CHAPTER 3

TROUBLESHOOTING

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

Section I. PREVENTIVE MAINTENANCE

28. 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 breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles from occurring.

29. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion.

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

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

30. Use of Preventive Maintenance Form (fig. 28)

a. DA Form 11–239 is a preventive maintenance checklist to be used by third echelon repairman.

b. Items not applicable to Radio Sets AN/PRC–9A and –10A are lined out on figure 28. References in the ITEMS block in the figure are to paragraphs in this manual which contain additional maintenance information pertinent to the particular item.

31. Performing Preventive Maintenance

For daily and weekly preventive maintenance instructions, see TM 11–612.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation. For operating instructions, refer to TM 11–612.

a. Inspect seating of pluck-out items, such as tubes, plug-in cans, and crystals (figs. 32 and 33).

b. Inspect electron tubes externally for apparent breakage without removing the tubes from their sockets.

c. Inspect fixed capacitors for leaks, bulges, and discoloration (figs. 32 and 33).

d. Inspect relay K1 and relay K2 (fig. 33) for loose mountings, burned, pitted, or corroded contacts, misalined contacts, and insufficient spring tension.

e. Inspect TUNING capacitor C9 (fig. 33) for dirt, moisture, misalinement of plates, and loose mountings.

f. Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.

g. Inspect terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts.

h. Clean and tighten switches within each subchassis.

i. Lubricate equipment as specified in paragraph 73.

j. Check batteries for low voltage.

k. Inspect the cases for leaking waterproof gaskets and worn or loose parts.

l. Inspect moistureproofing and fungiproofing treatment.

m. If deficiencies noted are not corrected during inspection, indicate action taken for correction.

Section II. GENERAL TROUBLESHOOTING TECHNIQUES

32. Extent of Instructions

Troubleshooting at a field maintenance level includes all the techniques outlined for organizational maintenance and any other techniques that may be required to isolate a defective part. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at an organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques.

33. Troubleshooting Techniques

a. Troubleshooting must be systematic to be effective. It is not often possible to observe a trouble symptom and immediately diagnose the cause correctly. Generally it is necessary to perform a *sequence* of operational checks, observations, and measurements before the fault can be found. Usually the trouble is first traced to a unit, then to a portion of the unit, and finally to the defective part. This sequence is commonly referred to as the sectionalization, localization, and isolation of trouble.

b. Sectionalization means determining which particular unit of the system is at fault. This can usually be determined through visual checks, operational procedures, or by substitution with interconnecting cables and units known to be in operating condition.

c. Localization means tracing the fault within the unit to the circuit, subassembly, or component responsible for the abnormal operation of the set. This can usually be accomplished by inspection, specialized tests and measurements, and component substitution.

d. Isolation means tracing the localized fault to the defective part or cause of trouble. Some faults, such as leaky capacitors, burned-out resistors, rf arcing, and shorted transformers, can often be found by sight, smell, and hearing. Most faults within a circuit or stage, however, must be found by checking continuity and taking voltage and resistance measurements.

e. Do not apply power to the radio set unless the operational symptoms are known and are of such nature as to eliminate the possibility of further damage. If the symptoms are not known, disconnect the battery plug from the equipment and check the power circuits for shorts and/or grounded circuit (par. 38).

f. Troubleshooting an intermittent requires skill, patience, and institution. Intermittents are troubles that appear and disappear without any apparent reason. If present, this type of trouble often may be made to reappear by tapping or lightly jarring the equipment. It is possible that the trouble may exist because of external conditions such as a poor cable connection etc. The important point to remember when troubleshooting an intermittent, is that the radio set is not normal and must be repaired since it may break down during operation. By tapping with an insulated device, it is often possible to localize the intermittent to a single stage, or components of a specific circuit. Inspect closely for mechanical causes, and check sealed components. The intermittent fault can be caused by something physically defective in a sealed can.

34. Electron Tube Replacement Procedure

To reduce waste of material where electron tubes are needlessly discarded as faulty, observe the following:

a. When replacing tubes, *do not discard tubes* merely because they fall *on or slightly above* the minimum acceptable value when checked in a tube tester. It is possible that a certain percentage of new tubes will fall near the low end of the acceptable range of the tube specification and, therefore, begin their operational life at a value close to the tube tester *retention limit.* Do not discard these tubes because they may provide satisfactory performance throughout a long period of operational life. Some circuits, for example oscillator circuits, may function with one tube and not another—even though both tubes are new. If practicable, retain any removed tube until its condition is checked by a suitable test instrument.

b. Be especially careful when withdrawing a miniature tube from its socket. *Pull it straight*

out. The external pin and the wire lead sealed in the glass base are two different metals that are butt-welded together where the pin appears to enter the glass. Rocking or rotating the tube causes bending, which tends to break this weld or cause a resistance or intermittent joint to develop.

Caution: Flat subminiature tubes that are tested in the flat subminiature sockets of tube testers may be inadvertently inserted in reverse. This places B+ on the filament and causes the tube filament to burn out. To prevent this, *always line up the red mark on the tube with the red mark on the tube socket.*

35. Additional Troubleshooting Data

Refer to the following list of figures when troubleshooting the radio set:

Figure	Title
57	Radio Sets AN/PRC–9A, and –10A, schematic diagram.
4	Radio Set AN/PRC–9A and –10A, receiver-transmitter, block diagram.
21	Control circuit diagram.
55	Radio receiver-transmitter RT–179A/PRC–10, wiring diagram.
56	If. chassis, wiring diagram.
30	Voltage and resistance measurements, bottom and rear of chassis.
31	Voltage and resistance measurements, top and front of chassis.
23	Handset H–33B/PT, schematic diagram.
20	Voltage distribution in Radio Receiver-Transmitter RT–176A/PRC–10.
35	First rf box U3, inside view.
36	Second rf box U4, inside view.
37	Receiver oscillator box U6, inside view.
38	Mixer box U5, inside view.
39	If. subchassis with shield removed.
53	MIL–STD resistor color codes.
54	MIL–STD capacitor color codes.

36. Test Equipment Required

The test equipment required for troubleshooting Radio Sets AN/PRC–9A and –10A is listed below. A common usage name is indicated after each component.

Nomenclature	Common name
Audio Oscillator TS–382A/U	Audio oscillator.
Battery Tester TS–183/U	Battery tester.
Electronic Multimeter ME–6A/U or Voltmeter ME–30A/U.	Millivoltmeter.
Electronic Multimeter TS–505/U.	Vtvm.
Electron Tube Test Set TV–7/U.	Tube tester.
Frequency Meter TS–174B/U	Frequency meter.
Multimeter TS–352A/U	Multimeter.
Multimeter TS–297/U	Multimeter.
Output Meter TS–585A/U	Output meter.
RF Wattmeter ME–11/U	Wattmeter.
Signal Generator AN/URM–48	Rf signal generator.
Signal Generator AN/URM–25	If. signal generator.
Panoramic Indicator IP–173/U	Panoramic indicator.

Section III. TROUBLESHOOTING RADIO SETS AN/PRC–9A AND –10A

Warning: The B battery voltages of the battery pack are high enough to produce shock and may be dangerous to life. Disconnect the battery pack when working on the equipment.

37. General Troubleshooting

The tests listed below will aid in finding the source of trouble. To be effective, follow the procedure in the order given. First localize the trouble to a single stage or circuit. Then isolate the trouble within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The servicing procedure is summarized as follows:

a. Inspection. An inspection locates any visible trouble. Through inspection alone, the repairman may frequently discover the trouble or determine the stage in which the trouble exists. Thoroughly inspect the equipment before performing the troubleshooting procedures. This inspection may locate the trouble.

b. Short-Circuit Checks. These measurements (par. 38) prevent further damage to the radio set from possible short circuits.

c. Troubleshooting Chart. This chart (par. 40) is useful in localizing common troubles in an orderly sequence.

d. Individual Stage Checks. Individual stage checks (pars. 41–53) utilize the signal substitu-

tion method, voltage and resistance measurements, and any other special checks that are indicated for a specific circuit. This procedure is used to locate the stage in which the trouble exists and then to locate the defective component.

e. Stage Gain Sharts. These charts (pars. 55 and 56) are used to locate defects that reduce the sensitivity of the set but do not make it inoperative.

38. Short-Circuit Checks

Release the two snap catches that fasten the receiver-transmitter case to the battery case, and separate the two cases by a few inches. Remove the battery plug from the battery socket. Then release the two snap catches that fasten the front panel of the receiver-transmitter to its case, and remove the receiver-transmitter panel and chassis assembly from its case.

a. Battery Cable. With an ohmmeter, measure the resistance between each pin of plug P1 on the battery cable (fig. 29) and each of the remaining pins. Also measure the resistance between each pin of plug P1 and the receiver-transmitter case. Any reading below infinity indicates a defective plug or battery cable.

b. POWER Switch S1. With the POWER switch at OFF and then at REMOTE, measure the resistance between pins B, F, and J of connector J5 and chassis ground. Any reading below infinity indicates a defective switch (or connector J5) (fig. 21).

Caution: Do not make this test with the POWER switch at ON. Also, do not contact pin A of connector J5 with the ohmmeter prod. Failure to observe either of these precautions may ruin tubes in the radio set because of the ohmmeter battery being connected, through the test prods, across the 1.5-volt filament circuits.

c. B+ Supply Circuits. Measure the resistance from terminals D and E of J5 to chassis ground. Any reading below 50 megohms at terminal D and 5 megohms at terminal E, indicates a defect in the 135-volt or 67.5-volt supply circuit, respectively (fig. 21).

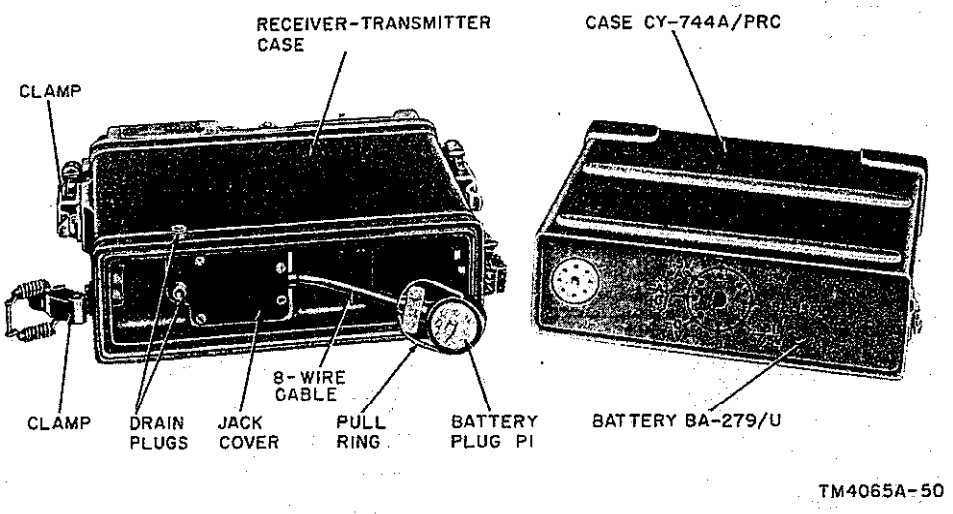
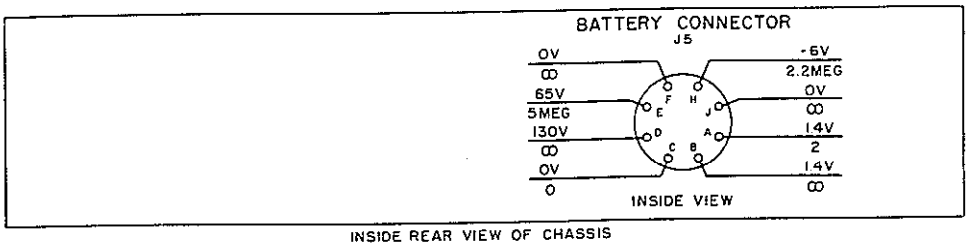


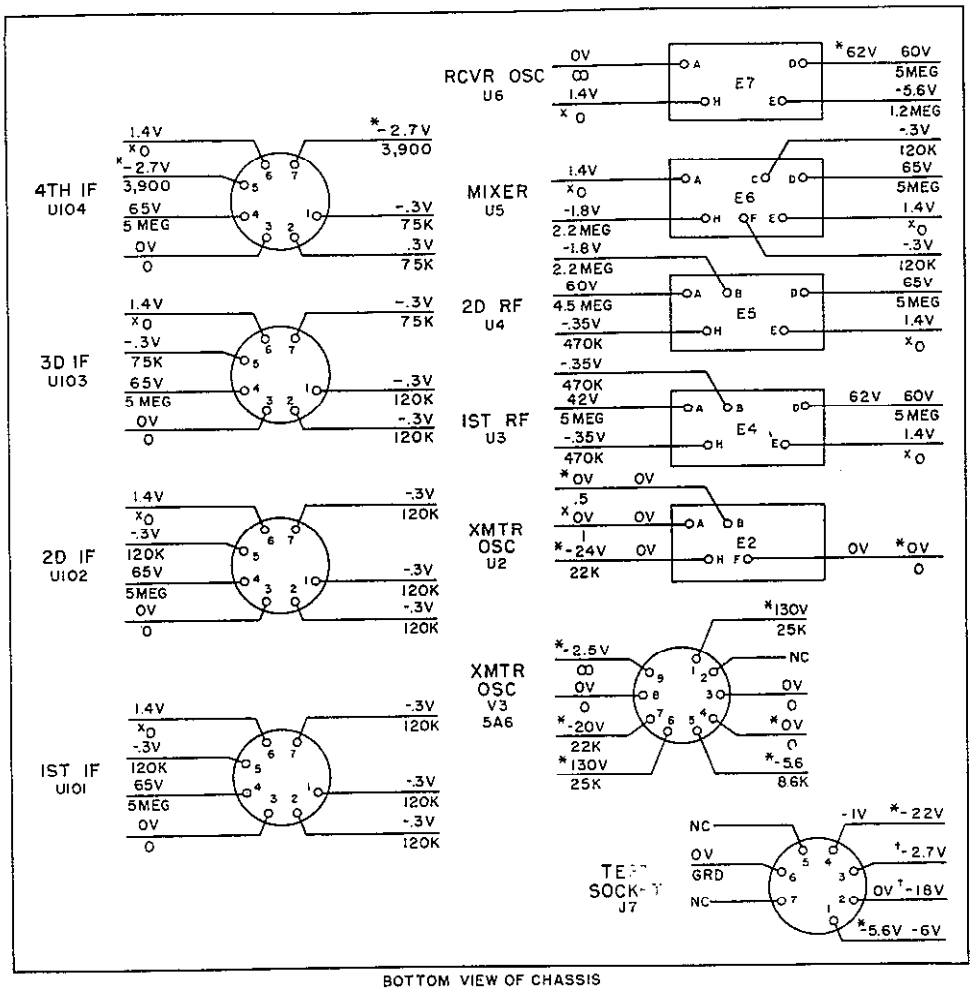
Figure 29. Battery and receiver-transmitter cases, separated.

39. Purpose and Use of Troubleshooting Chart

The troubleshooting chart is used to localize trouble in the receiver-transmitter, the battery, or in connections between the battery and the receiver-transmitter. This chart lists the symptoms obtained by the repairman while making a few simple tests. Connect the radio set as in normal operation, with the receiver-transmitter in its case and connected to the battery case. The troubleshooting chart also indicates how to localize trouble in the audio, if. or rf stage of the radio set. The individual stage checks described in paragraphs 41 through 53 can be used to supplement this procedure to locate the defective stage. After the trouble has been localized to the stage or circuit, tube checks and voltage and resistance



INSIDE REAR VIEW OF CHASSIS



BOTTOM VIEW OF CHASSIS

NOTES:

1. ALL VOLTAGES MEASURED WITH VTVM, WITH RADIO SET IN RECEIVE CONDITION, POWER SWITCH AT ON, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, AND HANDSET OUT UNLESS OTHERWISE INDICATED.
2. VALUES BELOW THE LINE ARE IN OHMS MEASURED WITH VTVM WITH BATTERY CABLE OUT, POWER SWITCH AT OFF, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, V3 OUT, AND HANDSET OUT.
3. * INDICATES VOLTAGE MEASURED WITH V3 IN AND RADIO SET IN TRANSMIT CONDITION.
4. † INDICATES VOLTAGE (MEASURED WITH V3 IN AND RADIO SET IN TRANSMIT CONDITION) WHICH DIFFER SLIGHTLY IN INDIVIDUAL SETS.
5. X TO AVOID BURNING OUT FILAMENTS, USE OHMMETER ON RANGE OF R X 10 OR GREATER.
6. NC INDICATES NO CONNECTION.

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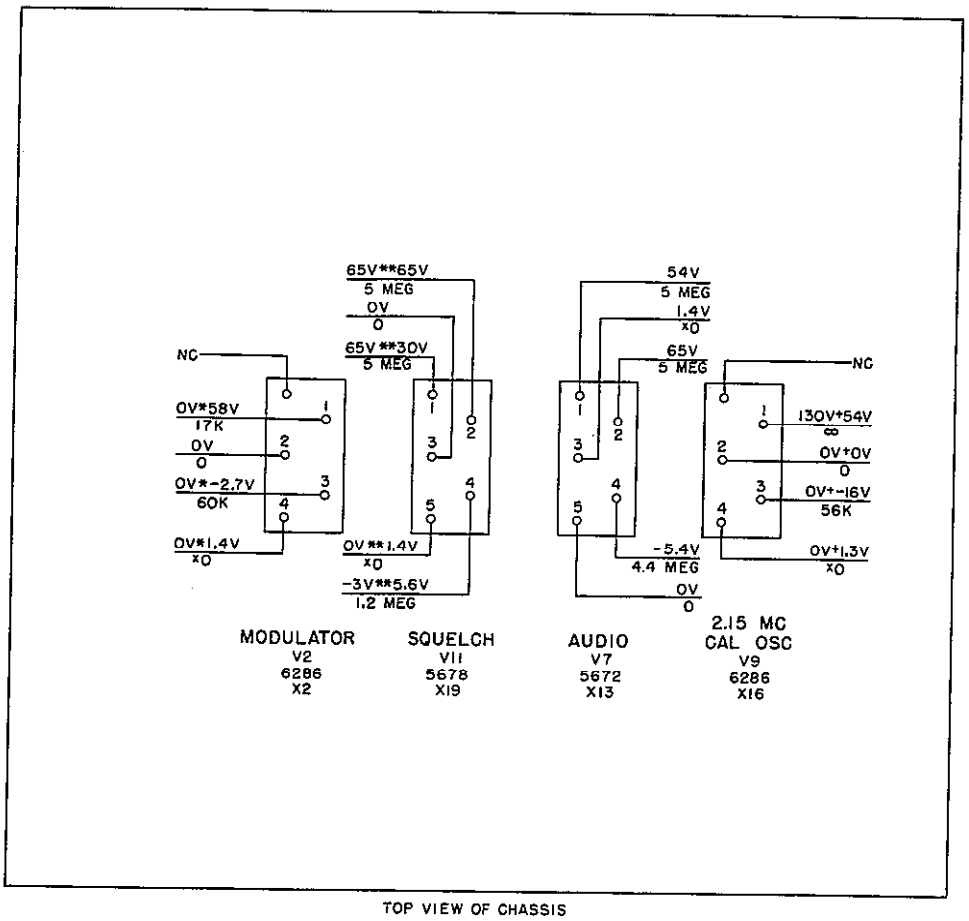
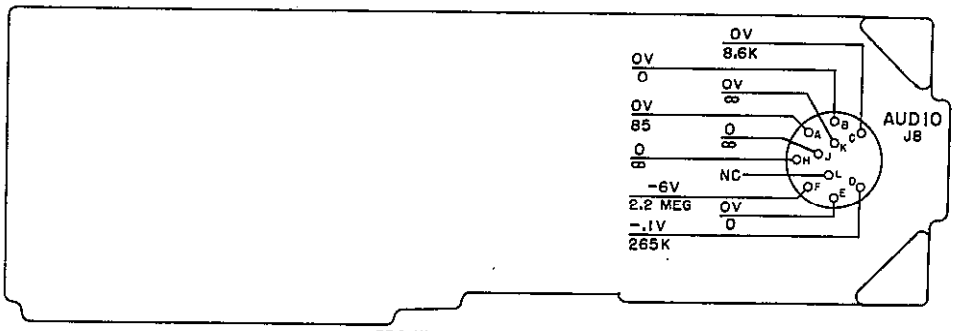
Figure 30. Voltage and resistance measurements, bottom and rear of chassis.



TOP VIEW OF CHASSIS



FRONT VIEW OF PANEL

NOTES:

1. ALL VOLTAGES MEASURED WITH VTVM WITH RADIO SET IN RECEIVE CONDITION, POWER SWITCH AT ON, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, AND HANDSET OUT UNLESS OTHERWISE INDICATED.
2. VALUES BELOW THE LINE ARE IN OHMS MEASURED WITH VTVM WITH BATTERY CABLE OUT, POWER SWITCH AT OFF, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, V3 OUT, AND HANDSET OUT.
3. + INDICATES VOLTAGE MEASURED WITH POWER SWITCH HELD AT CAL & DIAL LITE.
4. * INDICATES VOLTAGE MEASURED WITH V3 IN AND RADIO SET IN TRANSMIT CONDITION.
5. ** INDICATES VOLTAGE MEASURED WITH SQUELCH CONTROL AT EXTREME CLOCKWISE POSITION.
6. NC INDICATES NO CONNECTION.
7. X TO AVOID BURNING OUT FILAMENTS USE OHMMETER ON RANGE OF R x 10 OR GREATER.

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Figure 31. Voltage and resistance measurements, top and front of chassis.

measurements are used to locate the defective part. Voltage and resistance measurements are shown on figures 30 and 31. When using troubleshooting chart, perform the steps in the order in which they are given. Correct each defect before proceeding with the next step.

40. Troubleshooting Chart

Step		When to perform	What to expect	What to do next	
No.	Procedure			When results are normal	When results are not normal
1	Make an operational test. (Either repeat items 1–12 of the equipment performance checklist in TM 11-612, or follow steps 1*a*–1*c* below.)	(a) When the operation symptoms have not been determined. (b) After the possibility of short circuits has been eliminated.	The normal indications listed in the equipment performance checklist.	Step 2	The corrective procedure referenced in the equipment performance checklist.
1*a*	With battery, antenna, and handset installed, turn VOL control to 10, SQUELCH control to OFF, and POWER switch to ON.	Same as for step 1	Rushing noise in handset receiver.	Step 1*b*	Replace weak battery. Inspect for broken lead in battery cable or at J5, J6, or P1. Check the handset.
1*b*	Turn SQUELCH control clockwise until rushing noise stops.	When normal results are obtained in step 1*a*.	Rushing noise stops	Step 1*c*	Isolate trouble in the squelch circuit. Replace V11, clean or replace squelch relay K2, check SQUELCH control (S2 and R35).
1*c*	Turn SQUELCH control to OFF, hold POWER switch in CAL & DIAL LITE position, rotate TUNING control slowly from low to high end of dial.	When normal results are obtained in step 1*b*.	Dial lamp lights Beat notes are heard at every calibration point on the dial.	Step 1*d*	Replace dial lamp E8. Isolate trouble in circuit of 2.15-mc calibrating oscillator V9 or receiver oscillator V8. If beat notes are heard at some points, isolate trouble in circuit of V8.
1*d*	Tune in another radio set that is transmitting; adjust the VOL control as necessary.	When normal results are obtained in step 1*c*.	Voice signals are heard	Step 2	Check antenna connections. Replace weak battery.
2	With POWER switch at ON, press push-to-talk switch on handset and talk into microphone.	After receiver section is found normal.	Audio sidetone in handset receiver. A putt-putting sound may momentarily be heard at first.	Radio set is in operating condition; Step 3.	(a) If rushing noise is heard, check action of push-to-talk switch and relay K1. (b) If continuous putt-putting sound is heard, transmitter is inoperative. Isolate trouble in circuits of modulator V2 and transmitter oscillator V3.

40. Troubleshooting Chart—Continued

Step		When to perform	What to expect	What to do next	
No.	Procedure			When results are normal	When results are not normal
3	Test for intermittents by tapping, jarring, or vibrating equipment while in operation.	After radio set passes all preceding operational tests.	Continued normal operation if radio set is not intermittent.	Step 4	Localize the intermittent; isolate trouble and correct.
4	Check audio amplifier stage V7 (par. 43).	After trouble in the radio set persists, and a more detailed procedure is indicated.	Audio signals	Step 5	Isolate defect and then correct.
5	Check discriminator action of T201 (par. 44).	After step 4	Beat note as frequency of signal generator is varied.	Step 6	Replace discriminator can T201.
6	Check if. amplifier stages U101 through U104 (par. 45).	After step 5	—5-volt if. output at pin 4 of J7 with signal generator at 4.3-mc and 80,000 μv signal level at pin 5 of X8; 500 μv at pin 2 of X8 and 140 μv at pin F of E6.	Step 7	Replace defective if. can.
7	Check mixer stage V6 (par. 46).	After step 6	—5-volt if. output at pin 4 of J7 with signal generator at 4.3-mc and 140 μv signal level at E19.	Step 8	Isolate trouble in mixer box U5.
8	Check receiver oscillator stage V8 (par. 47).	After step 7	—3-volt minimum negative grid bias at pin 1 of J7.	Step 9	Isolate trouble in receiver oscillator box U6.
9	Check rf amplifier stages V4 and V5 (par. 48).	After step 8	—5-volt if. output at pin 4 of J7 with signal generator tuned to dial frequency and the 60 μv signal level at E18; 6 uv at E20.	Step 10	Isolate trouble in rf. box U3 or U4.
10	Check squelch amplifier V11 (par. 49).	After step 9	Squelch relay K2 inoperative when SQUELCH control is OFF. When SQUELCH control is on but at minimum, relay should be inoperative and about —3 to —5 volts on pin 4 of V11.	Step 11	Isolate trouble in squelch circuit.
11	Check transmitter oscillator stage V3 (par. 50).	After step 10	Normal power output registering on output meter. About —20 volts at pin 2 of J7.	Step 12	Aline stage; check circuit;replace tube V3.
12	Check modulator stage V2 (par. 51).	After step 11	Sidetone of modulation heard in handset. About —2.4 volts bias at pin 3 of V2 in transmit operation.	Step 13	Replace tube V2. Check afc circuit.
13	Check pulse-sweep generator stage V301 (par. 52).	After step 12	Putt-putting sound in handset receiver when in transmit operation and receiver oscillator V8 is shorted by shorting E21 to chassis.	Step 14	Replace defective U301 can.
14	Check 2.15-mc calibrating oscillator stage V9 (par. 53).	After step 13	About —2.5 volts across R31, as measured with vtvm.		Replace tube V9; change crystal Y1.

41. Test Setup for Individual Stage Checks

Bench tests of the radio receiver-transmitter require connection to various test equipments. The test connections vary from test to test, and upon whether the receiver or transmitter section is being tested. Typical connections for receiver testing are shown on figure 51, and connections for transmitter testing are shown on figure 52. The equipment may be powered from the battery pack, as in normal operation. No special power source is required.

a. Connections for Receiver Testing. For most receiver tests, the test equipment will be connected as shown in figure 51.

(1) Connect 600-ohm 5-watt resistor across the audio output pins A and B of J8 for all tests or connect an output meter, such as TS–585A/U, set for 600-ohm terminating impedance. Connect a millivoltmeter, such as the ME–6A/U, or ME–30A/U across output pins A and B of J8.

(2) Connect the high side of a vtvm, such as TS–505/U, to either pin 1, 3, or 4 of test socket J7, and the low side to chassis ground. For the input to the receiver, connect an rf signal generator (AN/URM–48) to AUX ANT connector J3 through the impedance-matching network shown in figure 51. When feeding a test signal from a signal generator (rf or if.) into the receiver at some point on the chassis, use a 1,000-$\mu\mu$f capacitor in series with the hot side of the signal generator input lead.

b. Connections for Transmitter Testing. For most transmitter tests the test equipment will be connected as shown in figure 52.

(1) A 50-ohm dummy load, nonreactive between 38 and 55 mc (27 and 39 mc in AN/PRC–9A), should terminate the transmitter output across AUX ANT connector J3 and chassis ground. This load is provided by RF Wattmeter ME–11/U. The frequency meter INPUT cable is loosely coupled to the radio set by coiling it around or near AUX ANT connector J3.

(2) Fabricate a test cable (fig. 52) with a mating plug at one end (for connection to AUDIO connector J8) and at the other end connect the leads to a terminal board. Label the terminals, corresponding to the pins on J8. Then connect a single-throw, double-pole switch, headphones, and Audio Oscillator TS–382A/U as shown in figure 52. Use ½-watt resistors of the values shown on the diagram to provide the proper impedance-matching network. Connect the millivoltmeter across the 10-ohm resistor to measure the audio signal voltage. For tests not requiring audio input, the headphones may be plugged directly into J8 instead of the test terminal board. The test switch permits either the transmitter to be turned on (closing the switch), or the receiver (switch open), functionally replacing the handset push-to-talk switch. The headphones functionally replace the handset receiver, so that this setup can be used to hear sidetone, listen for zero beat, and otherwise assist in servicing the radio set.

42. Individual Stage Checks

When making individual stage checks, refer to figures 32 and 33 for location of components and test points. Individual stage checks are made with the receiver-transmitter removed from its case and powered by a bench test battery pack. (See par. 10*b*(4) of MWO SIG 11–612–6.) If a bench test battery pack is not available, J5 of the receiver-transmitter chassis may be plugged directly into the socket of Battery BA–279/U. When a Battery BA–279/U is used, use an extension cable between the battery and the receiver-transmitter chassis. This cable must have two plugs, one to mate with the battery socket and the other to mate with J5, and with leads from terminal A on one plug connected to terminal A on the other, B to B, C to C, and so on. The cable should be about 2 to 5 feet.

Caution: Accidental shorting of the +67.5-volt or +135-volt supplies to ground causes several tubes to burn out either when the POWER switch is at OFF and the handset push-to-talk button is pressed, or when the POWER switch is at REMOTE. Therefore, when making checks inside the receiver-transmitter chassis, be sure that the POWER switch is not at REMOTE and that the handset push-to-talk button is not depressed when the POWER switch is at OFF.

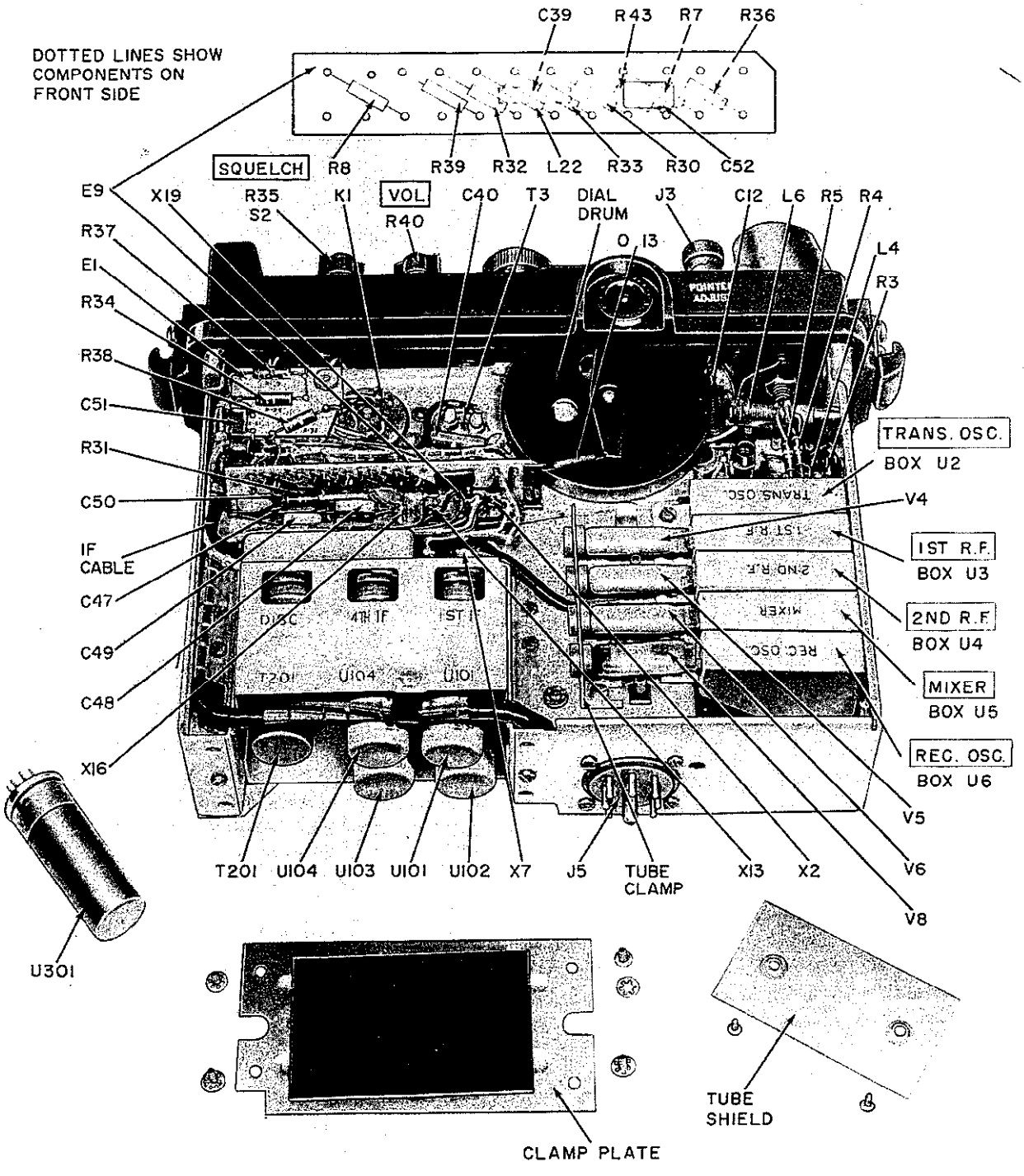

Figure 32. Receiver-transmitter chassis, top view.

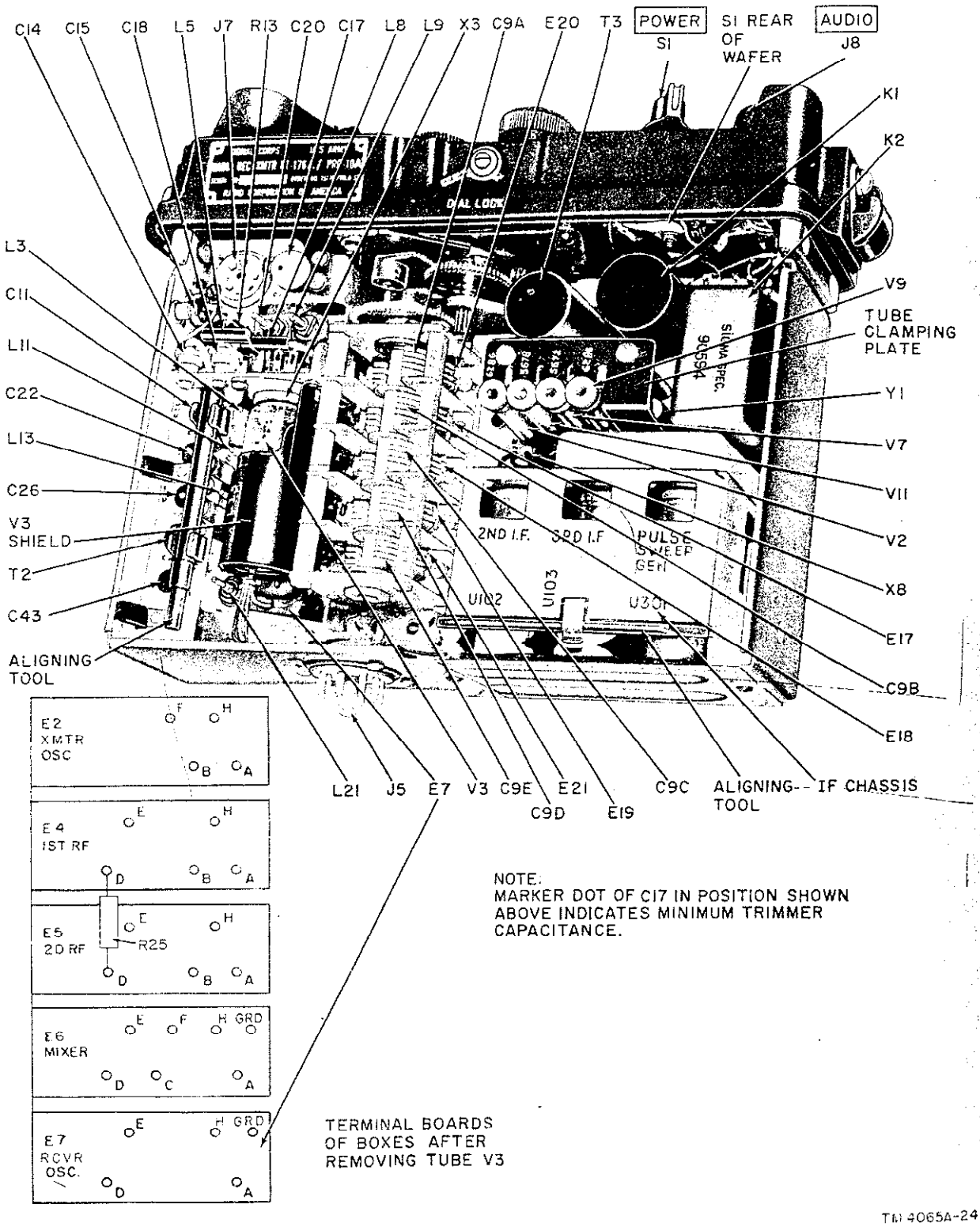

Figure 33. Receiver-transmitter chassis, bottom view.

43. Audio Amplifier V7

a. Remove the receiver-transmitter chassis from its case and connect it to the power source. Then proceed as follows:

(1) Set the POWER switch at ON.
(2) Set the SQUELCH control at OFF.
(3) Set the VOL control to its extreme clockwise position.
(4) Connect a handset to the AUDIO connector.

b. Connect the output of a 400- or 1,000-cycle audio oscillator across terminal 3 of output transformer T3 (fig. 32) and ground. The audio signal should be heard in the handset receiver. If no signal is heard, disconnect power from the receiver-transmitter and make an ohmmeter check of T3 and connections from T3 to the handset.

c. Connect a .01-μf capacitor to the end of the ungrounded lead of the audio oscillator, and connect the other end of this capacitor to terminal 2 of T3. The audio signal should be heard in the handset. This checks the primary of T3.

d. Connect the audio oscillator across the grid (pin 4) of V7 (socket X13) and ground. The signal heard in the handset receivers should be much louder than in *b* and *c* above if the output voltage of the audio oscillator is kept constant. If no noticeable increase in loudness is obtained, replace V7.

e. Connect the audio oscillator across pin 3 of test socket J7 (fig. 33) and ground. The signal in the handset should be almost as loud as in *d* above. Slowly turn the VOL control counterclockwise. The loudness of the tone in the handset should be reduced gradually until it is inaudible. The complete absence of a signal at the handset may be caused by a defective SQUELCH relay K2, by a short in C38, (fig. 39), capacitator C39 (fig. 32) grounded, or a short in VOL control R40. (fig. 32).

44. Discriminator T201

Put a 1,000-$\mu\mu$f capacitor in series with the hot lead of the if. signal generator, which is putting out an amplitude-modulated, 4.3-mc if. signal. Remove the fourth if. can, and apply this signal to pin 5 of socket X10 (fig. 39). This point connects to the input of the discriminator. Shift the if. signal generator output frequency above and below 4.3 mc while listening for a signal in the handset. The audio tone should be heard only when the signal is slightly above or below 4.3 mc. If no tone is heard, replace the discriminator can.

45. If. Amplifiers U101 Through U104

a. Feed an unmodulated 4.3-mc signal to pin 5 of socket X8 (second if. can), and connect a vtvm (10-volt range) to pin 4 of test connector J7. The negative bias voltage obtained at pin 4 of J7 indicates the level of signal at the input to the fourth if. amplifier and should change when the amplitude of the signal applied at pin 5 of X8 is changed. If no indication is obtained, interchange the third and fourth if. cans. If an indication is now obtained, place the good can back into the fourth if. socket and test a new can in the third if. socket. However, if no indication is obtained after interchanging the two cans, either both cans are bad or the trouble is in external operating input circuit. Substitute new cans.

b. An alternate check of the fourth if. can may be performed by connecting the vtvm to pin 3 of J7 and applying a 4.3-mc signal to pin 5 of X8. Vary the if. signal frequency above and below 4.3 mc. The vtvm reading should vary from positive to negative as the frequency is varied.

c. Apply the 4.3-mc signal to pin 2 of X8. The added gain of the second if. amplifier is now obtained, and the signal output level of the if. signal generator that is required to produce the same output voltage at the vtvm should now be less than that obtained in *a* above. If no indication is obtained on the vtvm or if the input signal level required to produce the same output voltage on the vtvm is not considerably less than in *a* above, replace the second if. can.

d. Apply the 4.3-mc if. signal to pin 2 of X7 (first if. can). Vary the output control of the generator so that the reading on the vtvm (connected to pin 4 of J7) is the same as that obtained in *c* above. The input signal level should now be considerably less than that applied in *c* above. If it is not, replace the first if. can.

46. Mixer V6

Apply the 4.3-mc signal through a 1,000-$\mu\mu$f capacitor to terminal E19 of main TUNING capacitor C9. If no indication is obtained at the vtvm, replace the mixer tube or box and aline the receiver-transmitter. If an indication is obtained at the vtvm, change the frequency of the signal generator from 4.3-mc to the receiver-transmitter frequency (as indicated on its TUNING dial).

If a vtvm indication is obtained, the mixer and receiver oscillator are operating. If no vtvm indication is obtained, receiver oscillator V8 is not operating or is off-frequency.

47. Receiver Oscillator V8

a. To check whether receiver oscillator V8 is operating, connect the vtvm across terminal 1 of J7 and ground. This measures the grid-leak bias voltage of V8. If V8 is oscillating, the bias voltage will be −3 volts or more; if it is not oscillating, the bias voltage will be zero.

b. If no bias voltage is obtained, replace tube V8; if this does not correct the trouble, remove V3 and make resistance and voltage checks at E7 (fig. 33). Be sure to disconnect the power source from the receiver-transmitter before making resistance checks. Replace any defective component.

c. After replacing the defective component, aline the receiver oscillator (par. 98).

48. Rf Amplifiers V4 and V5

Tune the receiver-transmitter to the middle of its frequency range. Tune the rf signal generator to the same frequency and apply a 330-μf signal through a 1,000-$\mu\mu$f capacitor to test point E19 (output of second rf amplifier). Approximately −5 volts dc should be indicated on the vtvm connected to pin 4 of J7. Then apply this signal (at levels approximating those given in par. 55) successively to test points E18, E20, and to the antenna jacks. Test points E18, E19, and E20 are lugs on the stators of C9C, C9D, and C9A respectively (fig. 33). The defective point is indicated by a loss of signal and no indication on the vtvm. Check voltages and, after disconnecting power, check resistances in the defective stage or circuit.

49. Squelch Amplifier V11

Slowly turn the SQUELCH control clockwise until squelch relay K2 is energized (pulls in). If the relay armature does not pull in (listen for a clicking sound), check the relay circuit. If this is not the trouble, replace V11. Also check for low battery voltages. If these tests do not locate the trouble, make voltage and resistance check on the entire squelch stage.

50. Transmitter Oscillator V3

a. Press the push-to-talk button on the handset, and listen to the receive-transmit relay K1. If the relay armature does not pull in, no clicking round will be heard. Turn off power and check the energizing circuit of relay K1.

b. Connect RF Wattmeter ME–11/U to the AUX ANT connector. Press the push-to-talk button on the handset. The rf power output should be approximately 1 to 1.5 watts. An alternate check of the transmitter oscillator operation is to measure the negative voltage in the grid circuit at pin 2 of test socket J7. This voltage should be about −20 volts.

c. If the power output of the transmitter oscillator is low, replace V3. If it is still low, aline this stage (par. 100).

d. If replacing V3 fails to result in any output from the transmitter oscillator, make a complete voltage and resistance check of this stage (fig. 30).

51. Modulator V2

a. Off-frequency transmitter operation and lack of modulation may be caused by a defective modulator stage. Check the bridge circuit, V2, and L4; replace defective components. The bias at pin 3 of V2 should be −2.4 volts when in transmit operation. If it is not, then check the source voltage (−2.4) at the junction of the resistors R41 and R42.

b. If the transmitter frequency is correct but there is no modulation, check the audio input circuit. This includes the handset microphone, capacitor C51, resistors R30, R33, and R43, and the 6-volt supply.

c. If the modulation is satisfactory but the transmitter oscillator drifts off-frequency, a defect exists in the afc circuit. Check the discriminator stage (par. 44), capacitor C38, and resistor R38 in the discriminator output circuit (fig. 11) to the modulator stage.

52. Pulse-Sweep Generator U301

a. While pressing the handset push-to-talk button, disable receiver oscillator V8 by placing a finger on lug E21 (fig. 33) on the stator of main TUNING capacitor C9E. A *putt-putting* sound should be heard in the handset receiver, indicating that the pulse-sweep generator circuit is operating.

b. If no *putt-putting* sound is heard and it has been ascertained that the fourth if. stage is normal (par. 45), replace pulse-sweep generator can V301. If this does not help, then check the pulse-sweep circuit (fig. 19).

53. 2.15-mc Calibrating Oscillator V9

a. While holding the POWER switch at CAL & DIAL LITE, measure the voltage across R31 (fig. 32) with a vtvm. Connect the low side of the vtvm to the grounded side of R31. The measured voltage should be about minus 2½ volts. If no negative voltage is obtained, the stage is not oscillating. Replace crystal Y1.

b. If the oscillator still does not operate, check the circuit for shorted or open capacitors, defective resistors, and broken leads. Check to see that plate voltage is being applied to V9.

54. Localizing Trouble to Stage by Stage Gain Measurements

Stage gain measurements are useful in locating a defective stage when the radio set is operating with reduced sensitivity. Under such conditions, the gain of each stage is compared with the required gain for that stage. The stage that shows a gain appreciably below its required gain then may be checked carefully by resistance and voltage measurements to locate and repair the defect.

55. Receiver Rf Stages and Antenna Circuit

The gain of the rf stages and the antenna circuit is checked by feeding an rf signal input voltage into the radio set from an rf signal generator. This produces a constant grid voltage at the fourth if. grid (terminal 4 of test socket J7) when the input signal voltage is applied to the various stages. Make all rf measurements at the center of the frequency range of the radio set being tested. If the gain is low, replace the tube of the stage being tested; then aline the radio set. If the gain is still low, remove the rf box and make resistance measurements to locate the trouble.

a. Test Conditions.

(1) Vtvm connected across terminal 4 of test socket J7 and ground (fig. 51).

(2) SQUELCH control at OFF.

(3) Vary frequency control of signal generator slightly until maximum output is obtained.

(4) Input signal voltage is adjusted to produce a reading of −5 volts on the vtvm. Although input voltages may show some variation from one set to another, the gain for similar stages should be fairly consistant. The stage gain shown in the fourth column of the chart in *b* below is calculated from the ratio of two successive input voltage readings. For example, the stage gain of 5.5 is the ratio of 330 : 60.

(5) Use a 1,000-μμf capacitor in series with the hot lead of the rf signal generator except when the signal is applied to AUX ANT connector J3.

b. Stage Gain Chart.

Input signal (uv) (approx)	Input terminal	Reading at terminal 4 of J7 (dc volts)	Stage gain	Remarks
330	E19	−5	------	Provides first figure from which to calculate gain.
60	E18	−5	5. 5	Gain of second rf stage.
6	E20	−5	10	Gain of first rf stage.
1. 5	J3	−5	4	Gain of antenna circuit. (Use 33-ohm resistor in series with hot lead of generator instead of 1,000-μμf capacitor.)

56. Receiver If. and Discriminator Stages

One set of conditions is given for an overall measurement of the gain of all the if. stages because it is difficult to reach the sockets of the last three if. stages. Location of the defective stage is accomplished by the substitution of a spare if. can.

a. Condition.

(1) Vtvm connected between terminal 4 of J7 and ground (fig. 51).
(This is grid bias voltage of the fourth if. amplifier.)

(2) SQUELCH control at OFF.

(3) Input signal is 4.3-mc; 1,000-μμf capacitor is connected in series with output lead of signal generator.

b. If. Stage Gain Chart.

Input signal (uv)	Terminal	Vtvm reading (volts)
500	Pin 2 of X7	−5

c. Discriminator.

(1) Increase the output of the signal generator until the vtvm reading no longer increases. This is necessary to operate the limiter at saturation.

(2) Change the vtvm lead from terminal 4 of J7 to terminal 3. The vtvm will now measure the dc output of the discriminator.

(3) Shift the signal generator frequency 30 kc above, then 30 kc below 4.3 mc. An output of 4.5 to 8 volts at each of these frequencies indicates normal discriminator sensitivity.

57. Receiver Audio and Squelch Stages

a. Audio Amplifier. Apply a 2-volt, 1,000-cps signal to the grid (pin 4) of audio amplifier V7. Connect Multimeter TS–352A/U, adjusted to provide a 600-ohm load, across terminal 3 of transformer T3 and ground. The output reading must be at least 7.5 milliwatts (mw).

b. Squelch Circuit.

(1) Short AUX ANT connector J3 to ground.

(2) Turn the SQUELCH control slowly clockwise to the point where squelch relay K2 just pulls in (rushing noise stops).

(3) Measure the voltage at terminal 4 of J7 with the vtvm. This voltage should be between −1.5 and −2 volts (squelch pull-in bias voltage).

(4) Slowly turn the SQUELCH control counterclockwise to the point where K2 just releases. The voltage at terminal 4 of J7 should now be about −2.5 volts (or about 1 volt more negative than the pull-in bias voltage). If the difference between the two readings is considerably more than 1 volt, the squelch circuit is defective.

58. Transmitter Modulator and Afc Discriminator Stages

The measure of modulator sensitivity is the amount of frequency shift of the transmitter with a given change in modulator (V2) grid voltage.

a. Tune the receiver-transmitter to the center of its frequency range.

b. Press the push-to-talk button of the handset to operate the transmitter and check the frequency with Frequency Meter TS–174B/U. The frequency should be the frequency indicated on the dial.

c. Short terminal 3 of J7 to ground. The frequency of the transmitter should change by more than 500 kc as measured by the frequency meter.

d. Remove the short. The transmitter frequency should be the same as in *b* above.

59. Isolating Trouble Within a Stage

When trouble has been localized to a stage other than a sealed plug-in type unit, use the following techniques to isolate the defective part.

a. Test the tube involved, either in a tube tester or by substituting a similar type tube known to be in good operating condition.

b. Take voltage measurements at the tube sockets (figs. 30 and 31) and other points related to the stage in question.

c. If voltage readings are not normal, disconnect power and take resistance readings (figs. 30 and 31) to isolate open and short circuits. If the stage in question is a removable box type, remove the unit from the chassis. Open its cover, and resistance-check the unit with reference to the main schematic diagram. Also, refer to figures 34 through 38 showing inside views of these boxes.

d. If signals are weak (below the normal average reading) and all checks fail to indicate a defective part, check the alinement of the radio set (pars. 95–100).

60. Dc Resistances of Transformers, Coils, and Relays

Resistance measurements of the components shown in the following chart should give readings approximately as shown. Components (L101, L102, L202) inside sealed cans that cannot be measured from the outside, are not included.

Symbol	Terminals	Ohms
K1	1–2	43
K2	1–2	16, 000
L3		(*)
L4	1–2	3, 000
L4	3–4	(*)
L5		(*)
L8		(*)
L9		(*)
L10		(*)
L11		(*)
L12		(*)
L13		(*)
L14		(*)
L15		(*)
L16		(*)
L21		(*)
L22		(*)
T3	1–2	2, 200
T3	3–4	85
T101	5–7	(*)
T102	1–2	(*)

*Measures less than 1 ohm.