DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-854

TO 16-35R-388-5

RADIO RECEIVER

R-388/URR

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

APRIL 1952

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RADIO RECEIVER

R-388/URR

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DEPARTMENTS OF THE ARMY AND
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CONTENTS

WARNING

HIGH VOLTAGE

is used in the operation of
this equipment.

DEATH ON CONTACT

may result if operating personnel
fail to observe safety precautions.

First Aid for Electric Shock

RESCUE.

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

SYMPTOMS.

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

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

TREATMENT.

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

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

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

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

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

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

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

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

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

f. The resuscitation procedure is as follows:

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

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

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

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

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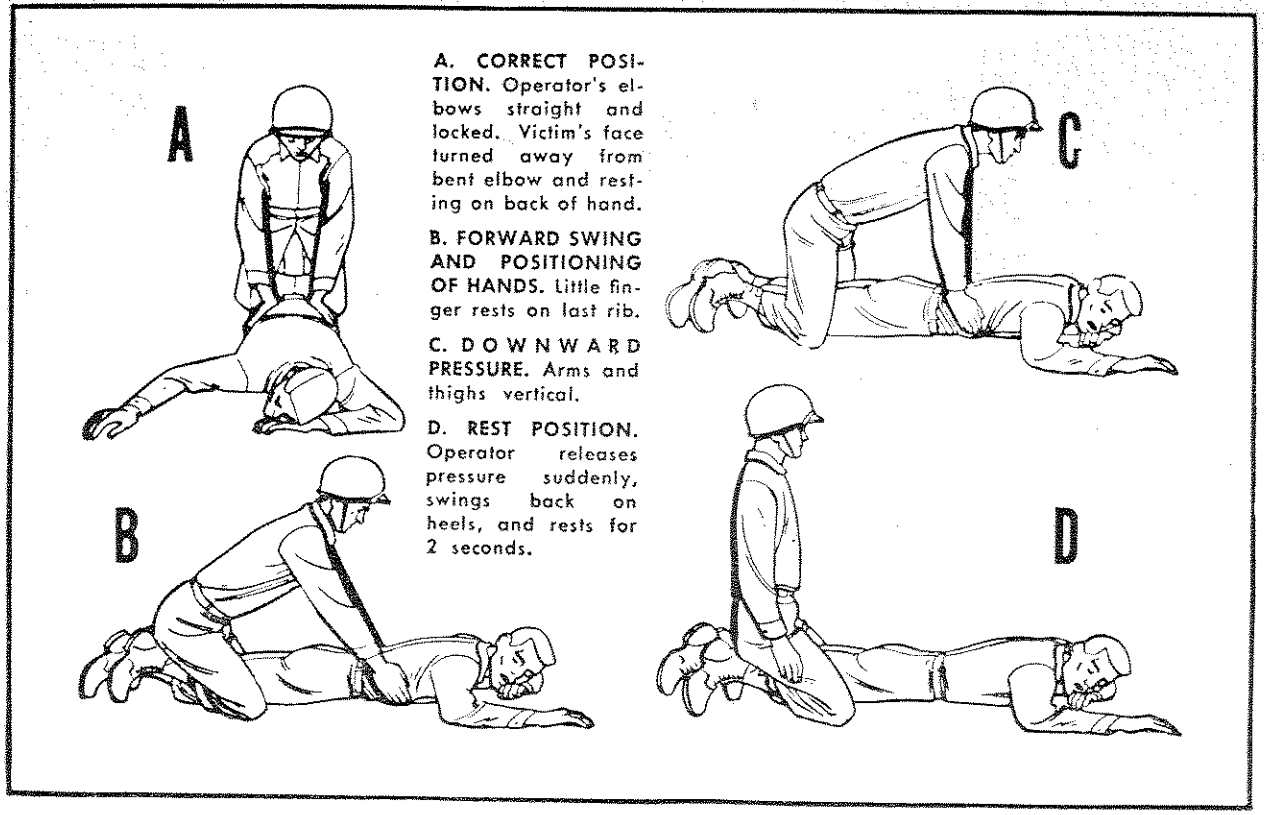

A. CORRECT POSITION. Operator's elbows straight and locked. Victim's face turned away from bent elbow and resting on back of hand.

B. FORWARD SWING AND POSITIONING OF HANDS. Little finger rests on last rib.

C. DOWNWARD PRESSURE. Arms and thighs vertical.

D. REST POSITION. Operator releases pressure suddenly, swings back on heels, and rests for 2 seconds.

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

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

RELIEVING OPERATOR.

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

STIMULANTS.

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

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

CAUTIONS.

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

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

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

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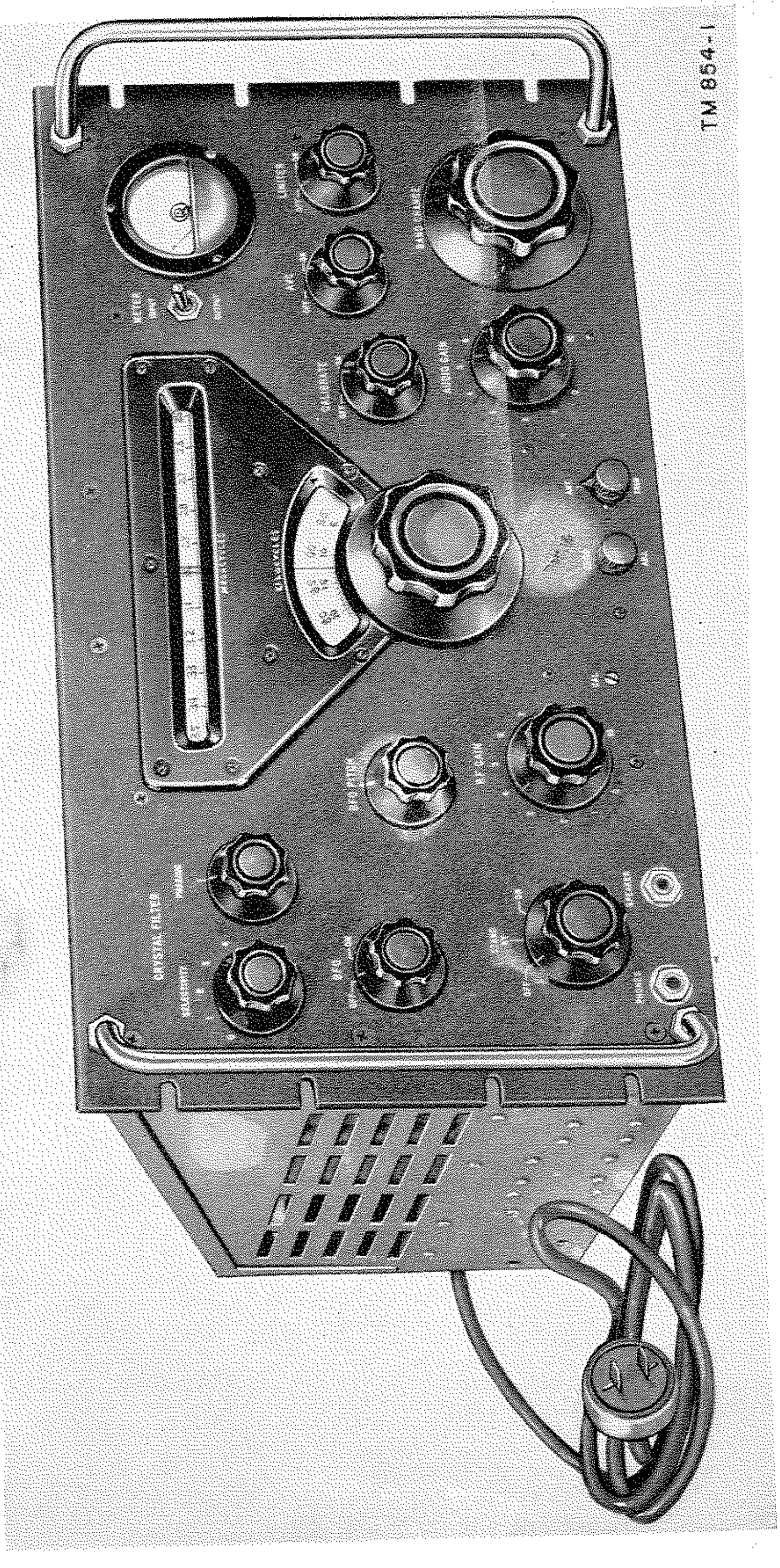


Figure 1. Radio Receiver R–388/URR.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

This technical manual contains instructions for the installation, operation, maintenance, and repair of Radio Receiver R–388/URR. Two appendixes covering a list of references and an identification table of parts, are also provided at the back of the manual.

2. Forms and Records

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

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

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

c. USAF Form 54 (Unsatisfactory Report) will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in AFR 65–26.

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

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

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Radio Receiver R–388/URR is a communications receiver, having exceptional frequency stability and calibration accuracy. The receiver covers the frequency range from .5 to 30.5 mc (megacycles). Although useful as a general purpose communications receiver, its accuracy and stability make it especially useful where it is desired to receive known frequencies without searching or frequent readjustment, and for the reception of frequency-shift keying transmissions. It is, therefore, particularly adaptable to the reception of radioteletype signals.

b. The receiver is intended for use as part of fixed or mobile installations. See the appropriate instruction book for complete details on each application.

c. Figure 2 is a simplified block diagram of the receiver in use and shows the minimum additional equipment required for operation.

d. Figure 3 is a simplified block diagram of the receiver in use with Radio Set AN/GRC–26A for the reception of radioteletype signals.

4. Technical Characteristics

a. Performance.

Frequency range ____ .5 mc to 30.5 mc.

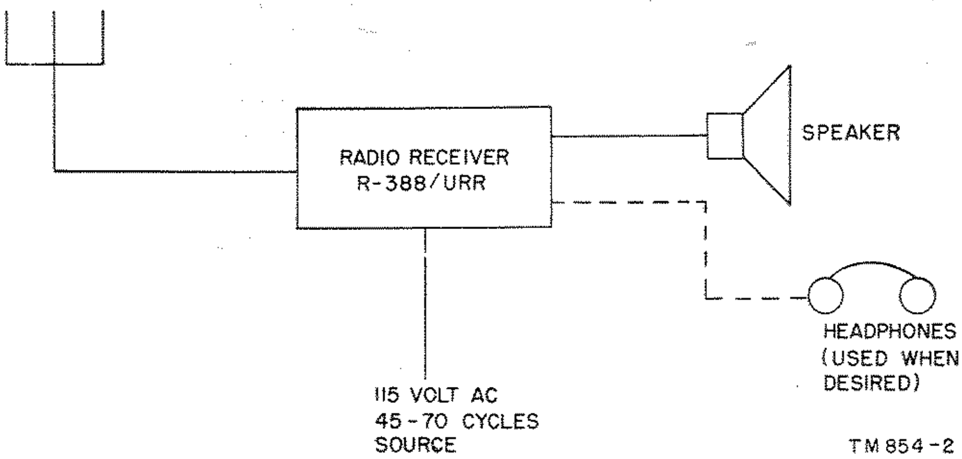
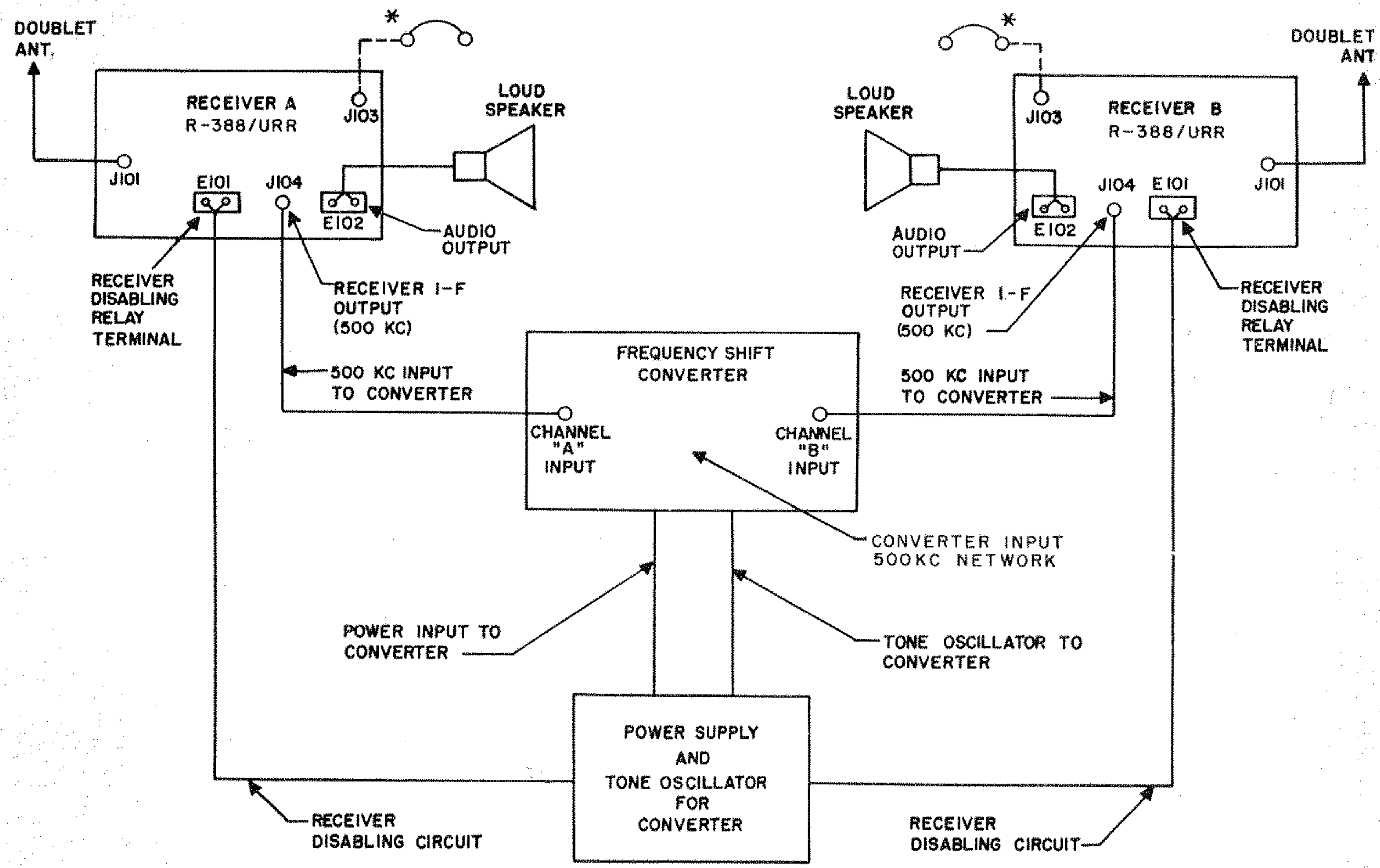


Figure 2. Receiver in use, simplified block diagram.

Receiver type	Single, double, or triple conversion superheterodyne.
I-f frequency	500 kc (kilocycles).
Types of reception	Voice, c-w (continuous-wave), and frequency-shift.
Number of tubes	18.
Tuning	Linear, divided into thirty 1-mc tuning steps.
Calibration	Direct reading in mc and kc.
Method of calibration.	Built-in crystal oscillator (100 kc).
Calibration points	Every 100 kc.
Frequency stability	Over-all stability within 1 kc for average conditions; within 2 kc for extreme conditions.
Sensitivity	A-m (amplitude-modulated) signal input of 5 uv (microvolts) maximum required to produce 500 mw (milliwatts) power output at a signal-plus-noise to noise ratio of 10 to 1.
Selectivity	Approximately 6 kc at 6 db (decibels) down, and not greater than 20 kc at 60 db down (total bandwidth) from resonant frequency. With crystal filter in operation, at 6 db down, the bandwidth may be varied from approximately .2 kc to 2.0 kc.
Spurious signal responses.	Down at least 50 db.
Avc (automatic volume control).	Less than 4-db increase in audio power output with an increase in r-f (radio-frequency) signal from 5 to 125,000 uv (microvolts).
Noise limiter	Series type ahead of first audio stage, effective for c-w operation.
Output impedances	4- and 600-ohm impedances.
Audio-frequency response.	With 1,000 cps (cycles per second) reference, response down not more than 3 db at 200 cps, and not more than 7 db at 2,500 cps.
Antenna input impedance.	Unbalanced to match short whip antenna (50 ohms, 100 $\mu\mu$f (micromicrofarads)).
Power requirements.	85 watts at 115 or 230 volts, 45 to 70 cps.
Weight	35 pounds.

b. Tuning Steps.

BAND CHANGE switch position	*Coverage (mc)*
No. 1	.5 to 1.5
No. 2	1.5 to 2.5
No. 3	2.5 to 3.5
No. 4	3.5 to 4.5
No. 5	4.5 to 5.5
No. 6	5.5 to 6.5
No. 7	6.5 to 7.5



* NOTE :— HEADSET PLUGS INTO JACK J103 ON FRONT PANELS OF RECEIVERS

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Figure 3. Receiver in use with frequency-shift converter for reception of radioteletype signals, simplified block diagram.

BAND CHANGE switch position	*Coverage (mc)*
No. 8	7.5 to 8.5
No. 9	8.5 to 9.5
No. 10	9.5 to 10.5
No. 11	10.5 to 11.5
No. 12	11.5 to 12.5
No. 13	12.5 to 13.5
No. 14	13.5 to 14.5
No. 15	14.5 to 15.5
No. 16	15.5 to 16.5
No. 17	16.5 to 17.5
No. 18	17.5 to 18.5
No. 19	18.5 to 19.5
No. 20	19.5 to 20.5
No. 21	20.5 to 21.5
No. 22	21.5 to 22.5
No. 23	22.5 to 23.5
No. 24	23.5 to 24.5
No. 25	24.5 to 25.5
No. 26	25.5 to 26.5
No. 27	26.5 to 27.5
No. 28	27.5 to 28.5
No. 29	28.5 to 29.5
No. 30	29.5 to 30.5

c. High-Frequency Oscillators V105 Crystals and Injection Frequencies

Crystal	*Band*	*Receiver frequency (mc)*	*Crystal frequency (mc)*	*Injection frequency (mc)*
1	1	.5 to 1.5	4	8 and 12
	2	1.5 to 2.5		
	3	2.5 to 3.5		
2	4	3.5 to 4.5	6	6
3	5	4.5 to 5.5	8	8
	6	5.5 to 6.5		8
	13	12.5 to 13.5		16
	14	13.5 to 14.5		16
4	7	6.5 to 7.5	10	10
	8	7.5 to 8.5		10
	17	16.5 to 17.5		20
	18	17.5 to 18.5		20
	27	26.5 to 27.5		30
	28	27.5 to 28.5		30
5	9	8.5 to 9.5	12	12
	10	9.5 to 10.5		12
	21	20.5 to 21.5		24
	22	21.5 to 22.5		24
6	11	10.5 to 11.5	14	14
	12	11.5 to 12.5		14
	25	24.5 to 25.5		28
	26	25.5 to 26.5		28
7	15	14.5 to 15.5	9	18
	16	15.5 to 16.5		18
8	19	18.5 to 19.5	11	22
	20	19.5 to 20.5		22
9	23	22.5 to 23.5	13	26
	24	23.5 to 24.5		26
10	29	28.5 to 29.5	10.6	32
	30	29.5 to 30.5		32

d. Tube Table.

Symbol	*Type*	*Function*
V101	6AK5	R-f amplifier
V102	6BE6	First mixer
V103	6BE6	Intermediate mixer
V104	6BA6	Calibration oscillator
V105	6AK5	Crystal oscillator
V106	6BE6	Second mixer
V107	6BA6	First i-f (intermediate-frequency) amplifier
V108	6BA6	Second i-f amplifier
V109	6BA6	Third i-f amplifier
V110	12AX7	Detector and avc rectifier
V111	12AU7	Avc amplifier and i-f output
V112	12AX7	Noise limiter and a-f (audio-frequency) voltage amplifier
V113	6AQ5	A-f power amplifier
V114	6BA6	Beat-frequency oscillator
V115	5V4	Power rectifier
V116	OA2	Voltage regulator
V001	6BA6	Variable-frequency oscillator
V002	6BA6	Buffer amplifier

5. Packaging Data

Radio Receiver R–388/URR and its spare parts are packed for export shipment in a wooden box. Between the receiver and wooden box, protection from water, moisture, and vapors is obtained by two barrier packages and two cartons. The arrangement of these protective layers is shown in figure 7. The front panel of the receiver is protected by a padded wooden frame. All sides of the receiver are padded with corrugated cardboard. Bags of silica gel are placed within the inner covering of the receiver to absorb any moisture locked in when the receiver is packed. A separate carton contains the spare parts, all of which are packed individually.

6. Description of Receiver
(figs. 4 and 5)

a. Radio Receiver R–388/URR is an 18-tube superheterodyne receiver for receiving a-m phone signals and c-w signals in the frequency range of .5 mc to 30.5 mc. The tuning range is divided into thirty 1-mc tuning steps which are selected by the BAND CHANGE knob at the lower right end of the receiver. Each change of band causes a different slide-rule type scale, graduated in tenths of megacycles, to appear in the upper MEGACYCLES dial opening. The center knob is the main tuning control, and it turns the KILOCYCLES dial which is visible through the lower opening. This dial is graduated in 1-kc intervals, and rotates exactly 10 times while the slide-rule MEGACYCLES dial is covering 1 mc. Frequency is read by adding the readings of both dials.

b. The receiver is constructed as a panel and shelf assembly for rack mounting. Top and bottom covers on the chassis protect it from dust.

c. Headphone and speaker jacks are provided at the lower left corner of the front panel. In addition, both 4- and 600-ohm output terminals are provided at the rear of the chassis.

d. The receiver has a 100-kc crystal calibration oscillator which enables checking dial calibration every 1/10-mc interval throughout the tuning range. Intermediate dial readings are within 300-cycle accuracy.

e. A coaxial antenna input connector and a coaxial connector for tapping the i-f output are also provided at the rear of the chassis.

f. A second terminal board on the rear of the chassis permits connection of an external circuit to control the built-in remote-disabling relay.

g. Power is applied through the cord extending from the rear of the chassis, with an overload protection fuse for the power input circuit also located at the rear of the receiver.

7. Running Spares

A group of running spares is supplied with the receiver to provide replacements for all normally expendable items, such as tubes, pilot lamps, and fuses. The following is a list of running spares:

- 1 tube, type 5V4G.
- 1 tube, type 6AK5.
- 1 tube, type 6AQ5.
- 1 tube, type 6BA6.
- 1 tube, type 6BE6.
- 1 tube, type 12AU7.
- 1 tube, type 12AX7.
- 1 tube, type OA2.
- 5 fuses, cartridge type, 1 ampere, 250 volts.
- 1 lamp, Mazda No. 47.

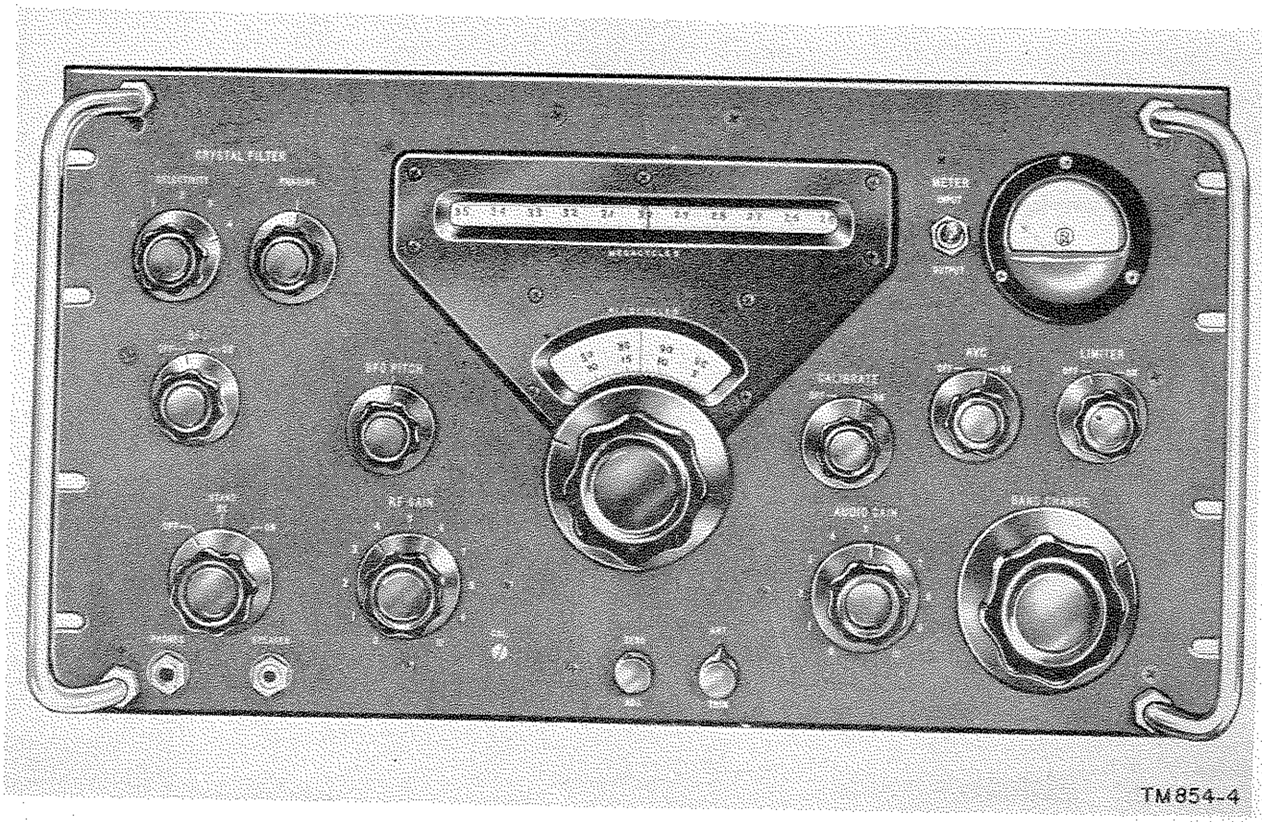

Figure 4. Radio Receiver R–388/URR, front view.

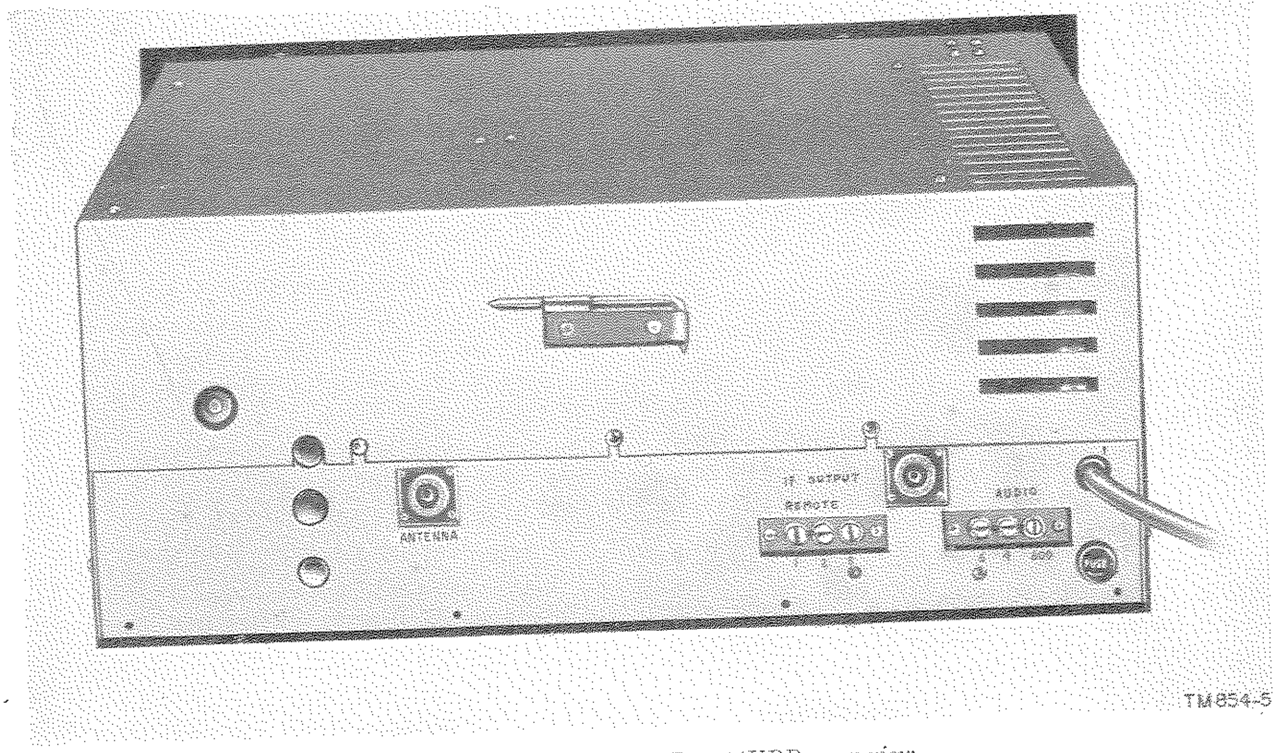

Figure 5. Radio Receiver R–388/URR, rear view.

8. Additional Equipment Required

The following material is *not* supplied as part of Radio Receiver R–388/URR, but it is necessary for its operation.

a. A suitable antenna for the reception of 500-kc to 30.5-mc signals, either single wire or doublet, and a good ground connection where possible.

b. A 115- or 230-watt source of a-c (alternating current), capable of providing at least 80 watts of power.

c. A headset or a, loudspeaker of suitable impedance.

d. A standard cabinet rack for mounting the receiver.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF RADIO RECEIVER R–388/URR

9. Siting

(fig. 6)

The best location for radio equipment depends on the tactical situation and local conditions, such as the following: possible installation in a vehicle, the terrain, the type of housing available, the need to house the equipment where it cannot be seen, and the need of easy access to messengers. Best reception is obtained when the antenna is located in an open area with no large structures nearby which may cause attenuation of incoming signals. Avoid operation near steel structures. Choose, if possible, a location on a hilltop or elevation.

10. Uncrating, Unpacking, and Checking New Equipment

Note.—For used or reconditioned equipment, refer to paragraph 13.

a. General. Equipment may be shipped in oversea packing cases (*b* below) or in domestic packing cases (*e* below). When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent or semipermanent installation of the equipment. Aside from checking to make sure that all carrying cases are present and that the equipment is undamaged, no special unpacking and uncrating procedures are necessary for equipment shipped in carrying cases.

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

b. Step-by-Step Instructions for Uncrating and Unpacking Export Shipments (fig. 7).

(1) Place the packing case as near the operating position as convenient.
(2) Cut and fold back the steel straps.
(3) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top; this may damage the equipment.
(4) Remove the waterproof metal container or moistureproof barrier and any excelsior or corrugated paper covering the equipment inside the case.
(5) Remove the equipment from its inner case and place it on the workbench or near its final location.
(6) Inspect the equipment for possible damage incurred during shipment.

c. Opening Cardboard Carton and Waterproof Barrier. No special instructions are needed for opening the waterproof paper barrier and removing the equipment from the cardboard carton.

d. Checking. Check the contents of the carton against the master packing slip. Check for broken tubes and check that tubes and crystals are inserted in the correct positions (par. 11).

e. Unpacking Domestic Packing Cases. Radio equipment may be received in domestic packing cases. The instructions given in *b* above also apply to unpacking domestic shipments. Cut the metal bands. Open the cartons that protect the equipment; or, if heavy wrapping paper has been used, remove it carefully and take out the components. Check the contents of the packing case against the master packing slip.

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

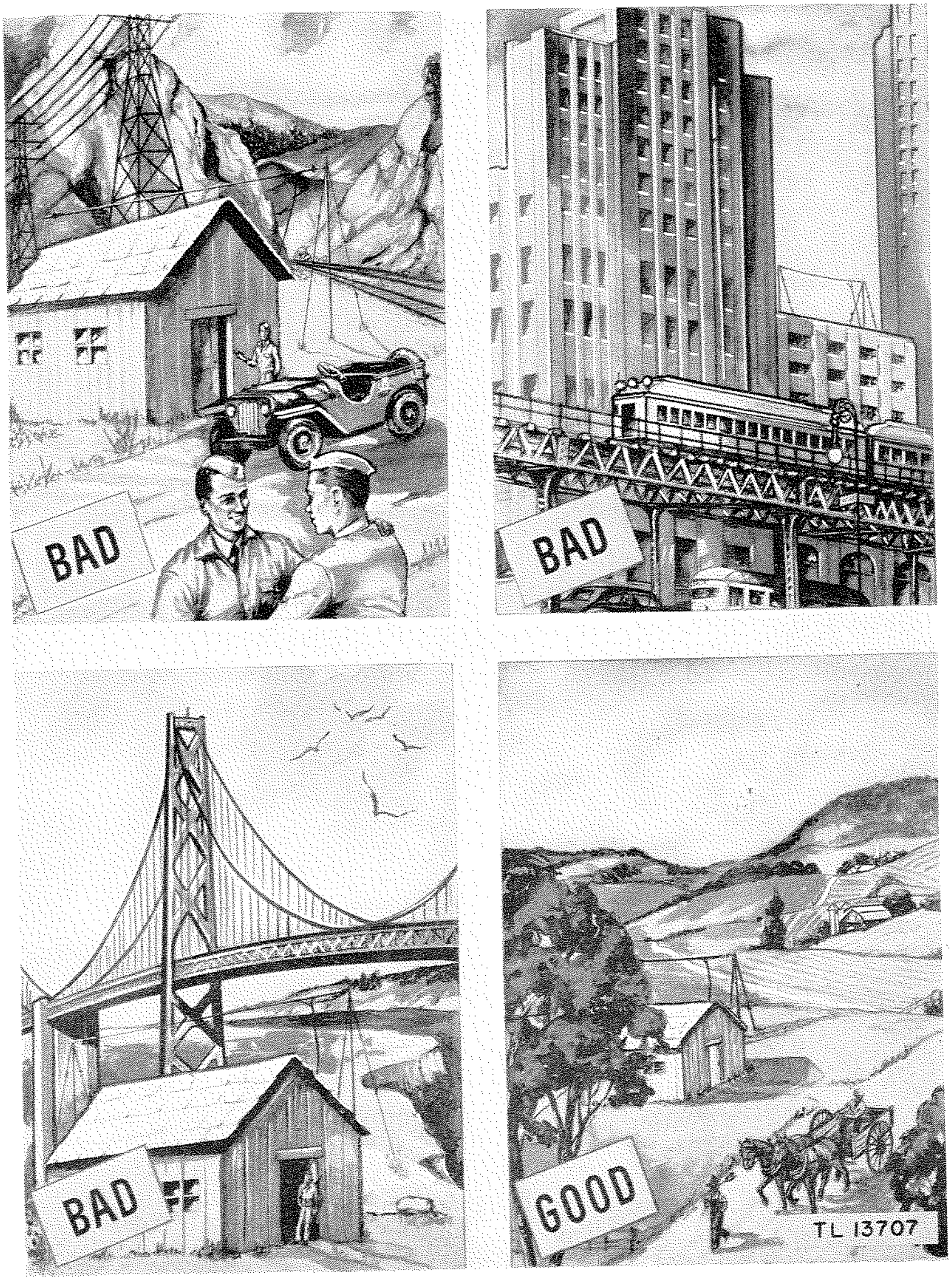

Figure 6. Siting, good and bad locations.

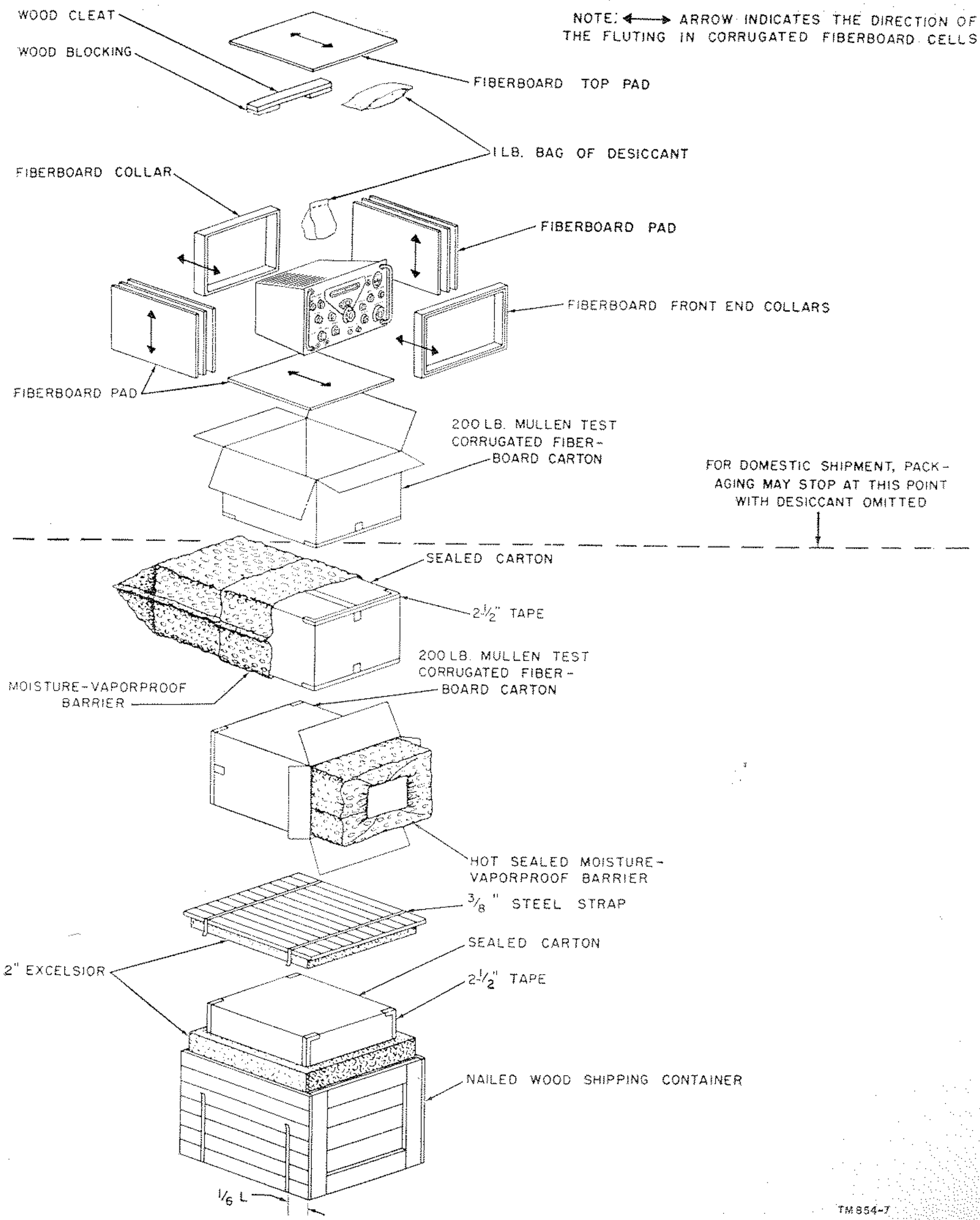

Figure 7. Packaging and packing of Radio Receiver R–388/URR.

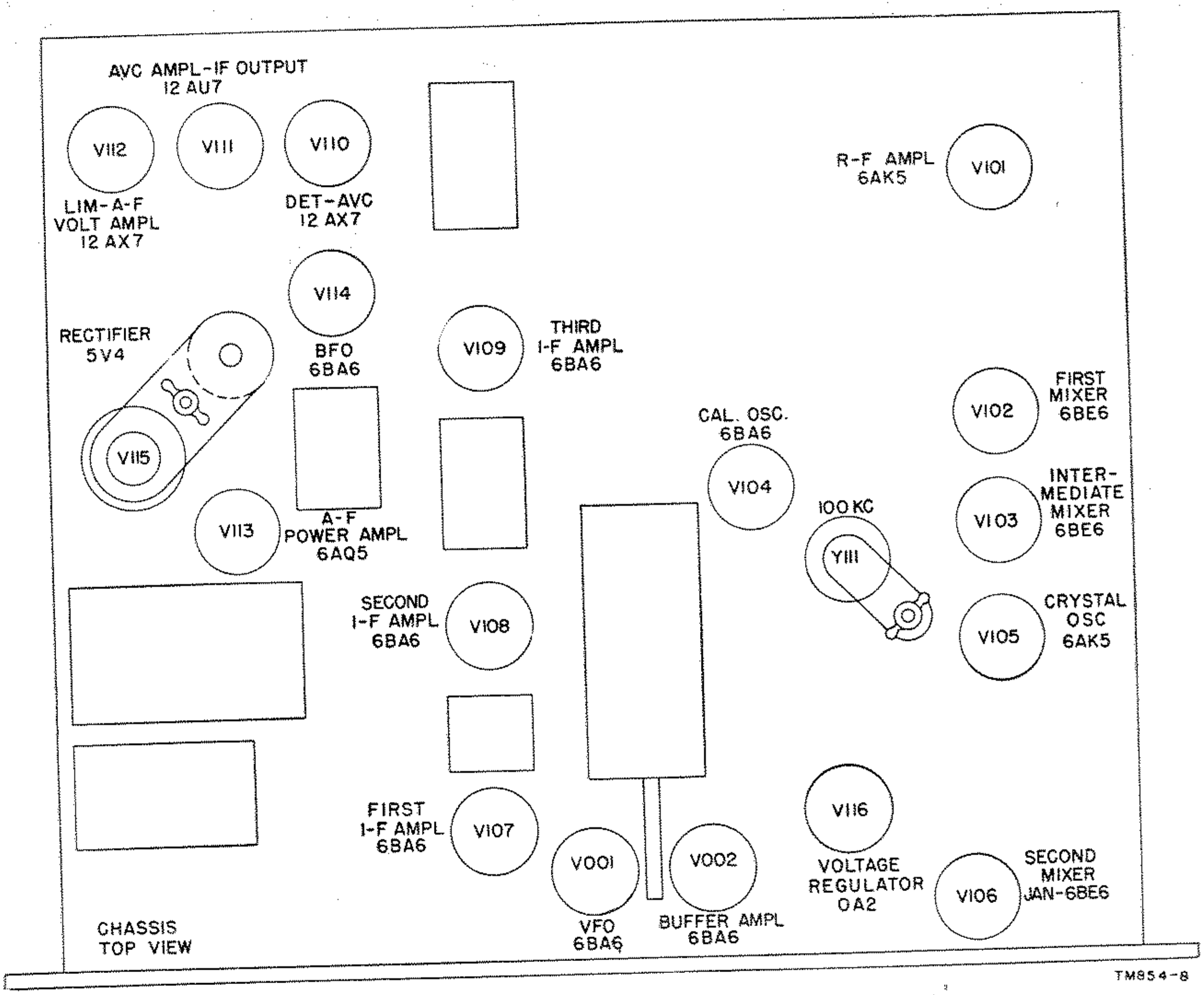

Figure 8. Radio-Receiver R–388/URR, tube location diagram.

11. Installation

To install Radio Receiver R–388/URR, proceed as follows:

a. Before installing the equipment, check the tubes. Remove the top dust cover from the chassis by removing the three screws which hold the dust cover to the rear of the chassis. A Phillips-head screw driver is mounted on the outside of the dust cover at the rear of the receiver (fig. 5). Check all tubes and crystals that they are in the correct sockets (fig. 8) and that none are broken. Note that all tubes except V115 are held in place by means of standard tube shields of the bayonet mounting type. Tube V115 and crystal Y111 are held in place by a strap and wingnut as shown. After checking, replace the dust cover by first mating the three cut-outs along the upper edge of the dust cover with the three studs on the chassis, and then replacing the three hold-down screws on the back.

b. Check the 1½-ampere fuse mounted in the fuseholder at the rear of the chassis.

c. The radio receiver is intended for mounting in a standard rack mounting. The front panel is 19 inches wide and 10½ inches high, and is slotted for mounting screws at points 1½, 3¾, 6¾, and 9 inches from the bottom. A depth of 13¼ inches must be available. For complete instructions on the installation of the receiver as part of complete radio sets, see the instruction book covering the particular set.

12. Connections

When the radio receiver is to be installed as part of a particular unit, make all connections as described in the instruction book covering that set. When the radio receiver is to be used independently, make connections (figs. 3 and 9) as follows:

a. Antenna Connection.

(1) Connect the antenna and ground, by means of a coaxial cable and connector, to the ANTENNA jack (J101) on the rear of the receiver.

(2) If the receiver is to be operated in conjunction with a transmitter, the receiver disabling relay (terminals 1 and 2 of E101) should be connected to the transmitter in such a way that the relay is energized by a 12-volt dc (direct current) when the transmitter is radiating.

b. Power Connection.

(1) The input power connection is made with the cord and plug (P101) which is permanently attached to the rear of the receiver chassis. Connection to a source of 115-volt 45- to 70-cycle ac should be made.

(2) If it is required to operate the receiver on 230-volt 45- to 70-cycle ac, the leads from the power transformer (T108) will have to be reconnected inside the receiver as follows:

(*a*) Disconnect transformer leads No. 2 and 3 from the input cord and power switch (S113), respectively, but leave leads No. 1 and 4 connected.

(*b*) Connect leads No. 2 and 3 together, solder, and cover the splice with electricians tape.

c. Speaker Connection.

(1) A speaker or an audio line, with approximately 600 ohms input impedance can be connected by means of

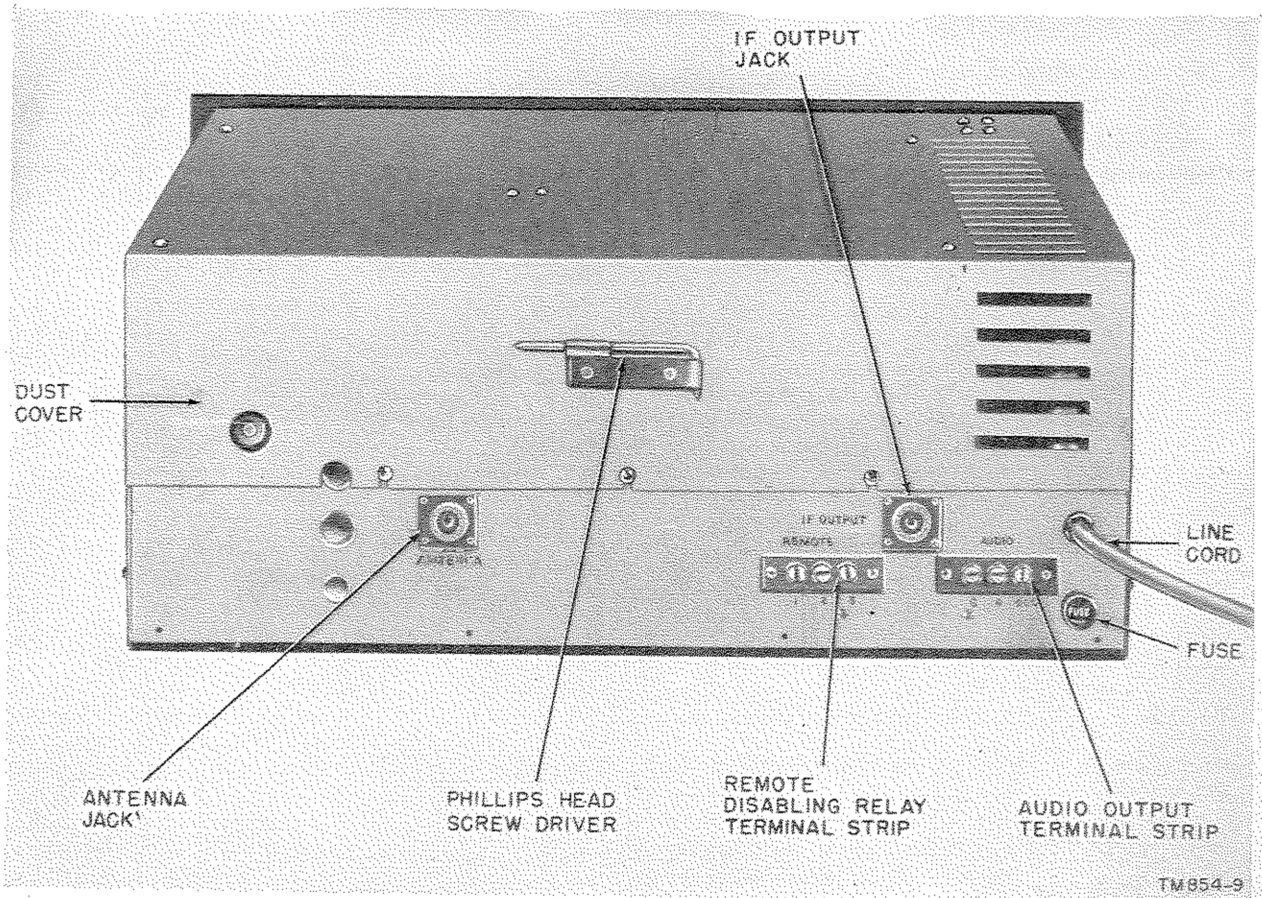

Figure 9. Radio Receiver R-388/URR, rear view, showing connections.

a standard cord and plug at the SPEAKER jack (J102) on the front panel. It can also be connected at the 600-ohm and ground terminals of the AUDIO terminal board (E102) at the rear of the receiver.

(2) A speaker with a 4-ohm voice coil can be connected only by means of the 4-ohm and ground terminals of the AUDIO terminal board.

d. Headphones Connection. Headphones of 600 or more ohms impedance can be connected by means of a standard cord and plug at the PHONES jack (J103) on the front panel.

e. I-F Output Connection. When radioteletype reception is desired, connection to the radioteletype converters can be made by plugging in a 70-ohm coaxial cord and connector at the IF OUTPUT jack (J104) on the rear of the receiver. The radioteletype converter must be capable of being tuned to the receiver 500-kc intermediate frequency.

13. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 10 for uncrating, unpacking, and checking the equipment.

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

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in paragraphs 30 through 32.

d. Perform the installation and connection procedures given in paragraphs 11 and 12.

Section II. CONTROLS AND OPERATION UNDER USUAL CONDITIONS

14. Controls and Their Use

(fig. 10)

Table I lists the controls of the radio receiver and indicates their functions.

Table I. Controls

Control	Function
OFF-STANDBY-ON switch (S113)	In OFF position, opens primary power circuit to turn equipment off completely. In STANDBY position, excites transformer producing filament and plate voltage but does not apply plate or screen voltage to three i-f amplifier tubes, thereby disabling receiver. In ON position (provided REMOTE relay is not energized) receiver is completely operative.
RF GAIN (R148)	Varies amount of fixed bias on r-f amplifier and three i-f amplifier tubes.
AUDIO GAIN (R154)	Controls audio power output.
BAND CHANGE knob	Band selector. Switches coils, capacitors, crystals, tuned circuits, tubes, and MEGACYCLES scale as required for each of 30 tuning steps. Each half-revolution introduces another 1-mc tuning step.
MEGACYCLES scale	Indicates to nearest tenth mc (100 kc) the frequency to which receiver is tuned. Graduated in 10 divisions of 1/10 mc each, each division corresponding to one full turn of KILOCYCLES dial knob. The 1.5- to 2.5-mc and 2.5- to 3.5-mc band graduations are printed in red to indicate that the red scale on the KILOCYCLES dial must be used when operating on these bands.
KILOCYCLES dial knob	Main tuning control. Moves indicator across MEGACYCLES scale and turns KILOCYCLES dial. MEGACYCLES scale indicator moves one division for each full turn (100 divisions) of KILOCYCLES dial.
KILOCYCLES dial	Indicates tens and units figures, in kc, of frequency to which receiver is tuned. Combined with reading of MEGACYCLES dial gives tuned frequency in kc. For example, a reading of 14.1 on MEGACYCLES dial and a reading of 78 on KILOCYCLES dial indicates the frequency is 14,178 kc. There are two scales

Control	Function
	of 100 graduations each, running in opposite directions, one red, the other black. The red scale is used only for the 2.5- to 1.5-mc and 3.5- to 2.5-mc tuning steps.
ZERO ADJ. knob	Moves indicator line on KILOCYCLES dial a few divisions in either direction for calibration purposes.
BFO OFF-ON switch	In OFF position, shorts screen voltage of V114 to ground.
CALIBRATE OFF-ON switch (S118)	In ON position, 100-kc crystal oscillator V104 is operative for calibration purposes.
AVC OFF-ON switch (S115)	In ON position, AVC is operative.
LIMITER OFF-ON switch (S116)	In ON position, automatic noise limiter is operative.
CRYSTAL FILTER SELECTIVITY switch (S114)	In position 0, crystal filter is not used and selectivity is broadest. In positions 1 through 4, crystal filter is in circuit, with its selectivity, becoming progressively sharper at higher numbers.
CRYSTAL FILTER PHASING knob (capacitor C188)	Used for attenuating unwanted heterodyne frequencies. Raises or lowers, slightly, the rejection slot of the crystal filter.
METER INPUT-OUTPUT toggle switch (S117)	In OUTPUT position, connects meter to measure audio power output. In INPUT position connects meter as an S meter. Switch is momentary action type with INPUT as the normal position.
CAL. screw (C224)	Screw-driver adjustment for precise adjustment of crystal calibration to 100 kc.
BFO PITCH control	Adjusts the pitch of incoming c-w signals to suit the operator (BFO ON).

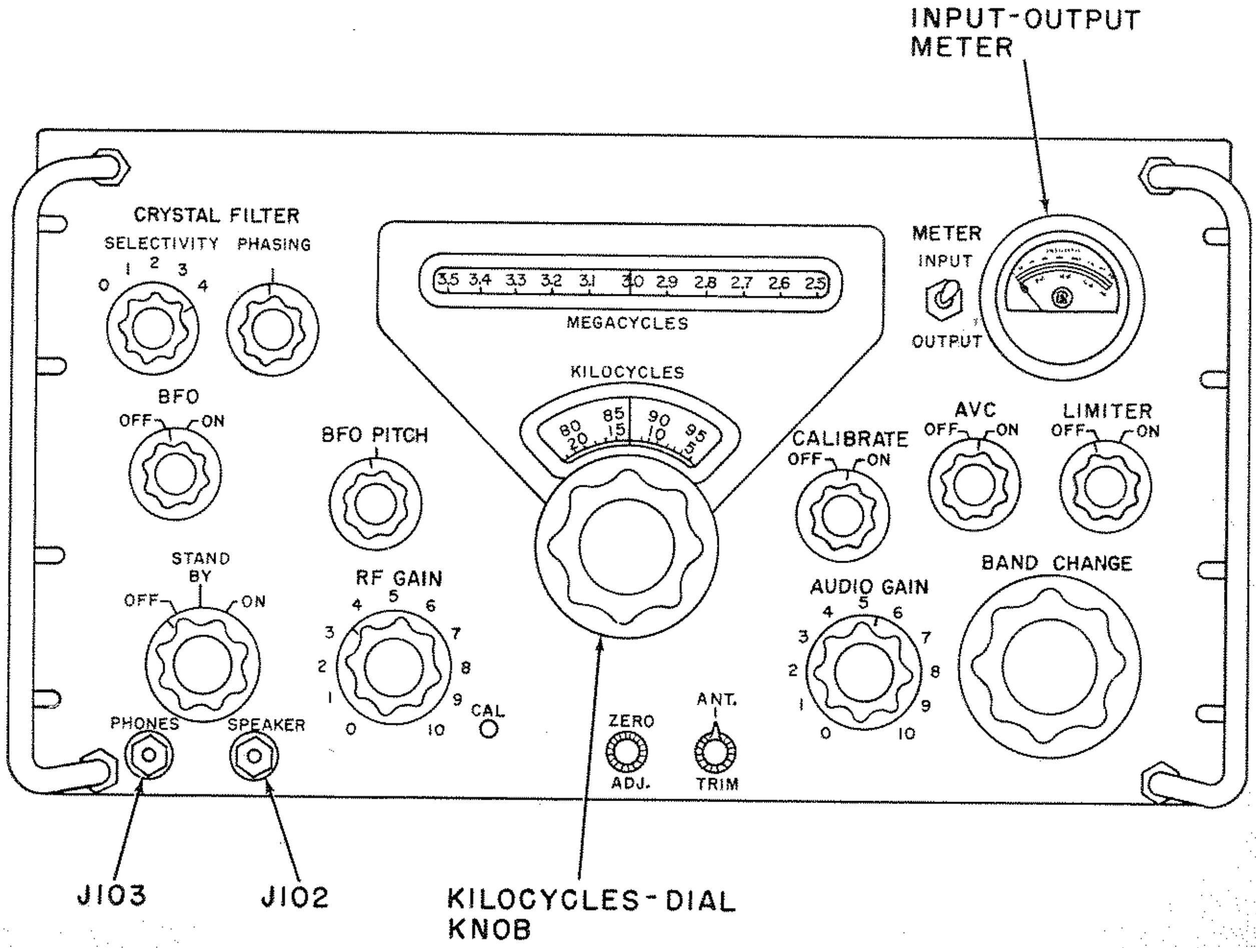

Figure 10. Radio Receiver R–388/URR, front panel.

Control	Function
Jacks and terminals	
ANTENNA jack (J101)	Connects antenna.
REMOTE terminal strip (E101)	Connects disabling relay with 12-volt d-c source.
IF OUTPUT jack (J104)	Connects i-f output to dual diversity unit for reception of radio-teletype signals.
AUDIO terminal strip (E102)	Provides connection for loudspeaker.
FUSE (F101)	1½-ampere cartridge fuse in series with a-c line.

15. Starting Procedure

a. Preliminary. Set the front panel controls as follows:

Control	*Position*
RF GAIN	Between 7 and 9.
AUDIO GAIN	Between 1 and 2.
BAND CHANGE knob	To band desired.
BFO OFF-ON switch	OFF.
CALIBRATE OFF-ON switch	OFF.
AVC OFF-ON switch	ON.
LIMITER OFF-ON switch	OFF.
CRYSTAL FILTER SELECTIVITY switch	0.
CRYSTAL FILTER PHASING control	Alined with mark on panel.

b. Starting.

(1) Turn OFF-STANDBY-ON switch to ON.

(2) Turn AUDIO GAIN control clockwise until noise or signal is heard. If there is no response, refer to paragraph 36.

16. Types of Operation

a. Radio Telegraph Reception.

(1) Place BFO switch to the ON position.

(2) Turn BFO PITCH control to midposition.

(3) Carefully set KILOCYCLES control to frequency of desired signal. If c-w signal is present, the beat note will vary as the exact frequency is approached. Tune for zero beat.

(4) Turn BFO PITCH control to position 1, 2, 3, or 4 as required to produce a desirable operating tone or to make signal readable above interference or unwanted signals on adjacent frequencies.

(5) Throw LIMITER switch to ON position.

(6) Throw AVC switch to ON position.

(7) Readjust AUDIO GAIN and RF GAIN controls to give suitable volume and best signal-to-noise ratio. Refer to paragraph 36.

(8) If unwanted heterodynes interfere with the signal, move CRYSTAL FILTER PHASING control back and forth until a setting is found for which the heterodyne is most attenuated. (The control will have to be moved farther for low-frequency heterodynes than for high ones.)

b. Tone or Voice Reception.

(1) Carefully set KILOCYCLES control to frequency of desired signal. If tone or voice signal is present, tune for loudest or least distorted signal.

(2) Turn CRYSTAL FILTER SELECTIVITY control to a higher position only if necessary to minimize interference from unwanted signals on adjacent frequencies.

(3) Throw LIMITER switch to ON position only if noise of the impulse type is being picked up.

(4) Readjust AUDIO GAIN and RF GAIN controls to give suitable volume and best signal-to-noise ratio.

(5) If unwanted heterodynes interfere with the signal, move CRYSTAL FILTER PHASING control back and forth until a setting is found for which the heterodyne is most attenuated.

c. Making Frequency Measurements. To determine accurately the frequency of an unknown signal or to make any frequency measurement, proceed as follows:

(1) Calibrate the receiver in accordance with the instructions given in paragraph 17*b*.

(2) Leave BFO switch at ON, and do not move BFO PITCH control after calibrating.

(3) Tune in the signal. A beat note should be audible as the exact frequency of the signal is approached. Using only the KILOCYCLES control, tune for zero beat.

(4) The receiver is now tuned to the exact frequency of the signal that can be read on the dials.

17. Calibrating Receiver

a. Although the over-all tuning accuracy of the receiver is within about 1 kc, every 100-kc portion of the tuning range can be individually calibrated to an accuracy of about *300 cycles* by means of the built-in 100-kc crystal oscillator and the ZERO ADJ. knob of the tuning dial. This oscillator emits a fundamental frequency of 100 kc and also every harmonic, 200 kc, 300 kc, etc., that is needed to cover the frequency range of the receiver. Three methods of calibrating the receiver can be used.

b. Use the following procedure to calibrate any portion of the tuning range:

(1) With the receiver on but the antenna disconnected, turn the dials to the nearest frequency which is an exact multiple of 100 kc in the range it is desired to calibrate. (For example, if it is desired to calibrate for a frequency of 14,230 kc, turn the dials to 14,200 kc.)

(2) Turn the BFO switch to the ON position and set the BFO PITCH control to line up exactly with the index on the panel.

(3) Turn the CALIBRATE switch to ON. A beat note should be audible.

(4) Turn the KILOCYCLES control so that zero beat is obtained. Do *not* touch the BFO PITCH control.

(5) Turn ZERO ADJ. control to move the dial indicator until it lines up exactly with 0 on the KILOCYCLES dial. The dial will now read accurately in this region.

c. To adjust the 100-kc calibration crystal to exact frequency against standard frequency transmissions, such as those from station WWV (Bureau of Standards radio station located in Washington, D.C. (but only for frequencies which are exact multiples of 100 kc)), use the following procedure.

(1) With the receiver on and the antenna connected, tune in the standard frequency signal. The BFO switch should be at ON and the BFO PITCH control knob marker position set to coincide with the panel mark. Using the main tuning knob, tune the WWV signal to zero beat.

(2) Do not change the BFO PITCH and main tuning knob positions. Turn the CALIBRATE switch to ON.

(3) If an audio signal is heard, carefully adjust the screw-driver CAL. adjustment for zero beat. The 100-kc signal harmonic is now exactly on frequency.

d. To avoid the necessity of recalibrating a frequency range every time it is used, the lower edge of the opening for the KILOCYCLES dial is engraved with a 10-division scale. By making a record or log of the calibrated position of the hairline for any frequency range, the hairline can be reset to the same position without calibrating whenever the receiver is again tuned to the same frequency range.

18. Zeroing Meter

To zero-set the meter for use as an input meter, proceed as follows.

a. Turn the receiver on.

b. Place the BFO switch in the OFF position.

c. Turn the AVC switch ON.

d. Turn the CALIBRATE switch to OFF.

e. Turn the RF GAIN control to position 10.

f. Short circuit the antenna terminals, and turn METER ZERO control R140 (on receiver chassis) until the INPUT meter reads zero.

19. Stopping Procedure

To turn off the receiver, turn the OFF-STANDBY-ON switch to OFF.

20. Operating Precautions and Notes

The following notes will aid the operator in securing maximum performance from the receiving equipment.

a. The AVC control should be in the ON position for practically all reception. However, it may be turned off for c-w reception if desired.

b. For the best reception of weak keyed signals through noise picked up on the antenna or generated in the receiver, set the RF GAIN control to a higher number and reduce the setting of the AUDIO GAIN control to give the desired audio output level. The LIMITER control should be in the ON position.

c. For the reception of phone or voice signals, keep the AVC control on and place the RF GAIN control as high as possible; use the AUDIO GAIN control to vary the output level in the loudspeaker or headset.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

21. General

The operation of Radio Receiver R–388/URR may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. In the following paragraphs instructions are given on procedures for minimizing the effect of these unusual operating conditions.

22. Operation in Arctic Climates

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

a. Handle the equipment carefully.

b. Keep the equipment warm and dry, if possible.

c. Wear a knitted woolen cap over the earphones when operating in the open air with headsets that do not have rubber earpieces. Frequently, when headsets without rubber earpieces are worn, the edges of the ears may freeze without the operator being conscious of this condition. Never flex rubber earcaps, since this action may render them useless. If water gets into the receivers, or if moistrue condenses within them, it may freeze and impede the actuation of the diaphragm. When this happens, remove the bakelite cap and remove the ice and moisture from the receiver.

d. When equipment that has been exposed to the cold is brought into a warm room, it will start to sweat and will continue to do so until it reaches room temperature. This condition also arises when equipment warms up during the day after exposure during a cold night. When the equipment has reached room temperature, dry it thoroughly.

23. Operation in Tropical Climates

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

24. Operation in Desert Climates

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

b. The main problem which arises with equipment operation in desert areas is the large amount of sand, dust, and dirt which enters the moving parts of radio equipment, such as gears and bearings. The ideal preventive precaution is to house the equipment in a dustproof shelter. Since, however, such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent their flapping in the wind.

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

d. Take care to keep the equipment as free from dust as possible. Make frequent preventive maintenance checks (pars. 25–36). Pay particular attention to the condition of the lubrication of the equipment. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

25. Tools and Materials

The tools and materials contained in Tool Equipment TE–41 (the ordinary hand tools and materials normally available to organizational maintenance personnel) are required for organizational maintenance of the receiver. The tools are listed in Department of the Army Supply Catalog SIG 6–TE–41.

26. Special Tools

a. A set of four wrenches of different sizes for setscrews of the fluted socket type is mounted in a tension clasp on the under side of the dust cover.

b. A 3/16-inch steel rod with a 90° bend, machined at each end to handle Phillips-type screws, is mounted on the outer side rear of the dust cover, in a retainer.

c. Two phenolic alinement tools are mounted inside the receiver in a tension clasp near the meter.

Section II. PREVENTIVE MAINTENANCE SERVICES

27. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that break-downs and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See AR 750–5.

28. General Preventive Maintenance Techniques

a. Use No. 0000 sandpaper to remove corrosion, never use emery paper.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent, dry-cleaning (SD) ; then wipe the parts dry with a clean cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride. Then wipe them dry with a clean cloth.

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

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

29. Performing Preventive Maintenance

The following preventive maintenance operations should be performed by organizational personnel at the intervals indicated, unless these intervals are reduced by the local commander, or unless the conditions of operation dictate otherwise:

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed may be damaged or broken.

a. Daily.

(1) Clean exterior of cabinet and dial faces.

(2) Set ZERO ADJ. on KILOCYCLES dial (ch. 4).

(3) Check for loose dial knobs.

b. Weekly.

(1) Check calibration oscillator (par. 17) against station WWV or some other stable frequency source.

(2) Check the meter for zero adjustment. Use a nonmetallic screw driver to adjust METER ZERO control R140 located inside the receiver to the left of the BFO PITCH shaft.

(3) Blow dust out of interior of receiver, upper surface only, and dust off MEGACYCLE dial cylinder.

(4) Inspect fuse F101 and its fuseholder for corrosion, cracks, and lack of tension sufficient to insure good contact.

(5) Inspect power transformer T108 for excessive heating or lamination buzz.

c. Monthly. Remove receiver from rack. Disconnect all outlets. Make visual inspection of the following; replace if necessary and clean.

(1) Check tube sockets for dirt and corrosion. To remove shields, press down, turn counterclockwise and lift over tube.

(2) Check tubes, replace if necessary.

Caution: These tubes, except the rectifier, are of the miniature type, with wire pins that bend easily. If it has been determined that a particular tube is malfunctioning, check the pins and sockets for possible misalinement before discarding.

(3) Turn receiver over (dial face downward) on a flat surface so that the draw handles support it. With a Phillips screw-driver remove 15 screws from base plate and 4 screws from folded top end of plate. Slide off plate exposing under side of receiver.

(4) Check for corrosion and leaking electrolyte, particularly about base of the filter unit, C217, and the bathtub capacitors.

(5) Inspect base plate for telltale signs of solder or electrolyte stains.

(6) Inspect resistors for blistering, discoloration, or other indications of overheating.

(7) Check relay for indications of malfunctioning. Usually the rf section will be faulty if the relay is burned out. Burnish contacts.

(8) With probe, using light pressure, check for loose connections and cold solder joints.

(9) Inspect switch disks for dirt, corrosion, and loose contacts.

Caution: Do not insert probe or screw driver between contacts of switches. This action may *spring* the contacts.

(10) Check PHONES and SPEAKER jacks J103 and J102 for tight fit and good contact.

(11) Check wires, cords, cables, shields, and tubing, for cracks, cuts, frayed insulation, grounds, and shorts.

(12) Check crystal terminal strip on the chassis under side for secure fit. If the crystals are to be removed, it is recommended that they be taken out and replaced individually so that they will not be returned to the wrong sockets.

(13) Check mounting screws in tube sockets, etc., for mechanical looseness.

(14) Inspect variable capacitors for dirt, corrosion, and bent plates.

(15) Check coils for dirt, corrosion and damaged turns.

(16) Check the dry disk rectifier, CR101, for loose connections.

(17) Check band switching gears and cams for excessive accumulation of grit (par. 28).

(18) Dust the interior.

(19) Replace base plate and screws, using caution when tightening.

Section III. LUBRICATION AND WEATHERPROOFING

30. Lubrication Instructions

a. It is only necessary to cover the tuning gear train teeth cam edges and slug table riders with a light grease film of AN–G–25 viscosity.

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

c. Remove old grease with lint-free cloth moistened with carbon tetrachloride or solvent (SD).

d. Wipe with dry cloth and apply lubricant.

31. Weatherproofing

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

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13 and TB SIG 72.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66 and TB SIG 219.

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

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69. Observe all precautions outlined in TB SIG 69, and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat. Refer to section III of this chapter for detailed instructions.

32. Rustproofing and Painting

a. When the finish on the front panel has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 00 or No. 000 sandpaper to clean the surface down to the bare metal; obtain a smooth bright finish.

Caution: Do not use steel wool. Minute particles frequently enter the equipment and cause short circuits.

b. To touch-up, apply paint with a small brush. When numerous scars and scratches warrant a complete repainting of the front panel, remove all knobs, mask the shafts, jacks, dials, meter, and trim, and spray-paint the entire panel. Remove rust spots, before painting, by cleaning the corroded metal with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to prepare the spot for painting. Paint used will be authorized and consistent with existing regulations.

Section IV. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

33. General

The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is necessarily limited in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, trouble shooting is based on the performance of the equipment and the use of the senses in determining which part is at fault.

34. Visual Inspection

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

(1) Burned-out fuse.

(2) Defective tube.

(3) Faulty antenna connections.

(4) Faulty loudspeaker or phone connections.

(5) Antenna or lead-in grounded.

(6) Defective plug and cord.

(7) Line voltage low or not applied.

(8) Corrosion or excessive accumulation of dirt in the set.

(9) Break-in relay burned out.

(10) Dial knobs loose.

b. When failures are encountered and the cause is not immediately apparent, check as many of the above items as it practicable before starting a detailed examination of the receiver components. If possible, obtain information from the operator of the equipment regarding performance at the time the trouble occurred.

35. Trouble Shooting, Using Equipment Performance Checklist

a. General. The equipment performance checklist will help the operator locate trouble in the equipment. This list indicates the item to be checked, the normal indications of correct operation, and the corrective measures the operator can take. To use the list, follow the items in numerical sequence.

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

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

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. A reference in the table below to chapter 5 indicates that the trouble cannot be corrected during operation and that trouble shooting must be done by the higher echelons. This would be a normal procedure. However, if the tactical situation requires that communication be maintained, and if the set is not completely disabled, the operator must maintain the set in operation as long as it is possible to do so.

36. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Antenna	Lead-in wire connected.		
	2	Loudspeaker	Speaker cords connected to AUDIO terminals at rear of set.		
	3	Phones	Inserted securely in PHONES jack.		
	4	Dual diversity converter	Lead-in inserted securely in IF OUTPUT jack.		
	5	Line cord	Line cord plug inserted into socket of 110-volt 50-60-cycle a-c source.		
	6	CRYSTAL FILTER SELECTIVITY control	Set at zero position.		
	7	LIMITER OFF-ON switch	Rotate to OFF.		
	8	AVC OFF-ON control	Set at ON.		
	9	FR GAIN control	Set at 10.		
	10	BFO OFF-ON control	Turn to OFF.		
	11	AUDIO GAIN control	Set at 7.		
	12	CALIBRATE OFF-ON switch	Turn to OFF.		

	Item No.	Item	Action or condition	Normal indications	Corrective measures
START	13	OFF-STANDBY-ON switch	Turn to ON	Dial lamp lights	Check fuse F101 at rear of set. If blown, try to determine cause by visual inspection before inserting new fuse. Check line cord and power source.
				Rushing noise is heard at output	Check tubes first by feeling. Look for tube too hot or cold. Tap tube lightly and listen for pop which indicates defect. Replace tube with one known to be in good condition. Check speaker and connections. Look for short or ground if speaker is remotely operated.
EQUIPMENT PERFORMANCE	14	KILOCYCLES dial knob	Set BAND CHANGE switch at any desired position. Tune across entire band by rotating KILOCYCLES dial knob.	Receiver tracking on signals. Meter in input position fluctuates with varying signal strength	If normal signals are heard, but meter shows no reaction, trouble shooting is necessary. If no signals or weak signals are heard check antenna for firm connections. Check shield for fraying that might ground antenna. Check soldered connections for corrosion or high resistance. Check ground along antenna. Vary ANT. TRIM control for optimum reception.
	15	BAND CHANGE switch	Check each of the tuning steps. Use procedures outlined in item 14 above.		
	16	PHONES jack	Insert phones plug into jack	Signals are audible	Check phones, cord and plug. Check for tight fit in jack.
	17	RF GAIN control	With set tuned to a particular station, rotate control	Strength of signal increases then decreases	Refer to paragraphs 74–79.
	18	AUDIO GAIN control	Rotate control	Volume changes proportionally	Do.
	19	AVC OFF-ON switch	Turn to ON	Signal level stabilizes. Meter becomes insensitive	Do.
	20	CRYSTAL FILTER SELECTIVITY switch	Rotate switch through positions 1, 2, 3, 4	Tuning becomes progressively sharper.	Do.
	21	CRYSTAL FILTER PHASING control	Rotate control in arc about centering index	Undesirable heterodynes should be tuned out	Do.
	22	LIMITER OFF-ON switch	Turn switch to ON. Tune to station on one of the lower bands.	Noise peaks are reduced	Do.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	23	BFO OFF-ON switch	Turn switch to ON and tune in a c-w station on one of the higher bands	Beat-frequency signal is heard at output	Check BFO tube V114. Refer to paragraphs 74–79.
	24	BFO PITCH control	With BFO OFF-ON switch ON, rotate BFO PITCH control	A change in audio pitch is noted at output	Refer to paragraphs 74–79.
	25	ANT. TRIM control	Rotate control in small arc	As optimum match is met, signal increases	Do.
	26	CALIBRATE OFF-ON oscillator switch	Turn to ON. Turn BFO OFF-ON switch ON. Rotate main tuning dial through 1-mc.	Audio beat note is heard at every 100 kc	Do.

CHAPTER 4

THEORY OF OPERATION

Section I. ELECTRICAL THEORY OF RECEIVER

37. General

a. Although Radio Receiver R–388/URR uses the basic superheterodyne principle, it differs from the conventional types: It uses single, double, or triple conversion (mixing) when tuning over the entire frequency spectrum of .5 to 30.5 mc.

b. The tuning range is divided into thirty 1-mc steps by a system of switches and coils in the r-f amplifier, first mixer, crystal oscillator, and variable i-f circuits. Band changing 1-mc steps consists of moving powdered iron *slugs* into selected coils changing the L-C (inductance-capacitance) ratio of the tank circuits by varying the inductances, thus changing the resulting resonant frequencies. Fine tuning is then attained by a cam arrangement controlling the precise position of the powdered iron slugs suspended from a common shaft (pars. 57 and 58). By changing coils and repeating the slug tuning procedure, a highly selective and stable system is attained.

c. When an incoming signal on bands 4 to 30 (3.5- to 30.5-mc) is mixed with the predetermined frequency of the crystal oscillator, V105, the first mixer output frequency (fig. 12) will always be either in the 2.5- to 1.5- or the 3.5- to 2.5-mc range, depending on the variable i-f switch which selects the 2.5- to 1.5-mc pass for the even-numbered bands and the 3.5- to 2.5-mc pass for the odd-numbered bands. The signal then is fed to the second mixer, V106, and beat with a calibrated variable-frequency oscillator signal (V001, V002) to produce an i-f output frequency of 500 kc. This 500-kc output then is fed through a crystal filtering network, Y112. From then on the equipment follows a conventional pattern, with three stages of i-f amplification (V107, V108, and V109); an avc detector section, V110; beat-frequency oscillator V114; avc amplifier and i-f output V111; noise limited and a-f voltage amplifier V112; and audio power amplifier V113 sections (fig. 11).

d. The only exceptions to the procedures as outlined above are tuning steps 1, 2, and 3. Tuning step 1 uses an intermediate mixer, V103, between the first and second mixers as described above. The 4-mc crystal selected by switch S109 (fig. 42) will produce a crystal oscillator (V105) output signal of 12 mc (third harmonic) for the first mixer. The first mixer, V102, output to the intermediate mixer, V103, then will be in the order of 11.5 mc to 10.5 mc. At the same time, by means of split plate-tank-coil tuning, crystal oscillator V105 also will feed to the intermediate mixer, an 8-mc signal (second harmonic of 4 mc) which, when beat with the 11.5-mc to 10.5-mc input signal will cause the intermediate mixer to produce a signal in the 3.5- to 2.5-mc range. This signal then is applied to the second mixer, V106, where it is beat with the 3- to 2-mc output of the vfo (variable-frequency oscillator) to obtain an intermediate frequency of 500 kc (fig. 11). Since bands 2 and 3 correspond to the input frequencies of the second mixer (2.5- to 1.5- and 3.5- to 2.5-mc), incoming signals on these bands are fed directly from the r-f amplifier to the second mixer, V106.

e. The power supply uses a conventional full-

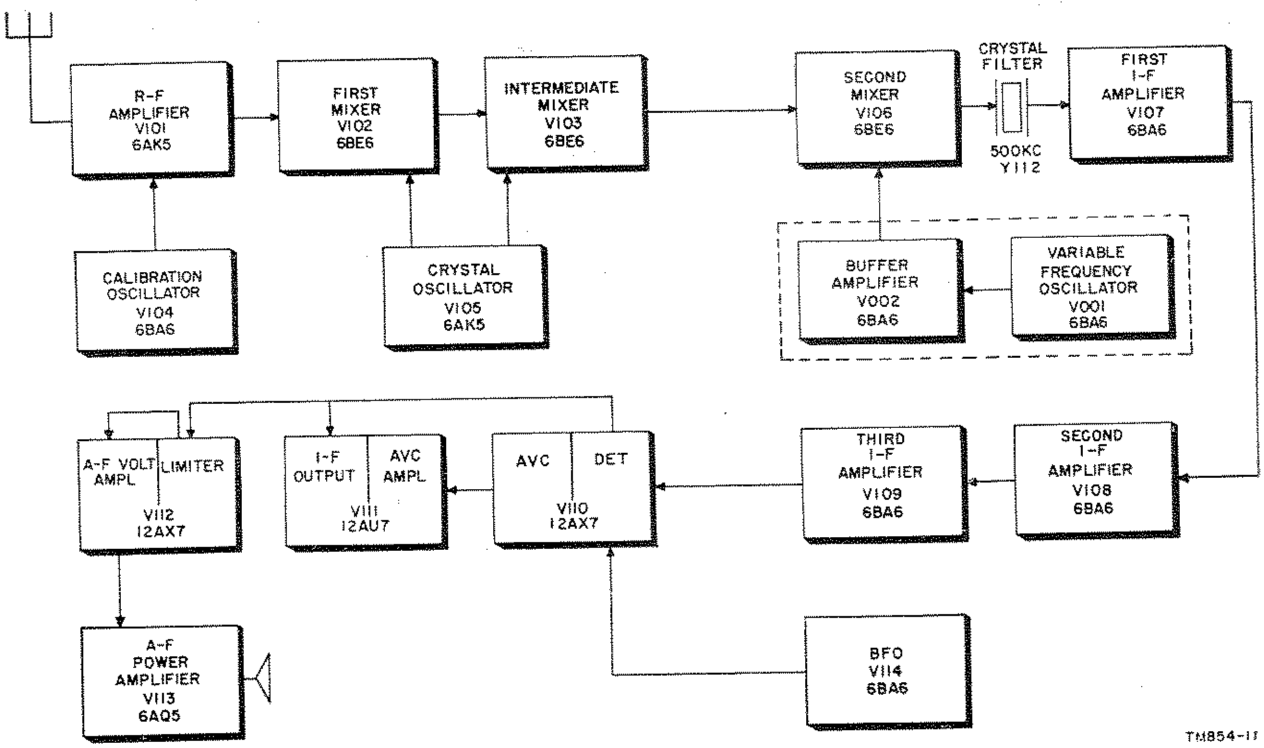

Figure 11. Radio Receiver R–388/URR, over-all block diagram.

wave high-vacuum rectifier, V115, for 115-volt operation, with a two-section choke input filter.

f. The equipment uses 18 tubes, 3 of which are dual-triodes. Their functions are discussed in the following circuit descriptions.

38. Radio-frequency Amplifier V101

The r-f amplifier stage uses a type 6AK5 miniature pentode, V101, the output of which is coupled into either the first or second mixer stage, depending on the position of the BAND CHANGE switch. In tuning step 1, the receiver uses triple conversion and the r-f amplifier output feeds into the grid circuit of the first mixer. In tuning steps 4 through 30, the amplifier output is also fed into the first mixer, and the receiver uses double conversion. In tuning steps 2 and 3, the amplifier feeds into the grid circuit of the second mixer and the receiver uses single conversion.

a. Tuning Step 1. With the BAND CHANGE switch at tuning step 1 (.5 to 1.5 mc), the following action takes place in the r-f amplifier (fig. 13). The incoming signal at ANTENNA jack J101 is applied to the grid circuit through capacitor C233 which, with ANT. TRIM variable capacitor C230, forms the antenna matching network. The r-f amplifier grid circuit is tuned to resonance with the signal by permeability-tuned inductance L101. Trimmer capacitor C102 is adjusted to improve the response at the h-f (high-frequency) end. Capacitor C101 is large (820 $\mu\mu$f) so that the effect of tube input capacitance changes (Miller effect) in frequency will be negligible. The tuned r-f signal is then fed through capacitor C113 to the control grid, pin 1, of V101. Resistors R101 and R102 are the grid and decoupling resistors, respectively. Capacitor C114 provides the interstage avc (automatic volume control) decoupling. Capacitor C111 couples calibration oscillator tube V104 output to the grid of V101. The cathode and suppressor grids of tube V101 are grounded. The screen grid, pin 6, potential is determined by dropping resistor R104. Resistor R104, in conjunction with capacitor C115 forms the screen decoupling network. The r-f amplifier output is impedance-coupled to the grid of the first mixer tube, V102, by resistor R105, capacitor C117, and permeability-tuned inductor L110. Resistor R105 is the r-f ampli-

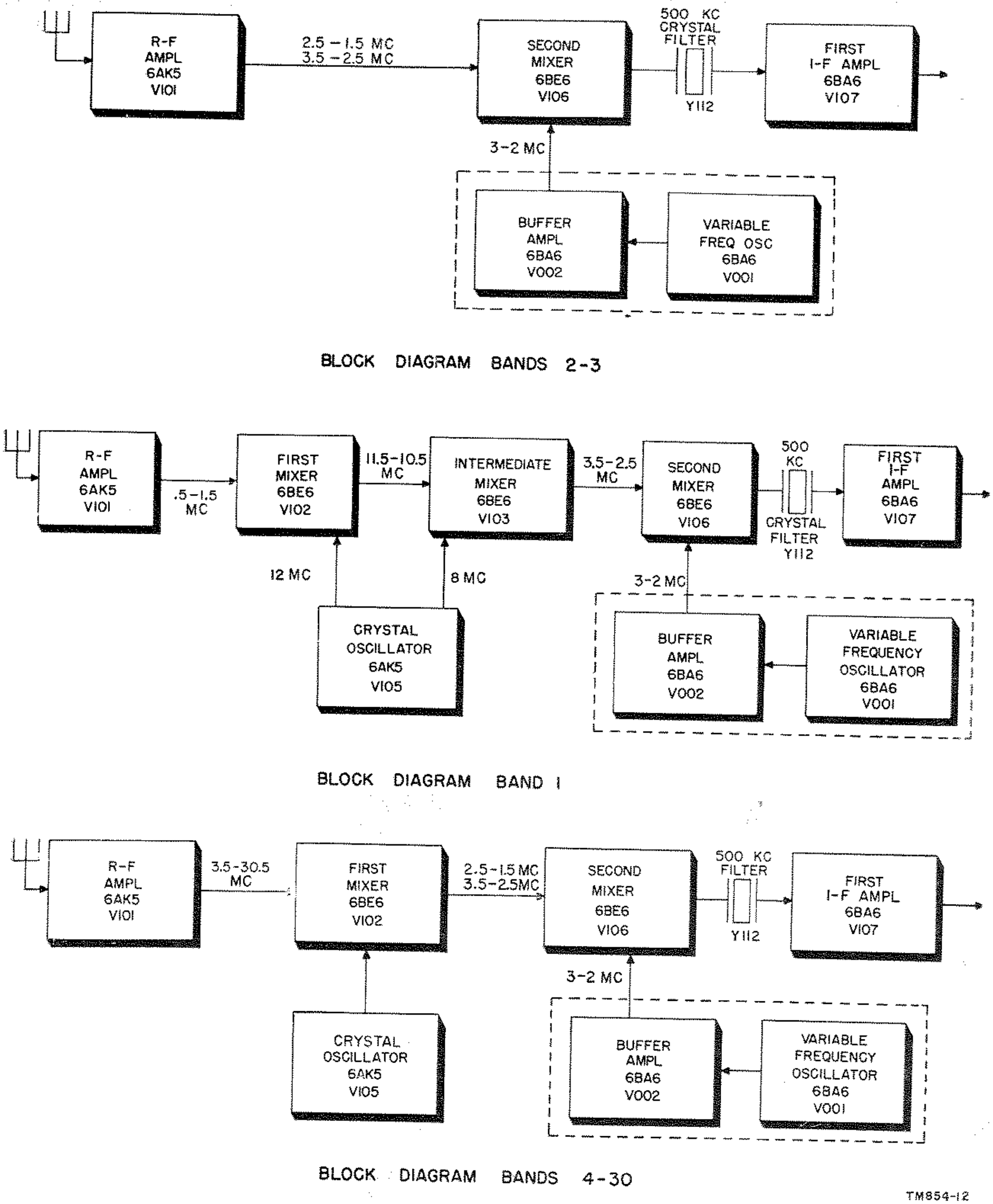

Figure 12. Radio Receiver R–388/URR, significant block diagrams of bands.

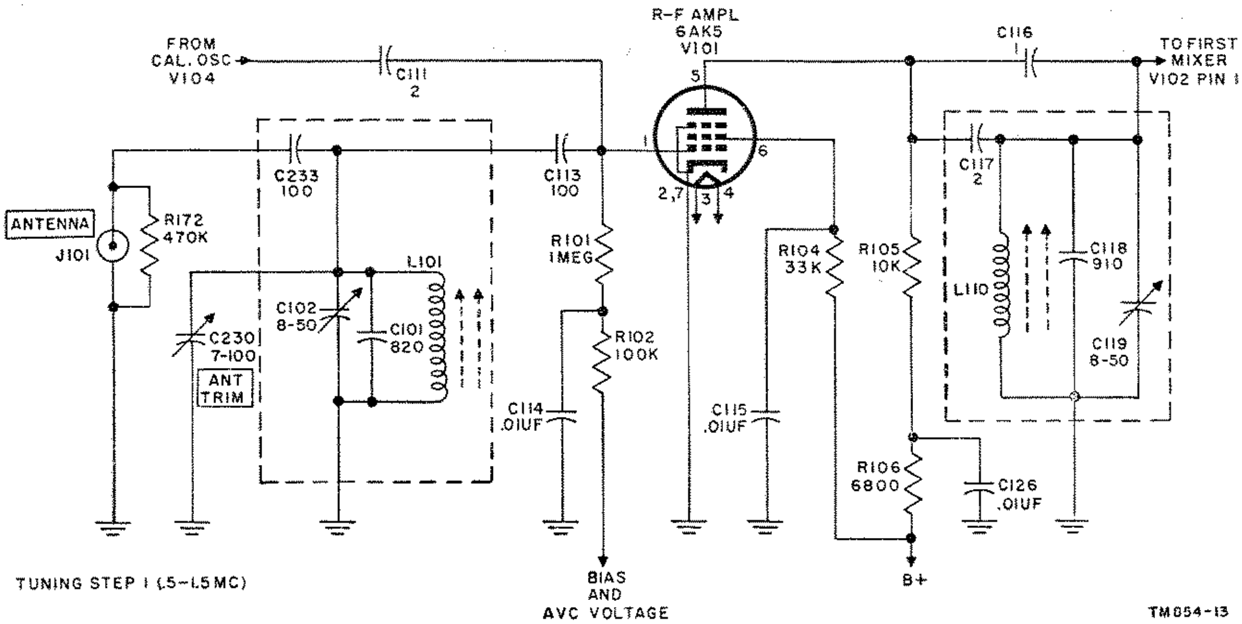

Figure 13. R-f amplifier, tuning step 1, schematic diagram.

fier tube V101 plate load. Capacitor and resistor R106 form the tube V101 plate decoupling network. Capacitor C118 is used for coarse tuning the resonant circuit and trimmer. Capacitor C119 is the alinement trimmer for inductor L110. Capacitors C116 and C117 are the interstage coupling capacitors.

b. Tuning Step 2. Figures 14 and 42 show the circuit components of the r-f amplifier when tuned to step 2 (2.5 to 1.5 mc). The function of the grid circuit is essentially the same as that for tuning step 1, with the exception that antenna coupling capacitor C234 is cut into the circuit by switch S102 (fig. 42) while switch S103 (fig. 42) cuts in the grid tank composed of capacitors C104 and C103 and inductor L102 (par. 55). The plate circuit is tuned by permeability-tuned inductor L116, band-setting trimmers C175 and C177; alinement trimmer C174 provides the vernier tuning of the tank. Capacitor C220 provides the interstage coupling. Permeability-tuned inductor L118 in conjunction with band-setting trimmers C181, C179, and alinement trimmer C180 forms the tuned grid circuit for the second mixer, V106.

c. Tuning Step 3. The r-f amplifier functions in the same manner for tuning step 3 (3.5 to 2.5 mc) as explained for tuning step 2 with the exception of the change in tuning components for the grid and plate circuit (fig. 14). In tuning step 3, as with all the odd-numbered tuning steps, permeability-tuned inductors L116 and L118 are shunted with trimmer inductors L117 and L119 to lower the tuned frequency. Refer to paragraph 55 for band-switch information.

d. Tuning Steps 4 Through 30. The r-f amplifier grid and plate tuning components for tuning steps 4 through 7 (3.5 to 7.5 mc), tuning steps 8 through 15 (7.5 to 15.5 mc), and tuning steps 16 through 30 (15.5 to 30.5 mc) are shown in figure 15.

39. First Mixer

The purpose of the first mixer, V102 (a pentagrid converter tube, type 6BE6), is to mix electronically the amplified r-f output of tube V101 on all tuning steps (except 2 and 3) with the output of the crystal oscillator tube, V105, type 6AK5. The first mixer output frequency will always be either in the 2.5- to 1.5-mc range or in the 3.5- to 2.5-mc range, depending on whether the tuning steps are even-numbered or odd-numbered, respectively. In tuning step 1, the first mixer output is applied to the input side of the intermediate mixer, and in tuning steps 4 through 30 the first mixer output is applied to the input side of the second mixer

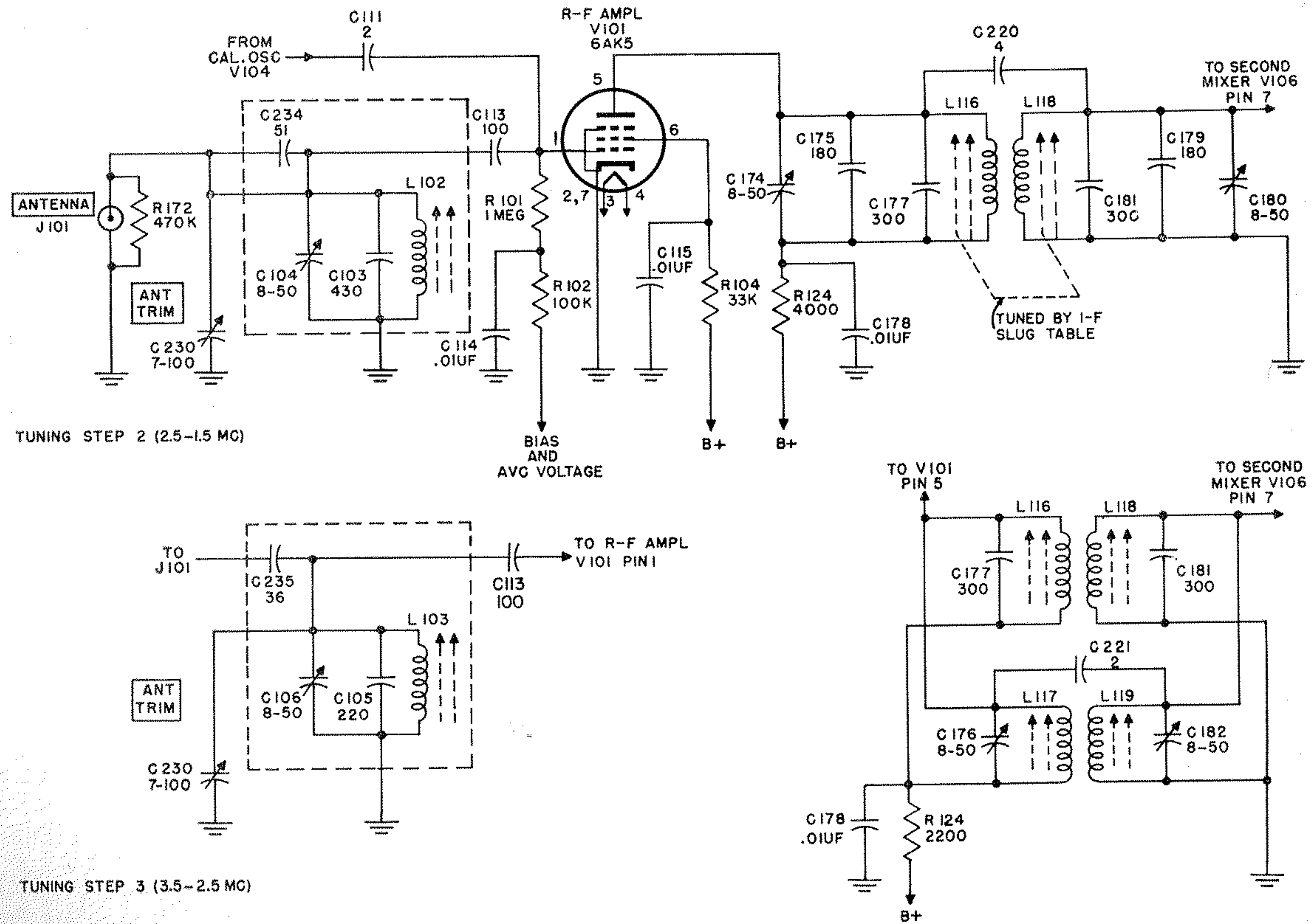

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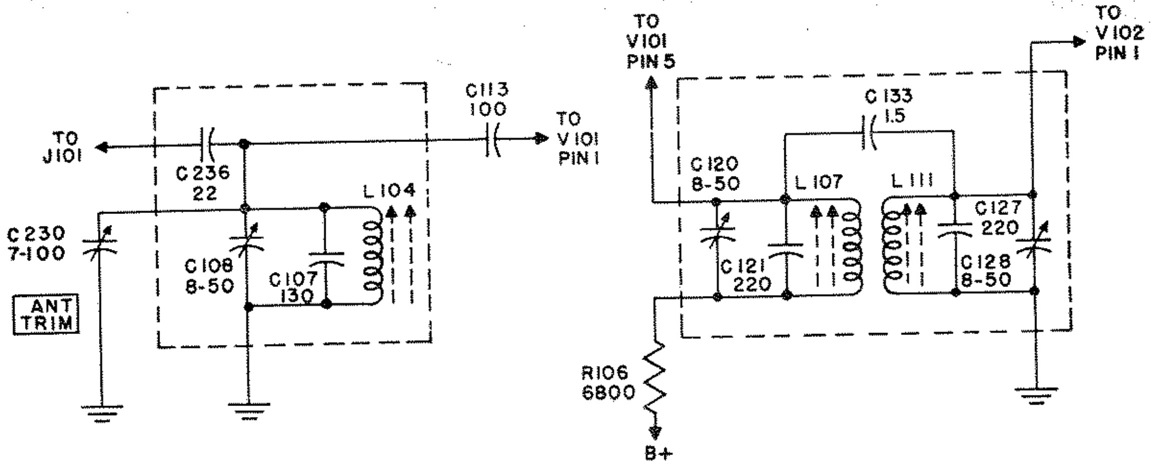
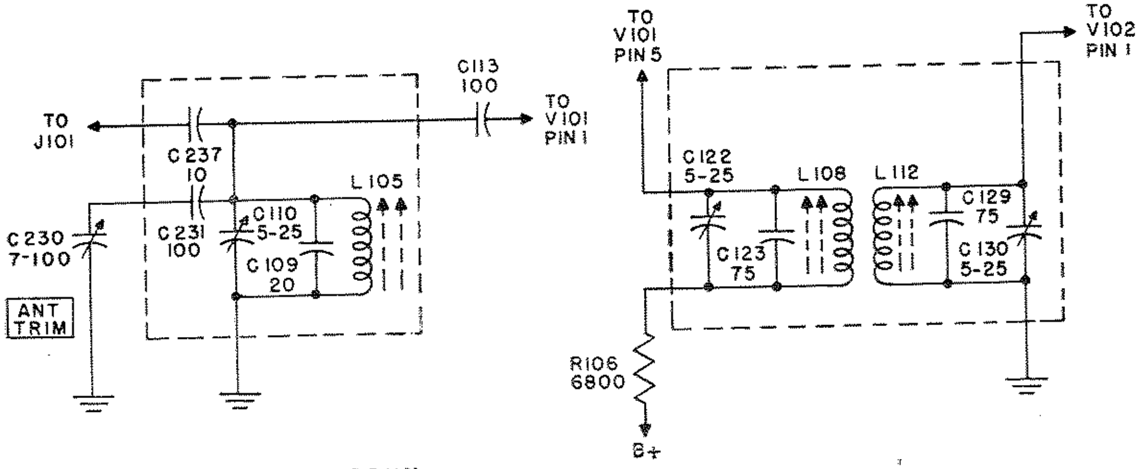
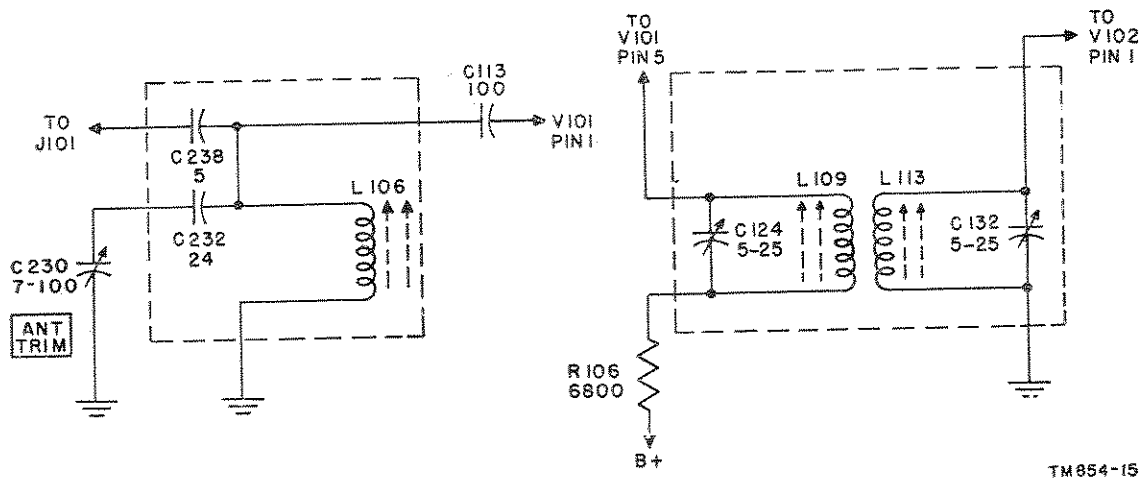
Figure 14. R-f amplifier, tuning steps 2 and 3, schematic diagram.



TUNING STEPS 4 THROUGH 7 (3.5–7.5 MC)



TUNING STEPS 8 THROUGH 15 (7.5–15.5 MC)



TUNING STEPS 16 THROUGH 30 (15.5–30.5 MC)

Figure 15. R-f amplifier, tuning steps 4 through 30, schematic diagram.

(fig. 12). The first mixer is not used in tuning steps 2 and 3. Table II shows the grid and plate components of the first mixer circuit for the different tuning steps.

a. Tuning Step 1 (.5 to 1.5 MC). In tuning step 1 (fig. 16), the signal voltage is heterodyned with a 12-mc signal from the crystal oscillator, V105, so that the usable output of the mixer will be between 11.5 to 10.5 mc. Capacitor C116 couples the output of r-f amplifier V101 to the grid (pin 1) of the first mixer tube, V102. The mixer grid r-f circuit consists of permeability-tuned inductor L110, fixed trimmer capacitor C118, and alinement trimmer capacitor C119. The .5- to 1.5-mc signal is applied to what is normally called the oscillator grid and the 12-mc oscillator signal from the crystal oscillator, V105, is applied to the control grid (pin 7) of the first mixer tube, V102. The 12-mc oscillator signal is applied through capacitor C136 and across the grid resistor R108 which is connected between pin 7 grid and ground. Electronic mixing of the two injected voltages results in the usual sum, difference, and original voltages being produced and present in the plate current stream. The difference voltage (11.5 to 10.5 mc) r-f signal is selected by the tuned circuit in the mixer plate circuit for application to the succeeding stage, the intermediate mixer, V103. The signal voltage is developed across the plate load inductor, L114, which is permeability-tuned as part of the ganged slug racks. The developed r-f voltage is impedance-coupled into the intermediate mixer stage, through capacitor C137 to inductor L115 which is the grid coil for the intermediate mixer. The plate circuit of the first mixer, V102, is decoupled from the power supply by resistor R110 and capacitor C138. The first mixer uses cathode bias, which is developed by cathode current flow through bias resistor R107. Capacitor C134 is the cathode bypass capacitor. The screen voltage is supplied through voltage-dropping resistor R109 which is bypassed by capacitor C135.

b. Tuning Steps 4 Through 30 (3.5 to 30.5 MC). The first mixer circuit for tuning steps 4 through 30 is shown in figure 17. The circuit is the same as for tuning step 1, except that the grid and plate tuning components change through the various frequency ranges and the output of the first mixer is fed to the input side of the second mixer, V106, instead of to the intermediate mixer, V103. Figure 15 shows the grid tuning components for the first mixer, V102. Capacitor C116 (fig. 17) is connected from the plate of V101 to the grid (pin 1) of first mixer V102 and provides the r-f coupling to the grid coils. Capacitor C133 parallels capacitor C116 in tuning steps 4 through 7 (the lower frequency tuning steps), where increased capacitive coupling is required. The output of the first mixer will be in the range of 2.5 to 1.5 mc on the even-numbered tuning steps, and 3.5 to 2.5 mc on the odd-numbered tuning steps. Inductor L116 tunes the plate circuit to the i-f frequency on the even-numbered tuning steps. On the odd-numbered tuning steps, inductor L116 is shunted by L117 to enable tuning to a higher i-f frequency. Only inductor L116 is tuned by the slug rack. Capacitors C177 and C175 are fixed trimmers. Trimmer capacitor C174 is used for alinement. Signals are transferred from the plate load inductance of the first mixer to the grid circuit of the second mixer, V106, by impedance coupling through capacitors C220 and C221. The grid circuit of the second mixer is tuned by inductor L118 on the even-numbered tuning steps, and by inductor L118 shunted by L119 on the odd-numbered tuning steps. Plate circuit decoupling for the first mixer, V102, is provided by resistor R124 and capacitor C178.

40. Intermediate Mixer
(fig. 18)

The intermediate mixer, V103, tube type 6BE6, operates only on tuning step 1. Its purpose is to beat a signal from the first mixer in the range of 11.5 to 10.5 mc with the 8-mc signal from the h-f oscillator, V105, so that a signal will be fed to the second mixer V106 in the range of 3.5 to 2.5 mc. The r-f signal across permeability-tuned inductor L114 in the plate circuit of the first mixer, V102, is impedance-coupled to inductor L115 in the intermediate mixer grid circuit (fig. 18). Capacitor C137 provides the coupling, and capacitor C138 is the plate bypass to ground for the first mixer. Trimmer capacitors C139 and C140, in con-

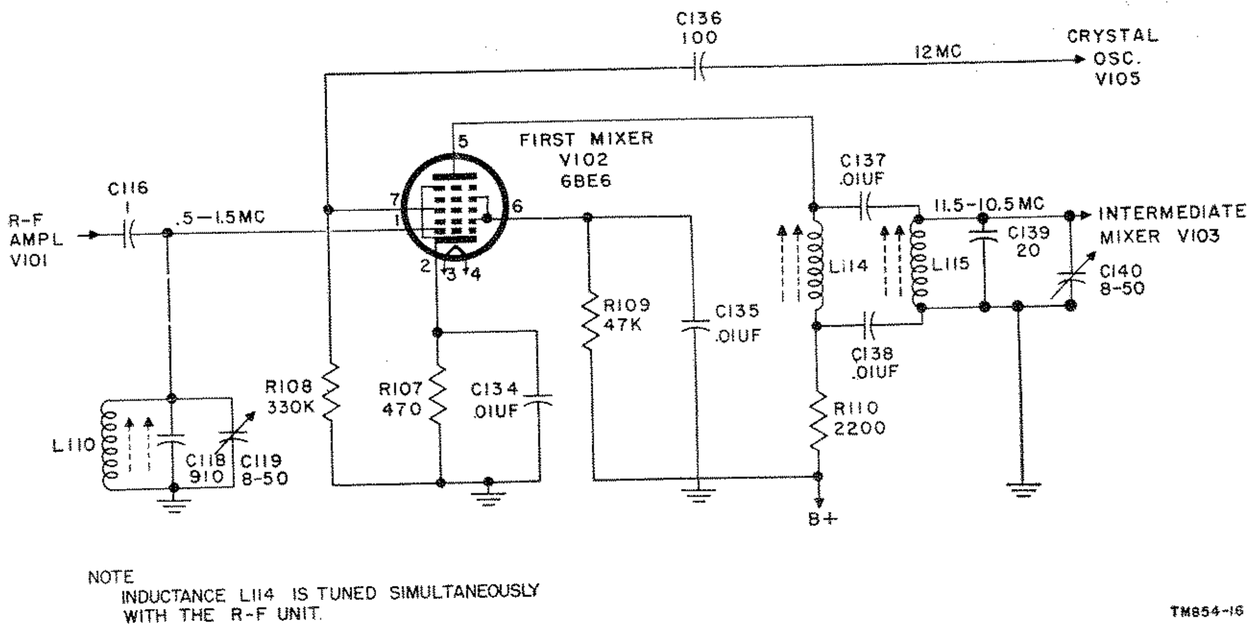


Figure 16. First mixer, tuning step 1 only, schematic diagram.

junction with inductor L115, form the grid tank circuit of V103. The signal impressed on the control grid (pin 7) of V103 is beat with the crystal oscillator (V105) frequency, introduced at injection grid (pin 1), through capacitor C143. Resistor R112 is the injection grid resistor. Resistor R111 provides the cathode bias; capacitor C141 is the cathode bypass to ground. The operating voltage of the screen grid (pin 6) is determined by dropping resistor R113. Capacitor C142 is the screen grid r-f bypass. Resistor R124 and capacitor C178 provide the plate circuit decoupling (fig. 18). The output at the plate (pin 5) is fed through a 1,250-kc wave trap consisting of inductor L124 and capacitor C159 and the variable i-f coil section to the second mixer, V106.

41. Variable Intermediate Frequency

The variable intermediate frequency consists of two ranges: one for a frequency of 2.5 to 1.5 mc, and the other for 3.5 to 2.5 mc, used on even-numbered and odd-numbered bands, respectively. Using two variable i-f bands in this manner, cuts in half the number of crystals necessary in the h-f oscillator, since each crystal fundamental frequency, or useful harmonic thereof, is used for two bands. Inductors L116 and L118 are the 2.5- to 1.5-mc coils, and are the coils in which the tuning slugs travel. The 3.5- to 2.5-mc range is obtained by shunting L116 with L117, and L118 with L119 to raise the resonant frequencies of L116 and L118. Tank switch sections S110 and S111 alternately switch in and switch out shunting coils L117 and L119 as the band switch is rotated. Band-setting capacitors C175 and C177 tune inductor L116. Trimmer capacitor C174 facilitates alinement at the h-f end of the coil. Capacitors C179 and C181 are fixed trimmers for variable inductor L118, and C180 is the alinement trimmer. Capacitors C176 and C182 are the alinement trimmers for h-f tuning of L117 and L119, respectively. Capacitors C220 and C221 provide the coupling for coils L116 and L118 and L117 and L119, respectively.

42. Second Mixer

The purpose of second mixer V106 is to mix electronically the i-f signal with the signal from the vfo so that an intermediate frequency of 500 kc will be developed at the second mixer, V106, output. The second mixer stage uses a 6BE6 pentagrid converter type tube. The vfo signal is fed through a shielded cable, across the filter network composed of inductor L125 and capacitor C168 (fig. 19). This network shunts to ground 500-kc noise from the vfo to

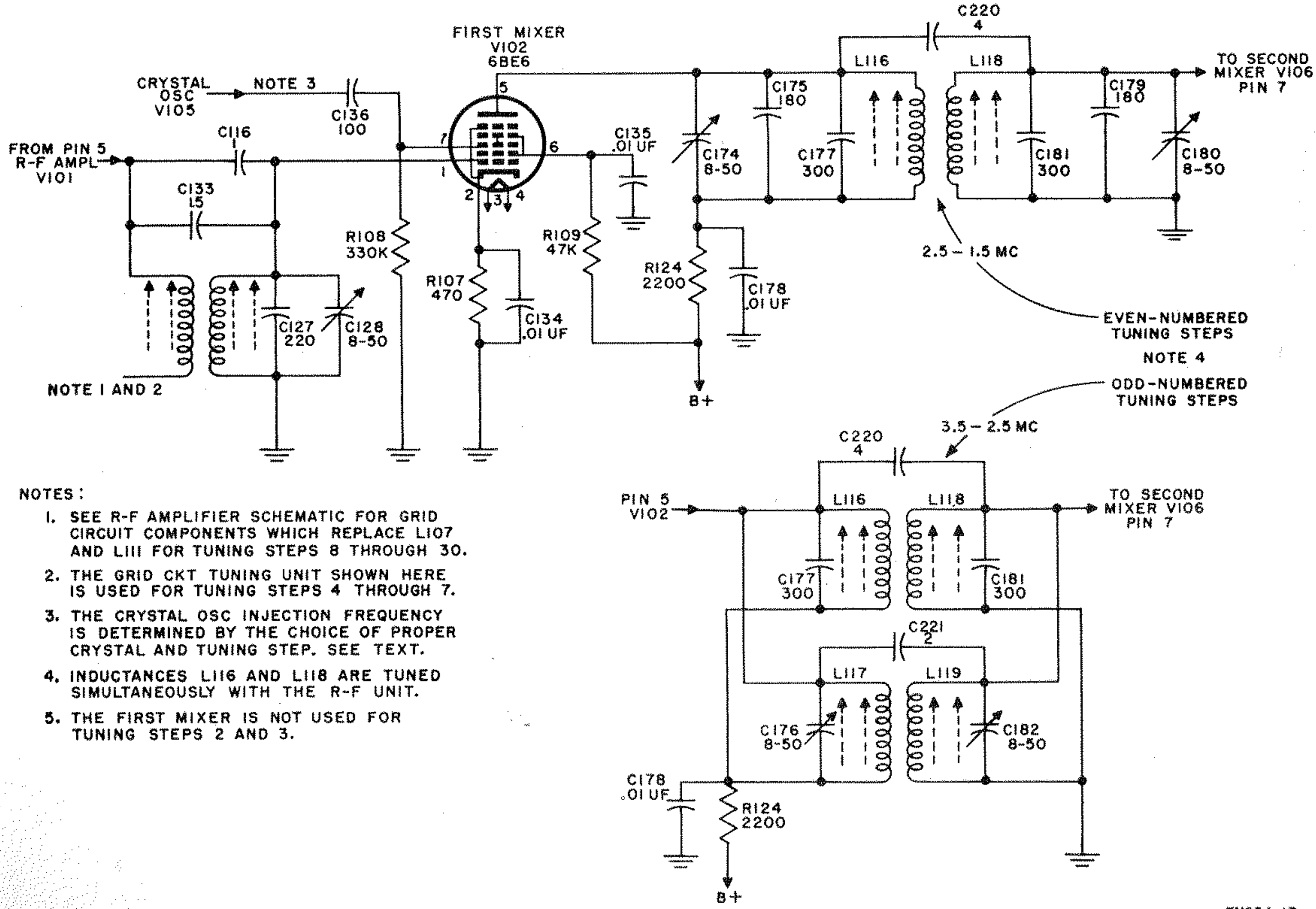


Figure 17. First mixer, tuning steps 4 through 30, schematic diagram.

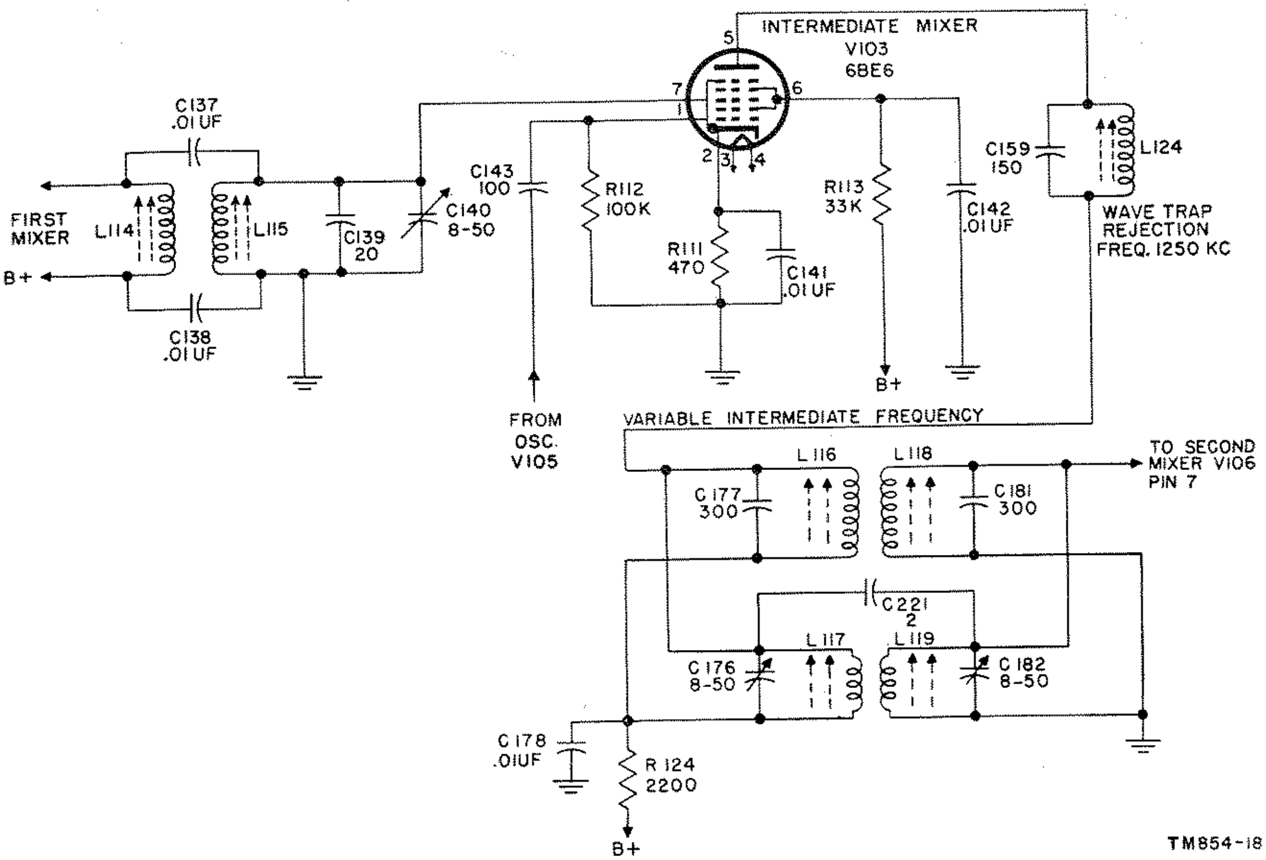


Figure 18. Intermediate mixer, schematic diagram.

keep it out of the 500-kc i-f amplifier channel. Capacitor C184 reduces the higher order harmonics from the variable-frequency oscillator. The oscillator signal is applied to the injection grid at pin 1 and the variable i-f signal is applied at the control grid (pin 7) for mixing. The i-f output at the plate (pin 5) of the second mixer, V106, represents the input frequencies, their sums, and their differences. The desired 500-kc signal voltage is developed across the primary of transformer T101. Resistor R123 is the injection grid resistor. Resistor R127 and capacitor C183 are the cathode bias resistor and bypass capacitor, respectively. Capacitor C185, in conjunction with resistor R128, forms the screen (pin 6) decoupler. Resistor R128 is the voltage-dropping resistor for the screen grid. Resistor R129 and capacitor C186 decouple the plate circuit. The plate supply voltage is applied through resistor R129 and the primary of T101. The output signal voltage from the plate is conducted through a shielded cable to the primary of transformer T101 (where the plate circuit is tuned) and coupled to the i-f crystal filter state.

43. High-Frequency Crystal Oscillator

The h-f oscillator, V105, type 6AK5, is a modified Pierce oscillator using 10 frequency-controlling crystals, each so selected that when its fundamental or harmonic signal is beat with the signal voltage in the first mixer, V102, it will produce in the mixer a usable output frequency between 2.5 and 1.5 mc or 3.5 and 2.5 mc on all tuning steps except steps 1, 2, and 3. On tuning step 1, the h-f oscillator produces a 12-mc signal for introduction to the first mixer, V102, and an 8-mc signal for introduction to the intermediate mixer, V103 (figs. 11 and 12). The h-f oscillator, V105, is not used in tuning steps 2 and 3, the signal on these steps being fed directly from the r-f amplifier to the second mixer, V106, through the variable i-f coils.

a. Tuning Step 1. Four-mc crystal Y110 is placed across the grid (pin 1) and in series with

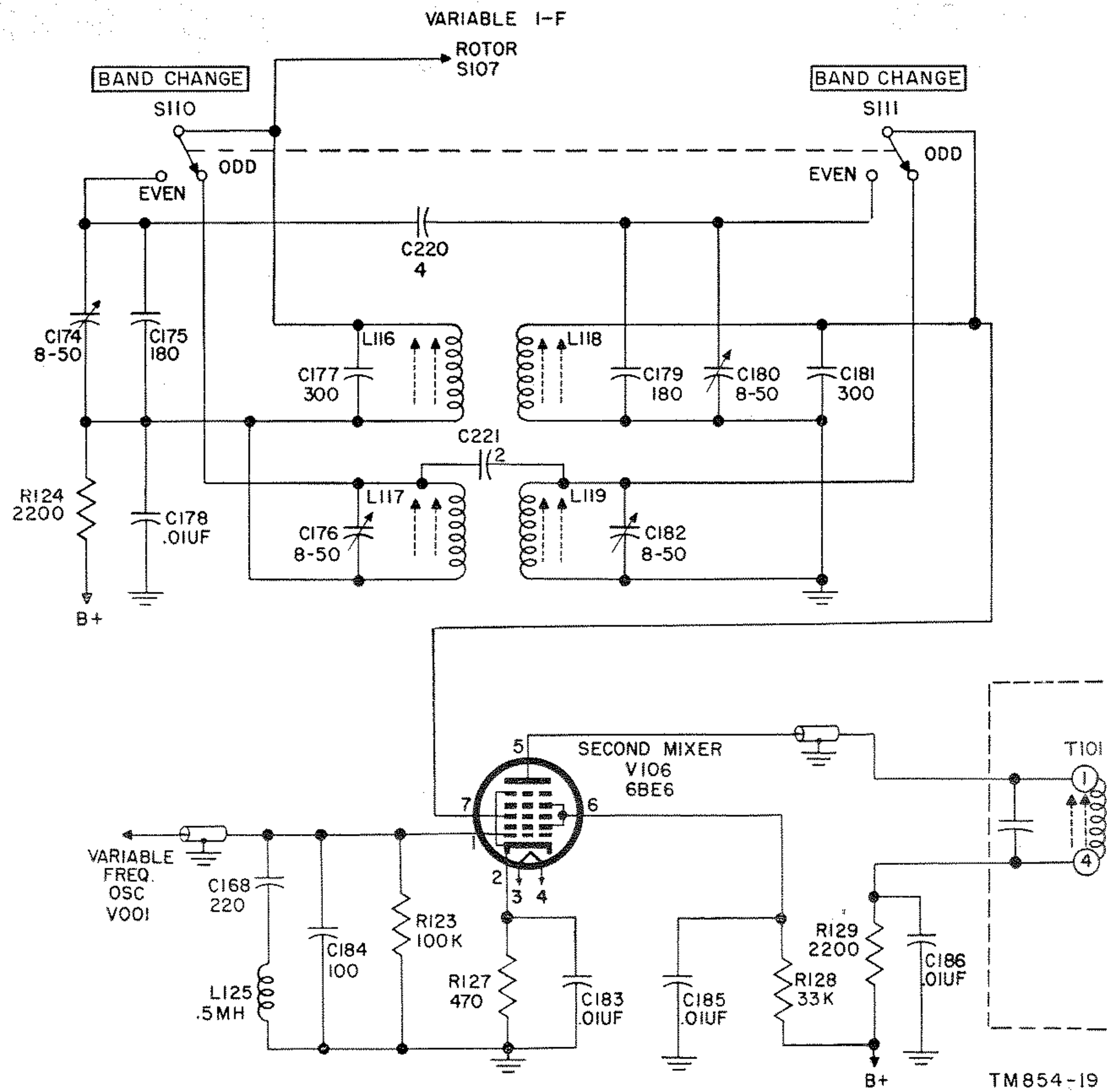


Figure 19. Second mixer and variable intermediate frequency, schematic diagram.

coil L120 to the cathode (pin 7) of V105. With the operating voltage applied, oscillations are maintained by the in-phase feedback voltage being produced across r-f choke L120 in the oscillator tube cathode circuit. Capacitors C165 and C166 form the oscillator feedback network. Capacitor C167 trims the total crystal circuit to 32 $\mu\mu$f for proper operation and frequency. Resistor R115 is the oscillator grid resistor. Oscillator tube screen voltage is obtained through voltage-dropping resistor R114, and the screen grid is held at r-f ground potential by capacitor C164. Resistor R117 is the plate voltage-dropping resistor for V105. Inductor L121 is split-tuned to provide second and third harmonic voltages of the crystal fundamental for application to intermediate mixer V103 and first mixer V102, respectively, in the following manner: The plate current flow of V105 through inductor L121 (upper half of coil) contains the fundamental and its harmonics. The tap on inductor L121 is held at r-f ground potential by capacitor C163, but the plate current flow through the upper half of the coil induces in the lower portion of the coil the fundamental and all of its harmonics. The top portion of inductor L121, fixed trimmer C161, and alinement trimmer C162 form a parallel-resonant circuit tuned to the third harmonic (12 mc) of crystal Y110. The developed oscillator voltage is coupled to first mixer V102 by capacitor C136. The lower portion of inductor L121, fixed trimmer C145, and alinement trimmer C144 form a parallel-resonant circuit tuned to the second harmonic (8 mc) of crystal Y110. The oscillator voltage developed is applied to intermediate mixer V103 through capacitor C143.

b. Tuning Steps 4 Through 12. On tuning steps 4 through 12, wafer switch S108 back contacts (fig. 42) provide the B+ voltage to V105 through plate load resistor R116. The h-f oscillator plate circuit is not tuned and the fundamental of the crystal frequency is taken from the plate for injection into first mixer V102. On these tuning steps, inductor L121 is not in the oscillator plate circuit. Refer to paragraph 4*c* for a listing of crystal frequencies used, and the injection frequencies for tuning steps 4 through 12.

c. Tuning Steps 13 Through 30. On tuning steps 13 through 30, the basic circuit arrangement of crystal oscillator V105 remains the same (fig. 20), but only the upper half of inductor L121 is tuned to secure the desired harmonic voltage for application to first mixer V102 (fig. 42). Capacitors C146 through C162 are switched by S108 across the upper half of L121 to form resonant circuits at the desired harmonic frequencies.

44. Variable-Frequency Oscillator

The vfo unit is composed of an oscillator and a buffer amplifier, electrically isolated and shielded from the rest of the receiver by a hermetically sealed metal case. The vfo tunes over the 2- to 3-mc frequency spectrum. The purpose of the buffer amplifier is to isolate the oscillator from varying load changes, amplify the oscillator voltage, and provide to the oscillator an in-phase feedback voltage to sustain oscillations. A voltage regulator tube V116 type OA2 is shunted across the B+ line to the oscillator plate to eliminate frequency drift caused by plate voltage variations.

a. Oscillator V001. Oscillator tube V001 is a type 6BA6, arranged in a circuit similar to a Hartley but different from it in that the in-phase feedback voltage is obtained from the amplifier tube V002 screen circuit through capacitor C008. The oscillator tank circuit consists of trimmer inductor L002, permeability-tuned inductor L001, and tank capacitor C001 in parallel with temperature-compensating capacitors C002 and C003. The value of C002 will differ from receiver to receiver, the correct

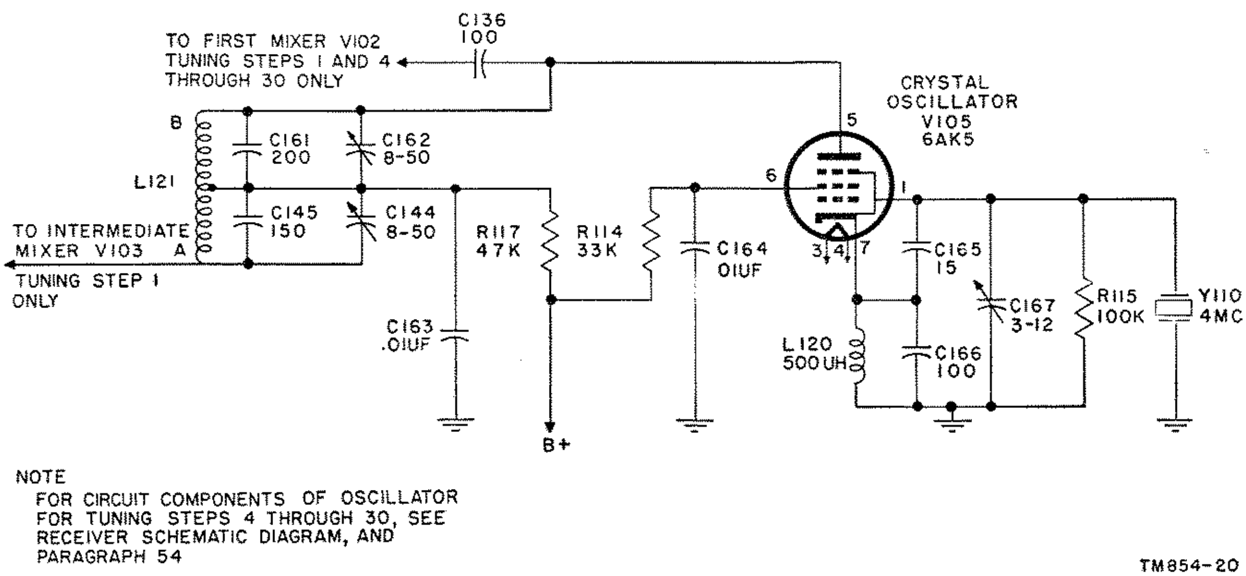


Figure 20. Crystal oscillator, tuning step 1 only, schematic diagram.

value being selected for a particular oscillator by factory test. The oscillator is tuned by movement of the iron core within the inductor L001 form. The powdered iron core, or slug, traverses a lead screw which is rotated by the receiver tuning control. Inductor L001 is tapped near the ground end and is connected through capacitor C008 to the screen of V002, resulting in some of the amplified oscillator voltage being fed back to the inductor (L001) to sustain oscillations. C004 and R001 are the grid capacitor and resistor, respectively. The oscillator tube is triode-connected and obtains its plate voltage through plate load resistors R002 and R003. The value of resistor R002 determines the amount of r-f voltage coupled to amplifier tube V002. The r-f voltage drop across resistor R002 is coupled to the control grid of V002 through capacitor C007 and through capacitor C005 to the ground or cathode of V002.

b. Buffer Amplifier V002. The buffer amplifier isolates the oscillator from the load (V106) and provides a small feedback voltage to sustain oscillations in the oscillator grid tank. Tube V002, type 6BA6, is pentode-connected, and obtains its drive from the oscillator voltage developed across grid resistor R005. The amplifier r-f output voltage is developed across plate load resistor R006 and coupled to second mixer V106 (pin 1) through capacitor C009 and a length of coaxial cable. The screen grid (pin 6) of V002 is supplied with the correct potential through voltage-dropping resistor R007. Both the oscillator V001 and buffer amplifier V002 plate circuits are decoupled from the power supply by resistor R004 and capacitor C006.

c. Voltage Regulation. Both the oscillator and buffer amplifier tubes secure their plate and screen voltage from a regulated source. The plate supply end of resistor R004 is connected to voltage regulator tube V116, type OA2, anode (pins 5 and 1). The regulator tube is series-connected with current-limiting resistor R181 across terminal 2 of power supply filter choke L122 and ground.

45. Crystal Filter

A 500-kc crystal, Y112, is used in a highly selective crystal filter i-f circuit (fig. 22) to enable the separation of the wanted signal from the interfering signals. A phasing capacitor, C188, is provided to shift the crystal rejection slot (parallel resonant frequency) so that unwanted signals can be eliminated. The SELECTIVITY control, by selection of resistors, varies the series resistance of the crystal circuit, thereby changing crystal Q and bandpass.

a. The secondary winding of transformer T101, crystal Y112, and phasing capacitor C188 form a bridge. Capacitor C187 (10 $\mu\mu f$) is shunted across crystal Y112 to bring the crystal holder capacitance up to the design factor chosen by the manufacturers of this receiver. When phasing capacitor C188 is adjusted to equal the total shunt capacitance presented by the Y112 crystal holder and C187, the following circuit conditions exist: An incoming 500-kc signal develops equal and opposite signal voltages across the halves of the secondary winding of T101. The reactive drop across C188 is equal to and opposite to the voltage developed across the crystal holder capacitance. Since the crystal is at series resonance at 500 kc, its impedance is low and the voltage generated across the upper half of T101 is applied through the low impedance (Y112) and across transformer T102. The impedance of Y112 rises sharply for frequencies off resonance, resulting in attenuation of a 500-kc carrier's extreme sidebands and adjacent signal frequencies.

b. A variable control of the i-f bandpass is obtained by the insertion of resistors in series with the crystal circuit. The SELECTIVITY control provides a choice of 5° of selectivity or bandpass. In position 0, the crystal is shorted out and the selectivity is determined by the Q of the L-C receiver circuits alone. In position 1, the selectivity of the circuit is lowest because of the series insertion of the high impedance represented by a parallel-resonant circuit consisting of T102 and its trimmer. In positions 2, 3, and 4, resistors R130, R131, and R132, respectively, are switched in series with Y112 to r-f ground. Resistor R132, being the lowest in value, allows development of highest Q of Y112 and narrowest bandpass.

c. Capacitor C188 not only neutralizes the voltages passed by the crystal holder, but serves to shift the rejection slot of the crystal filter circuit. The crystal holder and crystal act as a

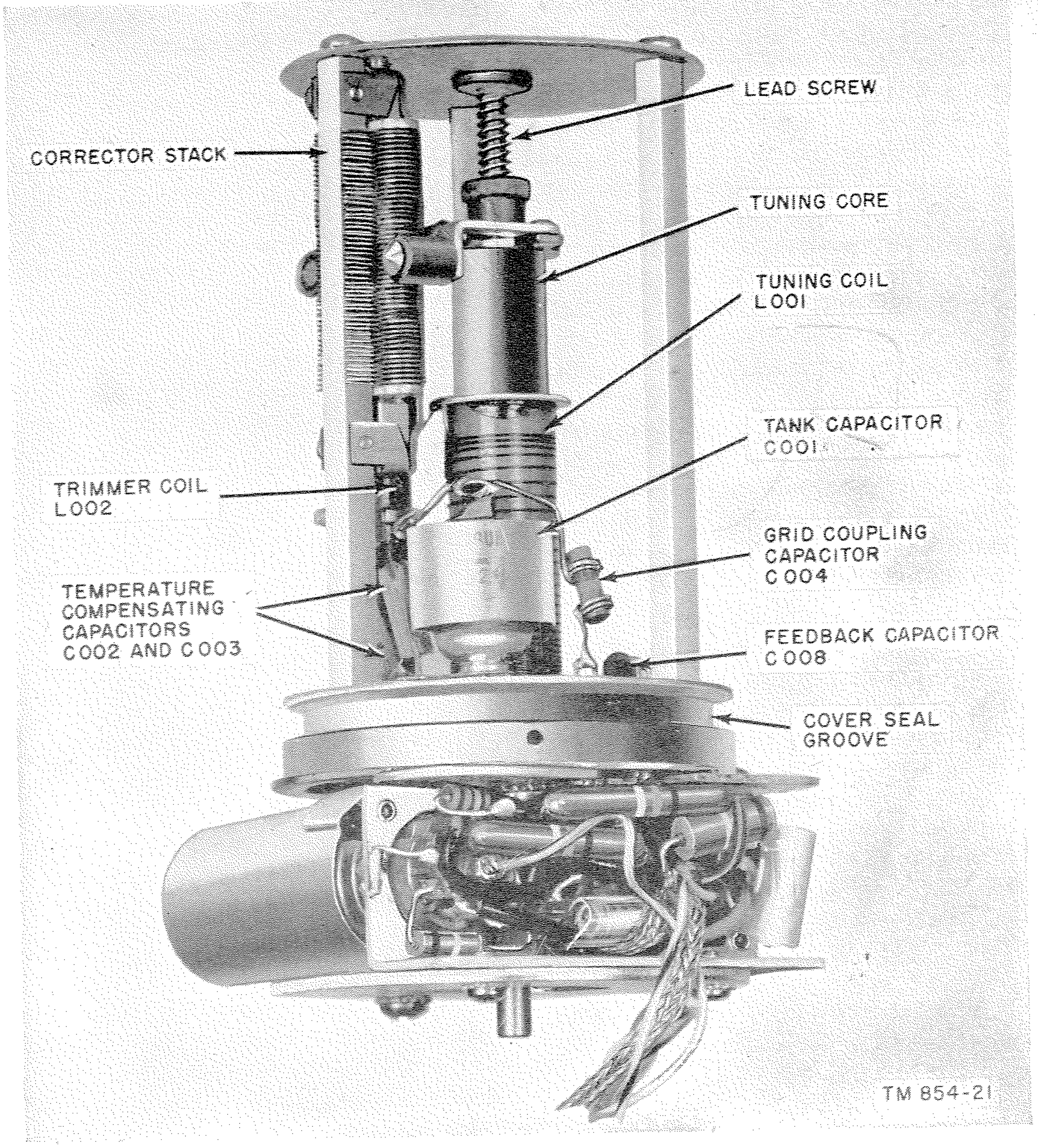
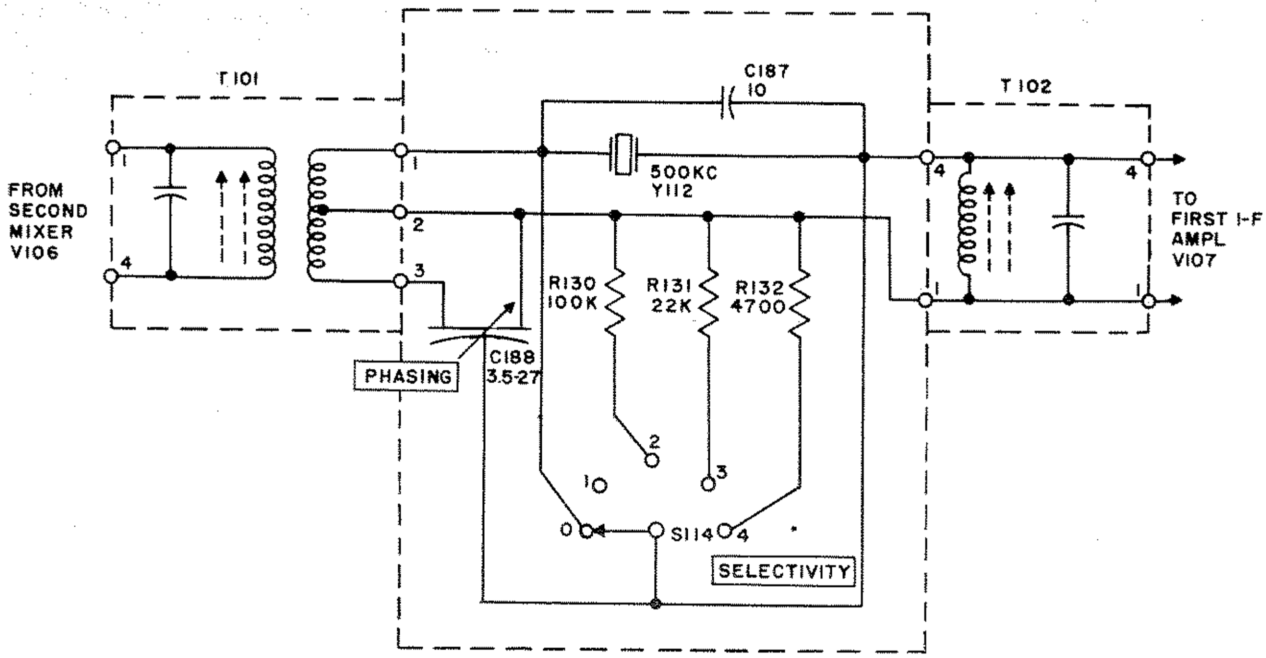


Figure 21. Vfo, shield cover removed.

parallel resonant circuit at frequencies slightly higher than the series resonant frequency, and PHASING capacitor C188 can be used to change the effective capacitance of the crystal circuit.

46. Intermediate-Amplifier Stages

There are three i-f stages in Receiver R–388/URR: V107, V108, and V109. Each stage uses a 6BA6 miniature pentode. Tuning between stages is done with permeability-tuned transformers T102, T103, T104, and T105. The purpose of the i-f stages is to amplify and to provide selectivity for the 500-kc intermediate frequency before the audio note is separated in the succeeding detector stage. An incoming signal is coupled to the first i-f section by permeability-tuned inductor T102. The signal developed across T102 is applied to the control grid (pin 1) of V107, through a grounded shield. The grid voltage is developed across resistor R125. Resistor R133, in conjunction with capacitor



TM854-22

Figure 22. Crystal filter, schematic diagram.

C189, forms the grid avc decoupling unit. Operating voltage for the screen (pin 6) is taken from the voltage divider consisting of resistors R126 and R134. Capacitor C190 is the screen bypass. The plate supply voltage is fed from switch S113 through load resistor R135, which, in conjunction with capacitor C191, also serves to prevent interstage coupling. The output from the first mixer plate (pin 5) is coupled to the second mixer by permeability-tuned transformer T103, and applied to the control grid (pin 1) of the second i-f tube V108. Resistor R136 and capacitor C193, form the grid avc decoupling. (Fixed bias in the form of an avc voltage is applied to the grids of all the i-f tubes, when this circuit is placed in operation by switch S115). R137 is the voltage-dropping resistor for the screen. Capacitor C194 is the screen bypass to ground. The plate supply voltage is fed through load resistor R138 and the primary of transformer T108 to the plate (pin 5). Resistor R138 and capacitor C195 form the plate decoupling circuit. The amplified signal from the plate is coupled to the third i-f stage through permeability-tuned transformer T104. Capacitor C196 is shunted across the primary and secondary of the transformer to increase the transformer coupling and to give the proper bandwidth. A center tap on the transformer secondary feeds the signal voltage to the grid (pin 1) of the third i-f stage, V109. Fixed bias voltage and an avc voltage is applied to the grid through resistor R139. This resistor, with capacitor C197, also forms the decoupling network for the grid circuit. Capacitor C198A is the cathode bypass. The plate supply voltage is applied through decoupling resistor R142 and the primary of transformer T105 to pin 5. Resistor R141 drops the screen voltage. Capacitor C199 is the screen bypass to ground. Resistor R142 and capacitor C200 provide the plate decoupling. The output of V109 is coupled to the detector by transformer T105. Capacitor C201 connected from the transformer primary (terminal 1) to the secondary (terminal 4), increases the coupling and gives the proper bandwidth.

47. Detector

The detector tube, V110A, is a triode with grid and plate tied together for diode operation (fig. 24). The i-f signal voltage across winding 6–3 of T105 is applied across the diode plate and cathode. Rectification occurs on the positive half cycle and the rectified current flows through T105 secondary, terminals 6 to 3, and through the diode load resistors R150 and R151

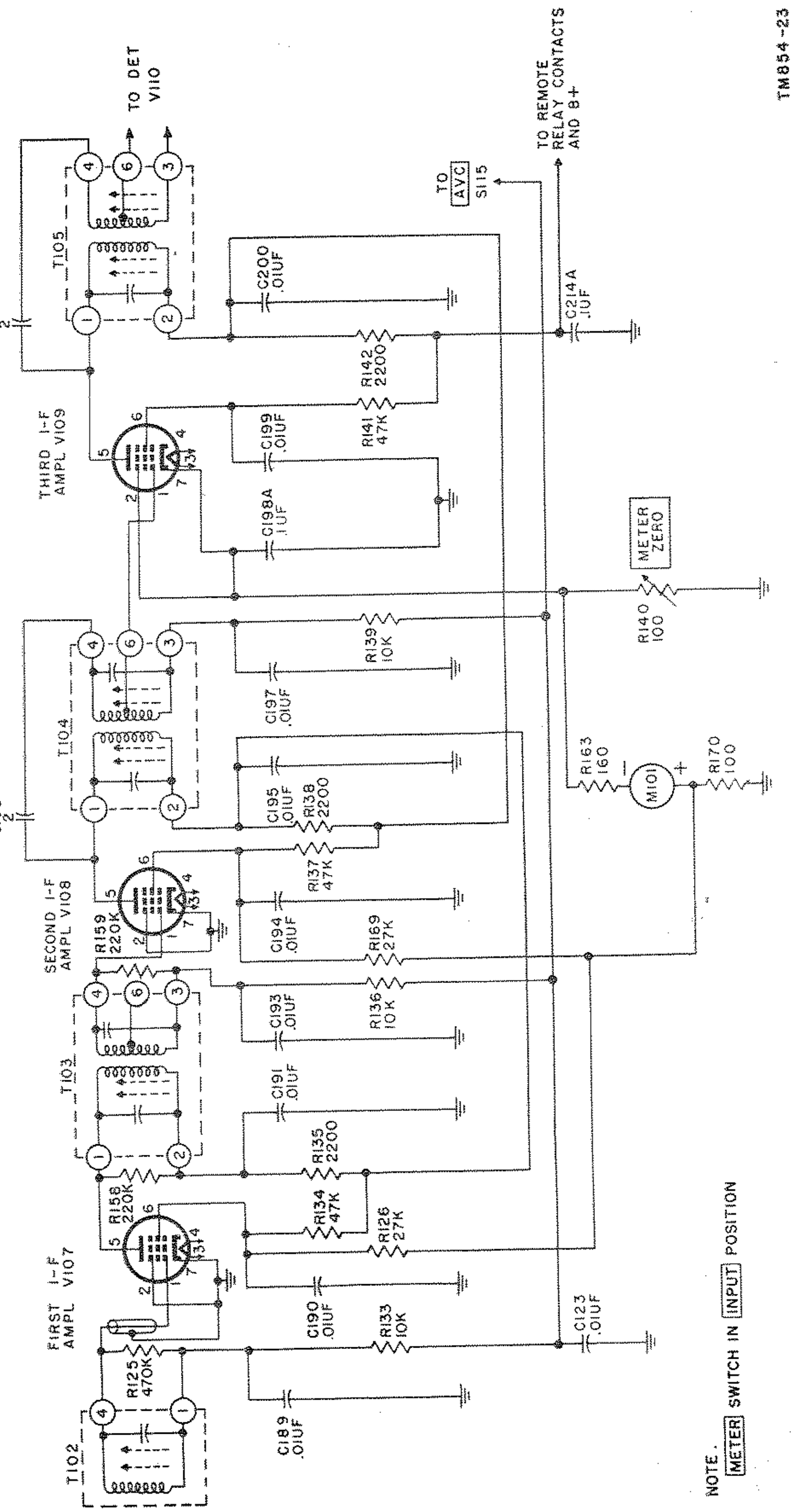


Figure 23. I-f stages, schematic diagram.

to ground and return to cathode. Capacitor C202 is the i-f filter capacitor. That portion of the developed a-f voltage appearing across R151 is applied to limiter V112A and the following a-f stage. I-f signal voltage for the avc circuit is taken from the detector plate and applied through capacitor C204 to avc tube V110B cathode (fig. 25). The i-f output tube secures its i-f signal from coupling to the detector diode plate through C226.

48. I-F Output

The i-f output tube, V111B, type 12AU7, functions as a cathode follower to provide a low-impedance i-f output at coaxial connector J104. The i-f signal is applied to the follower grid from a voltage divider consisting of resistors R177 and R178 which are in series with capacitor C226 between the detector tube plate and ground. Only that portion of the entire drop appearing across R178 of the divider is utilized for follower grid voltage. Tube V111B is operated class A, bias being secured from the drop across cathode resistor R179. Resistor R180 is the plate voltage-dropping resistor. Capacitor C227 places the follower plate at signal ground potential. The i-f signal voltage across resistor R179 is coupled to the IF OUTPUT jack through capacitor C228. The i-f output tube signal frequency is 500 kc and any converter unit to which this output is coupled must be capable of amplifying and rectifying this signal for operation of teletypewriters.

49. AVC and AVC Amplifier

The receiver avc system which feeds a low-impedance line, effectively eliminates blocking on strong input signals and maintains steady output signals over a wide range of input signal variations. Avc tube V110B produces the control voltage for triode avc amplifier V111A grid.

a. Avc V110B. The i-f signal voltage is coupled to avc tube V110B through capacitor C204 and across resistor R145 (fig. 25). Avc tube V110B is a triode which is diode-connected. The application of i-f signal voltage between cathode and plate produces a rectified a-f current flow through R145. The a-f voltage is filtered before application to the avc amplifier tube by resistor R144 and C205B. The time constant of R144 and C205B is approximately .06 second. The avc voltage does not have instantaneous effect on input signals because the avc amplifier V111A has a d-c bias of approximately —9 volts on its grid, which makes this a delayed avc system.

b. Avc Amplifier V111A. The avc circuit works only when AVC switch, S115, is in the ON position. Switch S115 completes tube V111A

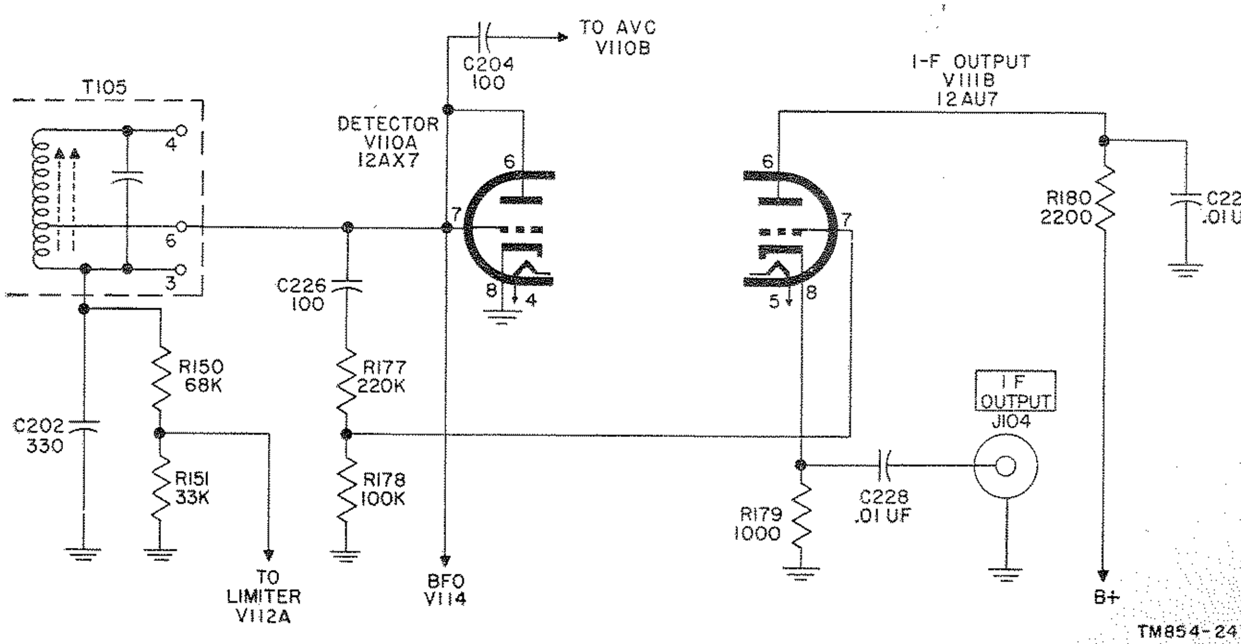


Figure 24. Detector and i-f output stage, schematic diagram.

plate circuit. The complete grid circuit of tube V111A, grid to cathode, consists of series-connected resistors R171, R144, R145, R164, and cathode resistor R168. Resistor R164 is part of the power supply voltage divider and fixes the operating bias of V111A (—9 volts). The plate voltage for tube V111A is secured from another divider consisting of resistors R147, R148, and R149. The plate (pin 1) of tube V111A is connected through plate load resistor R146 to a tap between R147 and R148. Potential at this point is more positive than the cathode divider tap, resulting in application of a positive voltage to tube V111A plate. When the rectified and filtered carrier (avc voltage) across capacitor C205B exceeds the grid d-c bias (—9 volts), the avc amplifier tube conducts. The plate current flow through resistor R146 produces an avc voltage in proportion to the strength of the input signal. The avc line is connected to the negative side of resistor R146. Degenerative feedback is used with resistor R167 and capacitor C208 connected between plate and grid to prevent the avc amplifier tube V111A from responding to low audio frequencies.

c. Manual Gain Control. When the AVC switch, S115, is in the OFF position, the avc amplifier plate circuit is open, resistor R146 is shorted by the switch, and a manually controllable bias is applied to the low-impedance avc line. The avc line is connected between resistors R146 and RF GAIN resistor R148, which with resistor R149 are series-connected as a voltage divider from the power transformer T108 h-v winding center tap to ground. The RF GAIN control provides manual control of receiver gain. Tubes controlled by the avc and manual voltage are V101, V107, V108, and V109.

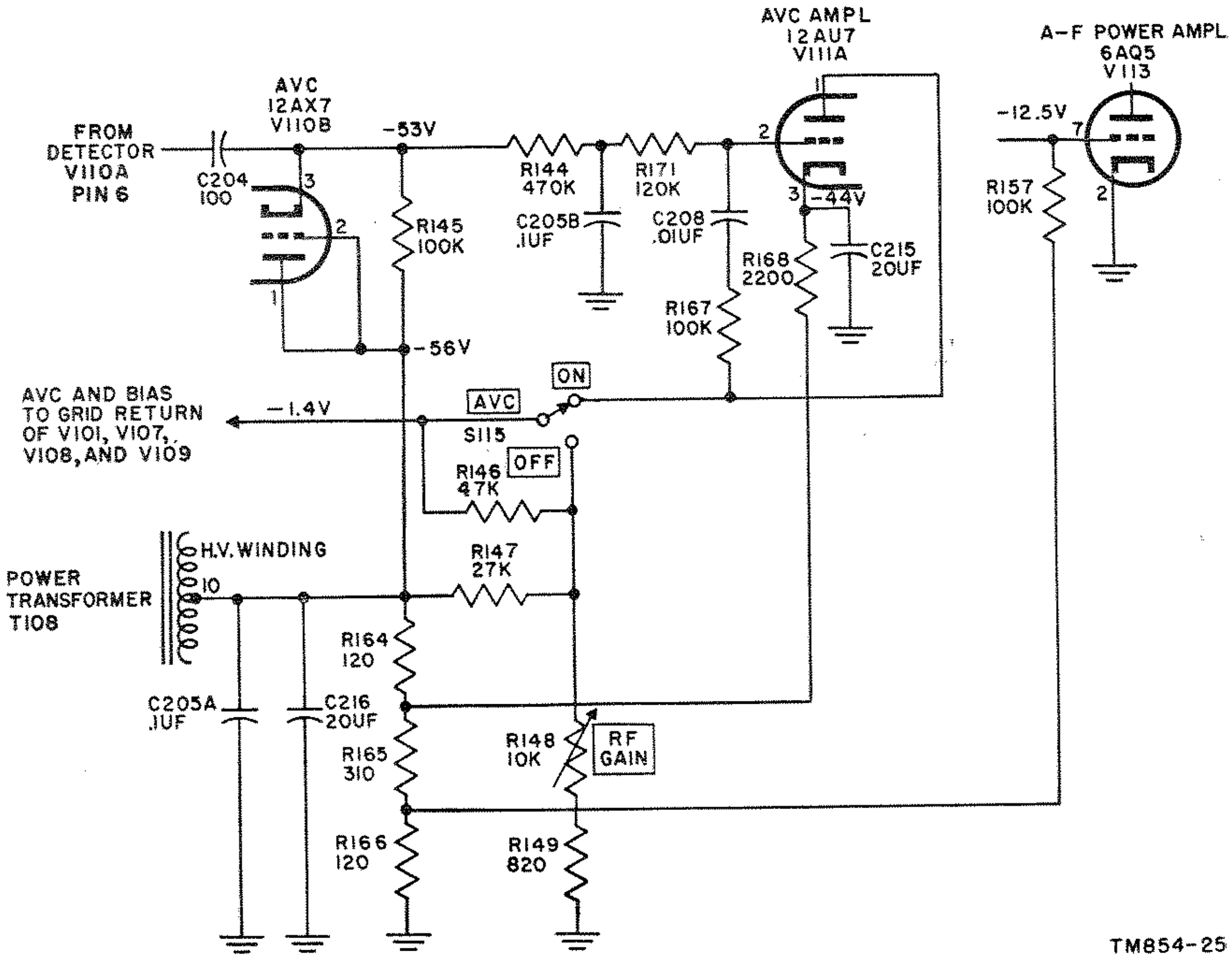


Figure 25. Avc and avc amplifier stages, schematic diagram.

50. Noise Limiter and A-F Amplifier

a. Noise Limiter V112A. Signal input for the noise limiter tube, V112A, type 12AX7, is taken from the detector load resistor consisting of R150 and R151. The drop across resistor R151 furnishes the required a-f voltage. The noise limiter tube acts as a series conductor of the audio voltage between detector and a-f amplifier during non-noise periods. When the noise peaks occur, the limiter tube does not conduct and the a-f voltage does not reach the a-f amplifier.

(1) Resistor R152 and capacitor C205C are series-connected from the negative side of R150 to ground. Resistor R153 is connected from the junction of R152 and C205C to the cathode of noise limiter tubes V112A. The time constant of R152 and C205C is such that all a-f is filtered and a steady negative bias applied to the cathode of V112A. The values of R152 and C205C are sufficient so that variations in af appearing across R150 and R151 do not affect the negative bias on the cathode of V112A. The cathode is kept at the potential of the negative end of R150.

(2) The plate of the limiter tube is connected to the junction of resistors R150 and R151. The potential at this point, and consequently the limiter plate potential, is more positive than the limiter cathode potential, and the tube conducts at the frequency at which the a-f voltage drop across R151 varies.

(3) On noise peaks, the voltage drop across R151 hits a simultaneous peak, which results in a large negative potential being applied to the limiter plate. Since R152 and C205C have a relatively large time constant (.047 second) a slow change in potential occurs at the limiter cathode. This condition allow the limiter plate to attain a more negative potential than the cathode and the limiter tube ceases to conduct. As soon as the noise peaks diminish, the limiter tube conducts, and the audio is transferred to the a-f amplifier through C209 and across AUDIO GAIN resistor R154.

b. A-F Voltage Amplifier V112B. A-f voltage amplifier V112B, type 12AX7, is operated class A and has cathode degeneration and controlable a-f gain. The a-f signal from the limiter stage is coupled to the amplifier through capacitor C209 and applied across the AUDIO GAIN resistor R154. The required amount of a-f drive is taken from R154, between slider arm and ground, and applied to the grid of V112B. Cathode bias voltage is developed across cathode resistor R155. The output a-f voltage is developed across plate load resistor R156 and coupled to the a-f power amplifier through capacitor C211.

c. A-F Power Amplifier V113. The a-f power amplifier V113 uses a tube type 6AQ5. The output of the a-f voltage amplifier, V112B, is applied across the grid resistor R157 of V113. The d-c grid bias is developed across resistor R166, a part of the power supply voltage divider consisting of resistors R164, R165, and R166 (fig. 25), and applied to V113 grid through resistor R157. Tube V113 output is developed across the primary of output transformer T107, induced in the tapped secondary winding, and applied from the appropriate portion of the secondary to either the PHONES or SPEAKER jack. Located at the rear of the receiver is a terminal strip labeled G, 4, and 600, to which external audio reproducing units can be connected. The SPEAKER and PHONES jacks are connected across the 600-ohm winding of the transformer. Screen voltage for V113 is obtained by connection to terminal 2 of filter choke L123 (fig. 42). Plate voltage for V113 is obtained by connecting the plate return side of the primary winding of T107 to terminal 2 of filter choke L122. Capacitor C212 connected between plate of V113 and terminal 2 of transformer E107 discriminates against the higher audio frequencies to equalize audio output.

51. Beat-Frequency Oscillator

The beat-frequency oscillator uses a type 6BA6 pentode tube, V114, in a Hartley circuit. The oscillator inductor, tuning capacitors, grid capacitor, and grid resistor are all contained in transformer T106 shield can. Connections from the packaged elements to their external

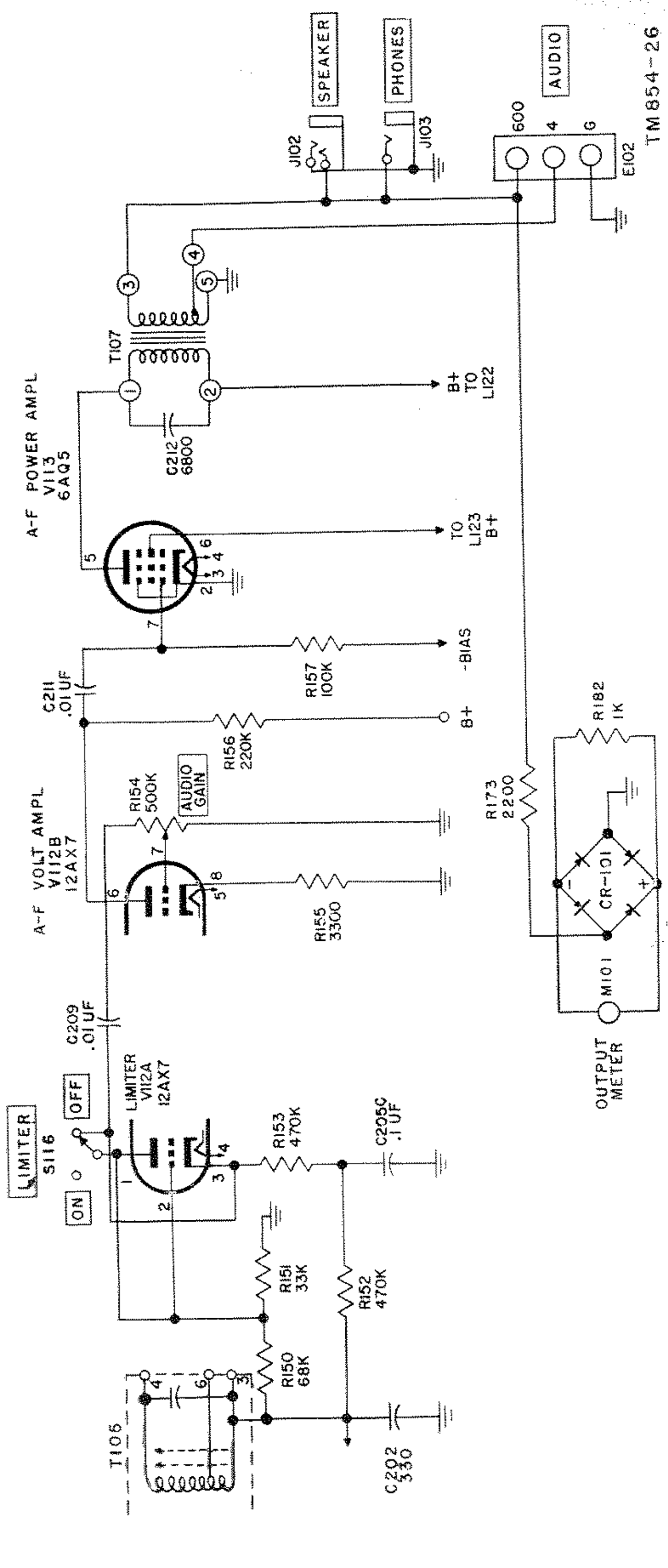


Figure 26. Limiter and audio amplifier stages, schematic diagram.

circuit are made from terminals 1, 5, and 2 of T106 (fig. 27).

a. The grid, cathode, and screen elements of tube V114 serve as a triode oscillator and output is taken from the plate through its coupling in the electron stream. The tank inductance in T106 is tapped and connected to V114 cathode for feedback path, screen to cathode. The BFO PITCH capacitor is in the T106 can and has an extension shaft to the front panel for control of beat frequency. The bfo output is fed to the detector V110A plate through capacitor C206.

b. The screen voltage for V114 is obtained through voltage-dropping resistor R160. The bfo tube plate load resistor is R161, and both R160 and R161 have their common plate return sides decoupled from the rest of the receiver by capacitor C210 and resistor R162. The BFO switch, S112, controls the screen voltage applied to V114 and consequently the operation of the bfo stage. When BFO switch, S112, is in the OFF position, the screen element is grounded through the switch contacts and screen voltage is removed from the tube. Capacitor C218 is the screen r-f bypass.

52. Calibration Oscillator

The receiver has a 100-kc calibration oscillator which has usable harmonic output voltages up to 30.5 mc. The output of the oscillator is applied to r-f amplifier V101 grid to provide check points at every 100 kc throughout the tuning range of the receiver for calibration purposes.

a. Tube V104, type 6BA6 is arranged in a Pierce circuit and uses a 100-kc crystal in place of the conventional tank circuit of coil and capacitor. Tube V104 is a pentode and the control grid, screen, and cathode are used as a triode oscillator. The oscillator output is coupled through the electron stream to the plate and then through coupling capacitor C173, a shielded lead, and another coupling capacitor C111 to the control grid (pin 1) of the r-f amplifier, V101 (fig. 42).

b. Crystal Y111 is connected between V104 control and screen grids to serve as the tank circuit of the Pierce oscillator (a version of the Ultraudion oscillator). The feedback voltage to sustain oscillations is developed across C169, which with capacitor C224 forms a voltage-dividing network effectively providing an

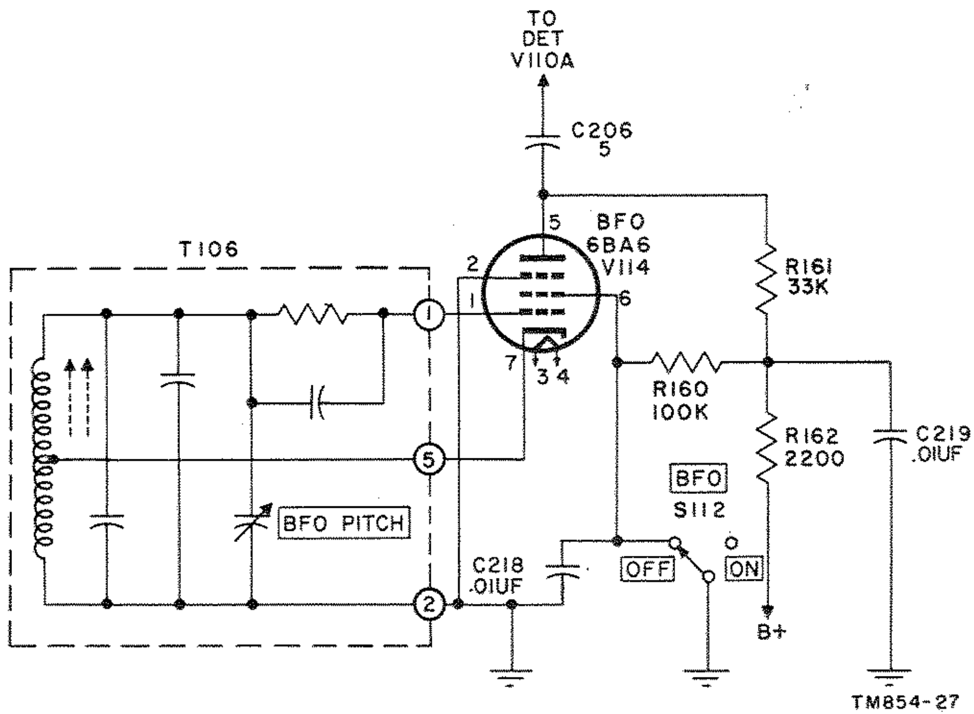


Figure 27. Beat-frequency oscillator, schematic diagram.