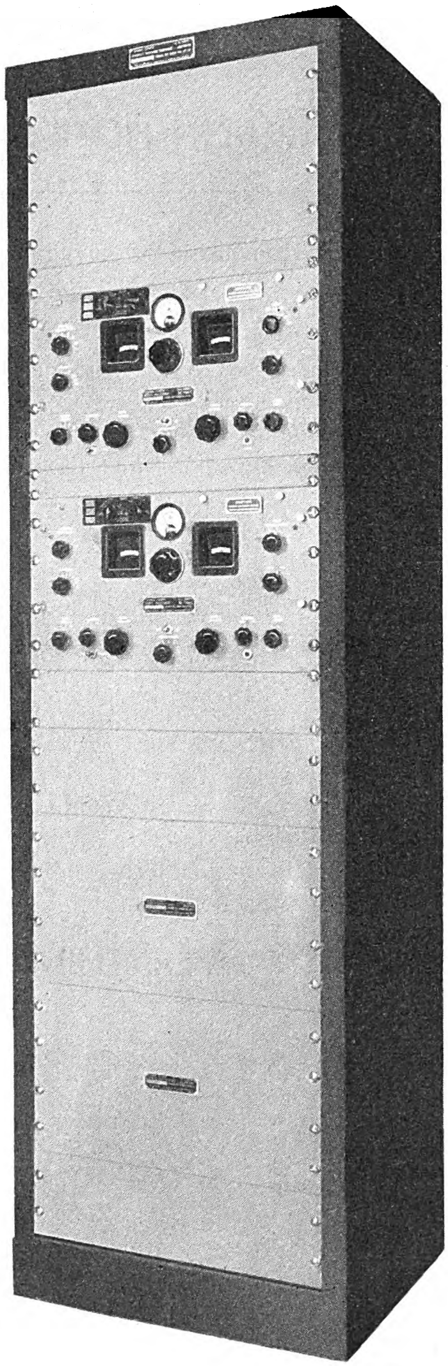


Figure 1. Radio Receiving Set AN/FRR-12.

PART ONE
INTRODUCTION

Section I. DESCRIPTION

1. General

Radio Receiving Set AN/FRR–12 (figs. 1, 3, and 4) is a fixed station set designed to avoid the effects of fading and primarily designed for use in a point-to-point radio-teletype system of communication. The term *fading* is intended to denote variations in signal strength over extremely short periods of time and is not to be confused with slow signal variations which may occur from hour to hour, day to night, or season to season.

2. Application

Radio Receiving Set AN/FRR–12 comprises two modified superheterodyne Radio Receivers R–270/FRR (designated receiver A and receiver B) operating independently from two separate antennas for the reception of frequency shift teletype and other type radio signals (fig. 2). A junction box provides for either balanced or unbalanced input from the antennas. This dual radio receiving system which prevents fading is known as dual diversity reception.

a. The i-f (intermediate-frequency) or a-f (audio-frequency) output of the receivers is fed to a converter which combines the signals at uniform strength for use in the teletypewriters. (Dual Diversity Converter CV–31( )/TRA–7 or Radio Teletype Terminal Equipment AN/GFC–( ) may be used.)

b. In addition to the operation of teletypewriters, the dual diversity receivers may be used for c-w (continuous-wave), ic-w (interrupted continuous-wave), mc-w (modulated continuous-wave) telegraph and for a-m (amplitude-modulated) telephone reception. These additional features are available for use when connection is made to suitable equipment.

c. Each Radio Receiver R-270/FRR has an external Power Supply Unit RA–74–D as its filament, bias, screen, and plate voltage source. The two receivers and their power supplies are mounted in Rack MT–660( )/FRR–12 (figs. 3 and 4).

d. Power Supply Units RA–74–D operate from a 95- to 130-volt (or a 190- to 260-volt) 25- to 60-cps (cycles per second) power source.

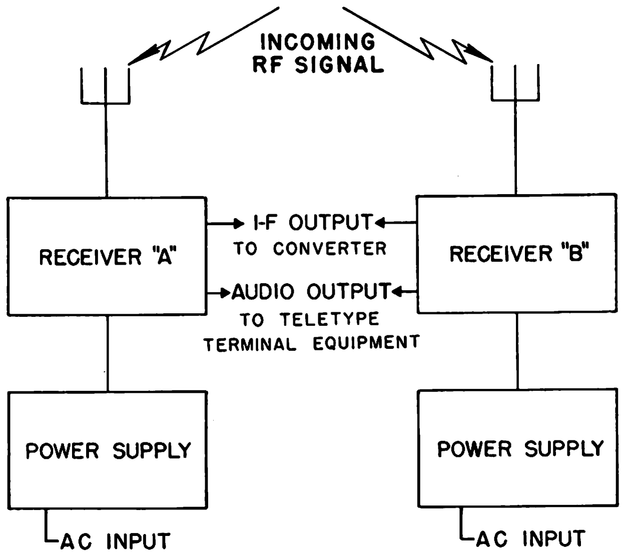


Figure 2. Radio Receiving Set AN/FRR–12, block diagram showing application of equipment.

3. Technical Characteristics

a. RADIO RECEIVER R–270/FRR.

Frequency range:	
Band 1	1.25 to 2.5 mc (megacycles).
Band 2	2.50 to 5.0 mc.
Band 3	5.0 to 10.0 mc.
Band 4	10.0 to 20.0 mc.
Band 5	20.0 to 40.0 mc.
	Note. Operation above 30 mc under certain conditions only.
Receiver type	Superheterodyne.
Type of signals which can be received.	Frequency-shift radio teletype; c-w, ic-w, mc-w telegraph; a-m telephone; certain types of fm (frequency modulation).

3. Technical Characteristics—Continued

a. RADIO RECEIVER R-270/FRR.—Continued

Number of tubes	17.
Intermediate frequency	465 kc. (kilocycles).
Sensitivity	2 microvolts up to 20 mc and 5 microvolts from 20 to 40 mc for 500 mw (milliwatt) a-f output (any frequency with carrier modulated 30 percent at 400 cps) with i-f output at least 200 millivolts.
Image rejection ratio	3000:1 or better, below 10 mc; 200:1 or better, between 10 mc and 20 mc; 30:1 or better, above 20 mc.
Signal-plus-noise to noise power ratio.	At least 10:1 below 10 mc.; 4:1 above 10 mc.
Selectivity	Variable. See selectivity chart (fig. 21).
Crystal control	Any 3 channels in the frequency range of 1.5 to 26 mc.

b. POWER SUPPLY UNIT RA-74-D.

Power source	95-105-117-130/190-210-234-260 volts 25-60 cps.
Number of tubes	2.
Nominal output voltages	50 volts dc (direct current). 6.3 volts ac (alternating current). 100 volts dc. 250 volts dc. 380 volts dc.
Power consumption (overall).	400 watts (approx.).

4. Frequency Spectrum Table

The following table shows the frequency range of various radio sets with which Radio Receiving Set AN/FRR-12 may be operated:

a. COMMAND RADIO (ARMY COMMUNICATIONS SERVICE).

Transmitting equipment	Frequency range (mc)
Radio Transmitter BC-339-( )	4.0 to 26.5.
Radio Transmitter BC-449-( )	2.0 to 8.0. 4.0 to 13.4.
Radio Transmitter T-172( )/FR (Press Wireless PW-15-A).	4.0 to 21.0.
Radio Transmitter Assembly OA-60/FRT (Press Wireless 40A).	5.3 to 21.0.
Radio Transmitter Assembly OA-60A/FRT (Press Wireless PW-40B).	5.3 to 21.
Radio Transmitter Assembly OA-60B/FRT (Press Wireless PW-40BA).	4.0 to 21.
Radio Transmitter T-177/FR (Press Wireless PW 981A).	2.0 to 23.0.
Radio Set AN/MRC-2 and -2A	2.0 to 18.0.

b. AIRWAYS SECTION (ARMY COMMUNICATIONS SERVICE).

Transmitting equipment	Frequency range (mc)
Radio Transmitter BC-339-( )	4.0 to 16.5.
Radio Transmitter BC-401-( )	2.0 to 18.1.
Radio Transmitter BC-460-( )	2.0 to 16.0.
Radio Transmitter BC-610-( )	2.0 to 18.0.
Radio Transmitter BC-1100-( )	1.5 to 10.0.
Radio Transmitting Equipment RC-52-( ).	1.7 to 9.0.
Radio Transmitter T-4/FRC	2.0 to 18.0.
Radio Transmitter (Aircraft Accessories Corp. 500B).	0.275 to 0.4. 1.6 to 10.0.
Radio Transmitter (Collins 32-RA)	1.5 to 15.0.
Radio Transmitter (Federal FT-300)	2.0 to 20.0.
Radio Transmitter (Pan American Airways 12-ACX-2).	1.6 to 24.0.
Radio Transmitter (Temco 250-GSC)	2.0 to 16.0.
Radio Transmitter (Temco 1000-AG-CW)	2.0 to 16.0.
Radio Transmitter T-158/FRT (Wilcox 96A).	2.0 to 18.0.
Radio Transmitter T-158A/FRT (Wilcox 96C).	2.0 to 18.0.
Radio Transmitter T-158B/FRT (Wilcox 96C-3).	2.0 to 18.0.
Radio Set AN/CRC-3 (Galvin 50-ACRB)	30.0 to 40.0.

5. Table of Major Components

Component	Required No	Over-all dimensions (in.)			Weight (lb)	Vol. (cu. ft.)
		Height	Depth	Width		
Rack MT-660( )/FRR-12	1	76	18	22	230	17. 5
Radio Receiver R-270/FRR	2	10½	16¾	19	60½	2. 0
Power Supply Unit RA-74-D	2	10½	10¼	19	60½	1. 2

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

6. Shipping Weights and Dimensions of Packed Sets

Radio Receiving Set AN/FRR-12 is packed for export in five wooden cases. One complete set consists of the following:

a. Package one contains Rack MT-660( )/FRR-12, one set of operating cables, and one set of running spares. This case is 83½ inches high,

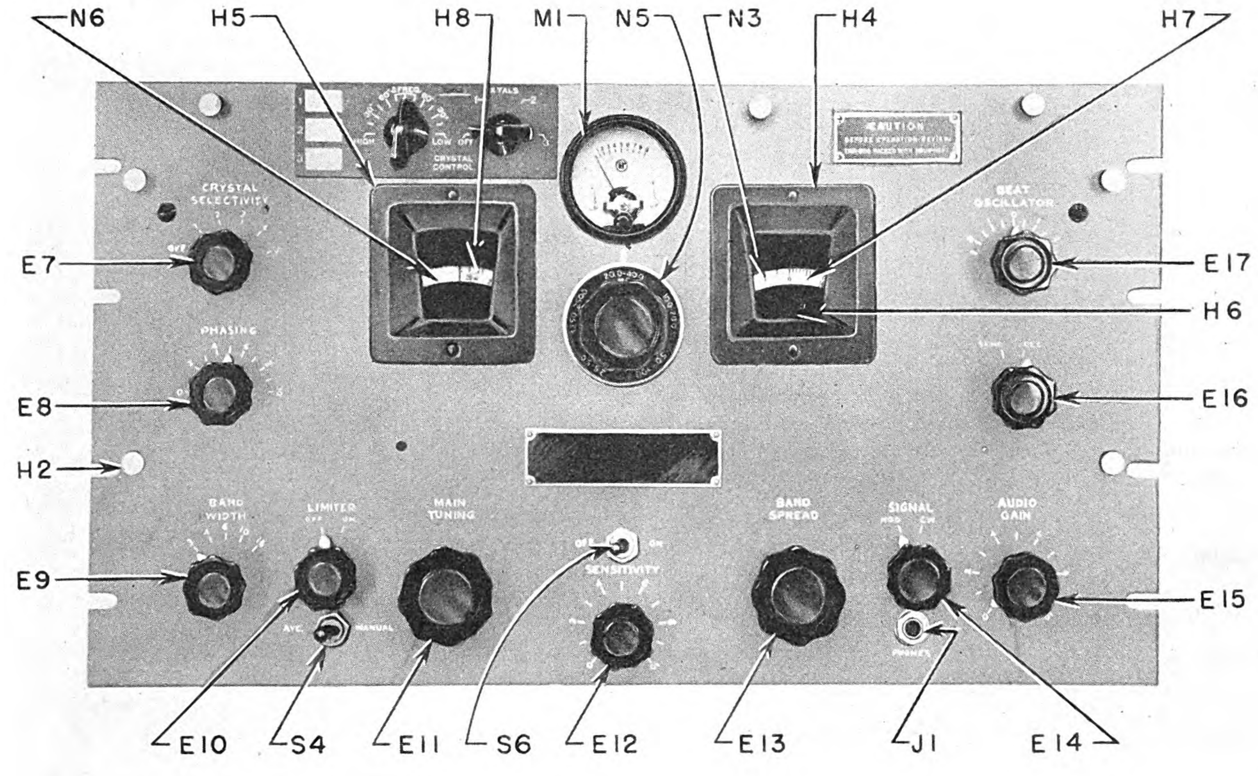


Figure 5. Radio Receiver R–270/FRR, front view.

23 inches deep, and 27 inches wide, and is equivalent to 30 cubic feet. The packed case weighs 475 pounds.

b. Packages two and three each contain a Radio Receiver R–270/FRR with operating tubes. Each case is 15½ inches high, 21¼ inches deep, and 24½ inches wide, and is equivalent to 4.5 cubic feet. The packed cases each weigh 117 pounds.

c. Packages four and five each contain a Power Supply Unit RA–74–D with operating tubes individually packed. Each case is 13¼ inches high, 14¼ inches deep, and 24 inches wide, and is equivalent to 2.8 cubic feet. The packed cases each weigh 115 pounds.

Note. For dimensions of the unpacked units, see paragraph 5.

7. Description of Main Components

Radio Receiving Set AN/FRR–12 consists of a standard Rack MT–660( )/FRR–12 which contains two identical receivers and their power supplies (figs. 1, 3, and 4).

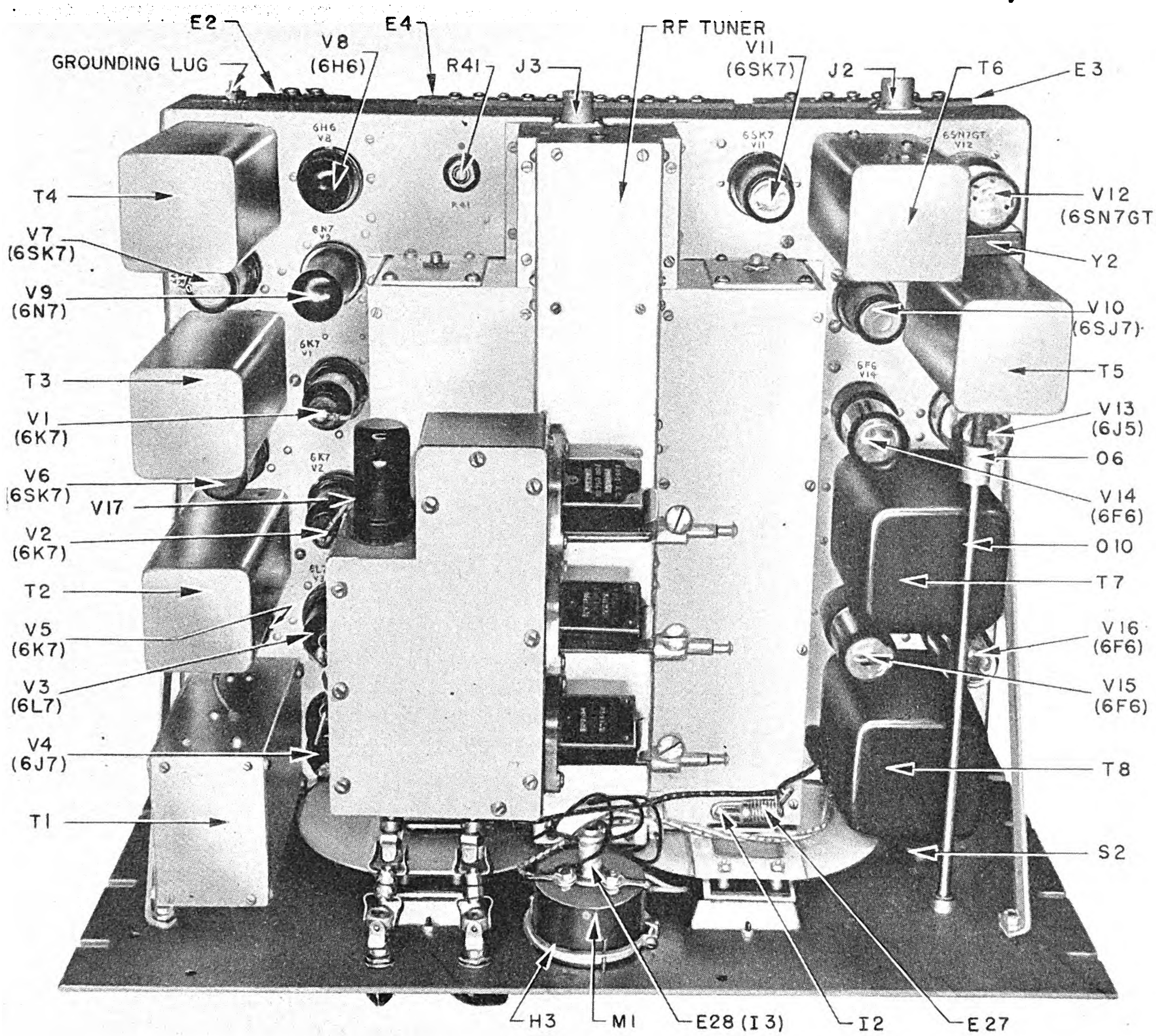


Figure 6. Radio Receiver R–270/FRR, top rear view.

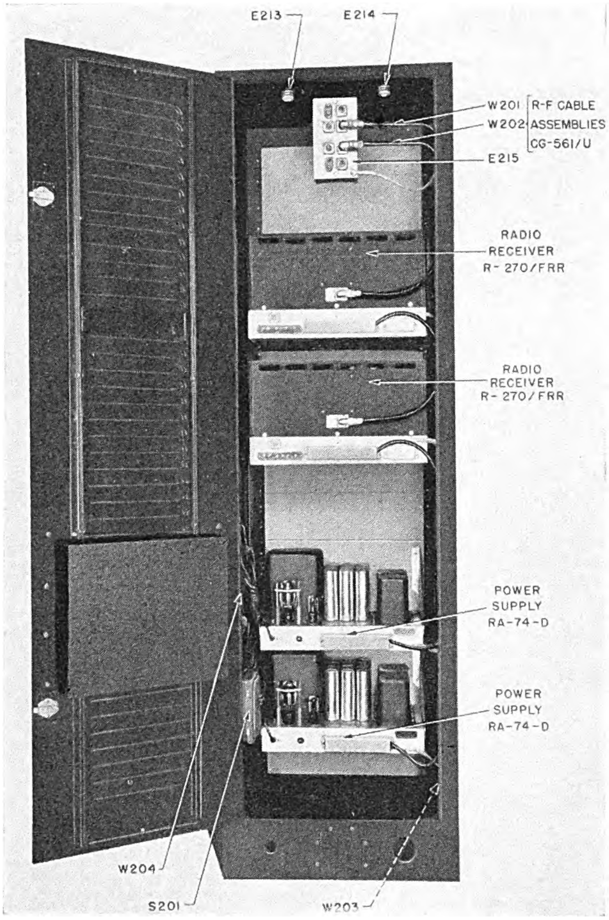


Figure 7. Radio Receiving Set AN/FRR-12, rear view, door open.

a. Rack MT-660( )/FRR-12 (figs. 1, 3, and 4). This standard radio rack has the receivers and power supplies mounted in it so that their controls are accessible at the front. A door on the back of the rack allows access to the chassis of the receivers and power supplies for servicing. The door contains an inverted box which must be reversed when Dual Diversity Converter CV-31/TRA-7 is installed in the rack.

b. Radio Receivers R-270/FRR (figs. 5, 6, and 7). The circuits and mechanical arrangement of receivers A and B are identical. All operating controls are mounted on the unit front panel (fig. 5). All power, input, and output signal connections are made to the rear of the chassis (fig. 6).

c. Power Supply Unit RA-74-D (figs. 8 and 9). The chassis attached to the front panel mounts all components of the power supply. Power input and output connections are made to the terminals on the rear of the chassis.

8. Differences in Models

a. Radio Receiving Set AN/FRR-12, comprising two receivers with their power supplies, does not contain several units which are a part of the AN/FRR-3 and AN/FRR-3A. The AN/FRR-12 is designed to obtain its signals from only two antennas; therefore, no antenna switching unit is used. The oscillators and power switches are built as a part of each receiver so that no external multiplier unit, oscillator unit, or power control unit used with the AN/FRR-3 and AN/FRR-3A is required with the AN/FRR-12. No remote control unit is included with Radio Receiving Set AN/FRR-12.

b. Several circuits of Radio Receiver R-270/FRR differ from the corresponding circuits in Radio Receivers BC-794-A and BC-794-B.

(1) The bfo (beat-frequency oscillator) has a crystal controlled circuit.

(2) The avc (automatic volume control) rectifier uses one-half of a dual purpose triode V-12 connected as a diode and the other half is used to supply i-f energy for an i-f output of the receiver.

(3) A crystal controlled h-f (high-frequency) oscillator may be switched alternatively into the receiver circuit insteald of h-f oscillator V-4.

c. The circuits of Power Supply Unit RA-74-D are essentially the same as those of Power Supply Unit RA-74-C, Power Supply Unit RA-84-B, and Power Supply Unit RA-94-A, except for the power transformer, power input, and the filter capacitors.

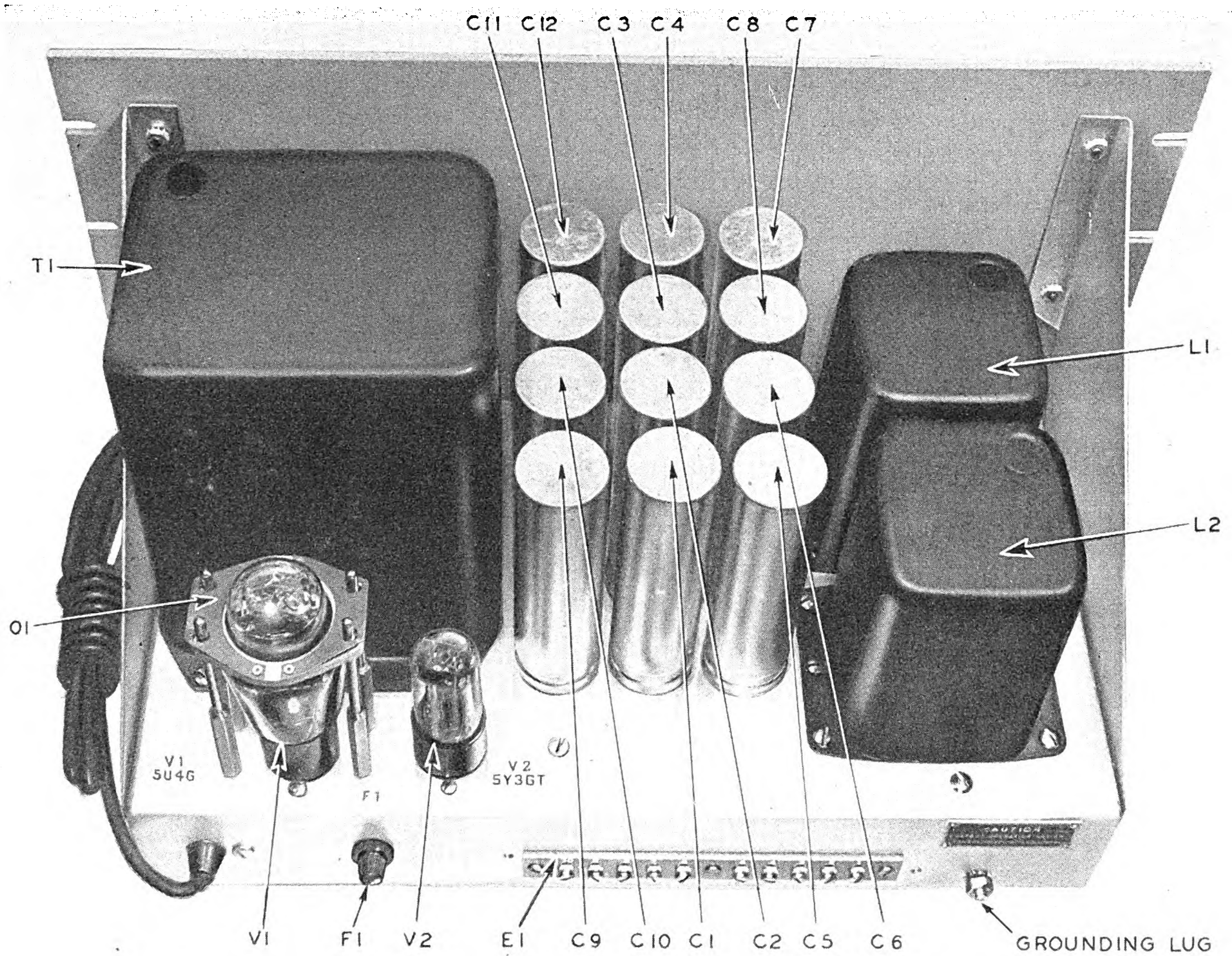


Figure 8. Power Supply Unit RA-74-D, top rear view.

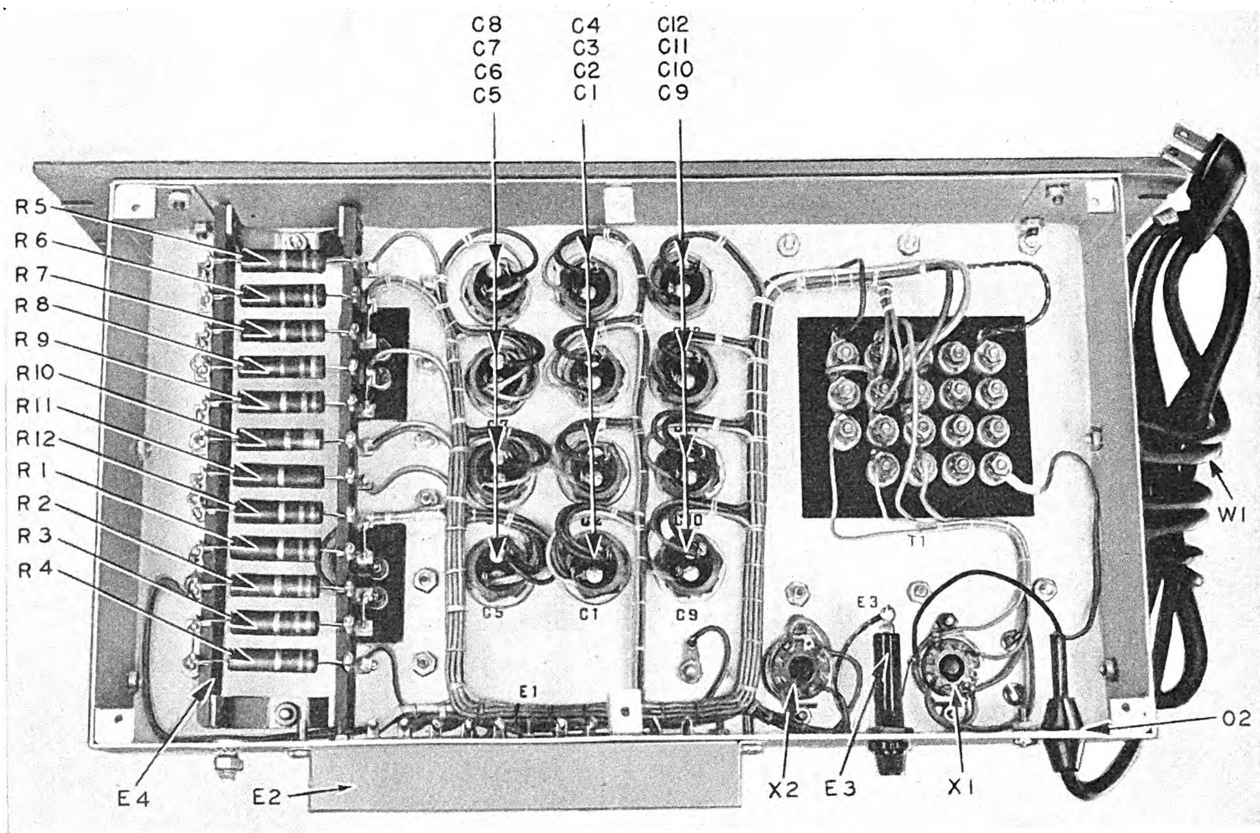


Figure 9. Power Supply Unit RA-74-D, bottom view.

Section II. INSTALLATION

9. Siting

The factors which determine the location of the equipment are power source, antenna location, and location of the associated teletype equipment. When Radio Teletype Terminal Equipment AN/FGC-1 is used, place Rack MT-660( )/FRR-12 to the left of the terminal equipment as you face the front of the cabinets. A clearance of 3 to 4 feet both front and rear is desirable. The cabinet should be protected from the weather and placed on a firm footing, preferably concrete, where it is reasonably free from vibrations. When Dual Diversity Converter CV-31/TRA-7 or CV-31A/TRA-7 is to be used in the receiver cabinet of Radio Receiving Set AN/FRR-12, the receiver cabinet should be located adjacent to the other station teletype printing equipment. For general information on antenna installation refer to TM 11-314; for specific information on rhombic or double-doublet antennas refer to TM 11-2611 or TM 11-2629.

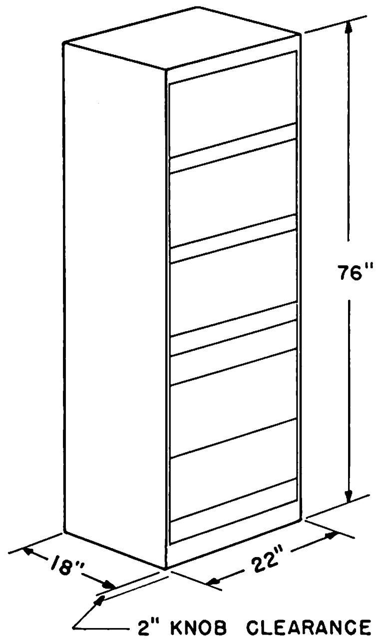


Figure 10. Rack dimensional drawing.

10. Unpacking, Uncrating, and Checking

a. Carefully unpack the equipment, inspecting it closely for possible damage due to shipment. Always remove nails from the cases with a nail-puller as prying the cases apart may damage the equipment. Erect the rack near its intended location after removal from the wooden packing case. Place the receivers and power supplies near the rack cabinet after removing them from their wooden packing cases.

b. Remove the waterproof protective wrappings from the rack, then remove the packages containing the cables, the antenna junction box front cover, and running spare parts from within the cabinet. Remove the bag containing the desiccant from within the packages. Remove the waterproof protective wrappings and the bags of desiccant from the packages containing the feed-through insulators, cables, running spares, antenna junction box cover, receivers, and power supplies. Remove the end seal coverings from the cable connectors. Remove the separately wrapped tubes from the wrappings of the power supply. As the equipment is unwrapped, inspect it closely for possible damage due to shipment.

Caution: Protective coatings cover many parts as protection against fungus, insects, salt spray, and corrosion due to excessive moisture to assure normal functioning of the equipment under abnormal conditions. *Do not remove any of these protective coatings.*

11. Installation of Cabinets and Components

a. When Radio Receiving Set AN/FRR-12 is used in conjunction with the radio teletype terminal equipment, the cable hole cover plates of the adjoining cabinet sides should be removed before bringing the two cabinets together. There should be at least 30 inches of clearance around the two adjoining cabinets. Bond the two cabinets together electrically with copper braid or any other suitable conductor to obtain a solid grounding connection.

Note.—In bonding the two equipments together, make sure that all paint, grease, dirt, or foreign matter is thoroughly removed from the bonding surfaces. Scrape or file until the metal is exposed.

b. Mount the receivers and their power supplies in the rack locations as shown in figure 12. Attach the unit front panels on the rack, using the screws and washers packed in the small containers included with each receiver and power supply. Connect the grounding braid to the grounding bus-bar which runs along the inside of the cabinet.

c. When a Dual Diversity Converter CV-31/TRA-7 or CV-31A/TRA-7 is used, it may be mounted in the same cabinet; if so, mount the units in the rack as shown in the alternate view of figure 12. It will be necessary first to mount the converter cradle to the rack; then slide the converter unit into the cradle. The converter unit may then be secured to the rack. The inverted rack door box must be reversed and mounted on the door to accommodate the converter connectors and cordage.

d. Ground the cabinet grounding bus-bar to the best available external ground point. Keep the conductor as short and direct as possible.

e. Fasten the feed-through insulators in the top of the rack cabinet when unshielded antenna lead-in lines are to be used.

12. Connections and Interconnections

a. Mount the cables for connection of input and output signals and for interconnection between the units in the bridle rings within the cabinet. The cording diagram (fig. 13) shows the manner in which the cables are mounted and the manner of connecting the cables which feed signals from the rack antenna junction box to the receivers. Figure 14 shows the connection of the cables between each receiver and its power supply. The interconnecting terminal boards of the receivers and power supplies have metal covers which must be removed to connect the cables. Replace covers after connecting cables. When CV-31 ( )/TRA-7 is used, connect the i-f output jacks from each radio receiver to the appropriate converter input connectors by means of R-f Cable Assemblies CG-562/U. Plug the power supply power cable connectors into the most convenient voltage receptacle on the receptacle strip.

b. The receivers of this equipment may be fed from a pair of either balanced or unbalanced antenna arrays. The antennas in the pair should have identical directional characteristics, and should be separated from each other by approximately 3 wavelengths, or 1,000 feet, to achieve diversity effect. Connect the transmission lines from the antennas to the appropriate connectors on the antenna junction box in the cabinet. Shielded transmission line may be connected into the cabinet through either the bottom or the top to suit the convenience of the installation. When unshielded transmission line is used for antenna

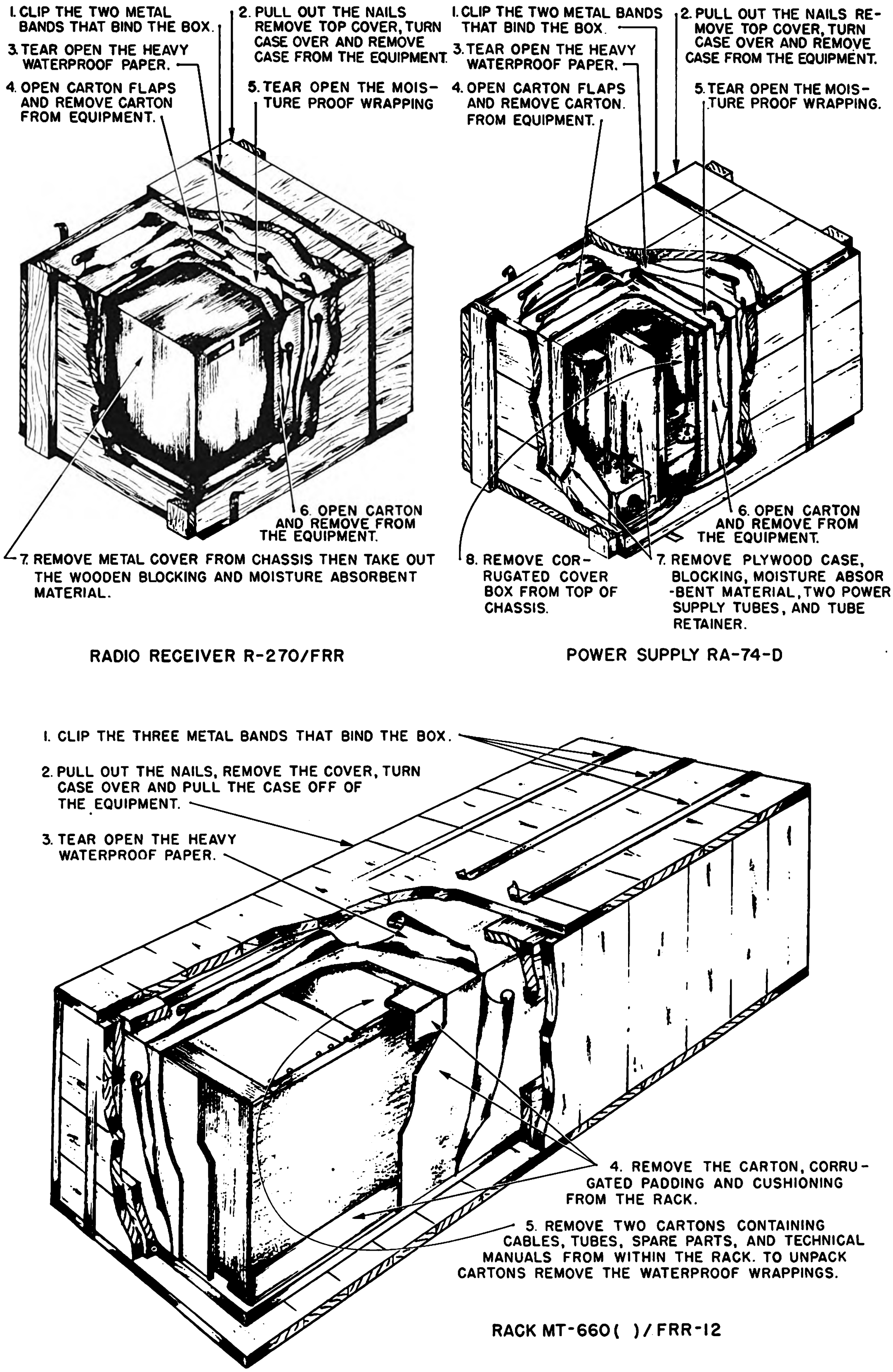
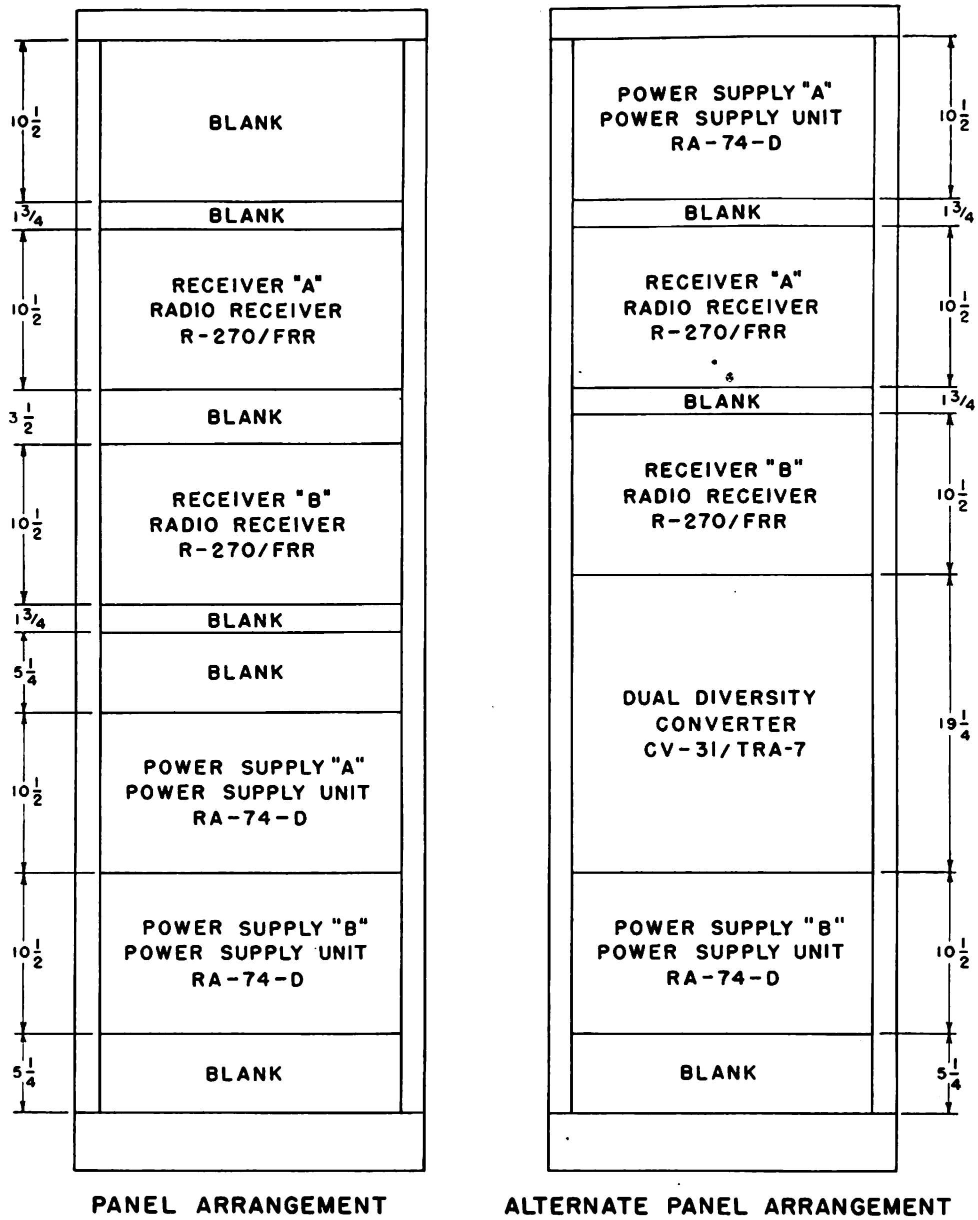


Figure 11. Typical packaging.



NOTE: WHEN CV-31/TRA-7 CONVERTER IS USED IN POSITION SHOWN THE EXTENSION COVER ATTACHED TO THE BACK DOOR MUST BE REVERSED.

Figure 12. Location of major components in rack, and alternate location when Dual Diversity Converter CV–31/TRA–7 is used.

lead-in, it must be connected through the insulators which should be attached to the top of the cabinet.

Caution: Use the same type transmission line inside the shelter to the receiver cabinet that is used between the antennas and the building. If this is not done, a mismatch will occur and considerable signal strength will be lost.

c. Attach the antenna junction box front cover on the junction box with the cam locks which are mounted on the cover. Connect the appropriate (balanced or unbalanced) antenna junction box connectors to the receivers by means of the cables (R-f Cable Assemblies CG–561/U) after they are mounted inside the cabinet, as shown in the cording diagram (fig. 13).

d. Connect the incoming power line to the switchbox in the lower rear part of the cabinet.

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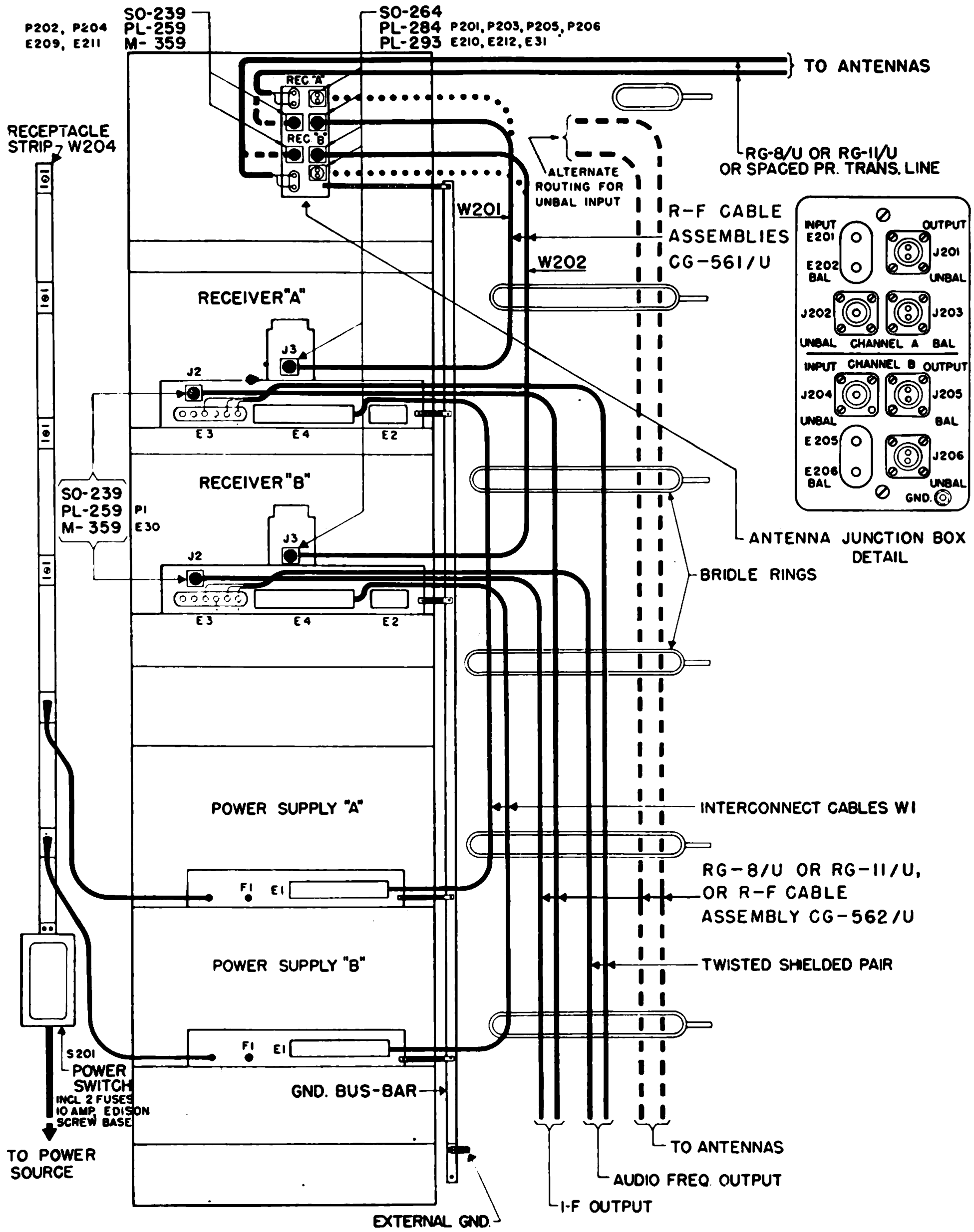
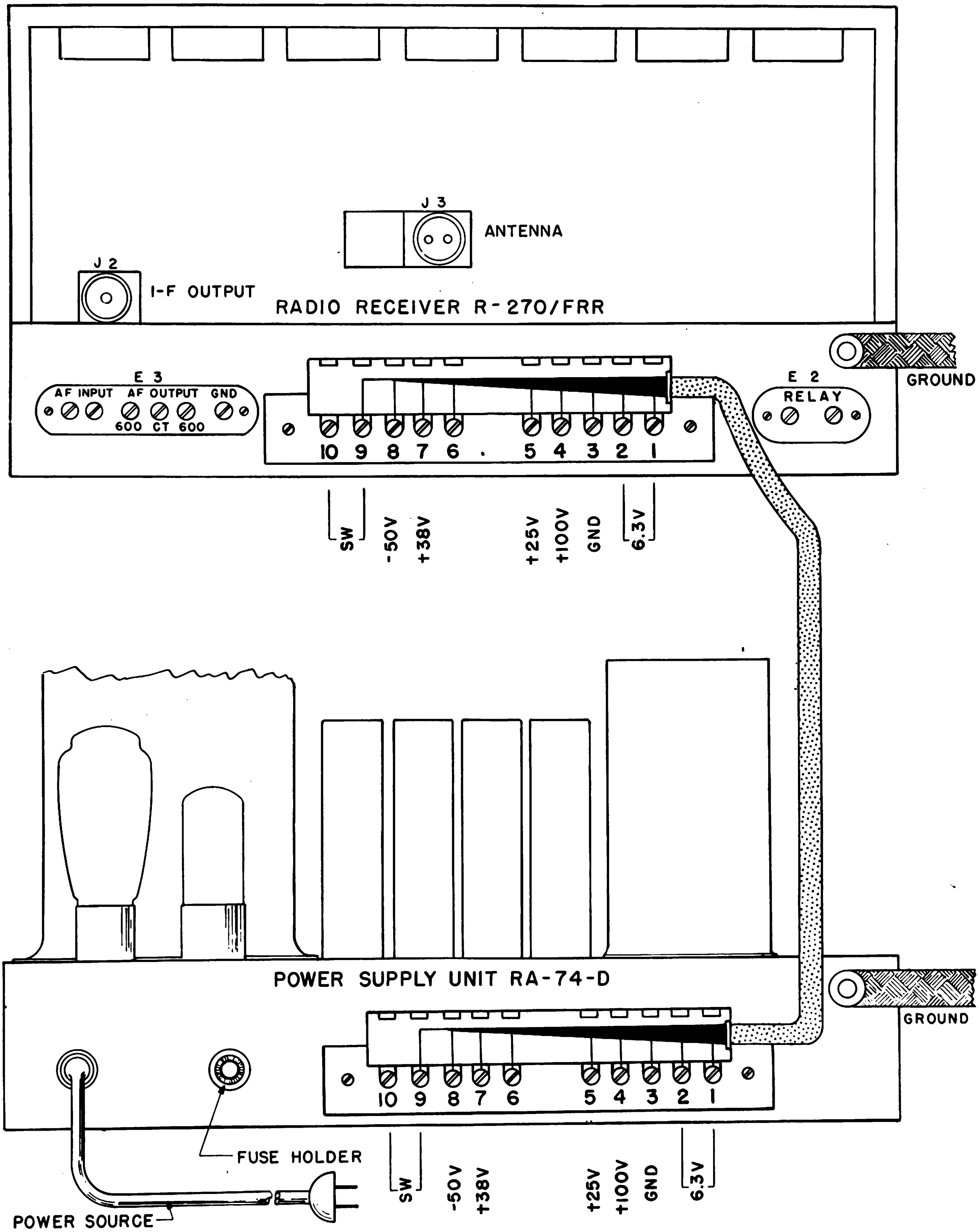


Figure 13. Cording diagram.

e. When a Dual Diversity Converter CV–31/TRA–7 is mounted in the rack, as previously explained, use the two coaxial cables to interconnect the receiver IF OUTPUT to the converter. The two coaxial cables have a connector plug on each end and are supplied with Radio Receiving Set AN/FRR–12. Connect the IF OUTPUT of receiver A and receiver B to the converter input connectors J–101 and J–102, respectively. A two-prong attachment plug cap for the 117-volt line of the dual diversity converter is also supplied with the radio receiving set. Remove the connector from the a-c power line of the converter and replace it with the two-prong a-c plug cap, which will permit the converter unit a-c power line to be connected to the most convenient a-c receptacle on the rack. If CV–31/TRA–7 is used, reverse the door box prior to repacking the rack.

13. Tube Installation and Other Assembly Details

a. Remove the dust cover from each of the receivers by loosening the thumbscrews which hold



AC OPERATION

Figure 14. Connection diagram, interunit connections, a-c operation.

the dust cover to the rear and front panel of the chassis.

b. Remove tubes from the packing cases; make sure that all tubes are in good physical condition. Figure 15 shows the proper location for the tubes in the receivers and power supplies. Tube type numbers and tube symbols are stenciled on the chassis adjacent to the tube socket. Insert tubes in their respective sockets. Place the tube retainer on the posts to hold tube V–1 securely in the power supply.

c. Tube symbols, types, and functions are as follows:

Radio Receiver R–270/FRR

Symbol No.	*Type*	*Function*
V–1	JAN–6K7	1st r-f amplifier.
V–2	JAN–6K7	2d r-f amplifier.
V–3	JAN–6L7	Mixer.
V–4	JAN–6J7	H-f oscillator.
V–5	JAN–6K7	1st i-f amplifier.
V–6	JAN–6SK7	2d i-f amplifier.
V–7	JAN–6SK7	3d i-f amplifier.
V–8	JAN–6H6	Detector.
V–9	JAN–6N7	Noise limiter.
V–10	JAN–6SJ7	B-f oscillator.
V–11	JAN–6SK7	Avc amplifier.
V–12	JAN–6SN7GT	Avc rectifier and i-f output.
V–13	JAN–6J5	1st a-f amplifier.
V–14	JAN–6F6	A-f driver.
V–15	JAN–6F6	A-f output.
V–16	JAN–6F6	A-f output.
V–17	JAN–6AC7	Crystal-controlled h-f oscillator.

Power Supply Unit RA–74–D

V–1	JAN–5U4G	H-v rectifier.
V–2	JAN–5Y3GT	Bias rectifier.

d. After tubes are installed in power supply, replace the dust cover on each receiver and tighten in place with the thumbscrews on the back and front panels.

e. The receivers were adjusted before shipment from the factory and no further adjustment should be necessary before operation.

f. Jack J–2 is provided for output connection of the intermediate frequency; the a-f output is available at terminal board E–3.

14. Power Supply Test

The power supplies were wired at the factory for use with a 117-volt power source. Check the line voltage. When it is any other value than 117 volts, change primary connections of the transformer in accordance with the power supply schematic (fig. 25).

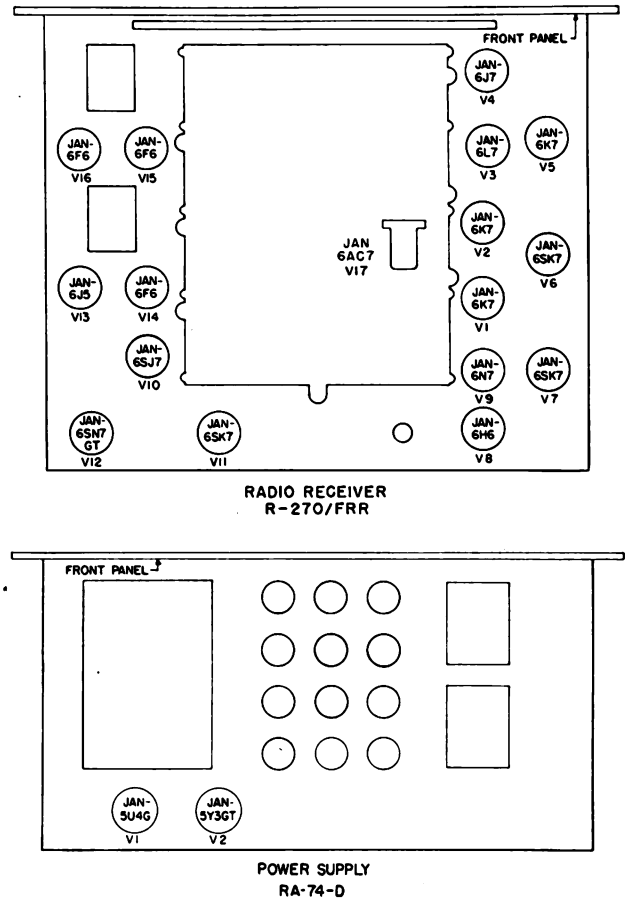


Figure 15. Tube Location chart.

15. Repacking Information

To repack Radio Receiving Set AN/FRR–12, the following procedure is recommended:

a. Disconnect the power line from the rack switch.

b. Disconnect the antenna transmission line and outgoing signal lines.

c. Remove the tubes from the power supplies. Pack the tubes in boxes and shipping cartons.

d. Disconnect the signal and power connections from the power supplies and receivers. Remove the cables from the bridle rings. Remove the antenna junction box cover.

e. Remove the receivers and power supplies from the rack, then pack them in their shipping cases.

f. Fasten the carton of equipment operating tubes within the rack cabinet. Pack the cables and antenna junction box cover in a carton; then secure the carton within the cabinet rack. Place the cabinet in its shipping case.

PART TWO

OPERATING INSTRUCTIONS

Note. For information on destroying the equipment to prevent enemy use, refer to the destruction notice at the front of this manual.

Section III. CONTROLS AND THEIR USE

16. Receiver Controls

a. The operating controls of Radio Receiving Set AN/FRR–12 are located on the front panels of the receiver units. The controls of both receivers are identical (fig. 16). The controls and their functions are as follows:

Control	*Function*
CRYSTAL SELECTIVITY.	Short-circuits crystal Y–1 or varies its selectivity.
PHASING	Sharpens selectivity characteristic.
BAND WIDTH	Changes pass bandwidth of i-f amplifier.
LIMITER OFF-ON	Turns noise limiter on and off.
AVC—MANUAL	Switches avc in and out of circuit.
MAIN TUNING	Tunes r-f (radio-frequency) amplifier, mixer, and h-f oscillator circuits.
OFF-ON	Turns power off and on.
SENSITIVITY	Controls r-f gain to attain balance between two receivers.
BAND SPREAD	Tuning within h-f bands.
SIGNAL MOD-CW	Selects type of received signal (controls bfo).
AUDIO GAIN	Controls audio output volume.
SEND-REC	Turns plate voltage on and off in the r-f stages and mixer stage, placing receiver in stand-by when transmitting.

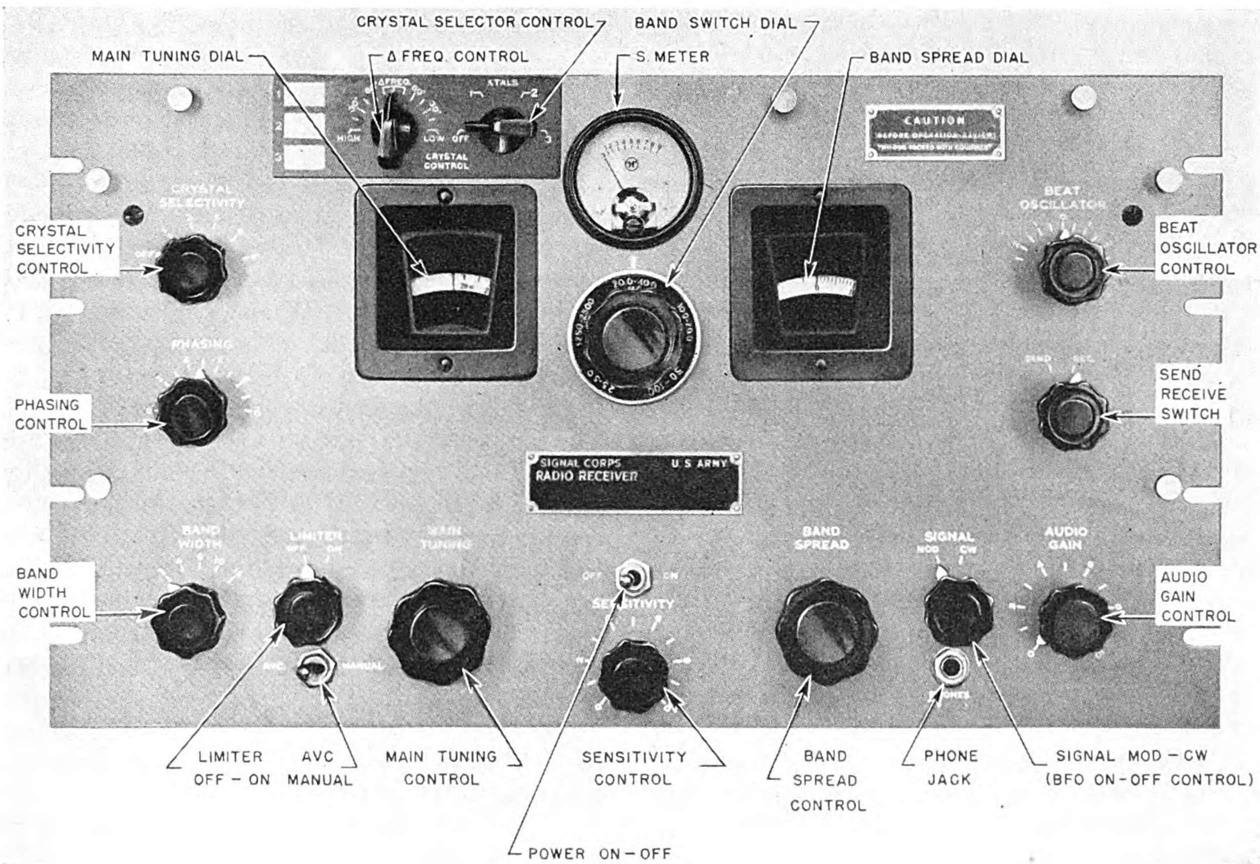


Figure 16. Operating control panel.

16. Receiver Controls—Continued

Control	*Function*
BEAT OSCILLATOR.	Adjusts bfo frequency each side of zero.
△ FREQ HIGH LOW.	Adjusts crystal frequency within narrow limits.
XTALS OFF 1 2 3.	Makes choice of control crystals.

b. Also located on the front panel is the band-switch control for choice of the desired one of five available frequency bands. The frequency dial which is visible through the changeable masked panel opening on the left indicates the tuning of the band selected by the band-switch control. The dial visible through the fixed mask panel opening on the right indicates the BAND SPREAD tuning. The meter dial is the S meter (S means sensitivity) indicator which is used as a tuning guide when the receiver is set for AVC; maximum indication shows resonance of the tuned circuits. A front panel phone jack is provided for listening to the receiver audio output.

Section IV. OPERATION

17. Starting and Tuning Procedure

a. Code Reception. Set the front panel controls (fig. 16) as follows:

Control	*Position*
CRYSTAL SELECTIVITY	OFF.
PHASING	On arrow.
BAND WIDTH	3.
LIMITER	OFF.
AVC-MANUAL	MANUAL.
SENSITIVITY	5.
BAND SPREAD	100.
SIGNAL MOD-CW	CW.
AUDIO GAIN	6.
SEND-REC	REC.
BEAT OSCILLATOR	0.
XTALS OFF 1 2 3	OFF.
ON-OFF power switch	ON.

(1) Adjust the band switch to the band which is likely to be most active. This will make it simpler to get familiar with the various adjustments. If interference is not serious, the BAND WIDTH control can be adjusted to a wider degree of selectivity, depending upon the amount of fidelity desired. In general, adjust this control to the band width giving the best quality with the least interference.

(2) Do all tuning, with or without the meter, with the BAND WIDTH control set at 3. Other settings give wider bandwidths which makes accurate tuning more difficult. Make final bandwidth adjustments after the signal is tuned in properly.

(3) The LIMITER OFF-ON control turns the noise limiter on and off. The noise limiter is most valuable on the higher frequencies where interference is serious from sources like gasoline engine ignition systems.

(4) On strong signals do not turn the SENSITIVITY control on all the way as it will cause circuit overloading. With the AUDIO GAIN control set at about 6, volume can be regulated with only the SENSITIVITY control.

(5) The BEAT OSCILLATOR control varies the pitch of the beat between the oscillator and the incoming signal. When the receivers are to be used for ordinary c-w telegraph reception, remove the bfo crystal, short-circuit the socket terminals, and realign the circuit as set forth in the maintenance section. The bfo then becomes a free running oscillator.

(6) Fading signals can be effectively controlled by returning the AVC-MANUAL switch to AVC.

b. Radiophone Reception. With the receiver in operation for code reception, flip the AVC-MANUAL switch to AVC for control of fading signals.

(1) Turn the SENSITIVITY control to 10 and the AUDIO GAIN control to about 6.

(2) Turn SIGNAL MOD–CW switch to MOD. This turns off the beat oscillator. Weak modulated signals may be located by using the beat oscillator; to accomplish this turn the SIGNAL MOD–CW switch to CW and adjust the BEAT OSCILLATOR control each side of 0.

(3) Adjust the BAND WIDTH control to get the best tone quality with the least interference.

c. Headphone Operation. Plug earphones into the PHONES jack on the front panel. Adjust the CRYSTAL SELECTIVITY control for the desired degree of selectivity, then use the PHASING control to eliminate heterodyne interference (*whistle*).

d. Improving Signal Output. After the receiver has been put in operation, make tuning adjustments to improve the receiver signal output.

(1) *Main tuning dial*. All tuning can be done with the MAIN TUNING control. In this case, leave the BAND SPREAD dial set at 100. The BAND SPREAD control spreads out a narrow band of frequencies below the frequency to which the main dial is set. In this manner, h-f signals

can be spread out over the band spread dial for easy tuning. The BAND SPREAD control operates continuously throughout the entire tuning range of the receiver, and signals can be spread out in any one of the five bands.

(2) *S meter tuning.* The front panel meter, commonly called the S meter, is used as a tuning guide and operates only when the receiver AVC-MANUAL control is set for AVC. It indicates an increased reading as the receiver approaches resonance with the incoming signal. Exact resonance is shown by the highest indication of the meter. The BAND WIDTH control must be set at 3 for accurate tuning by means of the S meter. A screw driver adjustment, R–41, located at the rear of the chassis near the second detector diode (fig. 6), will vary the resistance in shunt with the S meter. By means of this adjustment, an S indication of 9 may be obtained on any input amplitude between approximately 10 and 10,000 microvolts. The normal factory adjustment is made on an input of 50 microvolts, and when so adjusted, each S number represents a change in signal input of approximately 6 db.

(3) *Crystal filter.* The first three positions of the CRYSTAL SELECTIVITY control are generally used for radiophone reception and will serve for code reception when interference is not serious. The last two positions are for code reception only. After the CRYSTAL SELECTIVITY control is adjusted for the desired degree of selectivity, use the PHASING control to eliminate heterodyne interference (whistle).

e. CRYSTAL-CONTROLLED H-F OSCILLATOR. This oscillator is used for fixed frequency reception. With the XTALS selector switch set in the OFF position, the receiver h-f oscillator operates in a normal manner without being adjustable. When the crystals are inserted in their sockets and tightened in place, their frequency channel should be noted on the CRYSTAL CONTROL escutcheon plate. Set the Δ FREQ HIGH LOW control to the midpoint (vertical) position. Rotate the XTALS selector switch from the OFF position to the desired crystal position. Rotate the MAIN TUNING dial to the signal frequency to be crystal controlled. Rock the dial above and below the signal frequency to obtain maximum output. After the receiver warms up, oscillator drift at the receiver, and, to a considerable extent, transmitter drift, may be compensated for by adjusting Δ FREQ control toward the HIGH or LOW position, as required.

18. Stand-by and Stopping Procedures

a. STAND-BY. The receiver can be silenced by turning the SEND-REC. switch to SEND. This allows the receiver to remain ready for instant service in a stand-by condition during periods of transmission.

b. STOPPING. Throw the power OFF-ON switch to OFF. This will disconnect the line voltage from the power supply and remove all voltages from the receiver.

19. Adjustment Procedure for Frequency Shift Teletype Reception

The preceding paragraphs are given to acquaint the operator with the operation of the various controls of each receiver of the equipment for general reception. The following discussion is limited to reception of frequency shift teletype signals. While avc operation is possible, it is not desirable. It is most important that the control settings of both receivers are identical during radio teletype reception. This precaution will insure proper diversity action.

a. GENERAL. Regardless of the method used for frequency shift teletype reception, the general method of receiver tuning is the same as discussed in this subparagraph. Operation with Dual Diversity Converter Terminal Equipment AN/-FGC-( ). CV-31( )/TRA-7 is set forth in *b* below; and *c* below discusses operation with Radio Teletype.

(1) *Front panel control settings:*

Control	*Position*
CRYSTAL SELECTIVITY	OFF.
PHASING	On arrow.
BAND WIDTH	3.
LIMITER	OFF or ON.
AVC-MANUAL	AVC.
SENSITIVITY	10.
BAND SPREAD	100.
SIGNAL MOD-CW	CW.
AUDIO GAIN	6.
SEND-REC	REC.
BEAT OSCILLATOR	0.
Δ FREQ	0.
XTALS	1, 2, or 3.
ON-OFF	ON.

(2) *Tuning.* Select the proper crystal for the desired frequency to be received on the XTALS control. Set the band switch to the particular band to be received. Adjust the MAIN TUNING control dial to the frequency to be received and adjust for the maximum signal as indicated on the S meter.

b. Used with Dual Diversity Converter CV–31( )/TRA–7. When one of these converters is used as auxiliary equipment, make adjustments to the AN/FRR–12 receivers in conjunction with applicable adjustment instructions of the CV–31( )/TRA–7 as contained in TM 11–278.

(1) Make adjustments on each receiver separately and check each receiver output as indicated on the CV–31( )/TRA–7 instruments.

(2) Turn SIGNAL MOD–CW switch to MOD.

(3) Set AVC-MANUAL switch to MANUAL.

(4) Adjust SENSITIVITY control as required to maintain proper operation.

(5) Adjust Δ FREQ knob so that the receiver is tuned to the center frequency as indicated on the front panel instruments of the CV–31( )/TRA–7.

Note. The i-f circuits of the AN/FRR–12 receivers are adjusted to 465 kc. The h-f oscillator operates 465 kc above the incoming signal frequency for all bands except the 20–40 mc band. On the 20–40 mc band the h-f oscillator is 465 kc below the incoming signal frequency. Under these conditions, the foregoing adjustments should be made in conjunction with adjustments described in TM 11–278, particularly paragraph 22, for proper settings of Dual Diversity Converter CV–31( )/TRA–7.

c. Used with Radio Teletype Terminal Equipment AN/FGC–( ). When one of these terminal equipments is used as auxiliary equipment, make adjustments to the AN/FRR–12 receivers in conjunction with applicable adjustment instructions of the AN/FGC–( ) as contained in TM 11–356.

Note. Afc (automatic frequency control) connections as used with the AN/FRR–3 and the AN/FRR–3A in conjunction with the AN/FGC–( ) are not used with the AN/FRR–12.

(1) AVC–MANUAL remains on AVC

(2) SIGNAL MOD–CW remains on CW.

(3) Obtain a steady marking signal from a transmitter, then adjust the BEAT OSCILLATOR control to make marking frequency 2125 cps as indicated by the zero indication of the frequency indicator meter on the AN/FGC–( ).

(4) Set AVC–MANUAL switch to MANUAL.

(5) Adjust SENSITIVITY control as required to maintain proper operation.

(6) Adjust the AUDIO GAIN control to give proper input level to the AN/FGC–( ) terminal equipment as determined by the instructions in paragraph 9*k*, TM 11–356.

Note. When the crystal used in the h-f oscillator is of the proper frequency, the actual intermediate frequency is 465 kc; in this case the BEAT OSCILLATOR control will have a wide enough range to control the a-f output. Under certain conditions it may be necessary to adjust the Δ FREQ control to bring the BEAT OSCILLATOR control in range.

d. Crystal Operation. (1) Crystal control is provided for any three channels in the frequency range of 1.5 to 26 mc. Crystal units, using Crystal Holder HC–1/U, are confined to the frequency range of 1.965 to 8.5116 mc. Because the receiver i. f. of 465 kc and harmonic operation of the crystal must be taken into account, the crystal frequency will differ from the carrier frequency to be controlled. For example, if a 1,500-kc carrier were to be crystal-controlled, the receiver i. f. of 465 kc would be added to the carrier frequency and the crystal frequency would be 1,500 kc plus 465 kc, or 1,965 kc.

(2) In the frequency range of 1.5 to 20 mc, the h-f oscillator of the receiver is higher than the carrier frequency by 465 kc. In the frequency range of 20 to 40 mc, the h-f oscillator is lower than the carrier frequency by 465 kc. The crystal harmonics for a particular carrier frequency range, in order to confine the selection of crystals to the range of 1,965 to 8,511.6 kc, are:

Crystal harmonic	Carrier frequency (kc)
Fundamental (1)	1,500.0 to 8,046.7
Second (2)	8,046.7 to 6,558.4.
Third (3)	16,558.4 to 26,000

(3) In the range of 1.5 to 20.0 mc, the crystal frequency may be determined as follows:

Crystal frequency equals

$$\frac{\text{Carrier frequency (kc) plus 465 kc}}{\text{Harmonic}}$$

Expressed as a formula—

$$Fx = \frac{Fc + 465 \text{ kc}}{H}$$

when H = harmonic (1, 2, or 3),

Fx = crystal frequency from 1,965 to 8,511.6 kc,

Fc = carrier frequency in kc.

Example 1: It is desired to crystal control a carrier of 7,500 kc The chart above shows fundamental operation; therefore:

Fx (crystal frequency) equals

$$\frac{\text{7,500 kc plus 465 kc}}{1} \text{ or 7,965 kc.}$$

Example 2: It is desired to crystal control a carrier of 12.5 mc. The chart above shows second harmonic operation; therefore:

Fx (crystal frequency) equals

$$\frac{12{,}500 \text{ kc plus } 465 \text{ kc}}{2} \text{ or } 6{,}482.5 \text{ kc.}$$

Example 3: It is desired to crystal control a carrier of 18.3 mc. The chart above shows third harmonic operation; therefore:

Fx (crystal frequency) equals

$$\frac{18{,}300 \text{ kc plus } 465 \text{ kc}}{3} \text{ or } 6{,}255.0 \text{ kc.}$$

(4) In the range of 20.0 to 26.0 mc, third harmonic operation is indicated. However, the fact that the carrier frequency is higher by 465 kc than the h-f oscillator must be taken into account; therefore—

$$Fx \text{ equals } \frac{Fc \text{ minus } 465 \text{ kc}}{3}$$

Example: It is desired to crystal control a carrier of 22.5 mc.

Fx (crystal frequency) equals

$$\frac{22{,}500 \text{ kc minus } 465 \text{ kc}}{3} \text{ or } 7{,}345.0 \text{ kc.}$$

e. Radio Teletype Frequency Conversion System. See figure 17.

(1) If, for example, the assigned carrier frequency were 12,000 kc, the transmitter would be adjusted to provide the following mark and space frequencies:

(*a*) Mark equals 12,000 plus 0.425 equals 12,000.425 kc.

(*b*) Space equals 12,000 minus 0.425 equals 11,999.575 kc.

(2) Since the harmonic of the h-f oscillator is 465 kc greater than the carrier frequency, the marking and spacing frequencies in the i-f stages will be inverted so that the marking frequency is the lower of the two. The i-f and audio output frequencies obtained therefore are—

(*a*) IFF (465 kc):

Mark equals 465 minus 0.425 equals 464.575 kc.

Space equals 465 plus 0.425 equals 465.425 kc.

(*b*) Audio output:

Mark equals 464.575 minus 462.450 equals 2.125 kc.

Space equals 465.425 minus 462.450 equals 2.975 kc.

(3) In frequency range of 20 to 40 mc, the h-f oscillator is 465 kc lower than the carrier frequency. Therefore the i-f and a-f marking-spacing relations are reversed.

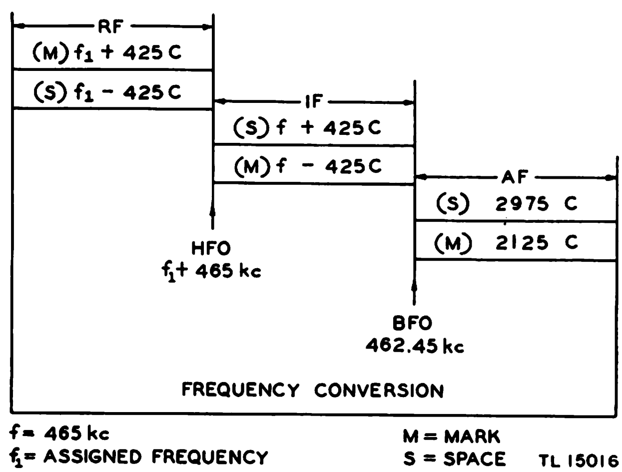


Figure 17. Frequency conversion.

Section V. EQUIPMENT PERFORMANCE CHECK LIST

20. Purpose and Use

a. General. The equipment performance check list (par. 21) will help the operator determine whether the equipment is functioning properly. The check 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. Check items 1 and 2 when starting, items 3 and 4 during operation, and item 5 when stopping (when turning the equipment off). Items 3 and 4 of this list should be checked at least once during a normal operating period, or at least four times a day during continuous operation.

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

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator will perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. CORRECTIVE MEASURES. The correct ve measures listed are those the operator can make without turning the equipment over to technicians for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting 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 it possible to do so.

e. ITEMS 1 AND 2. Items 1 and 2 should be checked each time the equipment is put into operation.

f. ITEMS 3 AND 4. The operator should be familiar with the operation of Radio Receiving Set AN/FRR-12 in order to know the characteristics of its reception of normal signals. By becoming familiar with the operation of the receiver, the operator will know the normal position of the AUDIO GAIN and SENSITIVITY controls. This will aid in an approximate determination of the sensitivity and amplification of the receiver.

g. ITEM 5. Item 5 is checked whenever the operation of the equipment is discontinued. Any abnormal indications at this time are probably caused by trouble in the set and should be corrected before the next expected period of operation.

21. Equipment Performance Check List

	Item No.	Item	Action or condition	Normal indication	Corrective measures
START	1	Power ON-OFF switch	Place in ON position	Dial pilot lamps will light	Check power connections and line fuse on power supply.
	2	Band change switch	Set to desired band	Proper section of dial is selected.	
EQUIP.	3	PHONES jack on receiver unit.	Plug in headphones	Either noise or signal should be heard.	Rotate AUDIO GAIN control to right; check to see that both receivers are on the same band.
PERF.	4	SIGNAL MOD-CW	Place in either MOD or CW position.	Incoming signal should be audible in the headset.	Check bfo circuit for oscillation.
STOP	5	Power OFF-ON switch	Place in the OFF position.	Dial pilot lamps go out	

PART THREE
MAINTENANCE INSTRUCTIONS

Section VI. PREVENTIVE MAINTENANCE TECHNIQUES

22. Meaning and Importance of Preventive Maintenance

a. MEANING. Preventive maintenance (PM) means making systematic checks and adjustments at regular intervals to keep equipment operating at top efficiency. There is a difference between preventive maintenance and trouble shooting and repair. The purpose of PM is to *prevent* break-downs, and, therefore, the need of repair. On the other hand, the purpose of trouble shooting and repair is to locate and *correct existing defects*.

b. IMPORTANCE. The importance of PM cannot be overemphasized. A system of radio communication depends upon the performance of every set. It must be *ready* to go on the air when it is needed, and it *must* operate efficiently. It is vitally important, therefore, that radio operators and repairmen maintain their sets properly.

Note. The operations in sections VI and VII are organizational maintenance. Some operations in sections XI are higher echelon maintenance.

23. Description of Techniques

Most of the electrical parts used in Radio Receiving Set AN/FRR–12 require routine PM of one kind or another. Hit or miss methods cannot be used. The following paragraphs will outline the various steps which should be followed in the inspection and PM of this equipment.

24. How to Perform Preventive Maintenance

a. FEEL. The Feel operation is used most often to check tuning controls, switches, transformers, etc. Also it is used to determine whether electrical connections and bushings are overheated. Feeling will show the existence of defects requiring correction. The maintenance man must become familiar with the normal operating temperature of coils, transformers, and other parts, to recognize signs of overheating. .

Note. Perform the Feel operation as soon as possible after shut-down and always before any other maintenance is performed.

b. INSPECT. Inspection is the most important operation in PM. A careless observer will overlook evidences of minor trouble. Although these defects may not at the time interfere with the performance of the equipment, time and effort can be saved if they are corrected before they lead to major break-downs. Make every effort to recognize the signs of a defective set; make every effort to become familiar with the normal functioning of the set. Inspect for the following conditions:

(1) Overheating, as indicated by discoloring, blistering, or bulging of the part or the surface of the container; leakage of insulating compounds; and oxidation of metal contact surfaces.

(2) Improper placement, by seeing that all leads and cabling are in their original positions.

(3) Lack of cleanliness, by carefully examining all recesses in the units where dust might accumulate, especially between connecting terminals and binding posts. Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high-humidity areas, inspect for fungus growth and mildew.

(4) Looseness, by testing any tube, connection, or mounting which appears too loose.

Caution: Do not tighten screws, bolts, or nuts carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken. Whenever a loose connection is tightened, it should be moistureproofed and fungiproofed again by applying the varnish with a small brush.

25. Vacuum Tubes

Caution: Do not work on tubes immediately after shut-down. Severe burns may result from contact with the envelopes of the hot tubes.

a. INSPECT. (1) Inspect glass and metal tube envelopes, tube caps, and tube connector clips for accumulation of dirt and for corrosion. Replace tubes with loose grid caps or envelopes if possible.

(2) Examine the spring clips that make contact with the grid caps for corrosion and for loss

of tension with resulting looseness. Check the condition of wires soldered to the spring clips. The wires should be free of frayed insulation or broken strands.

(3) Press tubes down in their sockets to test their firmness. Do not attempt to test tubes by partially withdrawing them from the sockets and jiggling them from side to side. Movement of a tube tends to weaken the pins in the base and unnecessarily spread the contacts in the sockets. Inspect the tube sockets when the tubes are removed.

(4) Be careful when removing a tube from its socket. *Never* jar a warm tube. Always remove connections to the grid caps.

b. Tighten. Tighten all loose connections to the tube sockets or to the tubes. If the connections are dirty or corroded, clean them before tightening. When tightening locknuts that hold the sockets to the insulated bushings, do not apply excessive pressure. Too much pressure will crack the bushings.

c. Clean. (1) Clean the tubes if necessary. Tubes operated with exposed grid connections must be kept free of dirt and dust to eliminate the possibility of leakage between terminals. In contrast tubes not having exposed grid caps do not require frequent cleaning. However, do not allow dirt to accumulate on tubes.

(2) Remove dirt and dust from the glass or metal envelopes with a clean, lint-free, dry cloth. If proper care is used, the grid caps may be cleaned with a piece of No. 0000 sandpaper by wrapping the paper around the cap and *gently* rubbing the surface. Excessive pressure is not needed. It is not necessary to grip the cap tightly. Wipe the cap with a clean dry cloth.

(3) When the tube sockets are cleaned and the contacts are accessible, fine sandpaper may be used to remove corrosion, oxidation, and dirt. Never use steel wool.

d. Adjust. Adjust loose tube connector clips. Do not flatten tube connector clips during adjustment, as flattened clips do not make adequate contact with the surface of the tube cap. If the clip is made of thin metal, it can be adjusted by compressing it gently with the fingers. If it is made of heavy-gage metal, suitable pressure can be applied with a pair of long-nose pliers.

26. Capacitors

a. Inspect. (1) Inspect the terminals of large fixed capacitors for corrosion and loose connections. Carefully inspect the mounting to discover loose mounting screws, studs, or brackets. Examine the leads for poor insulation, cracks, and evidences of dry rot. Cut away frayed strands on the insulation. If the wire is exposed, wrap it with friction tape. See that the terminals of the capacitors are not cracked or broken.

(2) Thoroughly inspect the case of each large fixed capacitor for leaks, bulges, and discoloration.

(3) Inspect the plates of variable capacitors for dust, dirt, or lint. Examine the movable set of plates for signs of damage or misalinement which would cause them to touch the fixed plates during tuning.

b. Tighten. Tighten loose terminals, mountings, and connections on the capacitors when necessary. Do not break the bushing or damage the gasket.

c. Clean. (1) Clean the cases of fixed capacitors, the insulated bushings, and all connections that are dirty or corroded. The capacitor cases and bushings can usually be cleaned with a dry cloth. However, if the deposit of dirt is hard to remove, moisten the cloth in Solvent, dry cleaning (SD).

(2) Clean the plates of variable capacitors with a small brush or pipe cleaner, removing all dust and lint. Dust, if present, may cause arcing.

27. Resistors

a. General. Various types of resistors are used in Radio Receiving Set AN/FRR-12. The connections to the various resistors are either of the pig-tail or solder-lug type.

b. Inspect. Inspect the coating of the vitreous-enameled resistors for signs of cracks and chipping, especially at the ends. Examine the bodies of all types of resistors for blistering, discoloration, and other indications of overheating. Inspect leads and all other connections for corrosion, dirt, dust, looseness, and broken strands in the connecting wires. Check the security of all mountings. Do not attempt to move resistors with pig-tail connections, because there is danger of breaking the connections at the point where they enter the body of the resistor. Such defects cannot be repaired.

c. Tighten. Tighten resistor connections and mountings wherever they are found loose. If a resistor is allowed to remain loose, vibration may break the connection or damage the body.

d. Clean. (1) Clean all carbon resistors with a small brush.

(2) The vitreous-enameled resistors must be kept clean to avoid leakage between the terminals. Wipe them with a dry cloth. However, if the dirt deposit is unusually hard to remove, use a solvent (SD).

(3) Resistors with discolored bodies cannot be cleaned. Discoloration indicates that there has been overloading and overheating at some time prior to the inspection. The discoloration is probably due to circuit trouble which requires analysis and correction.

28. Fuses

a. General. Fuses used in Radio Receiving Set AN/FRR-12 are common line fuses. They are easily removed for inspection. See that the fuses are kept clean and tight. If they are not, arcing and burning will occur, necessitating replacements. Throw fuses away when they blow.

b. Inspect. Inspect the fuse terminals for evidences of burning, charring, and corrosion.

c. Clean. Clean fuse ends with emery cloth, then wipe them with a clean cloth.

29. Bushings and Insulators

a. Description. Insulated bushings are constructed of ceramic material with a glazed surface. Because an insulator is no better than its surface, deposits of foreign substances on the surface reduce the insulating value of the bushing. Therefore, it is extremely important that all bushings be inspected frequently.

b. Inspect. (1) Inspect the physical condition of the insulated bushings. They should be clean without cracks or chips. A highly glazed insulator may develop fine-line surface cracks where moisture and dust will accumulate and eventually form a leakage for a high-voltage flash-over.

(2) As a rule, the bushings are held in position with nuts screwed onto the threaded conductors. These can be replaced very easily. If replacement is not possible because of a shortage of supplies, clean the defective bushing frequently and thoroughly with solvent (SD). Sometimes it is difficult to see dust on glazed surfaces. A satisfactory check can be made by sliding a clean finger across the bushing.

c. Tighten. When tightening loose bushings one precaution must be observed: *Avoid forcing the nuts or screws down too tight.* If excessive pressure is exerted on the bushings, damage or breakage is almost certain. If the threads on bushing stud bolts are stripped so that they cannot be tightened, replace the entire bushing.

d. Clean. Insulated bushings are easily cleaned Never use abrasive materials because the glazed surface will be destroyed, thus permitting moisture to be absorbed. A clean cloth is usually satisfactory. If deposits of grime or dirt on the surface of a bushing are hard to remove, use solvent (SD). After the surface has been cleaned with solvent, carefully polish it with a dry cloth. Otherwise, a thin film of the solvent will be left which may impair the effectiveness of the bushing as a high-voltage insulator.

30. Switches

a. Inspect. (1) Inspect the mechanical action of each switch, and while so doing, look for signs of dirt or corrosion on all exposed elements. In some cases, it will be necessary to examine the elements of the switch visually; in others, the action of the switch is checked by flipping the control knob or toggle, or pressing the switch button and noting the freedom of movement and amount of spring tension.

(2) Visually inspect ganged switches S-7, S-8, and S-1 to see that contacts are clean. Do not pry the leaves of the switch apart. The movable members should make good contact with the stationary members: and as the former slides into the latter, a spreading of the stationary contact leaves should be visible. Switch action should be free. Wiping action of contacts usually removes any dirt at the point of contact.

b. Clean. Clean the exterior surfaces of switches with a stiff brush, moistened with solvent (SD).

31. Coils

a. Inspect. Inspect the antenna, r-f amplifier, and oscillator coils for cleanliness of the coil form and secureness of mounting supports. Check all connections for proper contact.

b. Tighten. Tighten any loose coil mounting or connections by resoldering wires and tightening screws.

c. Clean. Clean the coil form and coil with a soft brush. Remember the coil form is actually an insulator. Therefore, the same PM will apply to the coil as to the insulators and the bushings.

32. Potentiometers

a. INSPECT. (1) Inspect the mechanical condition of the potentiometers. Shafts should turn easily in the bushing which supports them.

(2) Inspect the mounting screws, setscrews, and nuts.

(3) Examine all metallic parts for dust, dirt, and corrosion.

b. TIGHTEN. Tighten all loose assembly and mounting screws.

c. CLEAN. (1) Clean the exposed contact surfaces of the potentiometer whenever they are dirty or corroded.

(2) Remove grease and dirt from the potentiometer parts with carbon tetrachloride.

(3) If the contact surfaces are corroded, clean them with crocus cloth.

(4) To clean the contact surface of the arm, insert a strip of crocus cloth between the arm and the potentiometer winding, then pull the cloth back and forth.

(5) Clean the body of the potentiometer with a brush or cloth.

33. Terminal Blocks

a. INSPECT. (1) Inspect terminal blocks for cracks, breakages, dirt, loose connections, and loose mounting screws.

(2) Carefully examine connections for mechanical defects, dirt, and corrosion.

b. TIGHTEN. Tighten loose screws, lugs, mounting bolts, and all loose connections. Be sure to select a screwdriver of the correct size, when tightening screws. Do not exert too much pressure.

c. CLEAN. (1) Clean terminal blocks with a dry brush, if they require it. When necessary, use a cloth moistened with dry-cleaning solvent (SD). Wipe the block thoroughly with a cloth and then brush it to remove any lint.

34. Cords and Cables

The cables in Radio Receiving Set AN/FRR-12 are the life lines of the equipment. Carefully check the condition of the cabling.

a. INSPECT. Inspect the cables for cracked or deteriorated insulation, frayed or cut insulation at the connecting and supporting points, and improper placement which puts a strain on the cables or connections. Watch for kinks and improper supports.

b. TIGHTEN. Tighten loose cable clamps, coupling rings, and cable connections.

c. CLEAN. Clean connections on cables when they are dirty or corroded. Clean corroded connections with No. 0000 sandpaper. Clean the entire surface of the connector, but do not attempt to remove individual prongs from cable plugs.

35. Pilot Lamps

Pilot lamps indicate when power has been applied to a circuit. They are easily removed, inspected, and replaced.

a. Inspect the pilot lamp assemblies for loose lamps, loose mounting screws, and loose, dirty, or corroded connections.

b. Tighten loose mounting screws and resolder any loose connections. If the connections are dirty or corroded, clean them before resoldering.

c. Screw loose lamps tightly into their sockets.

36. Jacks and Plugs

Jacks require very little attention. It will be necessary occasionally to tighten the mounting nut, clean the contacts, or increase the spring tension. Remove dirt with a brush and carbon tetrachloride. Remove corrosion with a piece of crocus cloth followed by a clean cloth. Increase spring tension when necessary. Try the action of the jack after each adjustment. Be sure to keep all soldered connections intact. To clean dirty or corroded telephone type plugs, use Polish, metal, paste (Signal Corps stock No. 6G1516). After cleaning, remove all traces of polish remaining with carbon tetrachloride. Finish with a clean dry cloth.

37. Cabinets, Chassis, and Mountings

The cabinet which houses the various components of Radio Receiving Set AN/FRR-12 is constructed of sheet steel, coated with black crinkle paint.

a. INSPECT. Inspect the outside and inside of the cabinet thoroughly. Pay strict attention to every detail. Check the ventilator mountings and the panel screws. Examine the pilot lamp covers for cracks and breaks. Inspect the panels for loose knobs, switches, and jacks.

b. TIGHTEN. Tighten all loose mounting bolts, panel screws, plugs, and control knobs.

38. Coupling Shafts and Control Knobs

The control of various capacitors, switches, and potentiometers found throughout the set is effected through coupling shafts that connect these items to control knobs on the front panels. It is important that these shafts and control knobs be kept tight at all times. Use a screw driver or Allen wrench to tighten these items when they are loose.

39. Gears

a. INSPECT. Inspect the teeth of the gears behind the front panel for dirt or corrosion.

b. CLEAN. If the gears are dirty, clean them with a pipe cleaner or a small brush dipped in solvent (SD).

40. Power Transformers, Filter Chokes, and Audio Transformers

a. As soon as possible after shut-down, feel filter chokes L–1 and L–2 for abnormal heating which may indicate an overloaded condition or imminent failure due to moisture absorption or other causes. Likewise, feel audio transformers T–7 and T–8 for abnormal heating. Power transformer T–1 normally operates at a warm temperature. Feel for abnormal heating. Be careful to avoid burns.

b. Inspect power transformer T–1, filter chokes L–1 and L–2, and audio transformers T–7 and T–8 for signs of blistering, bulging, or leakage of tar or insulating compounds. Inspect for external signs of electrolytic action or corrosion.

c. Tighten all mounting bolts or screws, but not to the point that threads are destroyed. The securing of such heavy parts as transformers and chokes to the chassis is very important in PM.

d. Clean power transformers, filter chokes, and audio transformers with a dry cloth. Be sure that no dirt, lint, threads, or foreign material is present between terminals. Dirt, lint, and thread absorb moisture which may provide a leakage path for high voltages between these terminals.

Section VII. ITEMIZED PREVENTIVE MAINTENANCE

41. Introduction

For ease and efficiency of performance, PM of Radio Receiving Set AN/FRR–12 will be broken down into operations that can be performed at the specified time intervals. In this section the PM work to be performed on the equipment at the specified time intervals is broken down into units of work called items. The general techniques involved and the application of these in performing PM on individual parts are discussed in section VI, and are not repeated in this section. When performing PM refer to section VI if more information is required for the following items. Perform all work with the power removed from the equipment. After PM has been performed on a given day, put the equipment into operation and check it for satisfactory performance (pars. 20 and 21).

42. Preventive Maintenance Tools and Materials

The following PM tools and materials are needed:

- Common hand tools.
- Clean cloth.
- No. 0000 sandpaper.
- Crocus cloth.
- Fine file.
- Dry-cleaning solvent (SD).
- Paste metal polish (Signal Corps stock No. 6G1516).

Note. Gasoline will not be used as a cleaning fluid for any purpose.

43. Item 1, Exterior of Radio Receiving Set AN/FRR–12 (fig. 1)

Operations.	
ITC	Cabinet parts.
ITC	Control knobs.

Remarks. Use an Allen wrench and a screw driver to tighten all control knobs found loose. Two Allen wrenches are provided attached to components inside of the shield on the top of the receivers.

44. Item 2, Receiver A and Receiver B

Operations.	
ITCA	Tubes and sockets.
ITC	Capacitors.
ITC	Resistors.
ITC	Potentiometers.
ITC	Bushings and insulators.
ITC	Switches.
I	Cables.
IT	Couplings.

44. Item 2, Receiver A and Receiver B—Con.

Operations.

ITC	Coils.
IC	Gears.
ITC	Terminal blocks.
FITC	Audio transformers.

45. Item 3, Power Supply Units

Operations.

ITCA	Tubes and sockets.
ITC	Resistors.
ITC	Capacitors.
FITC	Transformers and chokes.
ITC	Terminals.

46. Preventive Maintenance Check List

The following check list is a summary of the PM operations to be performed on Radio Receiving Set AN/FRR-12. The time intervals shown on the check list may be reduced at any time by the local commander. For best performance of the equipment, perform operations at least as frequently as called for in the check list. The echelon column indicates which operations are organizational maintenance. Operations are indicated by the letters of the word FITCAL. For example, if the letters ITCA appear in the operations column, the item of that line must be inspected (I), tightened (T), cleaned (C), and adjusted (A).

Item No.	Operations	Item	When performed		
			Daily	Semi-annually	Maintenance performed by
1	ITC	Exterior of Radio Receiving Set.	X		O
2	FITCA	Receiver A and Receiver B.		X	O
3	FITCA	Power Supply Units		X	O

F Feel — I Inspect — T Tighten — C Clean — A Adjust — L Lubricate*

*The Lubricate operation does not apply to Radio Receiving Set AN/FRR-12.

Note. X indicates when operations are to be performed; O indicates operator.

Section VIII. LUBRICATION

47. Lubrication

No periodic lubrication is required for Radio Receiving Set AN/FRR-12.

Section IX. WEATHERPROOFING

48. General

Signal Corps equipment, when operated under the severe climatic conditions which prevail in the tropical, arctic, or desert regions, requires special treatment and maintenance.

49. Tropicalization

Because fungus growth, insects, corrosion, salt spray, and excessive moisture affect most materials harmfully, the following problems may be encountered:

a. Resistors, capacitors, coils, chokes, transformer windings, etc., fail because of the effects of fungus growth and excessive moisture.

b. Electrolytic action, often visible in the form of corrosion, takes place in resistors, coils, chokes, transformer windings, etc., causing eventual breakdown.

c. Hook-up wire insulation and cable insulation break down. Fungus growth accelerates deterioration.

d. Moisture forms electrical paths on terminal boards and insulating strips, causing flash-overs and crosstalk.

50. Moistureproofing and Fungiproofing Treatment

Radio Receiving Set AN/FRR-12 is protected against deterioration under tropical climatic conditions by a moistureproofing and fungiproofing varnish treatment applied at the time of manufacture. Technical bulletin TB SIG 13 and changes thereto provide adequate instructions for re-treatment of the equipment by field or base maintenance personnel.

51. Moistureproofing and Fungiproofing after Repairs

During repair, if the coating of protective varnish has been broken or punctured and if a complete treatment is not needed to reseal the equipment, apply a brush coat to the affected part. Be sure the break is completely sealed.

52. Winterization

Special precautions are necessary to prevent poor performance or total operational failure of equipment in subzero temperatures. Radio Receiving Set AN/FRR–12 can be used in winter if difficulties common in low temperatures are anticipated and precautions taken to prevent them. For operation purposes, always allow maximum possible warm-up before turning the equipment on. If possible, the equipment should be allowed to stand in a heated shelter, with the power off, prior to operation. Wrap it in blankets when on the march to protect it from winds and freezing temperatures. Refer to TB SIG 66, Winter Maintenance of Signal Equipment, for complete information.

53. Dustproofing

Signal Corps equipment operated in desert localities is affected by the extremely high temperatures and the amount of dirt, dust, sand, and other foreign matter in the air. Take care to keep such elements from filtering into equipment. Cover the equipment when it is not in use. Thorough cleanliness is imperative. Refer to TB SIG 75, Desert Maintenance of Ground Signal Equipment

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PART FOUR
AUXILIARY EQUIPMENT

54. Alternate Auxiliary Equipments

When Radio Receiving Set AN/FRR–12 is to be used in conjunction with Radio Teletype Terminal Equipment AN/FGC–1 or AN/FGC–1X, refer to technical manual TM 11–356. When Dual Diversity Converter CV–31/TRA–7 or CV–31A/TRA–7 is to be used, an alternate panel arrangement of the cabinet may be used (fig. 12). For further information on Dual Diversity Converters CV–31/TRA–7 and CV–31A/TRA–7, refer to TM 11–278.

PART FIVE
REPAIR INSTRUCTIONS

Section X. THEORY OF EQUIPMENT

55. General

a. A standard teletypewriter depends on two signals for its operation, the mark and the space. Each letter, numeral, or character sent is made up of a different combination of mark and space signals. In a radio-teletype system these mark and space signals are applied to an r-f carrier, and transmitted to another point where a receiver picks up the r-f signal and removes the mark and space signals from the r-f carrier.

b. One method of applying the mark and space signals to the r-f carrier is to shift the carrier frequency in one direction for the mark signal and in the opposite direction for the space signal. In practice, the carrier is shifted 425 cps higher than no-signal frequency for the mark signal and 425 cps lower than no-signal frequency for the space signal. The carrier remains on the air at all times during the transmission and merely changes frequency for the signal conditions.

c. In order to insure proper operation of the teletypewriter at the receiving location, a good steady signal is required at all times. Fading or variation in the strength of the received signal is highly undesirable. The term "fading" is intended to denote variations in signal strength over extremely short periods of time of from one cps to hundreds of cps. This definition is emphasized to avoid confusion with the slow signal variations which may occur from hour-to-hour, day-to-night, day-to-day, and season-to-season. The diversity system of radio reception is based upon the fact that an h-f signal, such as that which is used in long-distance teletype radio communication, does not fade simultaneously at two locations physically separated by a short distance, for example, several wavelengths. With two antennas spaced about 1,000 feet apart the signal will seldom fade out on both antennas at the same time. Thus by feeding the signal from two antennas to two independent receivers and combining the rectified receiver outputs in a mixer-converter, a relatively constant output signal level can be maintained. Generally, fading is due to the fact that radio waves travel over different paths between the transmitting and receiving antennas. The difference in the lengths of the paths causes the relative phases of the waves received over them to differ. These phase differences between the waves, and variations in these differences, result in partial or complete addition or cancellation at any instant at a specific receiving antenna. The resulting difference or diversity of fading at the receiving antenna is utilized, as previously described, to maintain a constant usable signal level in spite of fading. This system is known as dual diversity reception. The dual diversity system of reception gives a decidedly more constant signal than can be obtained with a single receiver. This is due primarily to the spaced antennas and to the method of combining the received signals from these spaced antennas.

d. After the r-f signal is received, the mark and space signals must be removed from the carrier. Radio Receiving Set AN/FRR–12 is intended primarily for reception of frequency shift teletype signals. The frequency is usually shifted 425 cps above the mean frequency for mark and 425 cps below the mean for space. The incoming r-f signal is beat against a fixed frequency oscillator. This produces two i-f output frequencies, one of 465.425 kc and the other of 464.575 kc which correspond with the mark and space signals, respectively. These i-f signals are amplified and fed into one type of radio teletype terminal equipment which produces a d-c output for operation of teletypewriters. The previously discussed i-f signals are further amplified and then beat against another fixed frequency oscillator within the receiver to produce two a-f signals, one for each frequency position of the carrier, of 2,975 cycles and 2,125 cycles. These individual tones are amplified and fed to another type radio teletype terminal equipment. This teletype terminal equipment combines, filters, amplifies, limits, and rectifies the individual tones from the diversity receivers. The rectified d-c pulses energize the mark or space windings of a polar relay which in turn operates the teletypewriter.

56. Simplified Block Diagram of Radio Receiving Set ANF/RR-12

a. GENERAL. Radio Receiving Set AN/FRR-12 uses two identical superheterodyne Radio Receivers R-270/FRR, receiver A and receiver B, powered by separate Power Supply Units RA-74-D and fed from separate antennas. The receiver circuit described in the following discussion is equally applicable to both Radio Receivers R-270/FRR. To understand receiver functioning refer to figure 18. The two Power Supply Units RA-74-D are also identical.

b. RADIO-FREQUENCY AMPLIFIER AND HIGH-FREQUENCY OSCILLATOR. The r-f signal from the antenna is amplified in two stages (V-1, V-2) and fed to mixer V-3. H-f energy, which is 465 kc different from the incoming carrier frequency, is generated in h-f oscillator V-4 and in crystal-controlled h-f oscillator V-17. Either of these generated oscillations is selected by means of a switch for combining in mixer V-3 to heterodyne the modulated r-f carrier to an intermediate frequency of 465 kc.

c. MIXER. The heterodyning frequency from either the h-f oscillator or the crystal-controlled h-f oscillator is mixed with the amplified r-f signal in mixer tube V-3 to generate an intermediate frequency of 465 kc.

d. CRYSTAL FILTER AND INTERMEDIATE-FREQUENCY AMPLIFIER. The crystal filter acts as a high impedance to all except resonant voltages fed from mixer V-3 to first i-f amplifier V-5. Selectivity of the crystal filter may be varied in definite steps by the CRYSTAL SELECTIVITY switch front panel control. In addition, its selectivity characteristic may be greatly sharpened on one side or the other by adjusting the PHASING capacitor controlled from the front panel. When the CRYSTAL SELECTIVITY switch is set at OFF, the crystal is short-circuited, then the signal voltages present in the secondary of the mixer plate coil are impressed directly on the control grid of first i-f amplifier tube V-5. There are three stages of i-f amplification (V-5, V-6, V-7) each of which has a coupling transformer (T-2, T-3, T-4) associated with it. The portion of the intermediate frequency that is used for the output signal is fed from the second i-f transformer through amplifiers V-11 and V-12 to I-F OUTPUT jack J-2. The i-f signal is fed through third i-f amplifier stage V-7 to detector V-8.

e. DETECTOR. The amplified i-f signal is fed to the detector tube which is a twin diode. The signal may be modified by the limiter action of V-9 which is controlled by the LIMITER OFF-ON front panel switch. Limiter action is for the purpose of reducing undesired noises carried by the i-f signal. The detected signal is fed to the a-f amplifier.

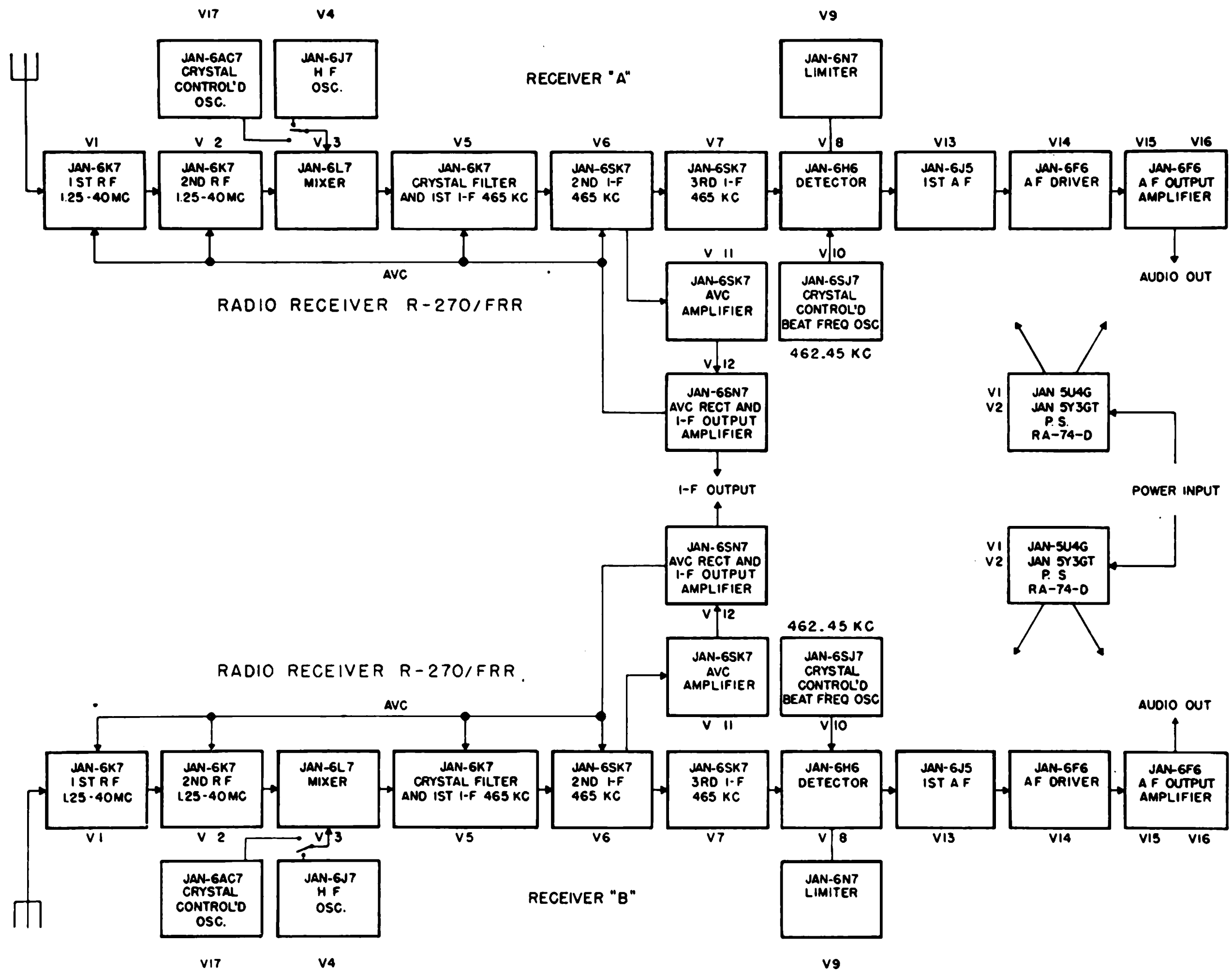
f. BEAT-FREQUENCY OSCILLATOR. Bfo V-10 is crystal-controlled and provides r-f energy at approximately 462.45 kc. When this energy is introduced into the input circuit of the detector it mixes with the i-f signal fed from third i-f amplifier tube V-7. The mixture of the two similar frequencies results in a beat, or a difference frequency, in the output of the detector. The pitch of the beat note may be controlled somewhat by adjusting the BEAT OSCILLATOR control.

g. AUDIO-FREQUENCY AMPLIFIER. The a-f amplifier has three stages: The first a-f stage which uses a triode V-13, the second a-f stage which uses one pentode V-14 as the a-f driver, and the third a-f stage which uses two pentodes (V-15, V-16) in a push-pull circuit. Each of these three pentodes is connected as a triode. There are two secondary windings on output transformer T-8. A 600-ohm output from the transformer is provided on terminal strip E-3 for use with a loudspeaker or for a 600-ohm audio transmission line. The other secondary winding of T-8 is connected to PHONES jack J-1 for headphone use.

h. POWER SUPPLY UNIT RA-74-D. The plate, screen, filament, and bias voltages for the receiver are furnished by the power supply unit. Tube V-1 is the high-voltage rectifier and V-2 is the bias voltage rectifier.

57. Functioning of Individual Stages and Circuits

a. GENERAL. The purpose of the following description is to clarify for technicians the basic operation of the various circuits of Radio Receiving Set AN/FRR-12. This knowledge will prove helpful in quickly tracing trouble to a specific component part of the equipment. The component part symbols used in the description are the



RADIO RECEIVER SET AN/FRR-12

Figure 18. Radio Receiving Set AN/FRR-12, simplified block diagram.

same as those used on the schematic diagrams (figs. 24 and 26) and in the identification table of replaceable parts (appendix II). Voltage and resistance measurements are also provided to help in finding trouble.

b. First Radio-Frequency Stage. The antenna input is coupled to the grid of V–1 through an input transformer with an untuned primary and a tuned secondary. There is an electrostatic Faraday shield between the primary and secondary to prevent capacitive coupling between the antenna circuit and any part of the tuned secondary. This shielding results in substantially pure inductive coupling only, and permits full advantage to be taken of a balanced transmission line lead-in. The impedance of the input circuit averages approximatey 100 ohms throughout the tuning range of the receiver. The choice of frequency band is made by switch S–1 operated from the front panel. Section A of this switch operates in the antenna input circuit and section B operates in the first r-f stage input circuit. The d-c plate supply is shunt-fed to the plate of V–1 through r-f choke L–35. The output of V–1 is coupled to the tuned circuit of the second r-f stage through fixed capacitor C–57. This arrangement keeps d-c plate voltage off the tuned impedance interstage coupling circuits. The differences in electrical values of the parts used for the various frequency bands are given in the identification table of replaceable parts.

c. Second Radio-Frequency Stage V–2. On the 20- to 40-mc band the output of the preceding stage is coupled to the second r-f stage through capacitor C–57 and coil L–49 resonated by capacitor C–99. All other frequency bands of the receiver use standard r-f transformer coupling. Section C of band switch S–1 operates in the second r-f stage.

d. MIXER STAGE V–3. On the 20- to 40-mc band the output of the seconf r-f stage is coupled to the mixer stage through capacitor C–58 and coil L–50, resonated by capacitor C–100. All other frequency bands in this stage use conventional r-f transformer coupling selected by section D of band switch S–1. High-frequency energy from either h-f oscillator V–4 or crystal-controlled h-f oscillator V–17 is coupled to the injection grid No. 3 (pin 5) through capacitor C–13. H-f oscillator V–4 operates only when the CRYSTAL CONTROL switch is turned OFF, and then the input to the injection grid is obtained from the cathode of tube V–4. When the CRYSTAL CONTROL switch is turned to position 1, 2, or 3, h-f oscillator V–4 is made inoperative and the resonant circuit selected by section E of switch S–1 is connected into the plate circuit of crystal-controlled h-f oscillator V–17. In this case, the h-f energy supplied to pin 5 of tube V–3 through capacitor C–13 is obtained from the plate circuit of tube V–17. The desired i-f output voltage (465 kc) of V–3 is selected by the tuned resonant plate circuit consisting of capacitor C–21 and the primary of transformer L–26.

e. HIGH-FREQUENCY OSCILLATOR STAGE V–4. The h-f oscillator uses a modified Hartley circuit with tube V–4 connected as a triode. The plate, screen grid, and suppressor grid are tied together and bypassed to ground by capacitor C–16. The cathode is tapped into the oscillator tuning coil selected by section E of switch S–1. The oscillator output is taken from the cathode and applied to injection grid No. 3 of mixer tube V–3. This method minimizes oscillator frequency changes caused by reaction from the mixer tube control grid signal circuit. On the 20- to 40-mc band no fixed series padding capacitor is used while each of the other frequency bands has a series padding capacitor.

f. CRYSTAL-CONTROLLED HIGH-FREQUENCY OSCILLATOR. Crystal-controlled oscillator V–17 is used as an alternate to receiver h-f oscillator V–4. The XTALS switch is used to select the desired one of three crystals or to turn off the crystal-controlled h-f oscillator.

(1) *Frequency range.* The crystal-controlled oscillator is designed to provide crystal control of any three signal frequencies in the frequency range of the receiver under conditions of varying line voltage and ambient temperature changes. Any one of the three crystal-controlled frequencies may be selected to replace the h-f oscillator frequency by means of XTALS selector switch S–8. The Δ FREQ HIGH-LOW control varies the nominal crystal frequency approximately ±0.005 percent when operated to HIGH or LOW position.

(2) *Circuit theory.* (*a*) The crystal-controlled h-f. oscillator is an electron-coupled oscillator using a Tube JAN–6AC7. The crystal oscillatory circuit consists of the cathode, control grid, screen grid, capacitors C–118 and C–120, and the crystal unit selected. Capacitor C–119 prevents d-c voltage from appearing across the crystal units. The crystal oscillatory circuit is electron-coupled to the plate of Tube JAN–6AC7. The receiver h-f oscillator tank circuit, a tuned plate circuit, may be tuned by the receiver tuning controls to the fundamental, second, or third harmonic of the crystal frequency. Note that the tuned plate circuit, which is actually the receiver h-f oscillator tank, is different for every band. Plate voltage is supplied through r-f choke coil L–57. Coupling capacitor C–116 also prevents d-c voltage from appearing across the receiver h-f oscillator tank circuit. The suppressor grid and cathode are connected to ground directly, while the screen grid is held above r-f ground by r-f coil L–58. Capacitor C–117 acts as an r-f filter in conjunction with voltage-dropping resistor R–63. The suppressor grid serves to prevent the plate load from affecting the crystal oscillator circuit.

(*b*) Change of crystal oscillator frequency over a minimum range of ±0.005 percent is obtained when Δ FREQ HIGH-LOW capacitor C–5 is rotated toward maximum (LOW) or minimum (HIGH) capacitance from its midpoint setting. The crystals operate at nominal frequency with capacitor C–120 in the half-open (midpoint) position. In the OFF (normal) position rotary XTALS switch S–8, section 1 rear, applies plate voltage to the receiver h-f oscillator tube V–4, while removing plate voltage from the crystal-controlled oscillator tube. For crystal operation, plate voltage is removed from h-f oscillator tube V–4 and applied to crystal-controlled oscillator tube V–17. Switch S–8, section 2 front, selects the desired crystal. The receiver h-f oscillator tank circuit selected by section E of band switch S–1 (to which is connected the output of the crystal-controlled oscillator) is tuned 465 kc higher than the signal frequency, except for the 20- to 40-mc band when the h-f oscillator is tuned 465 kc lower than the signal frequency; this tuning is accomplished by means of the MAIN TUNING dial. The frequency to be crystal-controlled by the fundamental, second, or third harmonic of the crystal unit differs from the received signal frequency by the intermediate frequency (465 kc). Capacitor C–117 places one end of L–57 at r-f ground and also decouples the screen circuit. Rectified grid current causes a bias voltage to appear across R–62. D-c screen voltage is supplied through R–63 and L–58. Interaction between harmonically related crystals is prevented by switch S–8, section 2 rear, which short-circuits the disconnected crystals. The output of the crystal-controlled oscillator is coupled to the mixer injection grid circuit through capacitor C–116, the selected tank circuits, C–15, and C–13 of the receiver.

g. First Intermediate-Frequency Stage V–5. Quartz crystal filter Y–1 couples the mixer output from the secondary of transformer L–26 to the control grid of first i-f amplifier tube V–5. When CRYSTAL SELECTIVITY switch S–7 is set at the OFF position, crystal Y–1 is short-circuited, then signal voltages present in the secondary of transformer L–26 are imposed directly upon the control grid of V–5. At all other settings of switch S–7 the quartz crystal is in the circuit. Crystal Y–1 acts as a series-tuned circuit, interposed between the secondary of L–26 and the first i-f grid circuit (L–27 and C–33). The grid circuit constitutes the load into which the crystal works. Selectivity is varied by altering the impedance of the parallel-tuned circuit which is accomplished by adding resistance consisting of R–42, R–43, R–44, and R–45 in series with coil L–27. As this series resistance is increased, the over-all selectivity of the filter is also increased. The first i-f amplifier tube is a remote cut-off pentode, the output of which is fed to primary coil L–28 of second i-f interstage transformer T–2. The tuned circuit comprised of L–28 and C–36 of the second i-f interstage transformer T–2 acts as the load for V–5.

h. Second Intermediate-Frequency Stage V–6. Second i-f transformer T–2 has a tuned secondary as well as a tuned primary. Secondary coil L–29 is fixed in position, while primary coil L–28 is mounted on slide rods and can be moved with respect to the secondary, thus changing the degree of inductive coupling. The coils are tuned by means of air-dielectric variable capacitors, the primary by C–36 and the secondary by C–37. Secondary coil L–29 is tapped at approximately one-tenth of the total turns up from the low potential end of the coil for connection to the control grid of second i-f amplifier tube V–6. Adjustable primary coil L–30 of third i-f transformer T–3 is tuned by capacitor C–38 and acts as the second i-f amplifier plate load. The coupling between the coils of T–2 and T–3 is varied simultaneously by the BAND WIDTH control.

i. Third Intermediate-Frequency Stage V–7. Third i-f transformer T–3 is similar to second i-f transformer T–2 with variable inductive coupling between the primary and secondary coils. Adjustable primary coil L–30 is tuned by variable capacitor C–38 and fixed secondary coil L–31 is tuned by variable capacitor C–39. Secondary coil L–31 is tapped at approximately one-tenth of the total turns up from the low potential end of the coil for connection to the control grid of third i-f amplifier tube V–7. The voltage which is used for avc and for i-f output is also taken from this tap on L–31. The primary coil of L–32 tuned by variable capacitor C–40 in transformer T–4 comprises the plate load of third i-f amplifier tube V–7.

j. Detector Stage V–8. Detector V–8 is a twin diode with both plates and both cathodes connected in parallel. The i-f input is obtained from the untuned secondary of coil L–32 in transformer T–4. The diode load resistance total is 508,000 ohms and is divided into two approximately equal parts. One part, 270,000 ohms (R–30), is placed between the parallel cathodes and ground; it is bypassed (for intermediate frequency) by a 51-mmf (micromicrofarad) capacitor (C–26). The other part, 238,000 ohms, is between the low potential end of L–32 secondary and ground, and is made up of 100,000 ohms (R–48), 82,000 ohms (R–24), and 56,000 ohms (R–25). The 100,000-ohm resistor (R–48), together with two 51-mmf capacitors (C–44 and C–45), constitute a filter to prevent i-f voltages from reaching the 56,000-ohm resistor (R–25) and the audio gain control (R–26) in the detector output circuit.

k. Noise-Limiter Stage V–9. Limiter tube V–9 is a class B twin triode with its two grids and two plates parallel-connected in order to obtain the lowest possible impedance. When LIMITER switch S–5 is closed, the relative potentials of V–9 cathode, grids, and plates depend on the d-c current flowing in the load circuit of the detector. The potential on the grids of V–9 is controlled by the filter consisting of resistor R–49 and capacitor

C–42. The time constant of this resistor-capacitor combination (1/20 sec) is long enough to prevent the grids of V–9 from following the carrier variations due to normal modulation and yet short enough to follow the variations due to fading. This arrangement provides automatic adjustment of the noise-limiter circuit for widely different carrier levels at the detector.

l. BEAT-FREQUENCY OSCILLATOR STAGE V–10. The bfo tube V–10 and associated oscillator circuit T–5 controlled by crystal Y–2 provide an i-f voltage of approximately 462.45 kc. When introduced into the detector circuit through capacitor C–41, this voltage mixes with the i-f signal being delivered to the detector from the third i-f stage. The mixture or heterodyning of these two similar frequencies results in a *beat* or difference frequency in the output of the detector. The bfo is switched into the circuit by throwing SIGNAL MOD-CW switch S–3 to CW position.

m. AVC CIRCUIT, V–11, AND V–12, INCLUDING BIAS SUPPLY AND SENSITIVITY METER CIRCUIT. (1) *Avc amplifier and rectifier, and I-f output amplifier.* Avc amplifier tube V–11 is a pentode. Avc rectifier V–12 is a twin triode, one section of which is used as a diode rectifier and the other as an amplifier to supply r-f output. The control grid of V–11 is connected in parallel with the control grid of third i-f amplifier tube V–7, and both grids are driven from the tap on secondary coil L–31 of transformer T–3. Coil L–34 of transformer T–6 in the avc circuit consists of a primary tuned by variable capacitor C–51, and a closely coupled untuned secondary. The untuned secondary is connected to V–12 and to the diode load composed of R–53, R–54, and R–55. Amplified i-f voltages present in the plate circuit of V–11 are impressed through L–34 on the directly connected plate and control grid of the avc rectifier section of tube V–12 and also on the control grid of the i-f output amplifier section of tube V–12. Control voltage from the cathode of the avc rectifier section of V–12 is obtained at the high end of resistor R–53 and connected to AVC-MANUAL switch S–4, through an i-f filter which is a part of transformer T–6, consisting of resistor R–52 and bypass capacitor C–56. Amplified i-f voltage is taken from the cathode of V–12, i-f amplifier section for connection through I-F OUTPUT jack J–2.

(2) *Avc system with S meter.* The S meter is included in the avc circuit when switch S–4 is set for AVC. The meter is connected in shunt with 1,000-ohm potentiometer R–41, which is in series with the avc diode load so that some of the rectified d-c current flows through the meter. The amount of this current depends on the strength of the i-f voltage impressed on the avc rectifier plate of V–12. This voltage in turn depends on both the strength of the incoming signal and the accuracy of tuning. The setting of R–41 controls the degree of meter deflection and is usually adjusted to produce an S meter reading of 9 on a 50-microvolt signal at 3.5 mc. When so adjusted, a change of one S number on the meter indicates a change in signal strength of approximately 2:1.

(3) *Avc for c-w reception.* For c-w reception, a longer time constant is obtained by adding a 250,000-mmf capacitor (C–17) in parallel with the 50,000-mmf capacitor (C–56). This extra timing capacitor C–17 is automatically added to the avc system when the SIGNAL MOD-CW switch S–3 is turned to CW. The low potential end of the avc rectifier diode load and the cathode of the avc rectifier section of tube V–12 are returned to the minus 3-volt point on the C bias voltage divider. The C bias voltage supply provides the minimum recommended grid bias for the controlled r-f and i-f amplifier tubes (V–1, V–2, V–5, and V–6) without regard to any negative bias furnished by the avc rectifier diode V–12.

n. FIRST A-F STAGE V–13. First a-f stage tube V–13 is a triode. The grid of this tube is connected to the moving arm of AUDIO GAIN control R–26 through blocking capacitor C–24. The plate is coupled to the grid of the next stage (a-f driver) by means of capacitor C–25, plate resistor R–28, and grid leak resistor R–29.

o. AUDIO-FREQUENCY DRIVER STAGE V–14. A-f driver stage V–14 uses a pentode as a triode by connecting the plate and screen together. This tube drives the output stage through push-pull transformer T–7.

p. AUDIO-FREQUENCY OUTPUT STAGES V–15 AND V–16. The output circuit is a push-pull arrangement using two pentodes (V–15 and V–16) connected as triodes. They are operated as class AB_2 amplifiers. This means that grid current flows during some part of the input cycle. For a power output up to approximately 3 watts, no grid current flows, and harmonic distortion is negligible. Above 3 watts, and up to 10 watts (maximum output), grid current increases steadily, causing a corresponding increase in distortion. A-f output transformer T–8 has two secondary windings: a 600-ohm secondary with a center tap (terminals 6, 7, 8) for power output, and another secondary for headphone (terminals 4, 5), designed to deliver about 3 percent of the output power into an 8,000-ohm resistive load, when the 600-ohm secondary is connected to a matching load. The turns ratio, and resistance of the headphone winding are such that the power delivered to any load between 8,000 ohms and 89 ohms varies less than 6 db, and the power input to a 250-ohm load is only 2 db greater than that to a 4,000-ohm load.

q. RELAY TERMINAL BOARD E–2. The *RELAY* terminal board is provided to afford a method of turning off the radio transmitter when the receiver is in operating condition. By studying the receiver schematic diagram (fig. 27) various uses for the *RELAY* terminal board may be evolved such as—

(1) A high resistance relay connected between one terminal and ground for controlling the transmitter when SEND-REC. switch S–2 is thrown from one position to the other.

(2) One terminal provides a connection for obtaining 250 volts dc for operating auxiliary apparatus whose current requirements are quite small.

(3) When a complete receiver-transmitter control system is used, the SEND-REC. switch may be left in the SEND position at all times, and a pair of contacts in the control system may be used to open and close the terminals on E–2 to control the receiver.

r. POWER SUPPLY UNIT RA–74–D. Each power supply unit furnishes A, B, and C voltages for its associated receiver. The primary winding of power transformer T–1 of this unit is provided with eight taps to allow connection to a 50- to 60-cycle single-phase a-c power source between 95 and 260 volts. See power supply schematic diagram, figure 25. Power cord W–1 is originally connected to terminal 4 and must be changed for input voltages other than 117 volts. There are four secondary windings on transformer T–1. The A or heater voltage is 6.3 volts ac obtained from the secondary winding, terminals 10 and 11, of transformer T–1. The B voltage is obtained from the center-tapped high-voltage secondary, terminals 16, 17, 19, connected to the plates of full-wave rectifier tube V–1. The rectified output of V–1 is filtered by the combined action of parallel-connected capacitors C–1, C–2, C–3, C–4, and choke L–1 to provide +380 volts dc for the plates of the receiver a-f output tubes. Further filtering by choke L–2 and capacitors C–5 and C–6 provides +250 volts dc for the plates of the remaining receiver amplifier tubes. Approximately +100 volts dc for the screen grids of the receiver tubes is obtained from the bleeder of the filter at the junction of resistors R–1, R–2, which point of the bleeder circuit is bypassed by parallel connected capacitors C–7, C–8. The negative *C* voltage is obtained from tap terminal 18 on the high-voltage secondary connected to the filament of bias rectifier tube V–2. The rectified output from the plates of V–2 is filtered by resistors R–5, R–6, R–7, R–8, R–9, R–10, and capacitors C–9, C–10, C–11, C–12. This supplies a *C* bias for the receiver of approximately minus 50 volts.

s. RACK MT–660( )/FRR–12. The electrical components of this rack are shown in the schematic diagram of figure 24. The external power source is connected to the three-pole solid neutral type switch in the lower rear part of the cabinet. Line voltage power is supplied to the receptacle strip through the switch and 10-ampere fuses. The receptacles permit the connection of equipment at any one of five points on the strip. On the opposite side of the cabinet there is a metal strap which is used as the ground for the chassis mounted within the cabinet and to which the external ground is connected. The antenna junction box at the top rear of the cabinet has mounted on it connectors for balanced and unbalanced antenna input connections. Bridle rings are provided in the cabinet to retain the interconnecting cables and the incoming and outgoing signal cables. The rack door contains a box which is so mounted that it faces toward the front of the cabinet. This box is reversed, when Dual Diversity Converter CV–31( )/TRA–7 is installed in order to accommodate the converter connectors and cables.

Section XI. TROUBLE SHOOTING

58. General

No matter how well equipment is designed and manufactured, faults occur in service. When such faults occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble shooting.

a. TROUBLE-SHOOTING DATA. Take advantage of the material supplied in this manual to help in the rapid location of faults. Consult the following trouble-shooting data when necessary:

(1) Block diagram of Radio Receiving Set AN/FRR-12 (fig. 18).

(2) Schematic diagrams (figs. 24, 25, and 27).

(3) Voltage and resistance data for all socket connections.

(4) Illustrations of components. Front, top, and bottom views of chassis which aid in locating and identifying parts.

(5) Pin connections. Pin connections on sockets are numbered on the various diagrams. Seen from the bottom, pin connections are numbered in a clockwise direction around the sockets. On octal sockets the first pin clockwise from the keyway is the No. 1 pin.

(6) Wiring diagram of Power Supply Unit RA-74-D (fig. 26). Wiring diagrams of Radio Receiver R-270/FRR (fig. 28) and Radio Receiver R-270/FRR r-f tuning unit (fig. 29).

(7) Tube base pins and tube elements—

Tube JAN-	Pin No.								Cap
	1	2	3	4	5	6	7	8	
5U4G	NC	H	NC	Plate	NC	Plate	NC	H	
5Y3GT	NC	H	NC	Plate	NC	Plate	NC	H	
6AC7	Shell	H	Suppressor	Grid	Cathode	Screen	H	Plate	
6F6	Shell	H	Plate	Screen	Grid	NC	H	Cathode	
6H6	Shell	H	Plate	Cathode	Plate	NC	H	Cathode	
6J5	Shell	H	Plate	NC	Grid	NC	H	Cathode	
6J7	Shell	H	Plate	Screen	Suppressor	NC	H	Cathode	Grid
6K7	Shell	H	Plate	Screen	Suppressor	NC	H	Cathode	Grid
6L7	Shell	H	Plate	Screen	Inj grid	NC	H	Cathode	Grid
6N7	Shell	H	Plate	Grid	Grid	Plate	H	Cathode	
6SJ7	Shell	H	Suppressor	Grid	Cathode	Screen	H	Plate	
6SK7	Shell	H	Suppressor	Grid	Cathode	Screen	H	Plate	
6SN7GT	Grid	Plate	Cathode	Grid	Plate	Cathode	H	H	

Notes.—NC means no connection. H means heater. All tubes are JAN octal type base.

b. TROUBLE-SHOOTING STEPS. The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the *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, r-f arcing, and shorted transformers, can be located by sight, smell, and hearing. The majority of faults, however, must be located by checking voltage and resistance.

c. SECTIONALIZATION. Careful observation of the performance of the equipment while turning the equipment on often sectionalizes the fault to one particular unit. Additional sectionalizing of the fault is discussed in paragraph 60.

d. LOCALIZATION. Paragraph 62 describes the method of localizing faults within the individual components. Use the trouble-shooting chart (par. 60) to determine which of the probable locations of the fault is the exact one. The voltage and resistance at every socket pin connection are shown in *h* and *i* below.

e. VOLTAGE MEASUREMENTS. Voltage measurements are an almost indispensable aid to the repairman because most troubles either *result from* abnormal voltages or *produce* abnormal voltages. Voltage measurements are taken easily, because they are always made between two points in a circuit and the circuit need not be interrupted.

(1) Unless otherwise specified, the voltages listed on the voltage chart (*h* below) are measured between the indicated points and ground.

(2) Always begin by setting the voltmeter on the highest range so that the voltmeter will not be overloaded. Then, if it is necessary to obtain increased accuracy, set the voltmeter to a lower range.

(3) In checking cathode voltage, remember that a reading can be obtained when the cathode resistor is actually open. The resistance of the meter may act as a cathode resistor. Thus, the cathode voltage may be approximately normal only as long as the voltmeter is connected between cathode and ground. Before the cathode voltage is measured, make a resistance check with a cold circuit to determine whether the cathode resistor is normal.

f. Precautions Against High Voltage. Certain precautions must be followed when measuring voltages above a few hundred volts. High voltages are dangerous and can be fatal. *When it is necessary to measure high voltages, observe the following rules:*

(1) Connect the ground lead to the voltmeter.

(2) Place one hand in your pocket. This will eliminate the possibility of making accidental contact with either ground or another part of the circuit, thus causing the electricity to travel from one hand to the other.

(3) If the voltage is less than 300 volts, connect the test lead to the hot terminal (which may be either positive or negative with respect to ground).

(4) If the voltage is greater than 300 volts, shut off the power, connect the hot lead, step away from the voltmeter, turn on the power, and note the reading on the voltmeter. *Do not touch any part of the voltmeter, particularly when it is necessary to measure the voltage between two points which are above ground electrically.*

g. Voltmeter Loading. It is essential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured. If the voltmeter resistance is comparable to the circuit resistance, the voltmeter will indicate a voltage lower than the actual voltage present when the voltmeter is removed from the circuit.

(1) The resistance of the voltmeter on any range can always be calculated by the following simple rule: Resistance of the voltmeter equals the ohms-per-volt multiplied by the full-scale range in volts. For example: The resistance of a 1,000-ohm-per-volt meter on the 300-volt range is 300,000 ohms (R=1,000 ohms-per-volt times 300 volts=300,000 ohms).

(2) To minimize the voltmeter loading in high-resistance circuits, use the highest voltmeter range. Although only a small deflection will be obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement will be increased. The decreased loading of the voltmeter will more than compensate for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

(3) When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage reading on two successive meter ranges. If the voltage readings on the two ranges do not agree, voltmeter loading is excessive. The reading (not the deflection) on the highest range will be greater than that on the lowest range. If the voltmeter is loading the circuit heavily, the deflection of the pointer will remain nearly the same when the voltmeter is shifted from one range to another.

(4) The ohm-per-volt sensitivity of the voltmeter used to obtain the readings shown on the voltage chart (*h* below) is 1,000 ohms per volt as indicated on the chart. Use a meter having the same ohm-per-volt sensitivity; otherwise, it will be necessary to consider the effect of loading.

h. Voltage Measurement Chart. (1) *Radio Receiver R-270/FRR.*

Socket ref symbol	Tube JAN-	Tube ref symbol	Voltage at socket terminal No.							Cap
			2	3	4	5	6	7	8	
X–1	6K7	V–1	H	250	135	0	NC	H	0	−1
X–2	6K7	V–2	H	250	135	0	NC	H	0	−1
X–3	6L7	V–3	H	250	115	*	NC	H	0	−1
X–4	6J7	V–4	H	150*	150*	150*	NC	H	0	0
X–5	6K7	V–5	H	250	135	0	NC	H	0	−0. 5
X–6	6SK7	V–6	H	0	−43	0	135	H	250	
X–7	6SK7	V–7	H	0	−1. 5	0	100	H	240	
X–8	6H6	V–8	H	−0. 2	0. 4	−0. 2	NC	H	0. 4	
X–9	6N7	V–9	H	0. 4	0	0	0. 4	H	0. 2	
X–10	6SJ7	V–10	H	0	−0. 5	0	40	H	155	
X–11	6SK7	V–11	H	0	−1. 5	0	110	H	240	
X–12	6SN7GT	V–12	0	−3. 2	0	+100	3. 5	H	H	
X–13	6J5	V–13	H	100	NC	−3. 2	NC	H	0	
X–14	6F6	V–14	H	240	240	−20	NC	H	0	
X–15	6F6	V–15	H	360	360	0	NC	H	38	
X–16	6F6	V–16	H	360	360	0	NC	H	38	
X–18	6AC7	V–17	H	0	0	0	175	H	250	

*Varies widely with different tubes; also varies with dial setting.

(2) *Power Supply Unit RA-74-D.*

Socket ref symbol	Tube JAN-	Tube ref symbol	Voltage at socket terminal No.							Cap
			2	3	4	5	6	7	8	
X-1	5U4G	V-1	H 470 dc	NC	410 ac	NC	410 ac	NC	H 470 dc	
X-2	5Y3GT	V-2	H 295 ac	NC	−290 dc	NC	−290 dc	NC	H 295 ac	

Notes:

1. All values given are positive d-c voltage unless otherwise noted, measured between socket terminals and chassis, with no signal present. The readings are based on an a-c line voltage exactly equal to the primary tap on power transformer T-1; higher or lower line voltage should result in corresponding variations in these readings. All d-c readings are based on the use of a meter having a resistance of 1,000 ohms per volt.
2. Voltages indicated by H are approximately 6.3 v ac between heater terminals.
3. NC means no connection.
4. All tubes are JAN type.
5. Terminal 1 of all sockets is at zero potential with respect to chassis. On X-12 terminal 1 potential is zero with no signal.
6. When measuring these voltage, set controls as follows: SENSITIVITY AUDIO GAIN at O; SIGNAL MOD-CW switch on CW; AVC-MANUAL switch on MANUAL; SEND-REC. switch on REC.; and LIMITER switch ON.

i. Resistance Measurement Chart. (1) *Radio Receiver R-270/FRR.*

Socket ref symbol	Tube element	Pin No.	Variable controls		Resistance (ohms)
			Ref symbol	Setting	
X-1	Plate	3	SW-2	SEND	Infinity
			SW-2	REC.	20, 000
	Screen	4	-------	-------	11, 500
	Suppressor	5	-------	-------	0
	Cathode	8	-------	-------	0
	Grid	Cap	SW-4	AVC	1, 180, 000
			SW-4	MAN	515, 000
X-2	Plate	3	SW-2	SEND	Infinity
			SW-2	REC.	20, 000
	Screen	4	-------	-------	11, 500
	Suppressor	5	-------	-------	0
	Cathode	8	-------	-------	0
	Grid	Cap	SW-4	AVC	1, 180, 000
			SW-4	MAN	515, 000
X-3	Plate	3	SW-2	SEND	Infinity
			SW-2	REC.	20, 000
	Screen	4	SW-2	SEND	Infinity
			SW-2	REC.	43, 000
	Inj Grid	5	-------	-------	50, 000
	Cathode	8	-------	-------	0
	Control grid	Cap	-------	-------	510, 000
X-4	Plate	3, 4, 5	-------	-------	30, 000
	Cathode	8	SW-1	-------	0.01 to 1.8
	Grid	Cap	-------	-------	50, 000
X-5	Plate	3	-------	-------	20, 000
	Screen	4	-------	-------	11, 500
	Suppressor	5	-------	-------	0
	Cathode	8	-------	-------	0

(1) *Radio Receiver R-270/FRR.*—Continued

Socket ref symbol	Tube element	Pin No.	Variable controls		Resistance (ohms)
			Ref symbol	Setting	
	Grid	Cap	SW-4	AVC	670, 000
			SW-4	MAN	
			R-56	0	14, 600
			SW-4	MAN	
			R-56	10	10, 300
X-6	Suppressor	3	-------	-------	0
	Grid	4	SW-4	AVC	670, 000
			SW-4	MAN	
			R-56	0	14, 600
			SW-4	MAN	
			R-56	10	10, 300
	Cathode	5	-------	-------	0
	Screen	6	-------	-------	11, 500
	Plate	8	-------	-------	20, 000
X-7	Suppressor	3	-------	-------	0
	Grid	4	-------	-------	10, 300
	Cathode	5	-------	-------	0
	Screen	6	-------	-------	68, 000
	Plate	8	-------	-------	20, 000
X-8	Plate	3	-------	-------	238, 000
	Cathode	4	-------	-------	270, 000
	Plate	5	-------	-------	238, 000
	Cathode	8	-------	-------	270, 000
X-9	Plate	3	-------	-------	270, 000
	Grid 2	4	-------	-------	1, 220, 000
	Grid 1	5	-------	-------	1, 220, 000
	Plate	6	-------	-------	270, 000
	Heater	7	Tube V9 removed from socket		4

(1) *Radio Receiver R-270/FRR.*—Continued

Socket ref symbol	Tube element	Pin No.	Variable controls		Resistance (ohms)
			Ref symbol	Setting	
	Cathode	8	SW-5	ON	117, 000
			SW-5	OFF	Infinity
X-10	Suppressor	3	-------	-------	0
	Grid	4	-------	-------	100, 000
	Cathode	5	-------	-------	0
	Screen	6	SW-3	CW	532, 000
			SW-3	MOD	Infinity
	Plate	8	SW-3	CW	73, 000
			SW-3	MOD	Infinity
X-11	Suppressor	3	-------	-------	0
	Grid	4	-------	-------	10, 300
	Cathode	5	-------	-------	0
	Screen	6	-------	-------	68, 000
	Plate	8	-------	-------	20, 000
X-12	Grid	1	-------	-------	37, 000
	Plate	2	-------	-------	37, 000
	Cathode	3	-------	-------	300
	Grid	4	-------	-------	35
	Plate	5	-------	-------	62, 000
	Cathode	6	-------	-------	1, 000
X-13	Plate	3	-------	-------	68, 000
	Grid	5	-------	-------	500, 000
	Cathode	8	-------	-------	0
X-14	Plate	3	-------	-------	18, 600
	Screen	4	-------	-------	18, 600
	Grid	5	-------	-------	500, 000
	Cathode	8	-------	-------	0
X-15	Plate	3	-------	-------	19, 400
	Screen	4	-------	-------	19, 400
	Grid	5	-------	-------	320
	Cathode	8	-------	-------	750
X-16	Plate	3	-------	-------	19, 400
	Screen	4	-------	-------	19, 400
	Grid	5	-------	-------	320
	Cathode	8	-------	-------	750
X-18	Suppressor	3	-------	-------	0
	Grid	4	-------	-------	47, 000
	Cathode	5	-------	-------	0
	Screen	6	S-1	1, 2, or 3	47, 500
	Plate	8	S-1	1, 2, or 3	19, 500

(2) Power Supply Unit RA-74-D.

Socket ref symbol	Tube element	Pin No.	Variable controls		Resistance (ohms)
			Ref symbol	Setting	
X-1	Filament---	2	-------	-------	19, 500
	Plate------	4	-------	-------	40
	Plate------	6	-------	-------	40
	Filament---	8	-------	-------	19, 500
X-2	Filament---	2	-------	-------	22
	Plate------	4	-------	-------	Infinity
	Plate------	6	-------	-------	Infinity
	Filament---	8	-------	-------	22

Notes:
1. All measurements are made between indicated socket terminal and chassis of unit.
2. When there is a front panel control in the circuit which will affect the resistance, set it as shown in the chart to attain the listed resistance.

59. Test Equipment

The equipment listed below is necessary for the testing of this radio receiving equipment. All listed items must be in perfect working condition.

Item	*Description*
a. Signal generator-------	This generator should be an accurately calibrated instrument producing r-f signals (modulated 30 percent, 400 cps). The frequency range required is 100 kc to 40 mc. The generator should have an output up to 100,000 microvolts.
b. Output meter---------	The meter should respond to the modulation frequency of the signal generator, preferably 400 cps. The meter must have a resistance greater than 1,000 ohms per volt. This may be a part of item *g* below.
c. Crystal calibrator-----	This equipment is required for testing dial calibration accuracy and should be adjustable for the listed frequencies: 465 kc for i. f., 1.25 to 2.5 mc, 2.5 to 5 mc, 5 to 10 mc, 10 to 20 mc, 20 to 40 mc.
d. Spare radio receiver---	To be used in comparing quality.

Item	Description
e. Standard loudspeaker__	To be used in alining and in listening during operational tests.
f. High-impedance headset.	For same purpose as the speaker.
g. Volt-ohm-milliampere meter, 1,000 ohm-per-volt sensitivity.	Necessary equipment for meter resistance, voltages, etc.; may also be used as an output meter (see item *b* above).
h. Resistor, 600 ohms ± 5% or better, 10 watts.	For audio output load resistor.
i. Two resistors, 100 ohms each.	Use in series with signal generator and i-f load.
j. Capacitor, fixed, mica, 250 mmf.	For signal coupling.

60. Trouble-shooting Procedures

The accompanying trouble-shooting chart, if properly used, will simplify trouble shooting. The chart covers the sectionalization of trouble in the equipment. It lists the various symptoms which may be recognized easily by the operator and gives the probable location for the existing trouble as well as the recommended correction. It tells the operator whether the trouble is in the cabinet rack, radio receiver, or power supply. By proper use of the chart, the operator can isolate the trouble to one particular component of the equipment and thus save time that might otherwise be lost in checking components that are free of trouble.

Symptom	Probable trouble	Correction
a. Receiver does not operate.	(1) No a-c power. (2) Fuse blown. (3) Defective power transformer.	(1) Check line voltage. (2) Replace fuse. (3) Make resistance check on transformer; replace transformer if defective.
b. Receiver does not operate, but filaments light up.	(1) H-f oscillator not operating. (2) No voltage on oscillator plate. (3) Oscillator crystal not functioning. (4) Antenna shorted. (5) Antenna disconnected.	(1) Check oscillator tube. (2) Check oscillator circuits for continuity. (3) Check crystal. (4) Check antenna for short circuit. (5) Check antenna junction box connections.
c. Fading.	(1) One of the receiver channels not functioning.	(1) Check each channel separately.
d. No avc action.	(1) Defective tube V–11 or V–12. (2) Defective avc circuit component.	(1) Replace tube. (2) Check circuit.
e. Hum.	(1) Open filter capacitor. (2) Defective rectifier tube.	(1) Check power supply filter capacitors and replace if open. (2) Check rectifier tube V–1 and replace if defective.
f. Weak output.	(1) I-f circuit out of alinement. (2) Defective tube or tubes.	(1) Aline i-f circuit. (2) Replace tube or tubes found defective.
g. Distorion.	(1) Leaking coupling capacitor. (2) Defective tubes.	(1) Replace defective coupling capacitor. (2) Replace tubes.

61. General Trouble Checking

When checking for trouble, proceed according to the following order:

a. Fuses. Check the fuses in the power switchbox and the power supply unit.

b. Cables. Check all cabling against the cording diagram (fig. 13). Check the cable plus and make sure that pins establish good contact to the plug. Check all cables for continuity.

c. Power. When the power switch is closed, power will be applied to all of the units in the rack. If no power is present, as indicated by tube-socket voltage measurements, check the power supply and investigate the power cables leading from each power supply to each receiver. Check the tubes to see if they are burned out or if there is any breakage or looseness.

d. Tube Terminal Voltages. Check all filament and plate terminal voltages with those shown in paragraph 58*h*. If plate or screen voltages are consistently low or nonexistent throughout the unit, power supply trouble is indicated.

e. TUBE CIRCUITS. If trouble still persists, measure all resistances at tube-socket pins. When they do not agree with the values in paragraph 58*i*, check the circuit for defective connections, resistors, or capacitors. If all the voltages are of the proper value, the trouble is due to tube failure or to trouble in the circuits immediately associated with these tubes.

62. Detailed Trouble Checking

Even though the resistance and voltage measurements are apparently correct, the receiver may be inoperative, may have a low output, or may show signs of trouble. Probable causes of failure are listed in *a* below. If the trouble cannot be traced to conditions listed there, the defective stage may be located by signal substitution or signal tracing (*c* below). A simple test, called circuit distrubance test, for locating a faulty stage is to touch the control grid of each tube with the metal blade of an insulated screw driver, working back from the output section to the first r-f stage. If no click or hum is heard through the loudspeaker, the stage may be bad. Check the tubes. Touch the grid again; if there is still no response, the trouble may be located between the last point giving a response and the tube that seems dead. If a stage is defective, refer to the paragraph covering the stage under test (par. 57). Trace the trouble to the defective part or parts by resistance and voltage checks.

a. PROBABLE CAUSES OF FAILURE. (1) If the set is inoperative and the S meter deflects when the dial is rotated, it may indicate failure between the detector and the audio output stage. A check of the successive stages, beginning with the dectetor, may localize the failure.

(2) If the S meter does not deflect as the dial is rotated and the fuse in the power supply is not burned, a failure between the antenna and the detector or improper power supply voltage input may be indicated. Check voltage at input terminal and test for defective stage.

(3) Weak reception or partial deflection of the S meter may be caused by too low screen or plate voltage, shorted bypass capacitor in the plate circuit or in a return screen circuit, or a short in the SENSITIVITY control. A check of the plate and screen voltage in the r-f stages, mixer, and i-f stages and a check of the SENSITIVITY control for an open circuit may correct this.

(4) Distorted reception may be due to a shorted grid capacitor or a shorted coupling capacitor in the audio stages. To locate the defective audio stage use headphones with a 0.01-mf (microfarad) capacitor in series with one lead and the other lead grounded.

(5) Noisy reception and fading may be caused by a faulty contact in the SENSITIVITY or the AUDIO GAIN control, defective tubes, near-end life of batteries, faulty connections, or a defect in the antenna system.

(6) Heavy hum in the output may be caused by an open or partially shorted filter capacitor, defective choke coil in the power supply, or improper line voltage frequency.

(7) If the capacitors listed below are shorted, the parts listed may burn out.

Shorted capacitor	*May burn out*
C-16	R-14.
C-18A	R-15.
C-19A	R-17.
C-20A	R-21.
C-27	R-35.
C-43	R-47.
C-53	R-51.
C-57	Tuning coils of stage for frequency set on dial.
C-58	Tuning coils of stage for frequency set on dial.

b. AUDIO CIRCUIT CHECK. The audio circuit can be checked by using an audio signal generator connected to the AF INPUT terminals at the rear of the receiver, and a speaker attached to the AF OUTPUT terminals. For an a-f output voltage check, substitute for the speaker a 600-ohm load resistor. Check the output voltage across the 600-ohm resistor with an a-c voltmeter which has a minimum resistance of 1,000 ohms per volt. Set the front panel controls as shown below:

Control	*Setting*
SENSITIVITY	0.
AUDIO GAIN	Maximum.
SIGNAL MOD-CW	MOD.
AVC-MANUAL	MANUAL or AVC.
LIMITER	OFF.
CRYSTAL SELECTIVITY	OFF.
SEND-REC	SEND.
BAND WIDTH	3.

(1) Turn on the audio signal generator and inject a 400-cycle note into the audio circuit. A clear loud tone should be heard. To check the

circuit for proper output voltage, adjust the audio signal generator output for a 0.3-volt signal and connect it to the receiver. The receiver output should be approximately 42 volts (3 watts). These values are not critical.

(2) If the audio output is below normal, replace V–13, V–14, V–15, and V–16, in turn, and test as shown above after each tube substitution. If this does not correct the condition, see paragraph 57 for information on the individual stages and test all parts of the faulty stage.

c. Signal Tracing Analysis and Chart. (1) Signal tracing is a quick and effective method of locating a defective stage. A signal of variable strength for a standard receiver output is injected into each stage, starting from the third i-f stage and working forward to the antenna. Set the band switch for 10 to 20 mc and the other controls as shown below:

Control	*Setting*
SENSITIVITY	Maximum.
AUDIO GAIN	Maximum.
SIGNAL MOD-CW	CW.
AVC-MANUAL	MANUAL.
LIMITER	OFF.
CRYSTAL SELECTIVITY	OFF.
SEND-REC	REC.
BAND WIDTH	3.
CRYSTAL CONTROL	OFF.

Test point	*Antenna	1st r-f V-1 grid cap	2d r-f V-2 grid cap	Mixer V-3 grid cap	1st i-f V-5 grid cap	2d i-f V-6 pin 4	3d i-f V-7 pin 4
Signal frequency	10 mc	10 mc	10 mc	465 kc	465 kc	465 kc	465 kc
R-f generator output in microvolts.	0. 5 to 1. 0	1 to 4	6 to 16	25 to 60	180 to 540	2, 800 to 6, 200	50, 000 to 100, 000

*100 ohms total impedance for antenna input.

(2) Minimum and maximum signal voltages and generator frequency per stage are given for a standard output of 3 watts (42 volts). An r-f signal generator is used and is not coupled directly to the grid but is applied through a 250-mmf capacitor. If the applied signal within the limits given in the chart does not give a 3-watt (42-volt) receiver output across a 600-ohm load, the stage is not giving proper gain. Replace the tube, realine the receiver, and retest. If the stage is still abnormally low, check for a faulty component by referring to the voltage and resistance data (par. 58*h* and *i*) and description of component parts (par. 57) for each individual stage.

d. Measuring Individual Stage Gain. The ratios listed below are those of the voltage appearing at the following stage to that applied to the stage under test to obtain a given output from the receiver. The third i-f is computed against an input of 300,000 microvolts to the second detector for a 3-watt (42-volt) output. Apply the signal in succession to each stage from the third i-f stage to the antenna. The signal frequency (400 cps, 30 percent modulated) should be the same for each stage.

Stage	*Ratio*
3d i-f	4:1
2d i-f	17:1
1st i-f	14:1
Mixer	7:1
2d r-f	3:1
1st r-f	5:1
Antenna	4:1

Section XII. REPAIRS

63. Replacement of Parts

a. Most of the parts of Radio Receiving Set AN/FRR–12 are readily accessible and are easily replaced if they are found to be faulty. If the r-f tuning unit of the receiver requires replacement, carefully mark with tags or other devices the wires connecting to the unit, to avoid misconnection when the new unit is installed. Follow this procedure whenever replacement requires the disconnection of numerous wires.

b. To replace the crystal-controlled h-f oscillator unit, tag all connecting wires in the manner described in *a* above. Allen wrenches are provided, attached to the side of the unit, for loosening front panel knob setscrews.

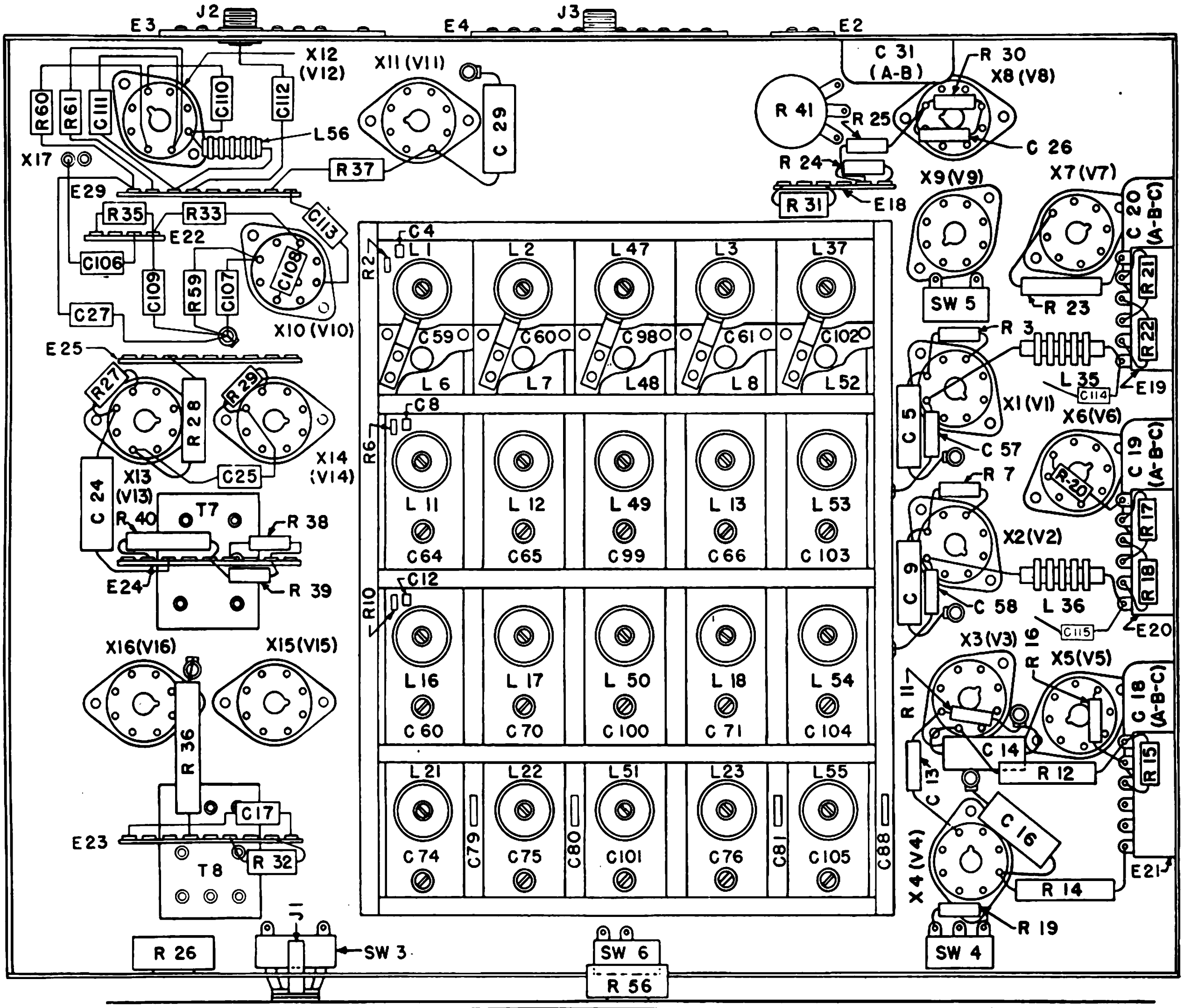


Figure 19. Radio Receiver R–270/FRR, location of parts.

64. Emergency Repairs

In emergencies, it is sometimes possible to perform field expedients in order to obtain operation from a faulty equipment. Among such expedients are the replacement of a defective resistor with another of incorrect size, the shorting out of defective decoupling or isolating resistors, the disconnecting of leaky or shorted decoupling or cathode bypass capacitors, etc. Whenever field expedients are used, however, a normal repair and parts replacement operation should be performed after the emergency has passed.

65. Rustproofing and Repainting

When the receiver is functioning properly, see TB SIG 13 and process the equipment as directed. Straighten out any dents on the cover case before replacing the cover on the chassis. Touch up all scratches with black wrinkle enamel, class 541. Clean the nameplate and retouch the background where necessary. Refinish front panels with gray metal primer, class 101, or lusterless gray air drying or baking enamel, class 101.

66. Unsatisfactory Equipment Report

a. WD AGO Form 468 (War Department Unsatisfactory Equipment Report) for Equipment Used by the Army. WD AGO Form No. 468 will be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C., when trouble occurs more often than is normal, as determined by qualified repair personnel.

b. AF Form 54 (Unsatisfactory Report) for Equipment Used by the Air Force. AF Form 54 will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, in accordance with AF Regulation 15–54.

Section XIII. ALINEMENT AND ADJUSTMENT

67. Required Test Equipment

The following items (all of which, except items *k* and *l*, are described in paragraph 59) will be required in the alinement of the receiver:

a. Signal generator; must be capable of being frequency-modulated.
b. Output meter.
c. Crystal calibrator.
d. Spare radio receiver.
e. A standard loudspeaker.
f. High-impedance headset.
g. Volt-ohm-milliampere meter.
h. Resistor, 600 ohms.
i. Two resistors, 100 ohms.
j. Capacitor, 250 mmf.
k. Insulated screw driver, 9/64 inch wide by 0.025 inch thick at bit.
l. Cathode-ray oscillograph, RCA type 155C or equivalent.

68. Receiver Alinement and Adjustment

a. PRELIMINARY OPERATIONS. The receiver to be alined must be disconnected, removed from the cabinet rack, and placed on a test bench. Remove cover case and bottom plate for access to the components on the chassis. Connect the power supply to terminal board E–4 as for conventional operation. Connect the output meter in parallel with a 600-ohm load resistor to the AF OUTPUT terminals on terminal board E–3. The alinement procedure is described for only one frequency band. The procedure for all bands is the same except for the input signals. All bands are to be properly alined at their operating frequencies.

b. I-F ALINEMENT. (1) Adjust the signal generator to 465 kc, and connect the output to the control grid cap of the mixer tube (V–3) through a fixed capacitor (approximately 250 mmf). Set front panel controls as follows:

Control	*Setting*
SENSITIVITY	0.
AVC-MANUAL	MANUAL.
SIGNAL MOD-CW	MOD.
SEND-REC	REC.
BAND SWITCH	2.5–5.0 mc.
AUDIO GAIN	10.
CRYSTAL SELECTIVITY	OFF.
PHASING	On arrow.
BAND WIDTH	3.
BAND SPREAD	100.
XTALS 1 2 3 OFF	OFF.

(2) Set the MAIN TUNING dial near 2.5 mc, without tuning in a powerful local signal. Set the CRYSTAL SELECTIVITY switch on 3 and the AVC-MANUAL switch on AVC, and advance the SENSITIVITY to 10. Turn off the modulation of the signal generator and adjust its frequency slightly until maximum deflection is attained on the S meter. The adjustment of the signal gen-

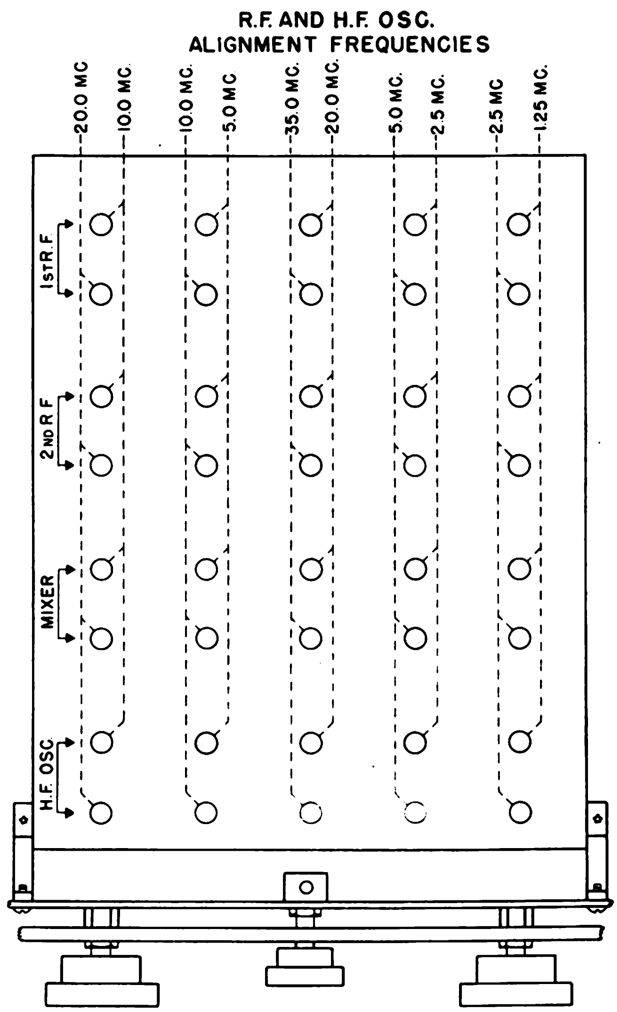


Figure 20. Radio Receiver R—270/FRR, alinement chart.

erator in this manner is necessary to get exact agreement with the natural period of the particular quartz crystal in the receiver being alined. After the SENSITIVITY is reduced to 0, the modulation may be switched on, but the tuning of the signal generator must not be altered until the alinement is completed. Return the CRYSTAL SELECTIVITY and AVC-MANUAL controls to their original settings of OFF and MANUAL and advance the SENSITIVITY control until a half-scale output reading of between 5 and 10 volts is obtained. Check the alinement of both upper (grid) and lower (plate) air trimmer capacitors in i-f transformers T–2 and T–3 and the single trimmer in T–4 for peak reading of the output meter. If one or more of these adjustments results in a sizable increase of output, reduce the SENSITIVITY control enough to bring the meter reading back to half-scale. Alinement of the plate circuit of the crystal filter (T–1) can be tested in the same way by means of the lower adjusting screw on the side of T–1. This screw varies the position of the powdered iron core of coil L–26.

Caution: Do not change the setting of the upper adjusting screw which tunes grid coil L–27; this circuit cannot be adjusted properly with the output meter. It can be alined by the use of the f-m signal generator and cathode-ray oscillograph as explained in paragraph 69.

c. ALINEMENT CHECK. Leave all other controls as above, and do not change the signal generator frequency. Reduce AUDIO GAIN to 0, switch to AVC, and increase SENSITIVITY to 10. Increase AUDIO GAIN to restore half-scale reading on the output meter and adjust the single trimmer capacitor in T–6 for minimum outout meter reading. The S meter should peak at the same time that the output meter reading dips.

d. BEAT-FREQUENCY OSCILLATOR ALINEMENT. (1) *When used as crystal controlled oscillator for frequency shift teletype reception.* Additional frequency standards and a test crystal for use in the crystal-controlled h-f oscillator unit are required for this alinement. The test crystal should permit the production of a 465-kc i. f. when a signal (for example, 5,000 kc) is obtained from a primary frequency standard or from a secondary frequency standard which can be instantaneously calibrated against a primary frequency standard. Keep all controls set as for the alinement check except as follows:

Control	*Setting*
SIGNAL MOD-CW	On CW.
XTALS 1 2 3 OFF	On position containing test crystal.
Δ FREQ	At center position.
BEAT OSCILLATOR	At 0 (zero).

Feed a standard signal into the receiver from the antenna connection at an amplitude to get a reading on the output meter. Adjust the trimmer in the bottom of T–5 so that a measurement of a-f output is at a frequency of 2,550 cps ±25 cycles.

(2) *When used as free running oscillator.* Remove the bfo crystal, Y–2, and short-circuit the socket terminals with a piece of bus-wire. Keep all controls as in the alinement check, switch off the output meter, and plug in a pair of headphones or a suitable loudspeaker. Throw the SIGNAL MOD-CW switch to CW and see that the BEAT OSCILLATOR control is at exactly 0 (zero). Readjust the trimmer capacitor near the bottom of T–5 until the tone in the phones or speaker is at its lowest pitch (zero beat). If the bfo is in perfect alinement, no sound will be heard, since the signal generator and the bfo will be oscillating at the same frequency with no audible difference or beat. This can be checked by turning the control off zero, toward either side. If this operation causes a tone which rises in pitch as the pointer is moved out, the beat-frequency oscillator may be considered operating perfectly.

Note. The bfo must be alined as discussed in *d* (2) above before checking h-f oscillator calibration. After h-f oscillator calibration is completed, realine the bfo as discussed in *d* (1) above.

e. HIGH-FREQUENCY OSCILLATOR CALIBRATION CHECK. The accuracy of the main dial calibration depends solely on the h-f oscillator frequency which, on all bands of the receiver except the 20- to 40-mc band, is 465 kc (the i. f.) higher than the signal frequency. The h-f oscillator frequency is 465 kc below the signal frequency on the 20- to 40-mc band. To check calibration, tune in signals of known frequency on each band and note the main dial reading. If it does not agree with the known frequency of the signal being received, the calibration is off. To correct dial calibration see the alinement chart (fig. 20) for location of h-f oscillator adjustments as well as the signal frequencies at which adjustments should be made. The signal generator may be set for the lower end of the band, and its second harmonic, if strong enough, may be used at the upper end. The output of the signal generator should be unmodulated, and the SIGNAL MOD-CW switch on the receiver should be set at CW, the BEAT OSCILLATOR control at zero, and the BAND WIDTH at 16. Disconnect output meter and use headphones or a loudspeaker to make the necessary adjustments by the zero beat method. The signal generator is to be connected to the antenna input for this test. If this test is made, for example, on the 2.5- to 5.0-mc band and the signal generator is tuned for 2.5 mc, the second harmonic may be used at the 5.0-mc end of the band. Tune in the second harmonic at the 5.0-mc end of the dial to zero beat. If the dial is off the 5.0-mc calibration line, turn the dial toward the correct setting just enough to set up a high-pitched tone but not enough to go above audibility. With the alinement screwdriver, adjust the 5.0-mc h-f oscillator trimmer capacitor (fig. 20) until the beat is returned to zero. Repeat this until the dial has been returned to a correct reading and zero beat. After alining the 5.0-mc end of the band, tune the 2.5-mc fundamental at the l-f (low-frequency) end of the main dial, and correct the calibration step by step as before, using the inductance trimming adjustment h-f oscillator (2.5 mc). The 5.0-mc end will now be found out of line again, when tuned, since the adjustment at one end of the band affects the other end of the band. A back-and-forth check and readjustment will be necessary to bring both ends of this band into exact agreement with signal frequency and dial calibration.

Caution: Adjust the SENSITIVITY control carefully to avoid overloading or the reception of spurious signals due to greatly increased amplification.

f. Crystal Controlled High-Frequency Oscillator Calibration. The calibration of the h-f crystal controlled oscillator depends entirely on the crystal switched into the circuit.

g. R-F and Mixer Alinement. Accurate calibration and modulation of the signal generator is not required to check these adjustments. The input to the antenna connector should be through approximately 100 ohms, including the output resistance of the signal generator. If the signal generator is modulated, the receiver controls should be set as for i-f alinement; if unmodulated, set BEAT OSCILLATOR knob to 2 (on either side) and SIGNAL MOD-CW switch to CW. Adjust SENSITIVITY to produce a half-scale reading on the output meter when the signals are exactly in tune. Starting with the 2.5- to 5.0-mc band, set the main dial at 5.0 mc with BAND SPREAD dial at 100, and adjust the frequency of the signal generator to peak deflection of the output meter. Check the setting of the 5.0-mc mixer trimmer (fig. 20). Repeat this procedure on trimmers indicated as 2d RF and 1st RF in the same row. If readjustment of the settings result in an increase in output meter reading, alter the SENSITIVITY control to reduce the reading to half-scale. Check the tuning of the receiver after each adjustment to see that the test signal is accurately tuned. The BAND SPREAD control may be used as a vernier for this purpose on the bands in which it operates.

Note. This tuning check is extremely important at the high end of the 20- to 40-mc band where there is some slight interaction between the mixer and h-f oscillator circuits. After checking the three trimmers at the high end of this band, turn the main dial to 2.5 mc and retune the signal generator to suit. Check the three inductance adjuster settings marked 2.5 mc in the same row. Since adjustments at one end of the band also affect the other end of the band, it will be necessary to repeat the procedure until no further improvement can be secured. The rest of the ganged capacitors can be checked in the same manner. For greatest efficiency with a particular antenna arrangement, the r-f circuits may be adjusted without being disconnected. This can be done by loosely coupling the output of the signal generator to the antenna system, instead of directly to the antenna terminals through a 100-ohm resistor. The signal from the signal generator must reach the receiver by way of the antenna, not by some form of indirect coupling. Headphones or a speaker should be used on all tests to monitor the signal to avoid false adjustments due to overloading and freakish or spurious signal responses.

h. "S" Meter Calibration. With test conditions given in *g* above, the signal generator input to the antenna connector, through 100 ohms, should be adjusted to 50 microvolts at 3.5 mc. Set the AVC-MANUAL switch to AVC, the SENSITIVITY control to 10, and rotate the MAIN TUNING control for maximum indication on the "S" meter. Then adjust potentiometer R–41 for full deflection of the indicating needle on the meter (number 9).

69. Alinement with Modulated Signal Generator and Oscillograph

Connect the input of the oscillograph vertical plates to the AF INPUT terminals on terminal board E–3 located on the rear skirt of the chassis. The high terminal is the second one from the end of the strip, the first terminal being connected to the chassis. Use external synchronizing signal from the signal generator for horizontal sweep. Set the signal generator to 465 kc and connect its output to the control grid cap of the mixer (V–3) through a fixed capacitor, approximately 250 mmf. With the CRYSTAL SELECTIVITY switch and XTALS control at OFF, readjust the signal generator frequency to produce the conventional single-peaked resonance curve on the screen of the oscillograph. Now turn the CRYSTAL SELECTIVITY switch to position 1. If the first i-f grid coil (L–27) is correctly tuned, the image on the oscillograph screen will remain symmetrical but will be only about two-thirds as wide as before, indicating an increase in selectivity. The oscillograph image is also affected by the PHASING control, maximum symmetry occurring at or very near the arrow on the PHASING control scale. Therefore, when tuning L–27, slowly rotate the front panel PHASING back and forth at the same time to secure closest adjustment.

70. Minimum Test Requirements

After the receiver has been moistureproofed and fungiproofed (sec. IX), it is necessary to make the final tests outlind in this paragraph to be sure that the receiver meets the minimum standards required of Signal Corps class A equipment. The following tests are described:

Beat-frequency oscillator.
Calibration accuracy.
Sensitivity (amplitude-modulated signal).
Signal-plus-noise to noise power ratio.
I-f output voltage.
Sensitivity (c-w signal).
Selectivity (without crystal).
Selectivity (with crystal).
Image rejection ratio.
I-f rejection ratio.
Avc characteristic.
Power output to speaker (modulated signal).
Power output to speaker (c-w signal).
Power output at phone jack.

a. Alinement Check. Although the receiver was correctly alined during the repair procedure, a recheck of this alinement is required after moistureproofing and fungiproofing has been completed. Check alinement with procedure outlined in paragraphs 68 and 69.

b. Test Conditions. (1) Unless otherwise specified, all the tests outlined shall be made with the panel controls, or switches, set as follows:

Control	*Setting*
CRYSTAL SELECTIVITY	OFF.
PHASING	On arrow.
BAND WIDTH	3.
LIMITER	OFF.
AVC-MANUAL	AVC.
SENSITIVITY	10.
BAND SPREAD	100.
SIGNAL MOD-CW	MOD.
AUDIO GAIN	6.
SEND-REC	REC.
BEAT OSCILLATOR	0.
OFF-ON	ON.
MAIN TUNING	As desired.
S meter	Maximum indication.
XTALS 1 2 3 OFF	OFF.

(2) If the receiver meets voltage and resistance requirements and appears to be properly alined but still fails to meet the minimum requirements of a test, check the conditions shown in the following table as possible sources of trouble. In all cases check the test equipment for accuracy before using it in a test, and see that it is correctly hooked up to the receiver. Be sure the power supply is delivering proper power to the receiver.

Test	Possible trouble causes
Beat-frequency oscillator.	Does not oscillate at the i-f frequency on the zero setting.
Calibration accuracy	Signal generator used in alineing not correctly calibrated. Alinement off.
Sensitivity	Low emission of tubes or alinement off.
Signal - plus - noise to noise.	Microphonic tubes. Ungrounded shields.
Selectivity	I-f alinement off.
Image and i-f rejection.	Interstage coupling leads too long. Leads not properly spaced.
AVC characteristic	Alinement off.
Power output	Low emission of tubes. Alinement off.

(3) Use a crystal calibrator to supply an r-f input for the calibration accuracy test. A signal generator which is of correct frequency and which is capable of producing r-f voltage modulated 30 percent at 400 cps is to be used on all other tests requiring an r-f input to the antenna.

(4) Apply all r-f input signals to the receiver through a 100-ohm dummy antenna.

(5) Measure all output voltages with an output meter across a 600-ohm load.

(6) All values given are based on the use of Power Supply Unit RA–74–D.

c. BEAT-FREQUENCY OSCILLATOR. (1) Apply an unmodulated signal from an r-f signal generator to the dummy antenna of the receiver being tested.

(2) Set SIGNAL MOD-CW switch on CW. The a-f output should then be 2,550 cps±25 cycles.

(3) If no tone is present in the output, trouble is indicated in the i-f stages or in the bfo circuit.

d. CALIBRATION ACCURACY. (1) Connect a suitable crystal calibrator with 100-kc and 1,000-kc secondary frequency standard (accurate to 0.01 percent) to antenna connection of receiver under test.

(2) Set SIGNAL MOD-CW switch to CW.

(3) Inject a signal from the calibrator at each of the low-, middle-, and high-frequency points of each band. A 2,550-cps tone will be present at the output.

(4) Dial calibration shall be within 1.0 percent of perfect accuracy.

(5) A probable cause of inaccurate dial calibration is the use of an off-calibration signal generator during alinement.

e. SENSITIVITY, AMPLITUDE-MODULATED SIGNAL, AND SIGNAL-PLUS-NOISE TO NOISE POWER RATIO. (1) Apply a 30-percent modulated signal from the r-f signal generator to the antenna connector of the receiver through a dummy antenna.

(2) Make tests at low-, middle-, and high-frequency points of each band.

(3) AUDIO GAIN control may be changed to give 17.3 volts output (500 mw).

(4) Minimum requirements:

Input (microvolts)	Frequency band	*Output voltage (with signal modulated)	†Max output voltage (signal not modulated)	Power ratio (calculated)
5	20–40 mc	17. 3	8. 6	4:1
2	10–20 mc	17. 3	8. 6	4:1
2	All other bands	17. 3	5. 5	10:1

*Adjust AUDIO GAIN to attain listed value.
†Do not change setting of AUDIO GAIN control.

f. I-F OUTPUT VOLTAGE. Under the conditions listed in *e* above, measure the i-f output across a 100-ohm load at the IF OUTPUT jack J2. The i-f output should measure at least 200 millivolts.

g. SENSITIVITY, C-W SIGNAL. (1) Apply a c-w signal from the r-f signal generator to the antenna terminals of the receiver through a dummy antenna and place SIGNAL MOD-CW control on CW.

(2) Make tests at low-, middle-, and high-frequency points of each band.

(3) Minimum requirements:

Input (microvolts)	Frequency band	*Output voltage (bfo on)	†Max output voltage (bfo off)	Power ratio (calculated)
1.5	20–40 mc	17. 3	8. 6	4:1
0.6	10–20 mc	17. 3	8. 6	4:1
0.6	All other bands	17. 3	5. 5	10:1

*Adjust AUDIO GAIN control to attain listed value, across 600-ohm load.
†Do not change setting of AUDIO GAIN control; change SIGNAL MOD-CW control to MOD.

h. SELECTIVITY WITHOUT CRYSTAL. Set the controls to the standard test conditions (*b* above) except for the following control settings:

Control	*Setting*
AVC-MANUAL	MANUAL.
AUDIO GAIN	At maximum.

(1) Test the receiver at the test frequency of 1,300 kc.

(2) Apply a 100-microvolt, r-f signal at the test frequency given for the receiver under test. Modulate the test signal 400 cps.

(3) Adjust the SENSITIVITY control to obtain a reading of 17.3 volts on the output meter.

(4) Increase the strength of the test signal from 100 to 1,000 microvolts (10 times test signal) and check bandwidth against the minimum requirements table below. Then increase to 100 times and again to 1,000 times the test signal strength and check the bandwidth.

Input signal strength	Bandwidth
10x (1,000 microvolts)	3.5 to 7 kc.
100x (10,000 microvolts)	Below 12 kc.
1,000x (100,000 microvolts)	Below 18 kc.

(5) To determine the bandwidth, proceed as follows:

(*a*) When steps 1 through 3 above have been completed and the test signal strength is increased 10 times in accordance with step described in (4) above, the output meter should register a decided increase in output voltage.

(*b*) Turn the r-f signal to either side of the test frequency. The output voltage should drop.

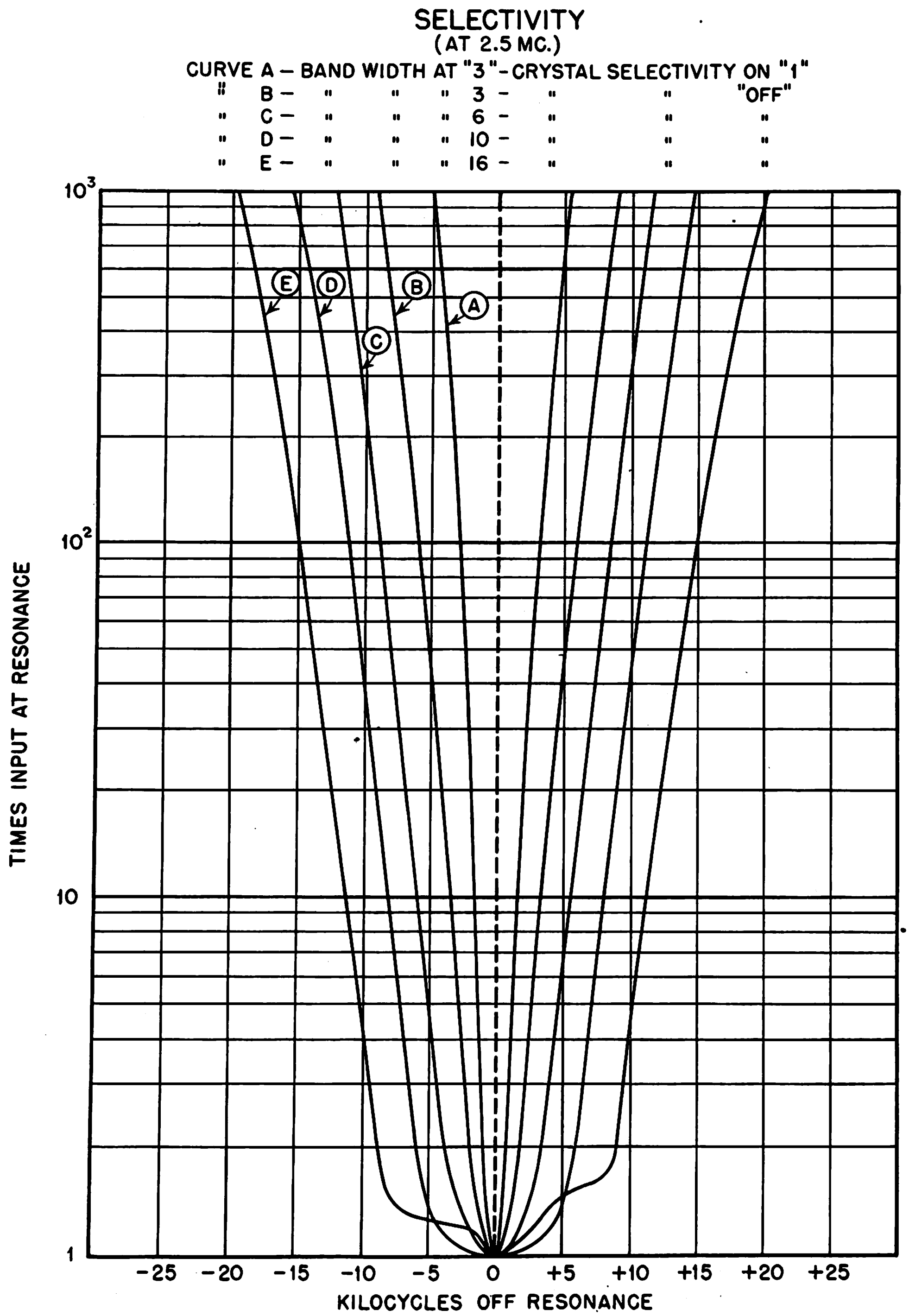


Figure 21. Radio Receiver R–270/FRR, selectivity chart.

When the output voltage drops to exactly 17.3 volts the signal generator frequency at that point is the bandwidth limit on one side of the test frequency.

(c) Turn the r-f signal in the reverse direction until the bandwidth limit on the other side is reached. This will occur when the output voltage passes through its peak and drops to exactly 17.3 volts again.

(d) The difference between the frequency on each side of the resonant frequency is the bandwidth in kc or mc.

i. SELECTIVITY WITH CRYSTAL. (1) This test is made in the same manner as the test without crystal, as described in *h* above, except for the following:

(*a*) Change the CRYSTAL SELECTIVITY control from OFF to the 4 position.

(*b*) Apply a 10,000-microvolt r-f signal at the test frequency of 1,300 kc, modulated 30 percent at 400 cps.

(2) The total bandwidth should be less than 5 kc.

j. IMAGE REJECTION RATIO. (1) *Minimum requirements.*

Test frequency (kc)	Rejection ratio
200	100,000 to 1.
400	100,000 to 1.
1,160	100,000 to 1.
2,500	9,000 to 1.
5,000	3,000 to 1.
10,000	800 to 1.
20,000	100 to 1.
40,000	30 to 1.

(2) *Test.* (*a*) *Conditions.* Same as *b* above except for the following control settings:

Control	*Setting*
AVC-MANUAL	On MANUAL.
AUDIO GAIN	On maximum.

(*b*) *Procedure.* Adjust the signal generator for the desired r-f test signal. Set the signal generator for a 5-microvolt signal, modulated at 400 cps. Tune the receiver to resonance at the test signal frequency. Adjust the receiver SENSITIVITY control for an output of 17.3 volts. Increase the frequency of the test signal 930 kc (twice the i. f.). Multiply the original 5-microvolt signal generator output by the rejection ratio given in the table in (1) above for a particular test frequency. For example, with a test frequency of 2,500 kc this would be 5 microvolts times 9,000 (9,000 to 1) or 45,000 microvolts. This increased signal generator output must not result in a receiver output of more than 17.3 volts (500 mw). Be sure that the receiver SENSITIVITY control is not disturbed after it has been set for a 17.3-volt output from a 5-microvolt input.

k. I-F REJECTION RATIO. (1) *Minimum requirements.*

Test frequency (kc)	Rejection ratio
200 and down	100,000 to 1.
400	100 to 1.
540	100 to 1.
1,250 and up	100,000 to 1.

(2) *Test.* (*a*) *Conditions.* Same as *b* above except for the following control settings:

Control	*Setting*
AVC-MANUAL	On MANUAL.
AUDIO GAIN	On maximum.

(*b*) *Procedure.* Adjust the signal generator for the desired r-f test signal. Set the signal generator for a 5-microvolt signal, modulated at 400 cps. Tune the receiver to resonance at the test signal frequency. Adjust the receiver SENSITIVITY control for an output of 17.3 volts. Tune the signal generator to 465 kc. Multiply the original 5-microvolt signal generator output by the rejection ratio for a particular test frequency. This increased signal generator output must not result in a receiver output of more than 17.3 volts.

l. AVC CHARACTERISTIC. (1) *Condition.* Same as *b* above.

(2) *Test.* (*a*) Apply a 5-microvolt, 2.5-mc r-f signal, modulated at 400 cps, through a 100-ohm dummy antenna to the receiver and tune the receiver to resonance.

(*b*) Adjust AUDIO GAIN for a 10-volt output.

(*c*) Increase the input signal from 5 to 50,000 microvolts.

(*d*) The output should not increase to more than 50 volts.

m. POWER OUTPUT TO SPEAKER (MODULATED SIGNAL). (1) *Conditions.* Same as *b* above with the exception of the following control settings:

Control	*Setting*
AVC-MANUAL	On MANUAL.
SENSITIVITY	On maximum.
AUDIO GAIN	On maximum.

(2) *Test.* Apply a 1,000-microvolt, 2.5-mc r-f signal, modulated at 400 cps, through a 100-ohm dummy antenna to the receiver. The voltage output should not be less than 42 volts.

Caution: If the output is above 42 volts allow the receiver to remain on for only a short time.

n. POWER OUTPUT TO SPEAKER (C-W SIGNAL). (1) *Conditions.* Same as *b* above with the exception of the following control settings:

Control	Setting
AVC-MANUAL	On MANUAL.
AUDIO GAIN	On maximum.
SIGNAL MOD-CW	On CW.

(2) *Test.* (*a*) Apply a 1,000-microvolt, 2.5-mc r-f signal, unmodulated at 400 cps, through a 100-ohm dummy antenna to the receiver and tune the receiver to resonance.

(*b*) Adjust the SENSITIVITY control for maximum output.

(*c*) The output should not be less than 42 volts.

o. Power Output at Phone Jack. (1) *Conditions.* Same as *b* above except for the following control settings and condition:

Control	Setting
AVC-MANUAL	ON MANUAL.
AUDIO GAIN	On maximum.

Output to be measured at the phone terminals across an 8,000-ohm resistive load.

(2) *Test.* (*a*) Apply a 1,000-microvolt, 2.5-mc r-f signal, modulated at 400 cps, through a 100-ohm dummy antenna to the receiver and tune the receiver to resonance.

(*b*) Adjust the SENSITIVITY control for an output of 17.3 volts across the 600-ohm output terminals.

(*c*) Measure the output voltage developed across the 8,000-ohm load.

(*d*) The output should be at least 8.3 volts.

p. Receiver Operational Test. Perform an operational test on the radio receiver, using the regular power supply of the receiver, to ascertain whether the unit is functioning properly. This test is a listening test on received signals from a radio transmitter. Signals received by the set under test should be clear and intelligible. Extraneous noises and intermittent or microphonic conditions should not be present when the set under test either is tapped several times with a padded mallet to simulate vibration or is operated on a vibrating table.

q. Operational Test of Radio Receiving Set AN/FRR-12. If for some reason one channel, consisting of one receiver and power supply, becomes disabled, Radio Receiving Set AN/FRR-12 will work, although in an inferior manner. For example, one tube might become weak, a stage might become detuned, or, by error, the SENSITIVITY control of one receiver might be left at a low setting. It is desirable, therefore, to listen to the outputs of the two receivers occasionally to determine whether they are similar. When the receiving equipment is to be used for teletype reception, another test which may be useful is as follows: Watch the received copy while disabling first channel A receiver then channel B receiver, and note whether the copy is similar in each case. It is not advisable to use this procedure on a circuit which is in standard service.

APPENDIX I
REFERENCES

Note.—For availability of items listed, check FM 21-6 and Department of the Army Supply Catalog SIG 1. Also see FM 21-6 for applicable technical bulletins, supply bulletins, modification work orders, and Changes.

1. Color Codes

Use fixed resistor and fixed capacitor color codes (page 559 of JANP 109, or figs. 22 and 23).

2. Supply Publications

SIG 1, Introduction and Index.
SIG 3, List of Items for Troop Issue.
SIG 4–1, Allowances of Expendable Supplies for Technical Organizations.
SIG 4–2, Allowances of Expendable Supplies for Schools, Training Centers, Boards, and Fixed Installations.
SIG 5, Stock List of All Items.
SIG 10, Fixed Plant Maintenance Lists.
SB 11–76, Signal Corps Kit and Materials for Moisture- and Fungi-resistant Treatment.
SB 11–17, Electron Tube Supply and Reference Data.

3. Technical Manuals on Auxiliary Equipment and Test Equipment

TM 11–278, Frequency Shift Exciters 0–39/TRA–7 and 0–39A/TRA–7, Dual Diversity Converters CV–31/TRA–7 and CV–31A/TRA–7, and Control Units C–292/TRA–7 and C–292A/TRA–7.
TM 11–300, Frequency Meter Sets SCR–211–( ).
TM 11–303, Test Sets I–56–C, I–56–D, I–56–H, and I–56–J.
TM 11–307, Signal Generators I–72–G, –H, –J, and –K.
TM 11–321, Test Set I–56–E.
TM 11–356, Radio Teletype Terminal Equipment AN/FGC–1 or AN/FGC–1X.
TM 11–472, Repair and Calibration of Electrical Measuring Instruments.
TM 11–866, Radio Receivers BC–779–A, –B; BC–794–A, –B; BC–1004–B, –C, –D; and R–129/U; Power Supply Units RA–74–B, –C; RA–84–A, –B; and RA–94–A; Radio Sets SCR–244–A, –B; SCR–704; and AN/FRR–4 (Hammarlund Super Radio Receiver).
TM 11–2611, Antenna Kit for Rhombic Receiving Antenna.
TM 11–2613, Voltohmmeter I–166.
TM 11–2626, Test Unit I–176.
TM 11–2627, Tube Tester I–177.
TM 11–2629, Antenna Kit for Double-Doublet Receiving Antenna.

4. Painting and Preserving

TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment.

5. Shipping Instructions

U. S. Army spec No. 110–14A, Army-Navy General Specification for Packaging and Packing for Oversea Shipment.

6. Decontamination

TM 3–220, Decontamination.

7. Demolition

FM 5–25, Explosives and Demolitions.

8. Camouflage

FM 5–20, Camouflage, Basic Principles.

9. Other Publications

FM 21–8, Military Training Aids.
FM 21–40, Defense Against Chemical Attack.
FM 24–6, Radio Operator's Manual, Army Ground Forces.
FM 24–18, Radio Communication.
TB SIG 5, Defense Against Radio Jamming.
TB SIG 66, Winter Maintenance of Signal Equipment.
TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

TB SIG 75, Desert Maintenance of Ground Signal Equipment.
TM 1–455, Electrical Fundamentals.
TM 11–227, Signal Communication Equipment Directory, Radio Communication Equipment.
TM 11–310, Schematic Diagrams for Maintenance of Ground Radio Communications Sets.
TM 11–314, Antennas and Antenna Systems.
TM 11–453, Shop Work.
TM 11–454, The Radio Operator.
TM 11–455, Radio Fundamentals.
TM 11–462, Signal Corps Reference Data.
TM 11–483, Suppression of Radio Noises.
TM 11–496, Training Text and Applicatory Exercises for Amplitude-modulated Radio Sets.
TM 11–499, Radio Propagation Handbook.
TM 38–650, Basic Maintenance Manual.

10. Forms

WD AGO Form 468 (Unsatisfactory Equipment Report).
AF Form 54 (Unsatisfactory Report).

11. Abbreviations and Symbols

a-c	alternating-current.
a-f	audio-frequency.
afc	automatic frequency control.
a-m	amplitude-modulated.
avc	automatic volume control.
bfo	beat-frequency oscillator.
c-w	continuous-wave.
cps	cycle(s) per second.
db	decibel(s).
dc	direct current.
f-m	frequency-modulated.
h-f	high-frequency.
h-v	high-voltage.
i-f	intermediate-frequency.
ic-w	interrupted continuous-wave.
kc	kilocycle(s).
l-f	low-frequency.
mc	megacycle(s).
mc-w	modulated continuous-wave.
mf	microfarad(s).
uumf	micromicrofarad(s).
mw	milliwatt(s).
uv	microvolt(s).
r-f	radio-frequency.
xtal	crystal.

APPENDIX II

IDENTIFICATION TABLE OF REPLACEABLE PARTS

Note. The fact that an item appears in this technical manual is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as T/O&E, TE, TA, T/BA, SIG 6, SIG 7&8, SIG 7–8–10, SIG 10, list of allowances of expendable material, or another authorized supply basis. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1.

1. Identification Table of Replaceable Parts for Radio Receiving Set AN/FRR–12

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	RADIO RECEIVING SET AN/FRR–12: AM and CW; 1250 to 40,000 kc in 5 bands; 95/105/117/130/190/210/234/260 v AC, single ph, 25–60 cyc, 400 w input; mtd in Rack MT 660 ( )/FRR–12; 76″ h x 22″ wd x 18″ d overall; incl 2 ea Radio Receiver R–270/FRR and 2 ea Power Supply Unit RA–74–D; ea receiver has crystal controlled VFO and BFO and IF output jacks; crystal control available from 1.5 to 26 mc; incl spare tubes, fuses, etc; US Army spec #71–3280.	For radio communication and special radio teletype reception.	
	TECHNICAL MANUAL: TM 11–896		(Order thru AGO channels).
	POWER SUPPLY UNIT RA–74–D: electronic type; output 380 v DC at 50 ma, 250 v DC at 100 ma, approx 100 v DC at 4.5 ma, "C" bias approx 50 v DC at 11 ma; input 95/105/117/130/190/210/234/260 v AC, single ph. 25–60 cyc, 180 w; chassis w/std 19″ rack panel; 19″ lg x 10½″ h x 10″ d; 1 Tube JAN–5Y3GT half-wave; 1 Tube JAN–5U4G full-wave; built-in filter; Wecco part/dwg #W–030W25–GRP1.	Supplies ac and dc for radio receivers.	3H4496–74D
	RACK MT–660 ( )/FRR–12: equipment housing; steel, black wrinkle finish outside; smooth black enamel inside; w/contents; contains 6 black panels; fusible switch box, Wiremold w/6 std AC receptacles, 2 ceramic feed-thru bushings, ground bus w/5 braided ground leads and term junction box w/2 interconnecting twin-axial cable assemblies; 76″ h x 22″ wd x 18″ d; 2 pull ring type snap catches located on door; door louvered and screened for ventilation; Wecco part/dwg #T–041W25–1.	Houses components.	
	RADIO RECEIVER R–270/FRR: AM and CW; 1250 kc to 40,000 kc in 5 bands; 95/105/117/130/190/210/234/260 v AC, single ph, 25–60 cyc, 200 w; chassis only w/std 19″ rack panel; 19″ lg x 10½″ h x 15⅝″ d; 17 tubes superheterodyne receiver incl crystal controlled VFO and BFO and IF output jack; crystal control from 1.5 to 26 mc; Hammarlund #2957–GI (modified).	For radio communication and special radio teletype reception.	2C4180.270

2. Identification Table of Replaceable Parts for Rack MT–660 ( )/FRR–12

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	RACK MT–660( )/FRR–12: Steel, black wrinkle finish: incl panels, switchbox, a-c receptacles, bushings, cable assemblies and wiring; 76″ h x 22″ wd x 18″ d; Wecco part/dwg #T–041W25–1.	Housing for Radio Receiving Set AN/FRR–12 components.	
E–209, E–211	ADAPTER, connector: Sig C Adapter M–359; male one end, female other end; single round cont; 1 3/16″ lg x 3/4″ diam x 1 3/16″ h over-all.		2Z299–359.
E–210, E–212	ADAPTER, connector: Sig C Adapter PL–293; male one end, female other end; 2 round cont; 1 3/16″ lg x 3/4″ diam x 1 3/16″ h over-all.		2Z7390–104.
E–203, E–204, E–207, E–208.	BOARD, terminal: 2 screw type term; molded phenolic; 1 1/2″ lg x 3/4″ wd x 13/64″ thk; GR #274–Z.	Binding post strip	2Z9402176.
	CABLE, RF: Army-Navy RF Cable RG–22/U; twin coaxial; 95 ohms impedance; 0. 405″ diam; polyethylene dielectric.	R-f transmission line	1F425–22.
J–202, J–204	CONNECTOR, female contact: Sig C Socket SO–239; 1 female cont; 1 1/16″ lg x 1″ wd x 1″ thk.	Input connector for unbalanced antennas.	2Z8799–239.
J–201, J–203, J–205, J–206.	CONNECTOR, female contact: Sig C Socket SO–264; 2 round female cont; 1 1/16″ lg x 1″ wd x 1″ thk.	Output connectors from antenna junction box to radio receivers.	2Z7390–103.
P–202, P–204	CONNECTOR, male contact: Sig. C Plug PL–259; 1 male cont; 1 1/2″ lg x 3/4″ diam, less cont.	Cable connectors for unbalanced antenna line.	2Z7226–259.
	CONNECTOR, male contact: Sig C Plug PL–284; 2 male cont; 1 1/2″ lg x 3/4″ diam.	Cable connectors for r-f lines from antenna junction box to radio receivers.	2Z7390–102.
E–201, E–202, E–205, E–206.	POST, binding: screw type; 13/16″ lg x 3/8″ diam; brass, nickel pl; GR #138–VD.	Input posts for balanced antennas.	3ZK741–1.
S–201	SWITCH, box: 3PST, solid neutral; 125/250 v ac, 30 amp; fusible; gray enameled steel body; 6 1/8″ lg x 4 1/32″ wd x 3 3/16″ d; toggle type switch.	Power switch	3Z9504–4.1.

3. Identification Table of Replaceable Parts for Radio Receiver R–270/FRR

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	RECEIVER, radio: Army-Navy Radio Receiver R–270/FRR; AM and CW; 1250 to 40,000 kc in 5 bands; 95/105/117/130/190/210/234/260 v AC, single ph, 25–60 cyc, 200 w; chassis only w/std 19″ rack panel; 19″ lg x 10 1/2″ h x 15 5/8″ d; 17 tube superheterodyne receiver incl; crystal controlled VFO and BFO and IF output jack; crystal control from 1.5 to 26 mc; p/o Army-Navy Radio Receiving Set AN/FRR–12; Hammarlund #2957–GI (modified)	For radio communication and special radio teletype reception.	2C4180–270.
W–1	CABLE ASSEMBLY, power: 9 cond, 7 #20 AWG stranded, 2 #16 AWG stranded; black cotton braid covered; 5/8″ OD; 7 ft lg overall; w/Hammarlund #3837 or Jones #12, 10 term strip ea end; Hammarlund #SA–35 (connects rectifier to receiver).	Power supply connector cable.	2C4528/3.
C–26	CAPACITOR, fixed: mica; 51 mmf ± 5%; 500 vdcw; max body dimen 51/64″ lg x 15/32″ wd x 7/32″ thk; JAN type CM20B510J.	Bypass for cathode of detector tube V–8.	3K2051022.

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
C–15	CAPACITOR, fixed: silver mica; 51 mmf ± 5%; 500 vdcw; max body dimen 51/64″ lg x 15/32″ wd x 7/32″ thk; JAN type CM20C510J.	Grid coupling to h-f oscillator tube V–4.	3K2051032.
C–13	CAPACITOR, fixed: silver mica; 91 mmf ± 2%; 500 vdcw; max body dimen 51/64″ lg x 15/32″ wd x 7/32″ thk; JAN type CM20C910G.	Grid coupling from h-f oscillator to mixer tube V–3.	3K2091033.
C–57, C–58	CAPACITOR, fixed: silver mica; 300 mmf ± 2%; 500 vdcw; max body dimen 51/64″ lg x 15/32″ lg wd 7/32″ thk; JAN type CM20C301G.	C–57—1st r-f stage plate coupling. C58—2d r-f stage plate coupling.	3K2030133.
C–3, C–7, C–11	CAPACITOR, fixed: mica; 620 mmf ± 5%; 500 vdcw; body dimen 1 1/16″ lg x 15/32″ max wd x 7/32″ max thk; JAN type CM25B621J.	C–3—1st r-f stage grid coupling. C–7—2d r-f stage grid coupling. C–11—Grid coupling to mixer tube V–3.	3K2562122.
C–4, C–5, C–8, C–9, C–12, C–14, C–16.	CAPACITOR, fixed: paper; 10,000 mmf ± 20%; 400 vdcw; molded bakelite case; 1 3/8″ lg x 41/64″ wd x 9/32″ thk; wax impregnated; JAN type CN41A103M.	C–4—1st r-f stage grid circuit bypass. C–5—1st r-f stage screen-grid bypass. C–8—2d r-f stage grid circuit bypass. C–9—2d r-f stage screen-grid bypass. C–12—Mixer stage grid circuit bypass. C–14—Mixer stage screen-grid bypass. C–16—H-f oscillator stage plate circuit bypass.	3DA10–383.
C–24	CAPACITOR, fixed: paper; 20,000 mmf ± 10%; 600 vdcw; HS metal case; max body dimen 1 11/16″ lg x 9/16″ diam; oil impregnated; JAN type CP28A1FF203K.	1st a-f stage grid coupling	3DA20–188.
C–25, C–27, C–29	CAPACITOR, fixed: paper; 50,000 mmf ±10%; 600 vdcw; HS metal case; max body dimen 1 13/16″ lg x 11/16″ diam; oil impregnated; JAN type CP28A1FF503K.	C–25—2d a-f stage grid coupling. C–27—Bypass for h-v circuits of bfo stage V–10. C–29—A-v-c amplifier stage screen-grid bypass.	3DA50–299.
C–18 thru C–20	CAPACITOR, fixed: paper; 3 sect; 50,000–50,000–50,000 mmf ±20% −10%; 600 vdcw; HS metal case; max body dimen 1 13/16″ lg x 1″ wd x 3/4″ h; oil impregnated; JAN type CP53B5FF503V.	C–18A—Mixer stage plate circuit bypass. C–18B—Common grid-return bypass. C–18C—1st i-f stage screen-grid bypass. C–19A—1st i-f stage plate circuit bypass. C–19B—2d i-f stage grid circuit bypass. C–19C—2d i-f stage screen-grid bypass. C–20A—2d i-f stage plate circuit bypass. C–20B—3d i-f stage grid circuit bypass. C–20C—3d i-f stage screen-grid bypass.	3DA50–298.

3. Identification Table of Replaceable Parts for Radio Receiver R–270/FRR—Continued

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
C–17	CAPACITOR, fixed: paper; 250,000 mmf ±10%; 600 vdcw; HS metal case; max body dimen 2⁵⁄₁₆″ lg x 1¹⁄₁₆″ diam; oil impregnated; JAN type CP28-A1FF254K.	A-v-c timing for c-w operation.	3DA250–379.
C–31	CAPACITOR, fixed: paper; 2 sect; 250,000–250,000 mmf ±20%; −10%; 600 vdcw; HS metal case; max body dimen 1¹³⁄₁₆″ lg x 1¾″ wd x ⅞″ h; oil impregnated; JAN type CP53B4FF254V.	C–31A—B+250-volt bypass. C–31B—B+100-volt bypass.	3DA250–378.
C–116	CAPACITOR, fixed: mica; 10 mmf ±10%; 500 vdcw; max body dimen ⁵¹⁄₆₄″ lg x ¹⁵⁄₃₂″ wd x ⁷⁄₃₂″ thk; JAN type CM20B100K.	Grid coupling from crystal controlled, h-f oscillator tube V–17 to tube V–4.	3K2010021.
C–117	CAPACITOR, fixed: mica; 10,000 mmf ±10%; 600 vdcw; max body dimen 1⅝″ lg x 1⅛″ wd x ²³⁄₆₄″ thk; JAN type CM45B103K.	Plate circuit bypass for tube V–17.	3K4510321.
C–118	CAPACITOR, fixed: mica; 100 mmf ±5%; 500 vdcw; max body dimen ⁵¹⁄₆₄″ lg x ¹⁵⁄₃₂″ wd x ⁷⁄₃₂″ thk; JAN type CM20C101J.	Screen-grid bypass for tube V–17.	3K2010132.
C–119	CAPACITOR, fixed: mica; 2200 mmf ±20%; 500 vdcw; max body dimen ⁵³⁄₆₄″ lg x ⁵³⁄₆₄″ wd x ⁹⁄₃₂″ thk; JAN type CM30B222M.	Blocking capacitor for crystals in plate circuit of tube V–17.	3K3022224.
C–120	CAPACITOR, variable: air dielectric; plate meshing type; single sect 9 to 140 mmf; 2½″ lg x 2³⁄₃₂″ wd x 1⁵⁄₁₆″ h excl shaft; shaft ½″ lg x ¼″ diam, bushing ⅜″–32 x ¹³⁄₃₂″ lg; isolantite ins; solder lug terms; single hole panel mtg by ⅜″–32 bushing and two #6–32 tapped holes w/1¹⁹⁄₃₂″ c; Hammarlund part #MC–140–M.	Crystal circuit tuning	3D9140V–29.
H–3	CLAMP; meter; brass; nickel pl; single bolt locking, screw driver adj; 2″ OD x 1⅞″ ID; 2″ diam; Weston #D–54108; Hammarlund #3926.	"S" meter mounting	3F2640.
H–10 thru H–12	CLAMP: crystal holder retainer; consists of nickel pl slide rod w/adj clamp of nickel pl beryllium copper w/knurled nickel pl thumbscrew and collar; rod 3⅝″ lg x ¼″ diam w/flat #6–32 thd on one end; spring 1⅝″ lg x ⅝″ wd x 1″ h overall for clamping Crystal Holder HC–1( )/U; Lavoie Lab part #B–1343–26 for rod and #B–1343–29 for clamp and thumbscrew.	Crystal holder retainers	2Z2646.39.
L–37	COIL, RF: antenna pri input; single winding; unshielded; phenolic form; 1160–2500 kc w/Faraday shield for separating input from output coil; Hammarlund #SA–49.	1.25- to 2.5-mc antenna coupling.	2C4528.7/10–7.
L–3	COIL, RF: antenna pri input; single winding· unshielded; phenolic form; 2.5–5 mc w/Faraday shield for separating input from output coil; Hammarlund #SA–48.	2.5- to 5-mc antenna coupling.	2C4528.3/10–1.
L–2	COIL, RF: antenna pri input; single winding· unshielded; phenolic form; 5–10 mc w/Faraday shield for separating input from output coil; Hammarlund #SA–47.	5- to 10-mc antenna coupling.	2C4528.3/10–2.
L–1	COIL, RF: antenna pri input; single winding; unshielded· phenolic form; 10–20 mc w/Faraday shield for separating input from output coil; Hammarlund #SA–46.	10- to 20-mc antenna coupling.	2C4528.3/10–3.
L–52	COIL, RF: antenna secd output, 1st RF grid input; single winding; unshielded; phenolic form; 1250–2500 kc; Hammarlund #SA–136.	1.25- to 2.5-mc, 1st r-f stage grid.	2C4528.8/8–1.

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
L–8	COIL, RF: antenna secd output, 1st RF grid input; single winding; unshielded; phenolic form; 2.5–5 mc; Hammarlund #SA–116.	2.5- to 5-mc, 1st r-f stage grid.	2C4528.3/8–2.
L–7	COIL, RF: antenna secd output, 1st RF grid input; single winding; unshielded; phenolic form· 5–10 mc· Hammarlund #SA–113.	5- to 10-mc, 1st r-f stage grid.	2C4528.3/8–3.
L–6	COIL, RF: antenna secd output, 1st RF grid input; single winding unshielded; phenolic form; 10–20 mc; Hammarlund #SA–110.	10- to 20-mc, 1st r-f stage grid.	2C4528.3/8–4.
L–48	COIL, RF: antenna secd output, 1st RF grid input; single winding; unshielded; phenolic form; 20–40 mc; Hammarlund #SA–130.	20- to 40-mc, 1st r-f stage grid.	2C4528.8/8–2.
T–5	COIL, RF: BFO; single winding; tuned; shielded; 5″ h x 2″ wd x 2″ d; built-in capacitor; tuned from front panel of receiver; 465 kc; Hammarlund #SA–169A.	Bfo coil assembly	2C4528.7/9.
L–35, L–36	COIL, RF: choke; 5 pie universal wound; unshielded; 2.1 mh; 35 ohms DC resistance; 1½″ lg x ½″ diam; ceramic core; Hammarlund type #CHX.	L–35—1st r-f stage plate. L–36—2d r-f stage plate.	3C308–4.
L–53, L–54	COIL, RF: 2d RF grid; 1st detector grid; pri and secd windings, secd tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 1250–2500 kc; Hammarlund #SA–137.	L–53—1.25- to 2.5-mc, 2d r-f stage grid. L–54—1.25- to 2.5-mc, mixer grid.	2C4528.8/5–1.
L–13, L–18	COIL, RF: 2d RF grid, 1st detector grid; pri and secd windings, secd tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 2.5–5 mc; Hammarlund #SA–117.	L–13—2.5- to 5-mc, 2d r-f grid. L–18—2.5- to 5-mc, mixer grid.	2C4528.3/5–2.
L–12, L–17	COIL, RF: 2d RF grid, 1st detector grid; pri and secd windings, secd tuned; unshielded; phenolic form; tunes w/ext capacitor, ceramic base; 5–10 mc; Hammarlund #SA–114.	L–12—5.0- to 10-mc, 2d r-f grid. L–17—5.0- to 10-mc, mixer grid.	2C4528.3/5–3.
L–11, L–16	COIL, RF: 2d RF grid, 1st detector grid; pri and secd windings, secd tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 10–20 mc; Hammarlund #SA–111.	L–11—10- to 20-mc, 2d r-f grid. L–16—10- to 20-mc, mixer grid.	2C4528.3/5–4.
L–49. L–50	COIL, RF: 2d RF grid, 1st detector grid; pri and secd windings, secd tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 20–40 mc; Hammarlund #SA–131.	L–49—20- to 40-mc, 2d r-f grid. L–50—20- to 40-mc, mixer grid.	2C4528.8/5–2.
L–55	COIL, RF: HF oscillator grid input; single winding, tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 1250–2500 kc; Hammarlund #SA–138.	1.25- to 2.5-mc, h-f oscillator grid.	2C4528.8/9–1.
L–23	COIL, RF: HF oscillator grid input; single winding, tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 2.5–5 mc; Hammarlund #SA–118.	2.5- to 5-mc, h-f oscillator grid.	2C4528.3/9–2
L–22	COIL, RF: HF oscillator grid input; single winding, tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 5–10 mc; Hammarlund #SA–115.	5- to 10-mc, h-f oscillator grid.	2C4528.3/9–3.
L–21	COIL, RF: HF oscillator grid input; single winding, tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 10–20 mc; Hammarlund #SA–112.	10- to 20-mc, h-f oscillator grid.	2C4528.3/9–4.
L–51	COIL, RF: HF oscillator grid input; single winding, tuned; unshielded; phenolic form; tunes w/ext capacitor; ceramic base; 20–40 mc; Hammarlund #SA–132.	20- to 40-mc, h-f oscillator grid.	2C4528.8/9–2.

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
L-57, L-58	COIL, RF: choke; 4 pie universal wound; unshielded; 25 mh, 125 ma, 160 ohms DC; 1 7/16" lg x 13/16" diam over-all; ceramic form, air core; 2 radial solder lug term at ends; Miller JW part #4541.	L-57—Plate choke for tube V-17. L-58—Screen-grid choke for tube V-17.	3C342.
J-2	CONNECTOR, female contact: Sig C Socket SO-239; single round female cont; coaxial; straight; 1" sq x 1 1/16" lg over-all; cylindrical, metal, silver pl body; mica filled bakelite insert; Sig C dwg #SC-D-5850.	I-f output	2Z8799-239.
J-3	CONNECTOR, female contact: Army-Navy Radio Frequency Receptacle UG-103/U; Sig C Socket SO-264; 2 round female cont; coaxial; straight; 1" sq x 1 1/16" lg over-all; cylindrical, metal, silver pl body; mica filled bakelite insert; Sig C dwg #SC-D-5941 and #SC-C-5918.	Receiver antenna input	2Z7390-103.
E-30	CONNECTOR, male and female contact: Sig C Adapter M-359; male 1 end, female other end; 90° angle type; adapts male to female connectors to make right angle turn; 57/64" lg x 13/16" h x 3/4" diam over-all; cylindrical, metal, silver pl body, polystyrene insert; Sig C dwg #SC-D-5890.	I-f output	2Z299-359.
E-31	ADAPTER, connector: Army-Navy Radio Frequency Adapter UG-104/U; Sig C Adapter PL-293; male 1 end, female other end; 2 round male cont 1 end, 2 round female cont other end; 90° angle type; 5/8" OD x 1 7/32" x 1 3/16" over-all; cylindrical, metal, silver pl body; polystyrene insert; Sig C dwg #SC-D-5943, #SC-C-5918, #SC-B-5942.	Antenna input	2Z7390-104.
P-1	CONNECTOR, plug: Sig C Plug PL-259; single round male cont; straight; 1 31/64" lg x 3/4" diam; 2 piece cylindrical silver pl body; bakelite insert; for 0.410" diam cable; Sig C dwg #SC-D-5888.	I-f output	2Z7226-259.
P-2	CONNECTOR, plug: Army-Navy Radio Frequency Plug UG-102/U; coaxial; straight; 1 31/64" lg x 3/4" diam over-all; cylindrical, die cast metal body; bakelite insert; Sig C dwg #SC-D-5940 and #SC-D-5918 (previously listed as Plug PL-284).	Antenna input	2Z7390-102.
0-15 thru 0-18	COUPLING ASSEMBLY, flexible: for coupling offset 1/4" diam shafts; nickel pl brass bushings w/ nickel pl bronze springs; cad pl steel collar at junction; 1 1/4" lg x 3/4" diam over-all; Miller part #39005.	Flexible coupling assembly.	2C449-33/C1.
Y-1	CRYSTAL UNIT, quartz: one crystal plate; 465 kc; RCA #M1-19453, per Hammarlund #SA-178.	I-f crystal	2X27-465.
Y-2	CRYSTAL UNIT, quartz: one crystal plate mounted in Sig C Crystal Holder FT-241-A; marked "For Use in AN/FRR-12"; freq 462.45 kc; + 25° C to + 45° C temp range; 2 pins spaced on bottom 1/2" c to c; solid pins 3/32" diam x 7/16" lg; body 1 1/8" lg x 7/16" wd x 1 9/32" h; nonadjustable air gap; Bliley Elec type #SR-901; Sig C spec #71-3021 and Crystal Data Sheet #15 of Sig C spec #71-3280.	Bfo crystal	2X210.462.45.
N-5	DIAL: band change sw; black bakelite knurled knob w/etched aluminum round disk; knob 1 5/8" diam, disk 2 1/8" diam x 1/16" thk; shaft 1/4" diam w/2 setscrews; marked scale 1250-2500 kc, 2.5-5.0 mc, 5.0-10 mc, 10-20 mc, and 20-40 mc; Hammarlund #SA-134.	Band change switch	2Z5836.3.

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
N-3	DIAL: band spread indicator; w/mtg disk and hub; plastic; 0–100 divisions; 6" diam; Hammarlund #SA-27.	Band spread tuning	2C4528/13.
N-6	DIAL: main tuning indicator; calibrated dial and masking disk; scales 1250–2500 kc, 2.5–5.0 mc, 5.0–10.0 mc, 10–20 mc, 20–40 mc, 6" diam; Hammarlund #SA-133.	Main tuning	2C4528.5/14.
N-4	DRIVE, dial: main tuning and band spread; incl bearing, shaft, and driving disk; bearing $\frac{61}{64}$" lg x $\frac{5}{16}$" diam, shaft $\frac{1}{2}$"-32 x 2" lg, disk $1\frac{1}{2}$" diam; Hammarlund #SA-199.	Main and band spread dial drive.	2C4779B/D1.
E-32, E-34	TERMINAL, lug: round post shape; white, grade L2 ceramic, glazed; $\frac{7}{8}$" lg x $\frac{13}{32}$" diam over-all; 0.073" diam hole; consists of insulator w/spur on bushing for mtg and soldering lug; Rhoden part #502-S.	Terminal	3Z12073-32.
J-1	JACK JK-34: telephone; for 2 cond 0.250" diam plug; $1\frac{1}{4}$" lg x 1" wd x $\frac{3}{4}$" h; J-1 cont arrangement; Sig C dwg #SC-D-2339.	Phones jack	2Z5534.
E-7 thru E-10, E-12, E-14 thru E-17.	KNOB: round; black bakelite; $\frac{1}{4}$" diam shaft hole; #8-32 tapped hole and setscrew; $1\frac{1}{8}$" diam w/ pointer; $\frac{9}{16}$" diam brass bushing; knurled finger grip; Kurz-Kasch #S-308-64B; Hammarlund #SA-86.	Control knobs	2Z5822-6.1.
E-11, E-13	KNOB: round; black bakelite; $\frac{1}{4}$" diam shaft hole; #10-32 headless setscrew in tapped hole; $1\frac{5}{8}$" diam x $\frac{3}{4}$" thk over-all; brass bushing; knurled finger grip; Hammarlund #3856.	Control knobs	2Z5822-88.
E-35, E-36	KNOB: bar; black bakelite; for $\frac{1}{4}$" diam shaft; single #8-32 Allen head setscrew engraved arrow filled white; $1\frac{1}{4}$" diam x $\frac{5}{8}$" h; irregular shape; Kurz-Kasch part modified per Lavoie Lab part #A-1343-24.	Control knob	2Z5821-128.
I-1, I-2	LAMP LM-25: incandescent; 6–8 v, 0.15 amp; Mazda #40, bulb T-$3\frac{1}{4}$ clear; C-2 fil; miniature screw base (dial).	Dial lights	2Z5925.
I-3	LAMP LM-52: incandescent; 6–8 v, 0.15 amp; Mazda #47, bulb T-$3\frac{1}{4}$ clear; $1\frac{3}{16}$" lg overall, miniature bayonet base (for meter).	Meter light	2Z5952.
E-28	LAMPHOLDER: miniature bayonet; steel shell phenolic insert, cadmium pl; for 6–8 v, 0.15 amp lamp; $1\frac{3}{16}$" lg x $\frac{7}{8}$" diam; spring prongs grip in $\frac{5}{8}$" diam hole; United-Carr #99315; Hammarlund #4929 (for "S" meter).	Holder for lamp I-3	2Z5883-15.
E-26, E-27	LAMPHOLDER: miniature screw base; metal base and bracket; for 6–8 v, 0.15 amp lamp, approx 2" lg overall w/$1\frac{1}{4}$" lg adj slot; Drake #106CE (for tuning and band spread dial).	Holders for dial lights I-1 and I-2.	2Z5882-10.
M-1	METER, ammeter: DC; 0–200 microamperes; round, metal flush mtg case; 2" diam body; black numerals on white background; self-contained; special scale calibrated "1 to 9"; Hammarlund #4903 (tuning and "S" indicator).	"S" meter	2C4528.7/15.
R-31, R-32	RESISTOR, fixed: wire-wound; 4 ohms $\pm 5\%$; 7 w; max body dimen 1" lg x $\frac{19}{32}$" diam; JAN type RW30G4RO.	R-31—Noise limiter heater dropping. R-32—Dial lamp series dropping.	3RW9902.

3. Identification Table of Replaceable Parts for Radio Receiver R–270/FRR—Continued

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
R–38	RESISTOR, fixed: comp; 300 ohms ±5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF301J.	Bias voltage divider	3RC21BF301J.
R–36	RESISTOR, fixed: wire-wound; 800 ohms ±5%; 10 w; max body dimen 2″ lg x ⅝″ diam; JAN type RW56E801.	2d a-f cathode bias	3RW23723.
R–39	RESISTOR, fixed: comp; 1800 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF182J.	Bias voltage divider	3RC21BF182J.
R–3, R–7, R–15 thru R–17, R–20, R–21, R–47, R–51.	RESISTOR, fixed: comp; 2000 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF202J.	R–3—1st r-f stage screen filter. R–7—2d r-f stage screen filter. R–15—Mixer stage plate filter. R–16—1st i-f stage screen filter. R–17—1st i-f stage plate filter. R–20—2d i-f stage screen filter. R–21—2d i-f stage plate filter. R–47—3d i-f stage plate filter. R–51—A-v-c amplifier stage plate filter.	3RC21BF202J.
R–40	RESISTOR, fixed: comp; 3000 ohms ±5%; 1 w; max body dimen 1.28″ lg x 0.310″ diam; JAN type RC31BF302J.	Bias voltage divider	3RC31BF302J.
R–35, R–54, R–55	RESISTOR, fixed: comp; 4700 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF472J.&	R–35—Bfo stage plate and screen filter. R–54—A-v-c diode load. R–55—A-v-c diode load.	3RC21BF472J.
R–2, R–6, R–10, R–18, R–22.	RESISTOR, fixed: comp; 10,000 ohms ± 10%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF103K.	R–2—1st r-f stage grid filter. R–6—2d r-f stage grid filter. R–10—Mixer signal grid filter. R–18—2d i-f stage grid filter. R–22—3d i-f stage grid filter.	3RC21BF103K.
R–14	RESISTOR, fixed: comp; 12,000 ohms ± 10%; 2 w; max body dimen 1.78″ lg x 0.405″ diam; JAN type RC41BF123K.	H-f oscillator stage plate filter.	3RC41BF123K.
R–53	RESISTOR, fixed: comp; 27,000 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF273J.	A-v-c diode load	3RC21BF273J.
R–12	RESISTOR, fixed: comp; 24,000 ohms ± 5%; 2 w; max body dimen 1.78″ lg x 0.405″ diam; JAN type RC41BF243J.	Mixer stage screen filter	3RC41BF243J.
R–11, R–13	RESISTOR, fixed: comp; 51,000 ohms ± 5%; ½ w; max body dimen 0.468″ lg x 0.249″ diam; JAN type RC20BF513J.	R–11—Mixer-oscillator grid coupling. R–13—H-f oscillator stage grid coupling.	3RC20BF513J.

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
R–25	RESISTOR, fixed: comp; 56,000 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF563J.	Detector diode load	3RC21BF563J.
R–23, R–28, R–37	RESISTOR, fixed: comp; 51,000 ohms ± 5%; 1 w; max body dimen 1.28″ lg x 0.310″ diam; JAN type RC31BF513J.	R-23—3d i-f stage screen filter. R–28—1st a-f stage plate coupling. R–37—A-v-c amplifier stage screen filter.	3RC31BF513J.
R–24	RESISTOR, fixed: comp; 82,000 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF823J.	Detector diode load	3RC21BF823J.
R–30	RESISTOR, fixed: comp; 270,000 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF274J.	Detector cathode bias	3RC21BF274J.
R–1, R–5, R–9	RESISTOR, fixed: comp; 510,000 ohms ± 5%; ½ w; max body dimen 0.468″ lg x 0.249″ diam; JAN type RC20BF514J.	R–1—1st r-f stage grid coupling. R–5—2d r-f stage grid coupling. R–9—Mixer signal grid coupling.	3RC20BF514J.
R–27, R–29, R33	RESISTOR, fixed: comp; 470,000 ohms ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF474J.	R–27—1st a-f stage grid coupling. R–29—2d a-f stage grid coupling. R–33—Bfo stage screen dropping.	3RC21BF474J.
R–52	RESISTOR, fixed: comp; 1 meg ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam; JAN type RC21BF105J.	A-v-c timing	3RC21BF105J.
R–19	RESISTOR, fixed: comp; 2 meg ± 5%; ½ w; max body dimen 0.655″ lg x 0.249″ diam: JAN type RC21BF205J.	AVC-MANUAL shunt	3RC21BF205J.
R–41	RESISTOR, variable (potentiometer): wire-wound; 1000 ohms ± 10%; max body dimen 1.28″ diam x 0.91″ thk· JAN type #RA20A1SA102K ("S" meter adjustment).	"S" meter shunt	3RA5718.
R–56	RESISTOR, variable (potentiometer): comp; 50,000 ohms ± 20%; 2¼ w; 3 solder lug term; enclosed metal case 1⅙″ diam x 9/16″ d; round metal shaft ¼″ diam x 25/32″ lg from mtg surface; bushing ⅜″–32 x ⅜″ lg; Allen-Bradley type J; Hammarlund #15362–1 (RF and IF sensitivity control).	SENSITIVITY control, r-f and i-f.	2C4528.6/20.
R–26	RESISTOR, variable (potentiometer): comp; 250,000 ohms ± 20%; ½ w; 3 solder lug term; body dimen 1¼″ diam; taper "B"; IRC type C; Hammarlund #4919 (AF gain control).	A-f gain control	2C4528.6/16.
R–59	RESISTOR, fixed: comp; 100,000 ohms ± 10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam; JAN type RC20BF104K.	Bfo stage grid leak	3RC20BF104K.
R–60	RESISTOR, fixed: comp; 1000 ohms ± 10%; ½ w; max body dimen 0.468″ lg x 0.249″ diam; JAN type RC20BF102K.	I-f amplifier tube V–12 cathode.	3RC20BF102K.
R–61	RESISTOR, fixed: comp; 47,000 ohms ± 10%; 1 w; max body dimen 1.28″ lg x 0.310″ diam; JAN type RC31BF473K.	Plate dropping for tube V–12.	3RC31BF473K.

3. Identification Table of Replaceable Parts for Radio Receiver R–270/FRR—Continued

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
R–62	RESISTOR, fixed: comp: 47,000 ohms ± 10%; ¼ w; max body dimen 0.406″ lg x 0.170″ diam; JAN type RC10BF473K.	Tube V–17 grid	3RC10BF473K.
R–63	RESISTOR, fixed: comp; 27,000 ohms ± 10%; 2 w; max body dimen 1.41″ lg x 0.405″ diam; JAN type RC40BF273K.	Tube V–17 screen-grid dropping.	3RC40BF273K.
X–1 thru X–16	SOCKET, tube: octal· mica filled bakelite; 1¾″ lg x 1⁹⁄₃₂″ x ⅞″ d over-all; Amphenol #MIP8TM.	Tube sockets	2Z8795.12.
X–17	SOCKET, crystal: 2 cont; mica filled phenol plastic; ⁵¹⁄₆₄″ lg x ⁵⁄₁₆″ wd x ³⁵⁄₆₄″ h; silver pl cont; single 0.120″ diam mtg hole; two ⁵⁄₁₆″ diam clearance holes on ½″ c; Cinch #9816.	Crystal socket	2Z8672.8.
X–21	SOCKET, tube: octal; one-piece metal mtg plate; two ⁵⁄₃₂″ diam mtg holes on 1½″ mtg/c; oval shape w/1¹⁄₃₂″ diam ceramic body 1⅞″ lg x 1½″ wd x ⅜″ h excl term; silver pl beryllium copper cont; National #CIR–8.	Tube socket	2Z8678.53.
X–18 thru X–20	SOCKET, crystal: molded mycalex; oval shaped; 2⁵⁄₁₆ lg x 1⅝″ wd x ⁹⁄₃₂″ h less cont; two ⁵⁄₃₂″ diam mtg holes on 1⅞″ c; marked ETS–3; Mykroy part #ETS–3, u/w Sig C Crystal Holder HC–1( )/U per US Army spec #71–3074.	Crystal sockets	2Z8761–52.
S–5	SWITCH, rotary: SPST; 1⅛″ diam; shaft ¼″ diam x 10¾″ lg; Hammarlund #4916 (noise limiter).	LIMITER OFF-ON	3Z9900–3.
S–2	SWITCH rotary: SPST; 1⅛″ diam x ⅜″ lg; ¼″ diam shaft; Hammarlund #4917 (send-receive).	REC-SEND	3Z9900–2.
S–3	SWITCH, rotary: DPST; single sect; silver pl brass cont; lam phenolic wafer; cad pl steel body; 1½″ lg x 1″ wd: solder lug term; single hole mtg w/⅜–32 bushing, ⅜″ lg; ¼″ diam shaft ²³⁄₃₂″ lg; Hammarlund A915 (modulation CW).	SIGNAL CW-MOD	3Z9900–1.
S–7	SWITCH, rotary: 8 pole 6 position; fiber ins; 2 cont inside, 1 position; ¼″ diam shaft, ⅜″ x ⅜″–32 bushing· Hammarlund #4911 (crystal filter).	CRYSTAL SELECTIVITY.	3Z9903–5.
S–8	SWITCH, rotary: 3 pole, 4 position; 2 sect; silver pl brass cont; ceramic wafers; 2″ diam x 3¼″ d; solder lug term; single hole mtg w/bushing ⅜″–32 x ⁵⁄₁₆″ lg; ¼″ diam x ⁷⁄₁₆″ lg shaft; Centralab #2500 series per Lavoie Lab #B–1343–16.	Crystal selector	3Z9825.21.
S–6	SWITCH, toggle: DPST· 30 v, 15 amp; 125 v, 3 amp; 250 v, 1 amp; molded or laminated plastic; 1¹³⁄₃₂″ lg x ¹⁷⁄₃₂″ wd x 2″ d overall; locking, normally open; solder lug term; JAN type ST28K (power OFF-ON).	Power OFF-ON	3Z9859–52.
S–4	SWITCH, toggle: DPDT; 250 v, 15 amp; molded or laminated plastic; 1¹⁄₃₂″ lg x ¹⁷⁄₃₂″ wd x ⁹⁄₁₆″ d w/ ¹⁵⁄₃₂″ sleeve; locking action, normally open· solder lug term; JAN type ST28N (AVC-MANUAL).	AVC-MANUAL	3Z9863–28N.
T–7	TRANSFORMER, AF: plate coupling type; pri 3000 ohms impedance, secd CT, 34 ma DC; 2¾″ x 2¹³⁄₁₆″ x 3½″ h; ratio 1.14 to 1; Chi Trans Co #4212–C; Hammarlund #5081.	Push-pull audio input	2Z9635.7.
T–8	TRANSFORMER, AF: plate coupling type; pri 10,000 ohms impedance, CT; secd 600 ohms, 8,000 ohms impedance; fully enclosed metal case; 2¾″ x 2⁹⁄₁₆″ x 3½″ h; Hammarlund #5082 (output transformer).	Push-pull audio output	2Z9632.66.

3. Identification Table of Replaceable Parts for Radio Receiver R–270/FRR—Continued

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
T–6	TRANSFORMER, IF: 465 kc, AVC diode input; shielded; 2″ x 2″ x 5″ fixed selectivity, incl C–51, C–52, C–53, C–54, C–55, C–56, L–34, R–51, R–52, R–53, R–54, and R–55; Hammarlund #SA–168A.	A-v-c diode input	2C4528.7/61.
T–1	TRANSFORMER, IF: 465 kc; crystal filter, variable selectivity; shielded; 2 9/32″ x 3″ x 5″ h; powdered iron core; adj iron core tuning w/variable air capacitor; incl crystal and 6 position sw w/crystal selectivity and phasing adj from front panel; Hammarlund #SA–178–A.	Selectivity circuits	2C4528.7/63.
T–2, T–3	TRANSFORMER, IF: 465 kc; 1st IF, 2d IF; shielded; 5″ x 2″ x 2″; double tuned; variable air trimmers; Hammarlund #SA–166A.	Selectivity circuits	2C4528.7/5.1.
T–4	TRANSFORMER, IF: 465 kc; 2d detector input; shielded; 5″ h x 2″ wd x 2″ d; double tuned; variable air trimmers; Hammarlund #SA–167A.	Detector input	2C4528.6/7.
V–17	TUBE, electron: JAN–6AC7	Crystal controlled bfo	2J6AC7.
V–14 thru V–16	TUBE, electron: JAN–6F6	V–14—A-f driver V–15—A-f output. V–16—A-f output.	2J6F6.
V–8	TUBE, electron: JAN–6H6	Detector	2J6H6.
V–13	TUBE, electron: JAN–6J5	1st a-f amplifier	2J6J5.
V–4	TUBE, electron: JAN–6J7	H-f oscillator	2J6J7.
V–1, V–2, V–5	TUBE, electron: JAN-6K7	V–1—1st r-f amplifier V–2—2d r-f amplifier. V–5—1st i-f amplifier.	2J6K7.
V–3	TUBE, electron: JAN–6L7	Mixer	2J6L7.
V–9	TUBE, electron: JAN–6N7	Limiter	2J6N7.
V–10	TUBE, electron: JAN–6SJ7	Bfo	2J6SJ7.
V–6, V–7, V–11	TUBE, electron: JAN–6SK7Y	V–6—2d i-f amplifier V–7—3d i-f amplifier. V–11—A-v-c amplifier.	2J6SK7Y.
V–12	TUBE, electron: JAN–6SN7GT	A-v-c rectifier and i-f output amplifier.	2J6SN7GT.

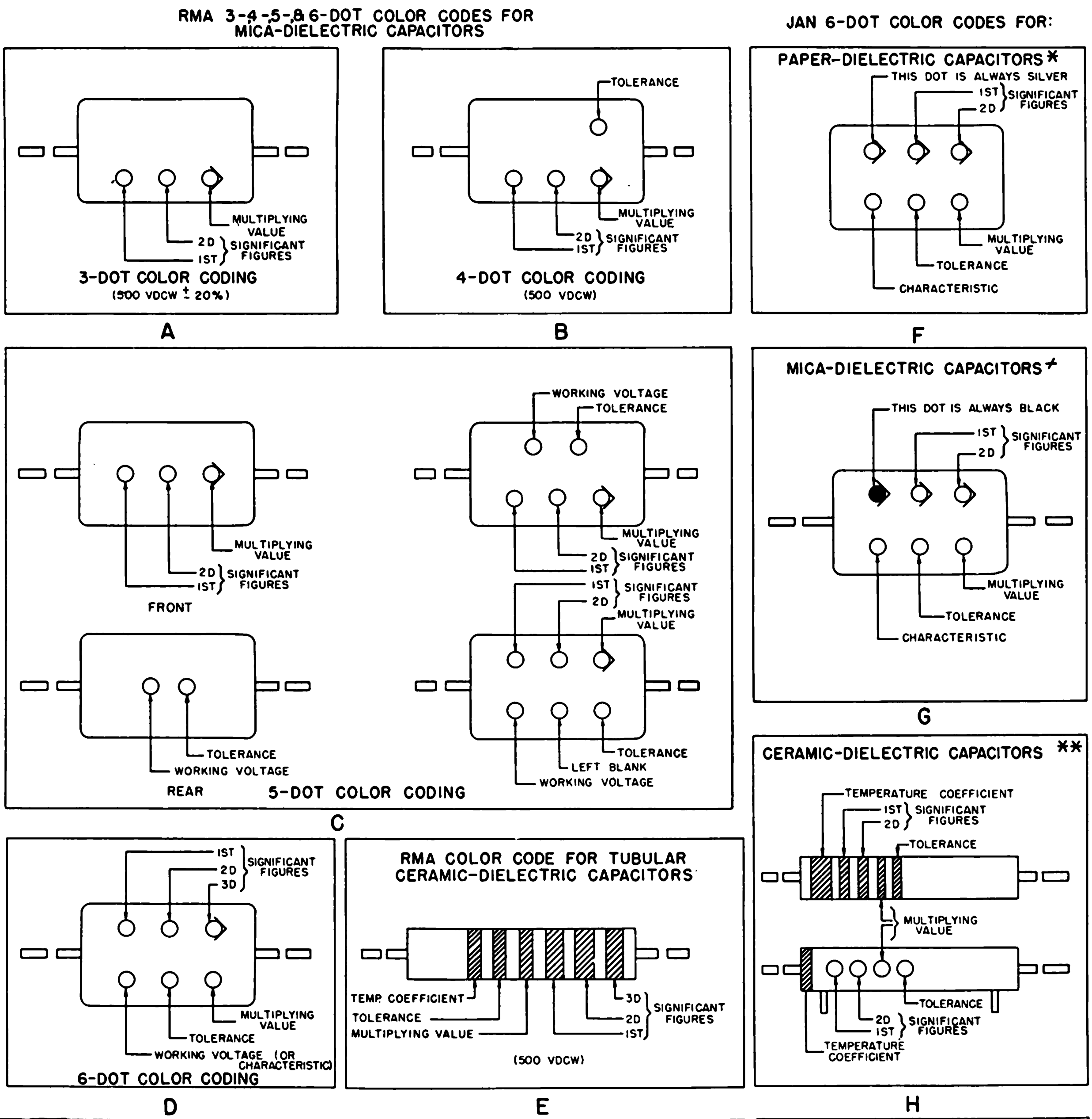
4. Identification Table of Replaceable Parts for Power Supply Unit RA–74–D

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	POWER SUPPLY: Sig C Power Supply Unit RA–74–D; electronic type; output 380 v DC at 50 ma, 250 v DC at 100 ma, approx 100 v DC at 4.5 ma, "C" bias approx 50 v DC at 11 ma; input 95/105/117/130/190/210/234/260 v AC, single ph, 25–60 cyc, 180 w; chassis w/std 19″ rack panel, 19″ lg x 10½″ h x 10″ d; 1 Tube JAN–5Y3GT half-wave, 1 JAN–5U4G full-wave; built-in filter.	Furnishes a-c and d-c operating voltages for Radio Receiver R–270/FRR, or Radio Receivers BC–779–A, –B; BC–794–A, –B; BC–1004–B, –C, –D; and R–129/U.	3H4496–74D.
E–1	BOARD, terminal: connecting power to receiver; 10 screw term; arranged in groups of 5 term ea; phenolic; term numbered 1 to 10; Jones HB per Hammarlund #3838.	Receiver connections	2C4528/35.
W–1	CABLE, power: Sig C Cordage CO–144; Underwriters type "S"; 2 #18 AWG cond ea comprising 41 #34 AWG strands; RC; ¼″ OD; Sig C spec #71–684.	A-c line cord	3E2144.

4. Identification Table of Replaceable Parts for Power Supply Unit RA–74–D—Continued

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
C–1 thru C–12	CAPACITOR, fixed: paper dielectric; 4.0 mf +20% −10%, 600 vdcw; max body dimen 4½″ lg x 1½″ diam; JAN type CP41B1EF405V.	C–1 thru C–8—Plate supply filter. C–9 thru C–12—Bias supply filter.	3DB4–288.
	CONNECTOR, plug: 2 flat parallel male blade cont; straight; 1 9/16″ OD x 1¼″ lg less cont; 15 amp, 125 v, 10 amp, 250 v; cylindrical steel body, cad pl; bakelite insert; cable opening 9/32″ diam w/cable clamp; Hubbell #7057.	A-c plug	6Z1727.
F–1	FUSE FU–27: cartridge; 2 amp, 250 v; glass body; ferrule term; 1¼″ lg x ¼″ diam over-all.	Overload protector	3Z1927.
E–3	HOLDER, fuse: extractor post; for #3AG cartridge fuse; molded black bakelite body; 125 v AC or DC, 10 amp max; 2⅛″ lg x ¾″ diam over-all, 2 solder lug term, red extractor knob; Littelfuse #341001.	For fuse F–1	3Z3275.
L–1	REACTOR: filter choke; 21.2 min hy, 160 ma; 350 ohms approx DC resistance; 2500 v RMS test; HS metal case; 4½″ lg x 3⅝″ wd x 4⅝″ h excl term; 6 holes 7/32″ diam w/1⅜″ ctrs spaced 3⅞″; per JAN–T–27 Chi Trans #7410E.	Smoothing choke	3C317–54.
L–2	REACTOR: filter choke; 45 min hy, 120 ma; 1050 ohms approx DC resistance; 2500 v RMS test; HS metal case; 4½″ lg x 3⅝″ wd x 4⅝″ h excl term; 6 holes 7/32″ diam w/1⅜″ ctrs spaced 3⅞″; per JAN–T–27; Chi Trans #12522.	Smoothing choke	3C317–55.
R–1 thru R–5, R–7, R–9, R–12.	RESISTOR, fixed: comp; 3300 ohms ±5%; 2 w; max body dimen 1.78″ lg x 0.405″ diam; JAN type RC41BF332J.	R–1 thru R–4 and R–12—Part of plate supply voltage divider. R–5, R–7, R–9—Part of bias supply filter.	3RC41BF332J.
R–6, R–8, R–10	RESISTOR, fixed: comp; 4700 ohms ±5%; 2 w; max body dimen 1.78″ lg x 0.405″ diam; JAN type RC41BF472J.	Part of bias supply filter	3RC41BF472J.
R–11	RESISTOR, fixed: comp, 2200 ohms ±5%; 2 w; max body dimen 1.78″ lg x 0.405″ diam; JAN type RC41BF222J.	Part of plate supply voltage divider.	3RC41BF222J.
O–1	RETAINER, tube: consists of 4 hex base stainless steel posts and removable spring retainer assembly to fit ST–16 type glass bulb; mts w/#10 screws in 4 mtg holes on rectangular ctrs 2 3/16″ x ⅞″; WECo part/dwg #D152560.	Holds Tube JAN–5U4G rectifier in socket.	2Z7780–19.
X–1, X–2	SOCKET, tube: octal; one-piece saddle mtg; two 5/32″ diam holes on 1½″ mtg/c; round molded phenolic body; 1⅛″ diam x ½″ h excl term; beryllium copper silver pl wrap-around type contacts; Cinch #9661.	Tube sockets	2Z8678.300.
T–1	TRANSFORMER, power: filament and plate type; input 95 to 260 v, 25–60 cyc, single ph; pri taps at 95/105/117/130/190/210/234 and 260 v; v; 4 output secd windings, secd #1, 5v, 3 amp; secd #2, 5 v, 2 amp; secd #3, 6.3 v, 7 amp; secd #4 830 v CT, 170 ma and tap at 270 v from CT at 28 ma; 3000 v ins; HS metal case; 5⅞″ lg x 6½″ wd x 7½″ h overall; 19 ins thd post type term on bottom of case; six ¼″ diam holes w/2⅛″ ctrs; per JAN–T–27; Chi Trans #1270S.	Power transformer	2Z9608–91.
V–1	TUBE, electron: JAN–5U4G	Plate supply rectifier	2J5U4G.
V–2	TUBE, electron: JAN–5Y3GT	Bias supply rectifier	2J5Y3GT.

CAPACITOR COLOR CODES



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

NOTES

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

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

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

RMA: RADIO MANUFACTURERS ASSOCIATION

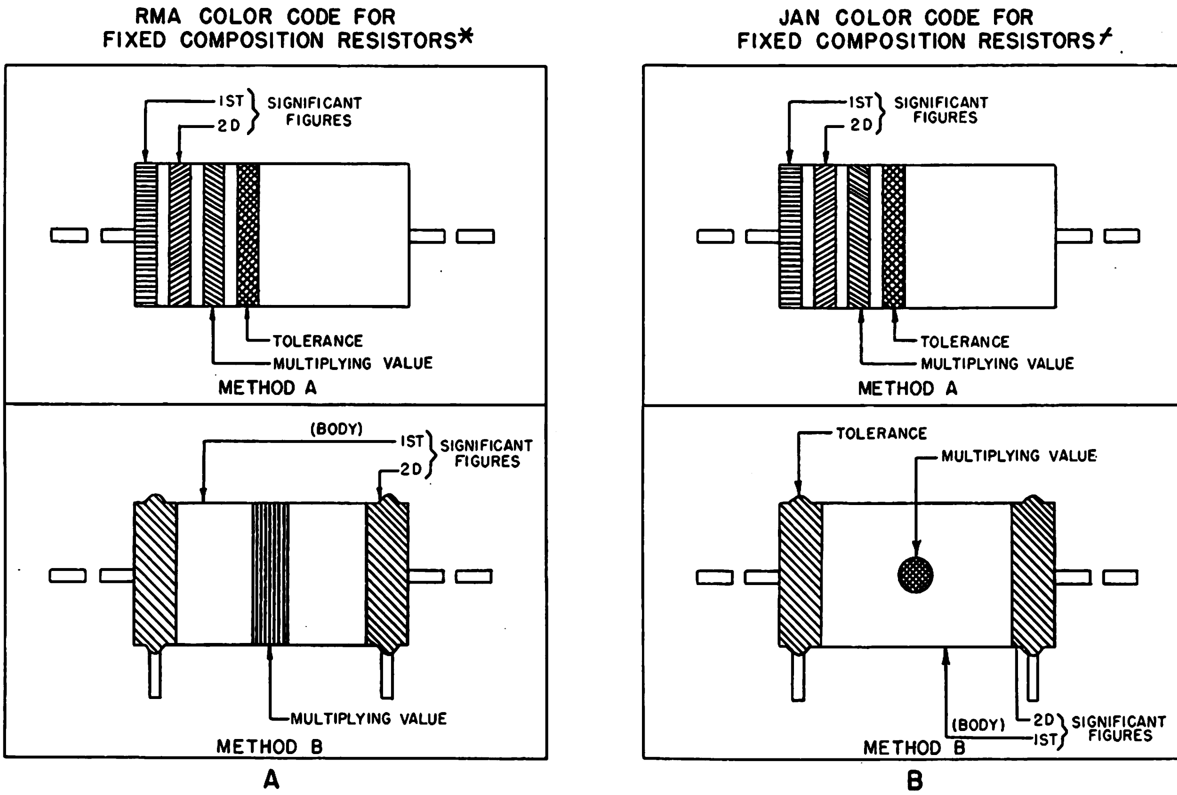
JAN: JOINT ARMY-NAVY

THESE COLOR CODES GIVE CAPACITANCES IN MICROMICROFARADS.

TL 32453S

Figure 22. Capacitor color codes.

RESISTOR COLOR CODES



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

NOTES

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

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

RMA: RADIO MANUFACTURERS ASSOCIATION

JAN: JOINT ARMY-NAVY

THESE COLOR CODES GIVE ALL RESISTANCE VALUES IN OHMS.

TL32454S

Figure 23. Resistor color codes.

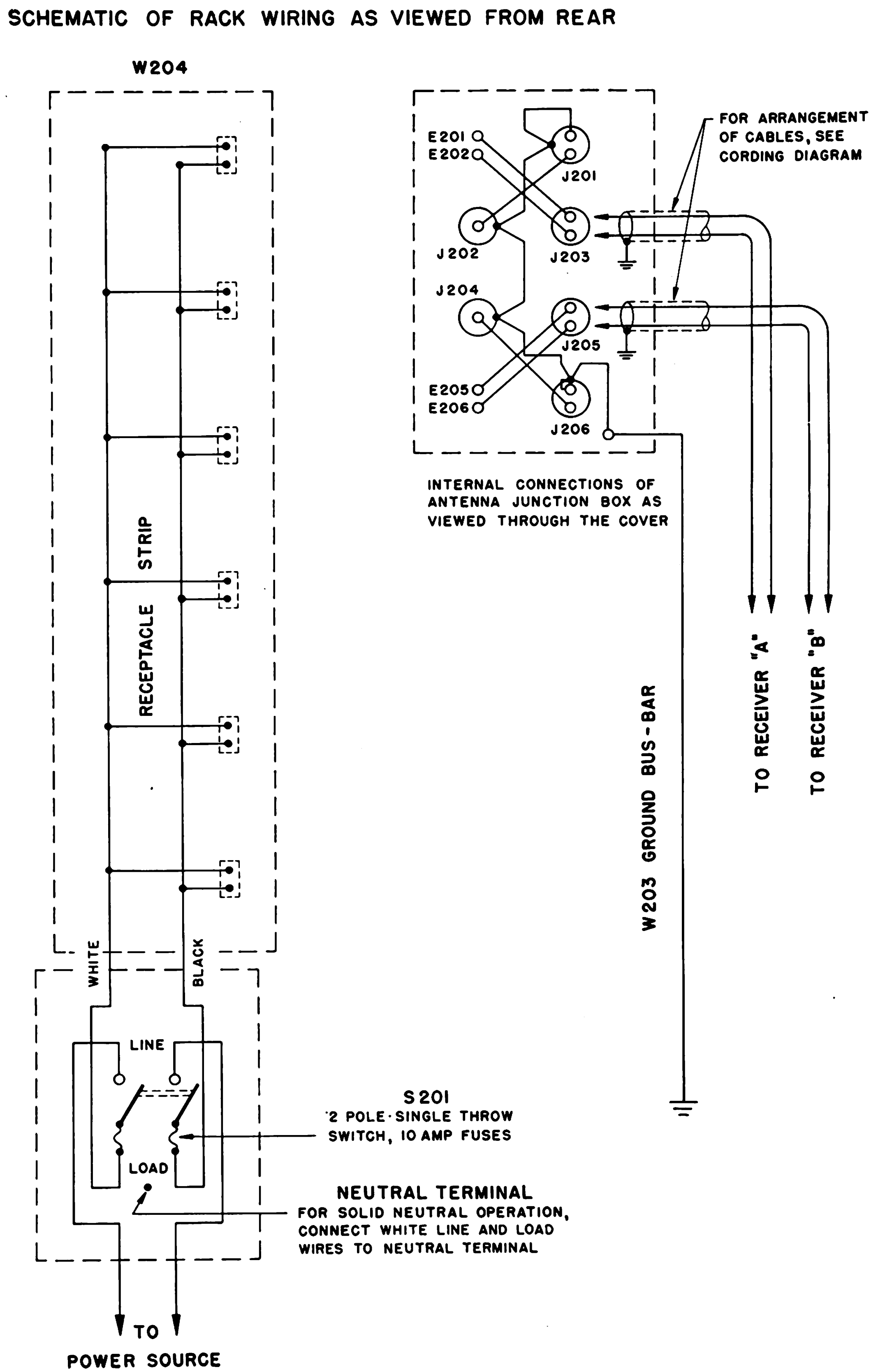


Figure 24. Rack MT-660( )/FRR-12, wiring and schematic diagram.

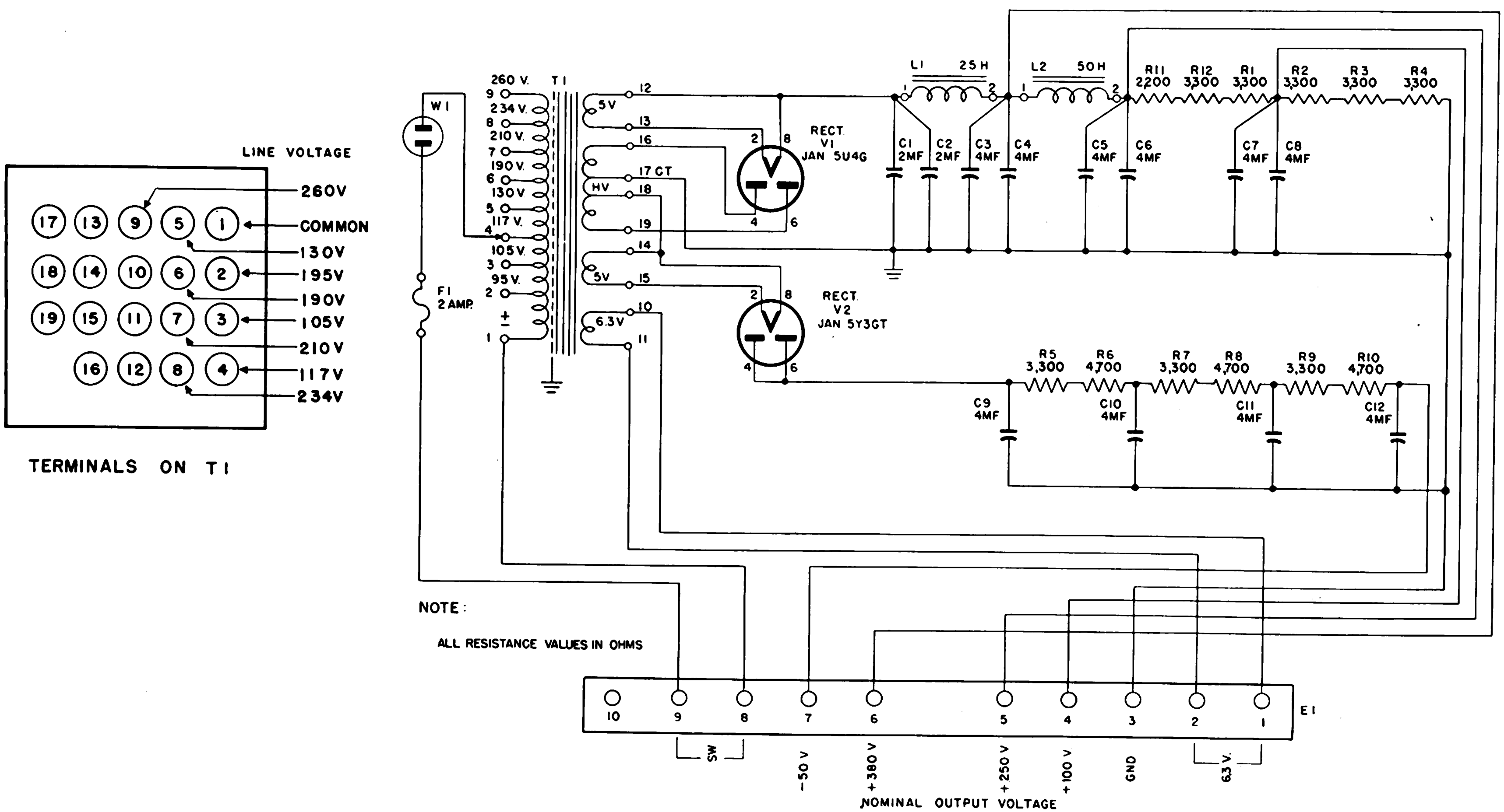
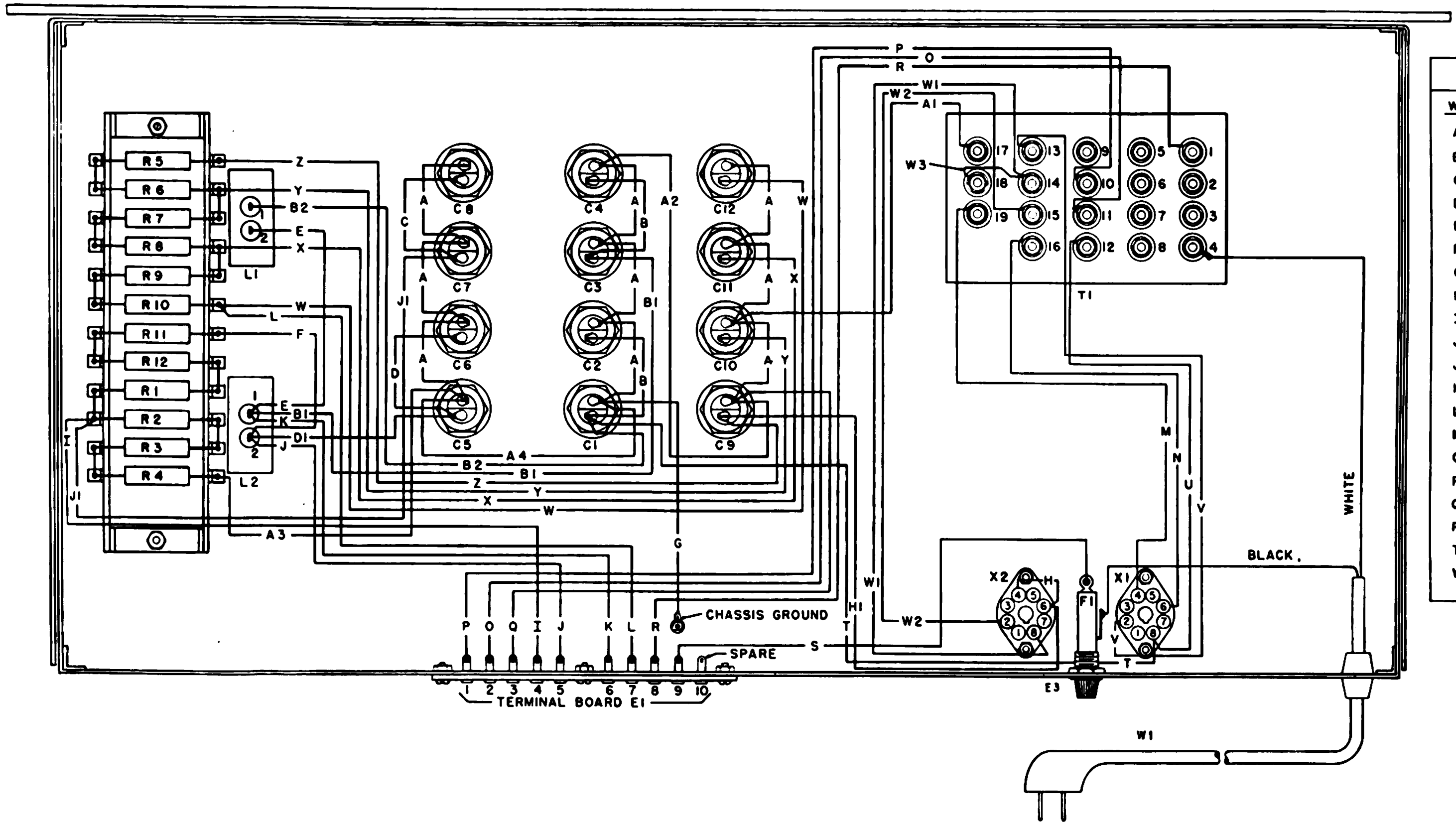


Figure 25. Power Supply Unit RA-74-D, schematic diagram.



WIRE TABLE

WIRE LETTER	COLOR	SIZE
A, A1, A2, A3, A4	BLACK	20
B, B1, B2	RED	20
C	RED GREEN TR.	20
D, D1	RED WHITE TR.	20
E	RED	20
F	RED WHITE TR.	20
G	BLACK	20
H, H1	ORANGE	20
I	RED GREEN TR.	20
J	RED WHITE TR.	20
J1	RED GREEN TR.	20
K	RED	20
L	GRN. WHITE TR.	20
M, N	ORANGE	20
O	BLUE	14
P	WHITE	14
Q	BLACK	20
R, S	BLK. WHITE TR.	20
T, U, V	RED	20
W, W1, W2, W3, X, Y, Z	GREEN	20

Figure 26. Power supply Unit RA-74-D, wiring diagram.

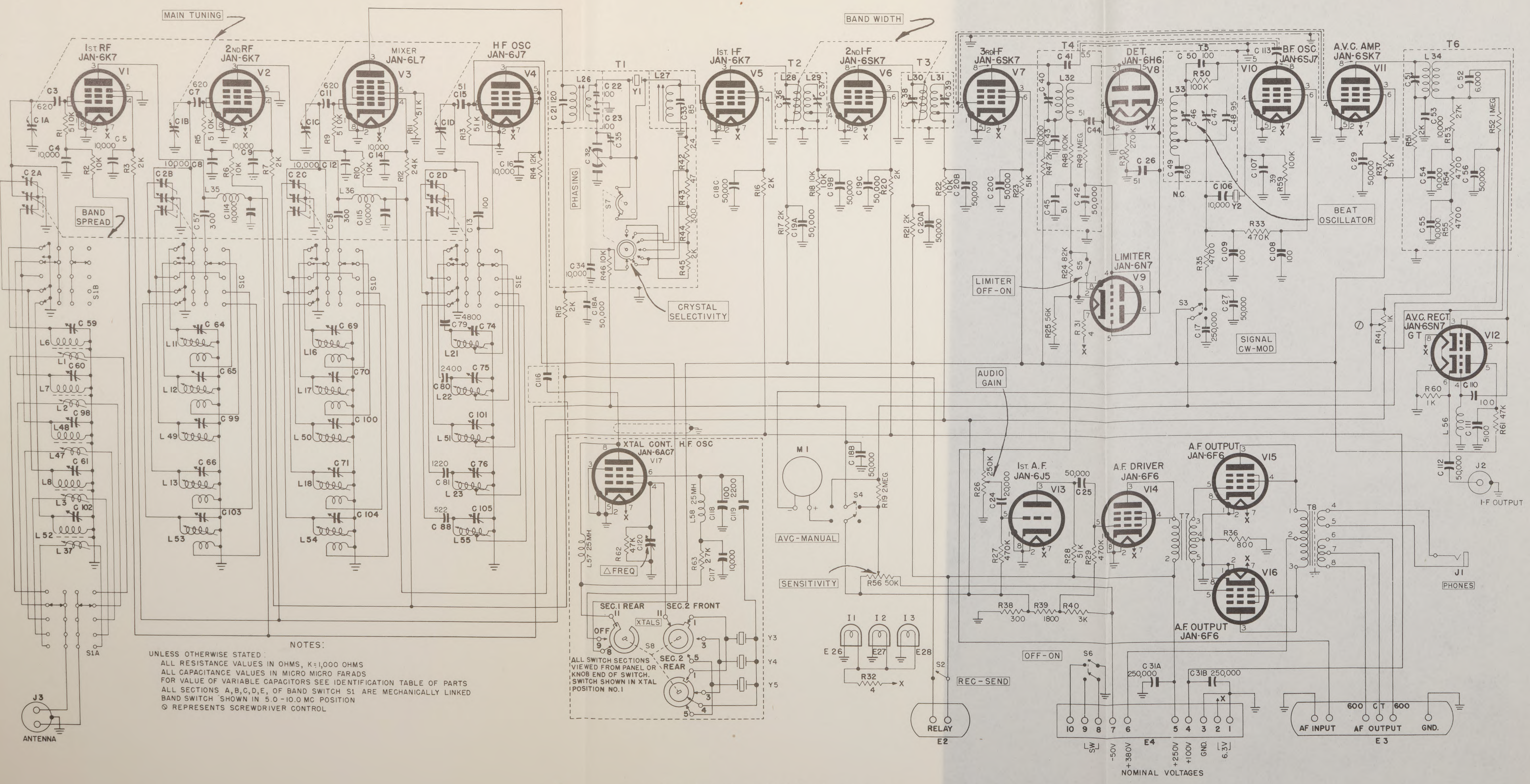


Figure 27. Radio Receiver R-270/FRR, schematic diagram.

809326 O - 48 (Face p. 70) No. 1

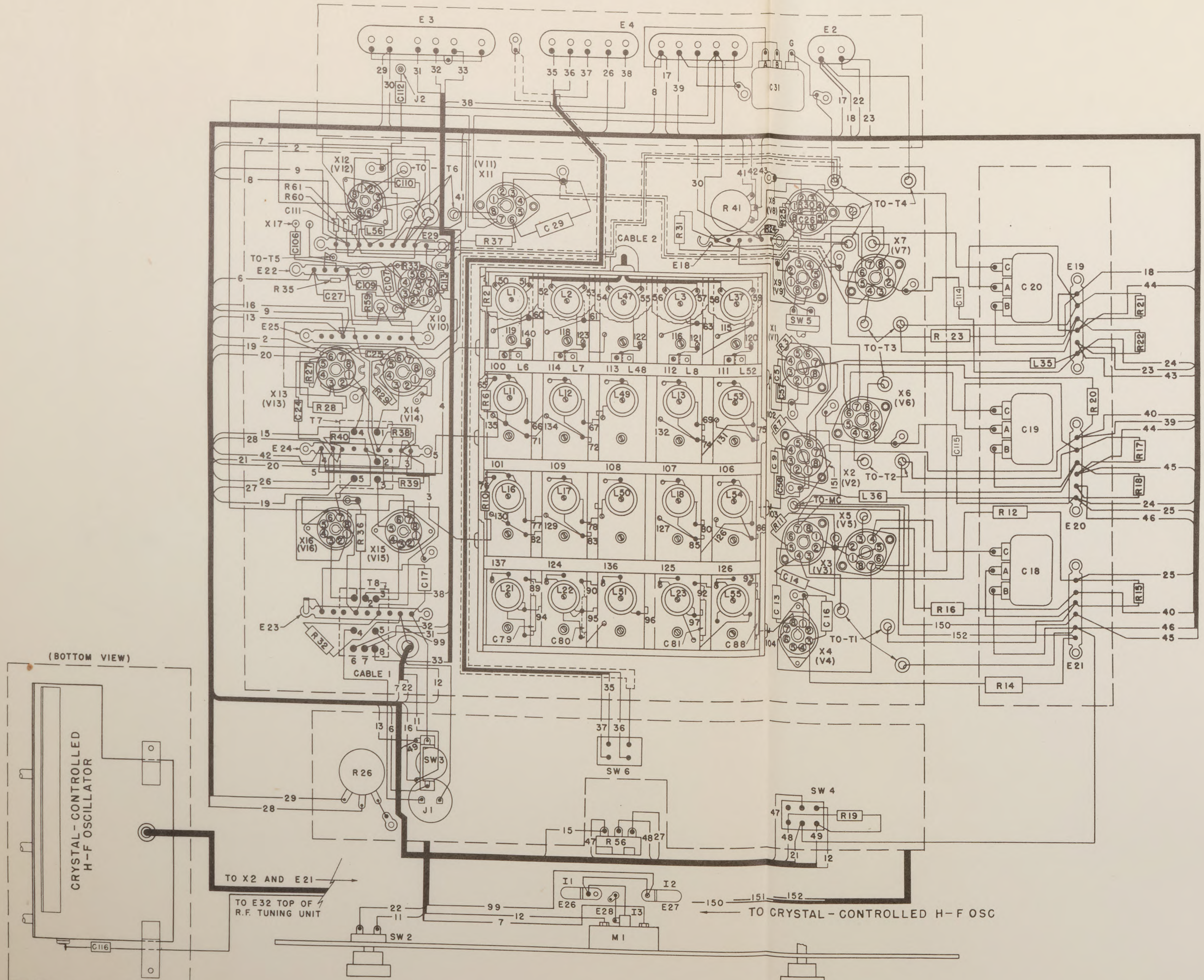


FIGURE 28. Radio Receiver R-270/FRR, wiring diagram.

809326 O - 48 (Face p. 70) No. 2

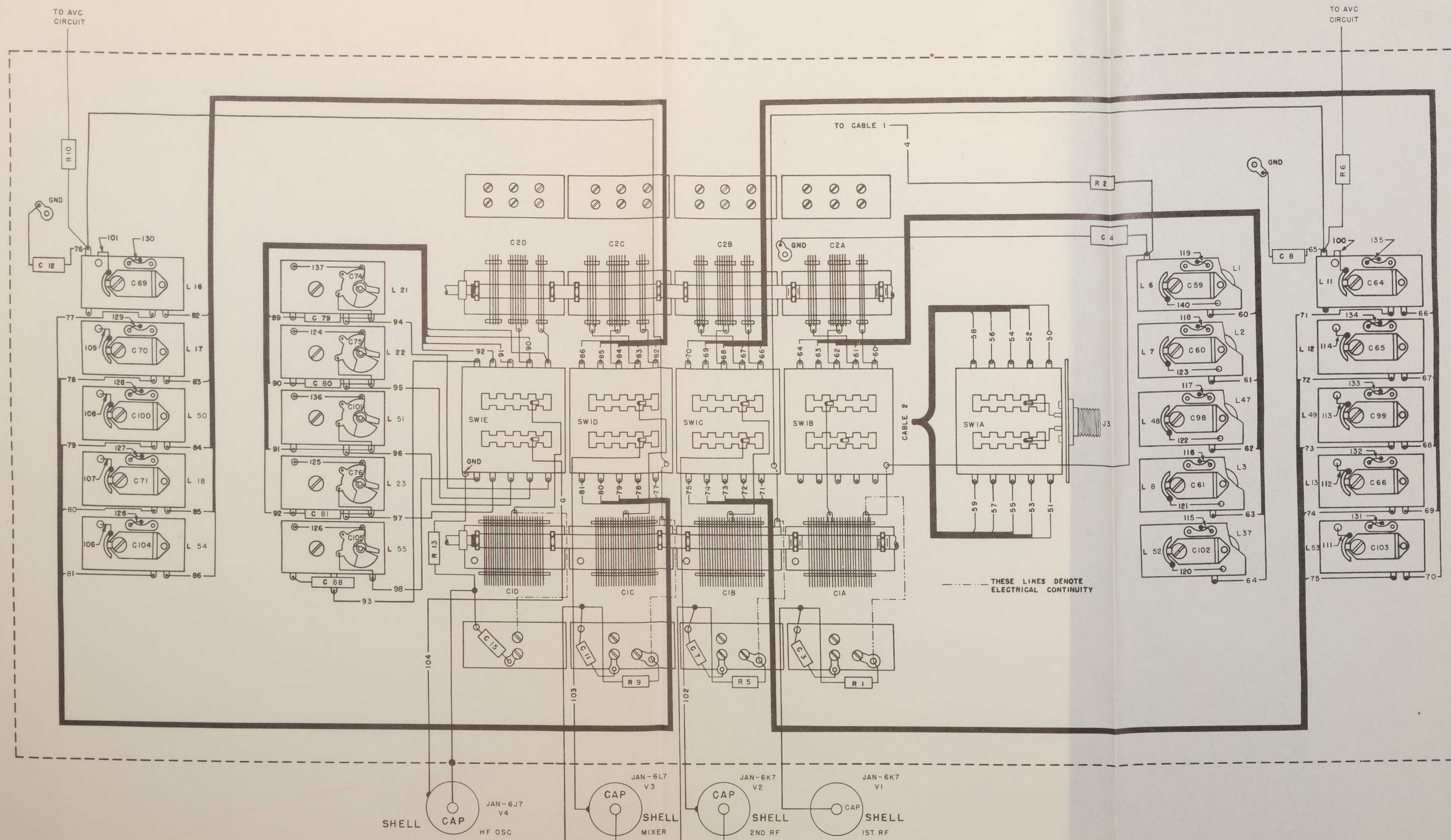


FIGURE 29. Radio Receiver R-270/FRR, r-f tuning unit, wiring diagram.