

PART FIVE

REPAIR INSTRUCTIONS

Note. Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on WD AGO Form 468 (Unsatisfactory Equipment Report); by Army Air Forces, on Army Air Forces Form 54 (unsatisfactory report). If either form is not available, prepare the data according to the sample form reproduced in figure 69.

Section XIV. THEORY OF EQUIPMENT

64. Block Diagram of Radio Set SCR-536-(*)

a. GENERAL. Radio Set SCR-536-(*) consists of a number of interlocking circuits which provide rapid change-over from receive to transmit. The transmitted signal is of the same frequency as the received signal. The five stages of Radio Receiver and Transmitter BC-611-(*) are all used in the receive position. Only four of the stages are used in the transmit position. The receiver and transmitter frequency is preset for the operator prior to

use and cannot be changed or adjusted by the operator.

b. RECEIVER. Figure 49 shows the signal paths through the receiver and transmitter. The same antenna is used for reception and transmission. The received signal voltage is amplified by tube VI and applied to the signal grid of tube V2. In converter tube V2, the incoming signal is mixed with the oscillator signal generated in the same tube, producing a beat frequency of 455 kc. The oscillator uses a

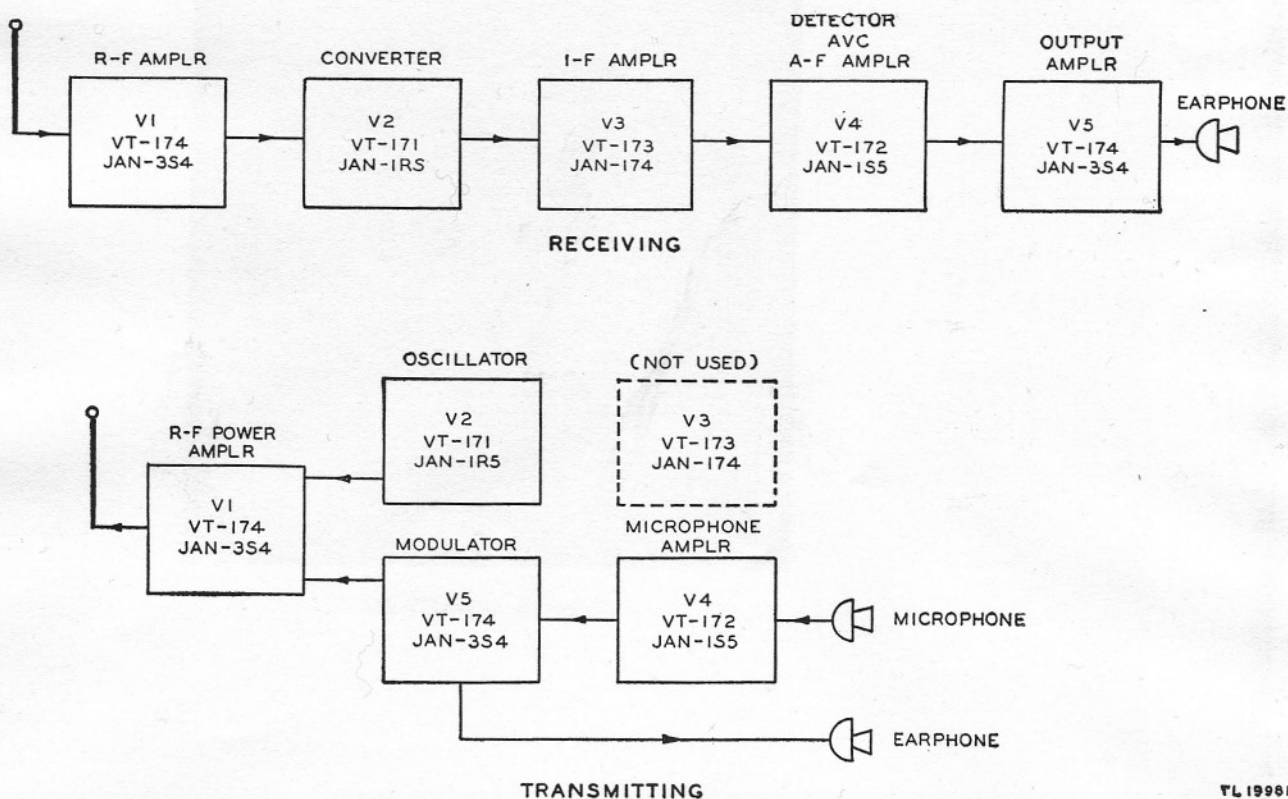


Figure 49. Radio Set SCR-536-(*), block diagram.

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crystal in a Pierce circuit, and functions at 455 kc above the carrier (or incoming signal) frequency. The receiver crystal, therefore, is 455 kc higher in frequency than the transmitter crystal. The beat frequency (or i-f signal) produced in the converter tube is amplified by tube V3 and is applied to the diode detector section of tube V4. Here the modulated i-f signal is demodulated and an audio voltage is impressed on the grid of the pentode amplifying section of tube V4. The amplified a-f (audio-frequency) signal is then applied to the grid of tube V5, the power amplifier, where it is amplified, and then applied to the earphone.

c. **TRANSMITTER.** In the transmit position, only four tubes are used. The r-f carrier wave is generated in the oscillator section of tube V2, again using a Pierce crystal-controlled circuit with a crystal 455 kc lower in frequency than that used for the receiver. The generated r-f voltage is applied to the grid of tube V1 where it is amplified and fed to the antenna. The microphone output is amplified by the pentode section of tube V4 and then applied to the grid of tube V5 where it is further amplified. The earphone is connected across the audio output of modulator tube V5 to provide sidetone. The audio output modulates the amplified carrier output of tube V1.

65. Circuit Description

The following paragraphs describe the function of each circuit element in the receiver and transmitter circuits. See the functional and complete schematic diagrams in figures 50 to 55.

66. Receiver R-F Amplifier

Capacitor C1 (in the antenna input circuit) is not necessary in the receiver circuit, but serves to block the d-c component of the plate voltage from the antenna rod in the transmitter circuit. The plug-in inductance L1 (marked ANTENNA) is a loading coil which aids in resonating the antenna to the preset frequency. The antenna is series-tuned by mica trimmer capacitor C7. The voltage developed across this capacitor is impressed on the grid of r-f amplifier tube V1 through section C of the change-over switch. Resistor R2, the grid resistor of tube V1, provides a d-c path for the bias applied to the grid of tube V1 and a high-impedance path to the r-f current, blocking it from the a-v-c (automatic-volume-control) circuits. Capacitor C8 is an r-f bypass for the filament circuit to reduce regeneration. Capacitor C2 bypasses the r-f current from the screen. Resistor R18 is a screen-dropping and de-

coupling resistor. The permeability-tuned inductance L2 (marked TANK COIL) provides the r-f plate load for tube V1 and is resonated by a capacitance made up of the distributed capacitance of the coil, the output capacitance of tube V1, the input capacitance of tube V2, and the capacitance of the circuit wiring. Coil L2 is adjusted to its operating frequency by a movable powdered-iron slug. Capacitor C3 and resistor R10 make up a decoupling filter for the plate circuit of tube V1. Resistor R10 also serves to lower the plate voltage of tube V1, reducing its plate current and giving more economical operation of the B battery. Only one filament section (pins 1 and 5) of tube V1 is used in the receiver circuit. This arrangement reduces the A battery drain.

Note. Capacitors C2, C5, and C23, and resistors R3 and R4 in Radio Receiver and Transmitters BC-611-A through -E are molded in a plastic ring surrounding the socket connections of tube V1 and cannot be replaced individually.

67. Converter

Converter tube V2 combines the functions of a mixer and oscillator in a single tube. Capacitor C10 is the coupling capacitor which provides passage for the r-f signal current to the mixer grid of tube V2 through section E (section F on BC-611-F) of the change-over switch, but blocks the direct current. Resistor R1 is the grid resistor of tube V2. Resistors R3 and R4 make up the grid leak which provides the bias voltage for the oscillator grid. Resistor R4 is also used to bias audio output tube V5. A voltage suitable for biasing purposes is produced across these resistors because of the d-c component of the grid current which exists as a result of driving the oscillator grid positive. In Radio Receiver and Transmitters BC-611-A through -E, resistors R25, R7, and R5 make up a voltage divider to provide the proper bias for receiving. These resistors are not present in BC-611-F which uses fixed (nonadjustable) bias. Capacitors C13 and C14 and resistors R9 and R26 (R26 is not used in BC-611-A) make up filters for the a-v-c voltage applied to the grids of tubes V1, V2, and V3. This a-v-c voltage is obtained from the detector load resistance made up of resistors R13 and R14. The filters remove the audio component of the detector voltage from the d-c component which is used for automatic volume control. Capacitors C5 and C23 (C23 is not used on BC-611-F) are r-f bypass capacitors to prevent voltage of the oscillator frequency from getting to the grids of the other tubes through the bias system. Capacitor C4 is a neutralizing capacitor. It reduces the voltage of the oscillator frequency on

the signal grid (which is due to coupling within the tube) by feeding back a voltage of the oscillator frequency out of phase with the internally coupled voltage. R-f choke L3 is a shunt-feed arrangement for the screen grid of tube V2. It provides a low-resistance d-c path and a high-impedance r-f path to the screen grid. The receiver crystal connected between the oscillator grid and the screen grid (plate of oscillator section) provides the necessary coupling for oscillation. This circuit is known as a Pierce oscillator circuit. Capacitor C11 and resistors R17 and R28 make up a decoupling filter for the screen circuit of tube V2. Resistor R28 is not used on BC-611-A and -B, and early issues of BC-611-C. It has been added to sets coded CZE (late issues of BC-611-C), and BC-611-D, -E, and -F. It is added for further decoupling and for dropping the screen voltage sufficiently to stabilize bias voltage when crystals of higher than normal activity are used in the transmit position. Capacitor C31 is the r-f bypass for the plate circuit of tube V2.

Note. Capacitors C3 and C13 and resistor R1 in BC-611-A through -E are molded in a plastic ring surrounding the socket connections of tube V2 and cannot be replaced individually.

68. I-F Amplifier

The first i-f transformer T1 (L4 in BC-611-A and -B models) is wound on iron cores. In BC-611-A through -E, it is surrounded by an iron sleeve to increase the inductance of the primary and secondary coils and to reduce their size. The coils are tuned by the trimmers C15 and C16 and resistor R8 contained within the shield serves to broaden the response of the transformer. In BC-611-F the iron sleeve has been replaced by powdered-iron cups; the coils are tuned by two tuning slugs, one at each end of the transformer, and R8 is omitted. Capacitors C15 and C16 have been changed from adjustable trimmers to fixed mica capacitors and are located at the ends of the transformer. In BC-611-A through -E only, Capacitor C17 and voltage-dropping resistor R12 make up a decoupling filter for the screen grid of tube V3. Capacitor C18 and resistor R15 comprise a decoupling filter for the plate circuit of tube V3.

Note. Capacitors C14, C17, C18, and C31, and resistors R12 and R15 in BC-611-A through -E are molded in a plastic ring surrounding the socket connections of tube V3 and cannot be replaced individually.

69. Detector, Automatic Volume Control, and First Audio Amplifier

Tube V4 consists of a diode detector and a pen-

tode amplifier combined in one tube. In BC-611-A through -E, the second i-f transformer T2 (L5 in BC-611-A and -B models) consists of two windings, each wound on an iron core and surrounded by an iron sleeve to increase the inductance of the primary and secondary coils and to reduce their size. Trimmer C19 tunes the secondary. In BC-611-F the iron sleeve has been replaced by powdered-iron cups. Both primary and secondary coils are tuned by tuning slugs, one at each end of the transformer. Capacitor C19 has been changed from an adjustable trimmer to a fixed mica capacitor, and fixed mica capacitor C19.1 has been added. These two capacitors in BC-611-F are located at the ends of the transformer to complete the tuned circuits. Resistor R14 is the detector load across which the audio voltage is obtained. Resistor R13 and capacitors C20 and C21 make up a filter to remove the i-f component from the audio component of the detector voltage. Capacitor C22 couples the detector to the grid of the pentode audio-amplifier section of tube V4. Resistor R20 is the grid resistor of the amplifier section of tube V4. Grid current which flows through the resistor on large signal inputs provides additional bias for this tube. Resistor R22 is the plate load of tube V4. Capacitor C25 is an i-f bypass to eliminate any i-f current which exists in the plate circuit from getting into audio plate load resistor R22. Capacitor C26 and dropping resistor R21 make up a decoupling filter for the screen. Capacitor C27 is the coupling capacitor from the first audio amplifier to the power output amplifier.

Note. Capacitors C25, C26, and C27 and resistors R9, R14, R21, and R22 in BC-611-A through -E are molded in plastic rings surrounding the socket connections of tube V4 and cannot be replaced individually.

70. Receiver Power Output Amplifier

Capacitor C27 is the coupling capacitor from the first audio amplifier to power output amplifier tube V5. Resistor R23 is the grid resistor of tube V5. Capacitor C29 and voltage-dropping resistors R24 and R16 make up a decoupling filter for the screen grid of tube V5. Resistor R16 is used in the receiver circuit to reduce battery drain by lowering the screen current. A-f choke L4 (L6 in BC-611-A and -B) provides a low-resistance d-c path for the plate current and offers a high-impedance path to the a-f plate current. Capacitor C30 and resistor R11 make up a plate decoupling filter. Resistor R11 also serves as a dropping resistor to lower the plate voltage. Capacitor C24 couples the audio output from the plate to the output transformer for the

earphone. Only one filament section (pins 1 and 5) of tube V5 is used in the receive position. This arrangement reduces the A battery drain.

71. Transmitter Oscillator

In the transmit position, only the oscillator section of converter tube V2 is used. The filament (pins 5 and 7) as the cathode, the screen grid (pin 3) as the plate, and the signal grid (pin 4) make up the triode oscillator section. The mixer section, with its associated circuits, is not used while transmitting. The transmitter crystal serves as the tuned circuit which determines the fixed frequency at which the oscillator functions. Resistors R3 and R4 make up the grid leak which provides the bias voltage for the oscillator grid. The d-c component of the voltage developed across resistor R4 is used also for the grid bias to modulator tube V5. Capacitor C6 determines the amount of feedback from the crystal circuit to the grid. Resistor R28 reduces the screen voltage, eliminating the possibility of oscillator failure when using an oscillator tube with low emission. Resistor R28 has been added to BC-611-C models coded CZE, and to BC-611-D, -E, and -F. R-f choke L3 keeps the oscillator output from flowing through the B battery to ground, forcing the generated r-f current to flow to the grid of the r-f amplifier tube. Capacitor C11 bypasses stray r-f current to ground.

72. Transmitter R-F Amplifier

Blocking capacitor C9 couples the oscillator output to r-f amplifier tube V1. Resistor R6 is the grid leak and provides the bias voltage for the grid of tube V1 when transmitting. Capacitor C2 is the r-f bypass for the screen grid. Coil L2 is the plug-in r-f amplifier TANK COIL. Coil L2 is tuned by capacitor C12. Capacitor C12 also acts as the input branch of the pi network to the antenna from the amplifier tank. The capacitance between the antenna rod and the case acts as the other branch of the pi network. In the receiver circuit this antenna capacitance becomes a part of the tuning capacitance of the antenna. In BC-611-F models beginning with serial No. 5635, capacitor C32 is added in parallel across capacitor C12. The plug-in ANTENNA coil L1 is the series branch of the pi network, and also acts as the antenna loading inductance. Capacitor C1 blocks the d-c plate current from the antenna rod. Capacitor C3 is the plate circuit r-f bypass.

73. Microphone Amplifier

Resistor R20 is the grid resistor of tube V4, as in the receiving circuit. The diode detector section of

tube V4 is not used in the transmitter circuit. Resistor R27 (not used in BC-611-A and -F) acts as the load resistor for the inductor microphone. Capacitor C26 and voltage-dropping resistor R21 make up a decoupling filter for the screen grid of tube V4. Resistor R22 is the plate load.

74. Modulator

Capacitor C27 is the coupling capacitor from the microphone amplifier to modulator tube V5. Resistor R23 is the grid resistor. Capacitor C29 and resistor R24 make up a decoupling filter for the screen grid of tube V5. Choke L4 (L6 in BC-611-A and -B) provides a low-resistance d-c path to the plate of the modulator and r-f amplifier tubes. It also offers a high-impedance load to the a-f plate current output of the modulator forcing it into the r-f amplifier plate circuit. Capacitor C28 provides a low-impedance path around modulation choke L4 for the stray r-f current. This is necessary since the r-f amplifier plate is supplied through choke L4. Resistor R19 prevents overloading of the earphone, because the a-f output for modulating the r-f amplifier is high. Capacitor C24 couples the audio output to the output transformer for the earphone. Capacitor C30 bypasses stray alternating currents to ground.

75. Press-to-talk Switch

The press-to-talk switch operates the change-over mechanism which makes the necessary circuit changes to convert the set from a receiver to a transmitter. The change-over switch is made up of 14 sections. Each section has a name which is marked on the transparent insulating strip covering the change-over switch. For simplicity, however, each section has been designated by a letter of the alphabet on the schematic and functional drawings and this letter also appears on the transparent insulating strip.

a. Section A connects the proper crystal into the circuit.

b. Section B connects the grid bias voltage divider made up of resistors R25, R7, and R5 (R5 is not used in BC-611-F) across resistor R4 in the receive position, and disconnects the voltage divider in the transmit position. In BC-611-F, r-f amplifier tuning capacitor C12 is connected to the plate of tube V1 in the transmit position.

c. Section C connects the control grid of tube V1 to the a-v-c voltage line in the receive position, and connects the control grid to grid-leak resistor R6 in the transmit position.

d. Section D connects the antenna to tuning capacitor C7 in the receive position, and to the plate of the r-f amplifier tube V1 in the transmit position.

e. Section E connects the plate of r-f amplifier tube V1 through the coupling capacitor C10 to the signal grid of converter tube V2 in the receive position, and to the r-f amplifier tank capacitor C12 in the transmit position.

f. Section F connects the oscillator feedback control capacitor C6 to ground in the receive position and connects capacitor C6 to the oscillator grid of tube V2 in the transmit position. In BC-611-C models coded CZE and in BC-611-F, sections E and F have been transposed to shorten their respective leads and to prevent abrasion from the case damaging the insulation. One dummy lug has been added to section F in these later models to serve as a soldering lug.

g. Section G puts voltage-dropping resistor R10 in series with the plate of tube V1 in the receive position and shorts out the resistor in the transmit position.

h. Section H connects the B battery to the plate and screen of tube V3 in the receive position, and disconnects the battery in the transmit position. Section H also puts voltage-dropping resistor R11 in series with the plate of tube V5 in the receive position, and shorts out the resistor in the transmit position.

i. No section I exists on the change-over switch.

j. In BC-611-A through -E section J grounds the microphone in the receive position, thereby eliminating the possibility of pickup from the microphone being introduced into the audio amplifier. In the transmit position section J connects the micro-

phone to the grid of the audio-amplifier section of tube V4. In BC-611-F, section J connects coupling capacitor C22 to the detector in the receive position, and to the microphone in the transmit position.

k. Section K in the receive position connects the filament of tube V3 to the A battery and disconnects one filament section of V1 and V5 from the A battery. Eliminating one of the parallel filaments of tubes V1 and V5 reduces the total A battery drain by 100 ma (milliamperes) in the receive position. In transmit position the filament of tube V3 is eliminated.

l. Sections L and M are tied together electrically through the moving arm of the switch. In the receive position, dropping resistor R16 is placed in series with the screen grid of tube V5 by section L and M. These switch sections also place dropping resistor R17 in series with the screen circuits of tubes V1 and V2 and connect the B battery to the plate of tube V1. In the transmit position, resistors R17 and R16 are shorted out by switch sections L and M.

m. Section M; see *l* above.

n. Sections N and O are tied together electrically through the moving arm of the switch. In the receive position they place the earphone across audio choke L4 (L6 in BC-611-A and -B in the plate circuit of tube V5. In the transmitter circuit, they connect the screen and plate circuits of r-f amplifier tube V1 to the plate of the modulator tube V5. This switch section also places dropping resistor R19 in series with the earphone to reduce the intensity of the signal in the earphone in the transmit position.

o. See *n* above. In BC-611-C models coded CZE, one dummy lug has been added to section O for resistor R28 connection.

Section XV. TROUBLE SHOOTING

Note. Operators are to make no checks other than those which involve removing the bottom cover only. The top cover and chassis are removed by organizational and higher echelon repairmen only.

76. General Trouble-shooting Information

No matter how well equipment is designed and manufactured, faults occur in service. When such faults occur, the equipment must be restored to normal operation in the shortest possible time. This section contains general information to aid personnel engaged in the important duty of trouble shooting. It is essential to establish a logical, rapid, systematic method of procedure for trouble shooting. Do not use haphazard, hit-or-miss trouble shooting methods. While such uncertain methods will sometimes locate

the trouble, inefficiency and damage to equipment are almost sure to result.

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

(1) Theory of equipment. To perform efficient repair on a set, a thorough knowledge of how and why it works is essential. Study and learn the functional theory of Radio Receiver and Transmitter BC-611-() as explained in section XIV, which

analyzes the operation of the set in a logical step-by-step sequence.

(2) Block diagram of Radio Set SCR-536-(*). (See fig. 49.)

(3) Complete schematic diagrams. (See figs. 54 and 55.)

(4) Functional schematic diagrams. (See figs. 50 through 53.) These diagrams are particularly useful in trouble shooting, because the repairman can follow the electrical functioning of the circuits more easily than on the regular schematics, thus speeding trouble location.

(5) Voltage data for all tube socket connections and change-over switch connections. (See figs. 64 and 65.)

(6) Illustrations of components and wiring diagrams. Figures 88 through 93 aid in locating and identifying parts.

(7) Pin connections. Pin connections on sockets, plugs, and receptacles are numbered on the various diagrams.

b. TROUBLE-SHOOTING STEPS. The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the circuit responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors, shorted leads, and broken connections may be located by sight and smell. The majority of faults, however, must be located by voltage and resistance checks and instrument tests.

c. SECTIONALIZATION. Careful observation of the performance of the radio set while operating the equipment often sectionalizes the fault to the transmitter circuit or the receiver circuit. Additional sectionalizing of the fault is discussed in paragraphs 84, 85, and 86.

d. LOCALIZATION. Paragraph 87 describes the method of localizing faults within the receiver and transmitter circuits. This paragraph is accompanied by trouble-shooting charts which list abnormal symptoms and their probable causes. The charts also give the procedure for determining which of the probable locations of the fault is the exact one. In addition, there are drawings which show the voltage at each tube socket connection and changeover switch connection.

e. VOLTAGE MEASUREMENTS. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from ab-

normal voltages or produce abnormal voltage. Voltage measurements are taken easily, because they are always made between two points in a circuit and the circuit need not be interrupted.

(1) The voltages listed on the voltage charts are measured between the indicated points and ground.

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

(3) Do not take voltage readings across grid coupling capacitors, because of possible damage to the circuit.

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

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

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

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

(4) The ohm-per-volt sensitivity of the voltmeter used to obtain the readings recorded on the voltage and resistance charts in this manual is printed on each chart. Use a meter having the same ohm-per-volt sensitivity; otherwise it will be necessary to consider the effect of loading.

77. Test Equipment IE-15-A

a. PURPOSE. This test equipment is used in the testing, alignment (secs. XVII and XIX), and pre-setting (sec. XVIII) of Radio Receiver and Transmitter BC-611-().

b. COMPONENTS. Test Equipment IE-15-A consists of the following components (fig. 56):

Test Stand FT-252-A, including dummy antenna and r-f galvanometer. (See par. 78.)

Test Case CS-81-A. (See par. 79.)

Milliammeter, d-c, 0-50 scale.

Milliammeter, d-c, 0-15 scale.

Harness.

Feedback capacitor.

c. SUPPLEMENTARY EQUIPMENT. The following additional equipment is required when using Test Equipment IE-15-A:

R-f signal generator.

Test Set I-56-(). (See par. 80.)

Frequency Meter Set SCR-211-().

Battery BA-40, or equivalent.

Microphone.

Headset.

Insulated tuning screw driver.

Small screw driver.

78. Test Stand FT-252-() (fig. 57)

a. There are two clamps on the test stand to hold the test case or radio chassis.

b. Antenna A-82-(), mounted on the test stand, consists of a 50-milliamperere r-f milliammeter to measure antenna current, and a receiver and transmitter dummy antenna comprising a receive-transmit switch, a 56-ohm resistor, and a variable capacitor.

c. A special test harness cord supplied with the stand provides connections for the batteries, r-f amplifier plate current meter, total B current meter, audio output meter, earphone, and microphone. The schematic drawing of this harness is shown in figure 58. The 15-milliamperere meter is used to measure the r-f amplifier plate current; the 50-milliamperere meter is used to measure the total Battery BA-38 current. The terminal board attached to the harness provides a simple method of making the connections to the chassis.

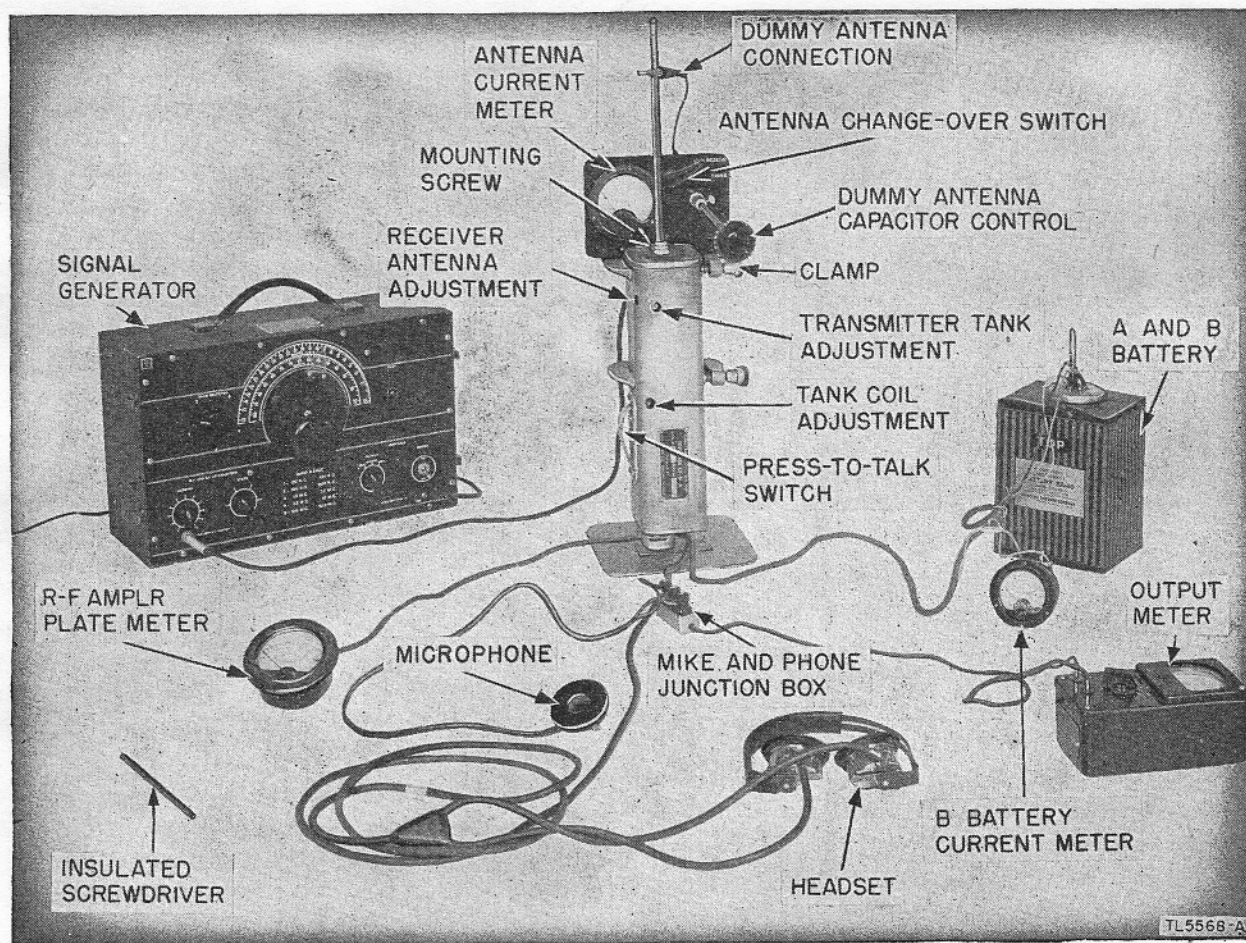


Figure 56. Test Equipment I-15-A, set up.

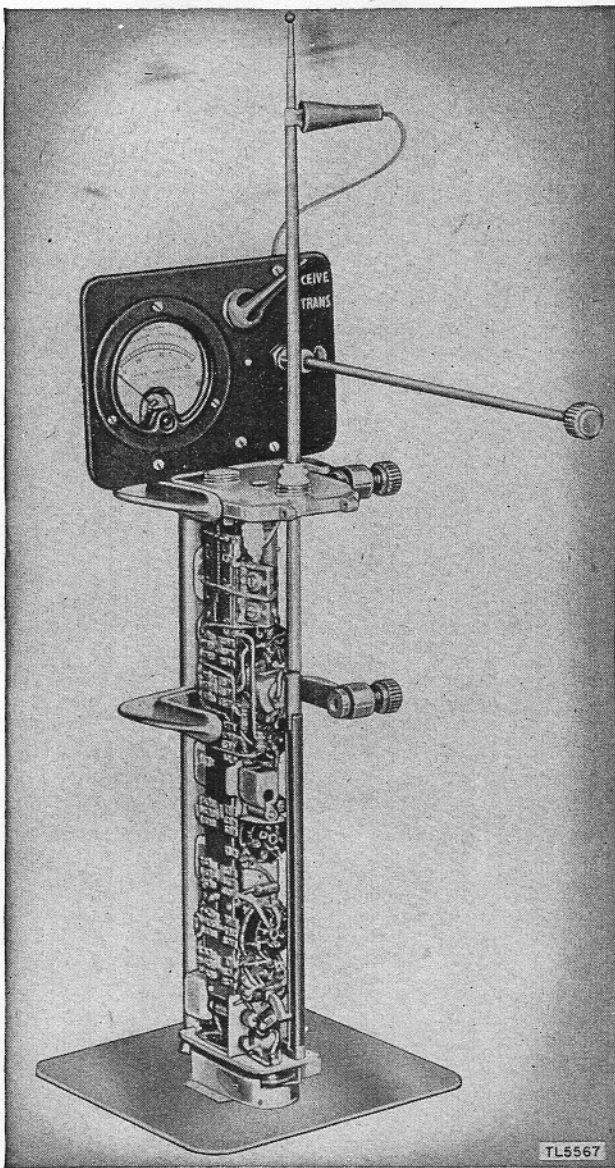


Figure 57. Test Stand FT-252.

79. Test Case CS-81-() (figs. 56 and 59)

Since the tuning adjustments are inaccessible when the chassis is covered by the radio set housing, a special housing is required to make these adjustments. Test Case CS-81-() is similar to the radio set housing except that holes are provided to permit access to the chassis adjustments and that there are no microphone and earphone projections. Use of the test case permits tuning the set under conditions identical to those of normal operation. The presetting adjustments should be made only with the chassis in the test case; otherwise, the set will be detuned when it is inserted into the regular housing. This detuning or misalignment results from the additional capacitance introduced into the circuit by the housing.

Note. An altered Test Case CS-81-() must be used when making adjustments on BC-611-F and later models. MWO SIG 11-311-1, which authorizes the equipment modification, describes the proper method of altering Test Case CS-81-(). (See fig. 60.)

80. Test Set I-56-()

Since the receiver output is designed to operate into a high-impedance earphone, the output meter provided in Test Set I-56-() is unsatisfactory for alignment purposes because of its low internal resistance. This output meter has a resistance of only 4,000 ohms. A vacuum tube voltmeter with a minimum input impedance of 10 megohms is preferable; however, the a-c voltmeter of the selective analyzer of Test Set I-56-() makes a satisfactory output meter if the 50-volt a-c range is used. Since the meter sensitivity is 1,000 ohms per volt, 50,000 ohms is placed across the receiver output when the 50-volt range is used. No external blocking capacitor in series with the a-c output meter is necessary to pre-

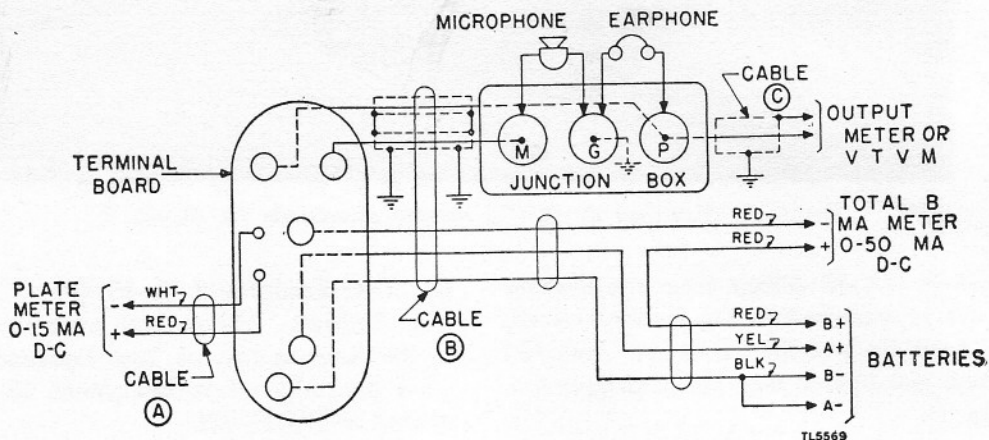


Figure 58. Test Equipment IE-15-A, harness connections.

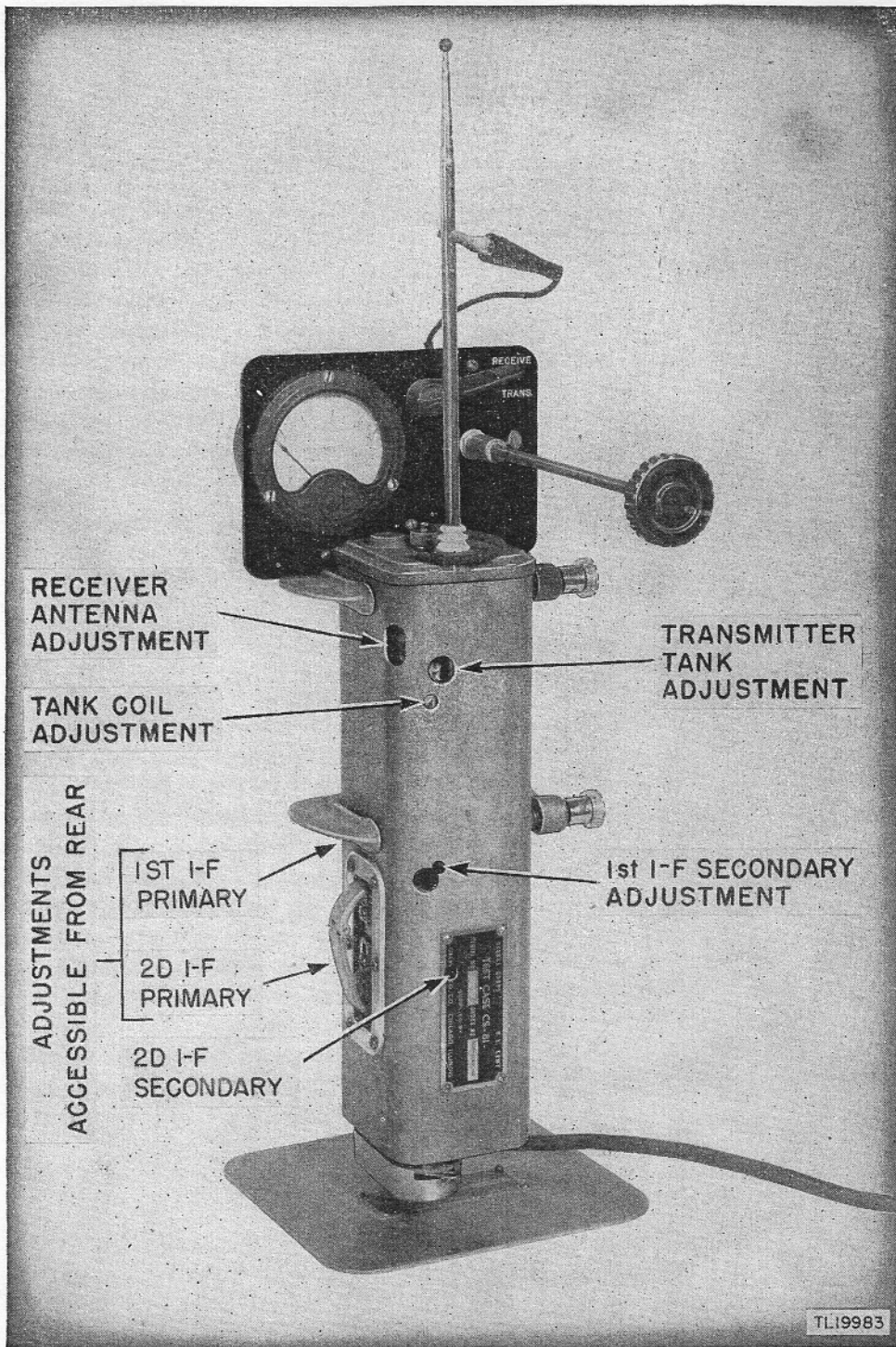


Figure 59. Test Case CS-81-() showing adjustments for BC-611-F.

vent the Battery BA-38 voltage from reaching the meter, as one is contained in the receiver circuit. The output meter leads of the test harness (par. 78) are fitted with jack tips, so they can be plugged into the voltmeter.

81. Test Equipment IE-17-()

a. PURPOSE. The purpose of this test equipment is the same as that of Test Equipment IE-15-A. (See par. 77.) Test Equipment IE-17-E is described in TM 11-311.

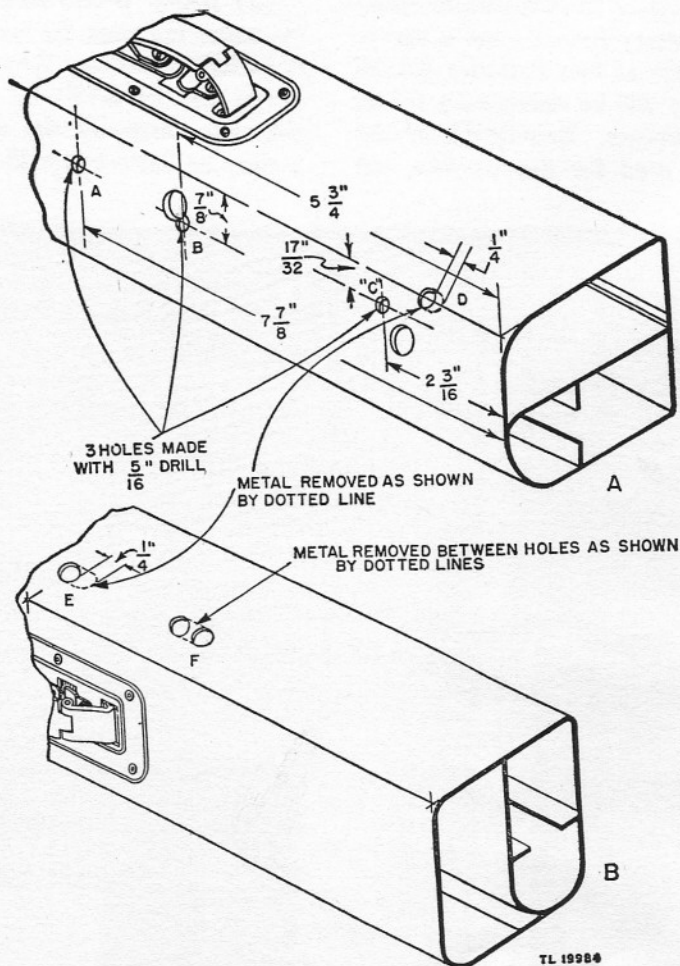


Figure 60. Test Case CS-81-() modification.

b. COMPONENTS. Test Equipment IE-17-() consists of the following components (fig. 61):

- Test Stand FT-252-()
- Antenna A-82-()
- Test Case CS-81-()
- Test Unit I-135-()

82. Test Unit I-135-()

Test Unit I-135-() contains a multirange voltmeter and milliammeter, a crystal tester, and an r-f and a-f signal source. (See fig. 62.) The test unit is used for measuring battery voltage and current, r-f amplifier plate current audio output voltage, and crystal activity. In addition, it supplies a modulated r-f signal source for the test, alignment, and pre-setting of the receiver and an a-f signal source for determining the modulation capability of the transmitter. It combines in one case all the meters and additional apparatus required for use with Test Equipment IE-15-A. (See par. 76.)

a. The r-f signal source is a Pierce crystal oscilla-

tor and makes use of a crystal such as the one contained in the transmitter circuit of Radio Receiver and Transmitter BC-611-(). The oscillator circuit is used to generate a signal of the carrier frequency, and also serves to check the activity of the receiver crystal and the transmitter crystal.

b. The a-f signal source is a Colpitts oscillator which generates a signal of 1,000 cycles per second. This tone is used to modulate the r-f oscillator and can be applied also to the microphone input terminals of the transmitter to test for modulation capability.

c. A test harness attached to the test unit provides the means for connecting the test unit to the chassis. The insulated screw driver attached to the cover of the test unit is used for making adjustments.

d. Compartments are provided in the test unit for Battery BA-37 and Battery BA-38 to permit these batteries to be tested under load. (See fig. 63.) Also, connections are provided for the use of ex-

ternal batteries. A heavy-duty 1.5-volt battery (such as Battery BA-23 or Battery BA-35) and a heavy-duty 90-volt battery (such as two Batteries BA-26 or two Batteries BA-36) will be satisfactory for all alignment and testing purposes. Battery BA-37 and Battery BA-38 can be used for this purpose, but

(3) BA-37 0-600 MA. D. C., in which position the meter indicates the current drain of the external A battery or Battery BA-37.

(4) BA-38 0-150 V. D. C., in which position the meter indicates the voltage of the external B battery or Battery BA-38.

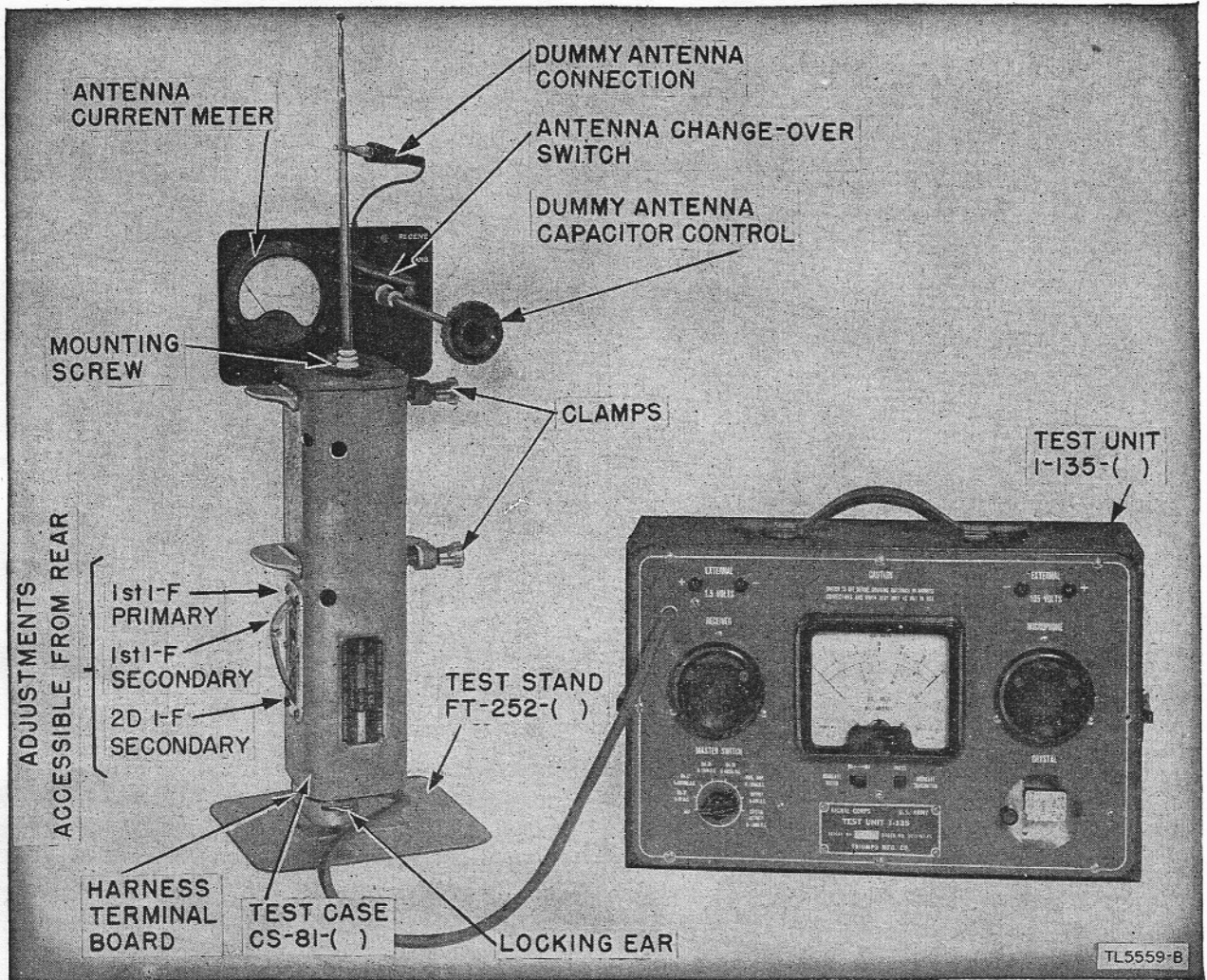


Figure 61. Test Equipment IE-17-(), set up.

are not recommended because of their short life under these conditions.

e. The positions of the MASTER SWITCH of the test unit (fig. 62) are as follows:

(1) OFF, in which position the external and internal batteries of Test Unit I-135-() are disconnected from the test unit and the radio set chassis. The radio set and oscillator are in all other positions of the MASTER SWITCH.

(2) BA-37 0-3V. D. C., in which position the meter indicates the voltage of the external A battery or Battery BA-37.

(5) BA-38 0-60 MA. D. C., in which position the meter indicates the current drain of the external B battery or Battery BA-38.

(6) PWR. AMP. 0-15 MA. D. C., in which position the meter indicates the r-f power-amplifier plate current when the radio set is in the transmit position.

(7) OUTPUT 0-60 V. A. C., in which position the meter indicates the audio output voltage of the receiver circuit. (The meter is connected across the test unit earphone.)

(8) CRYSTAL ACTIVITY 0-1.5 MA. D. C.,

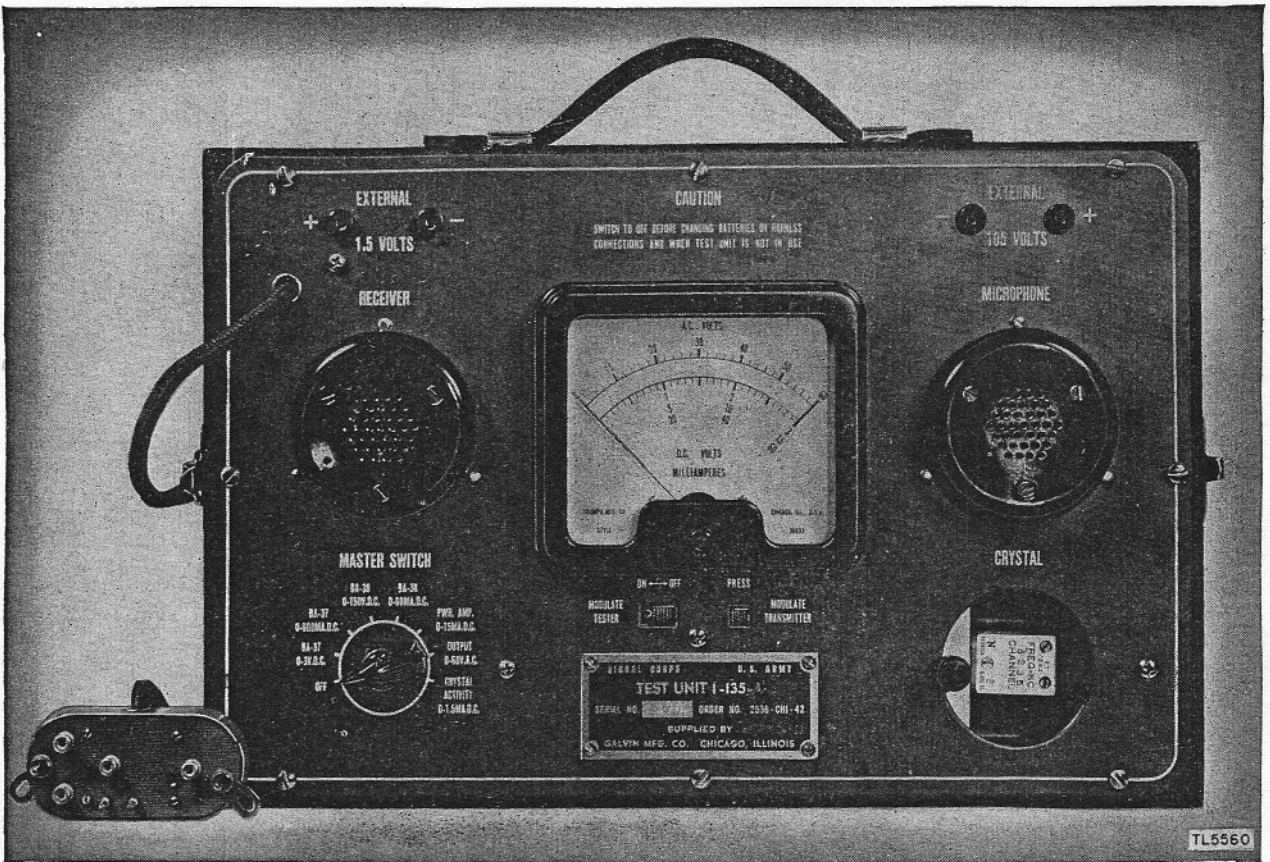


Figure 62. Test Unit I-135-().

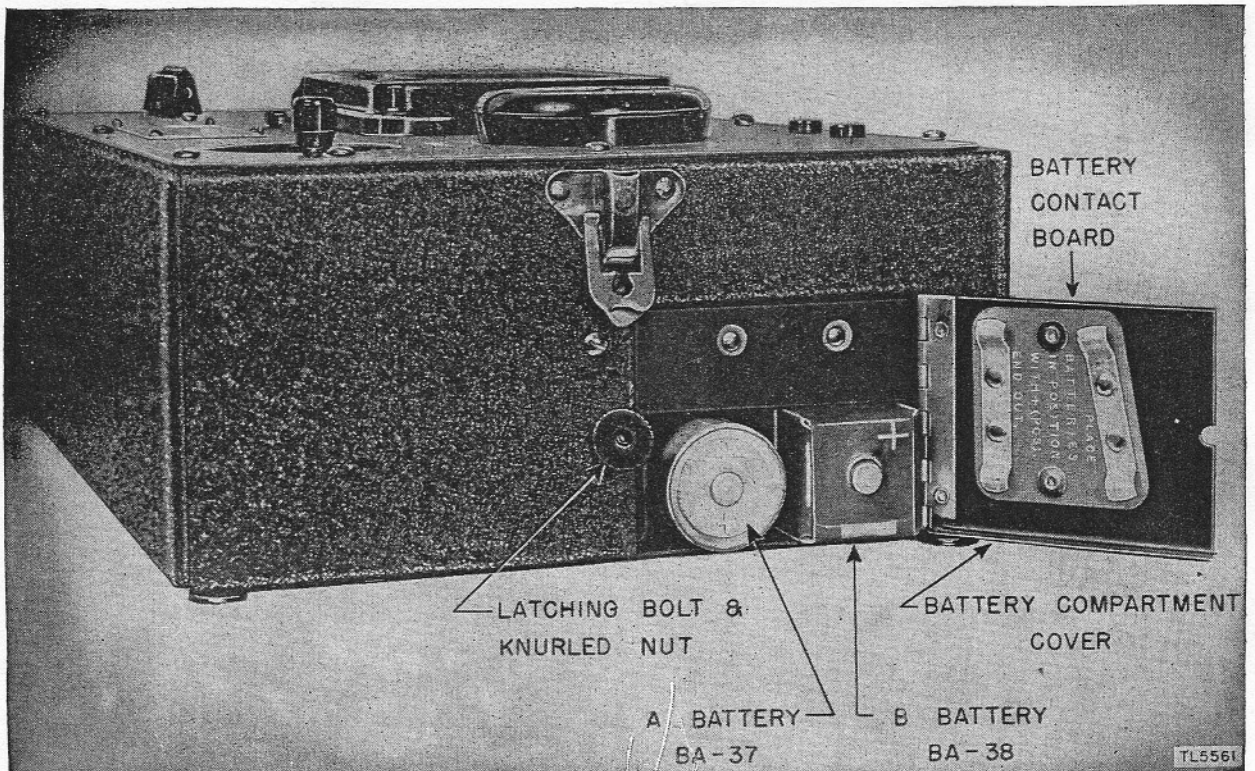
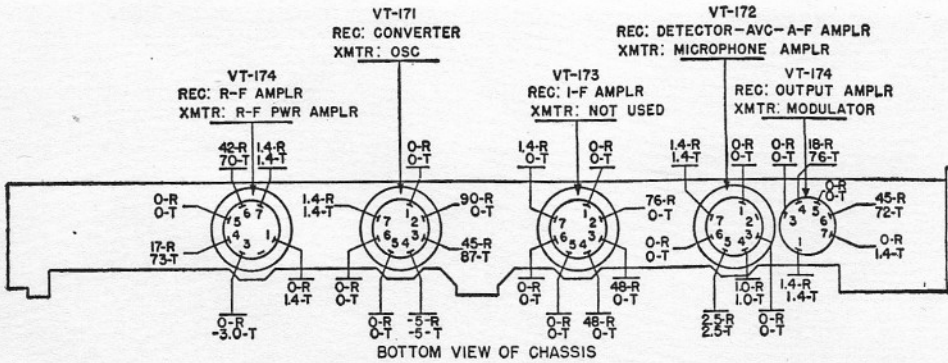
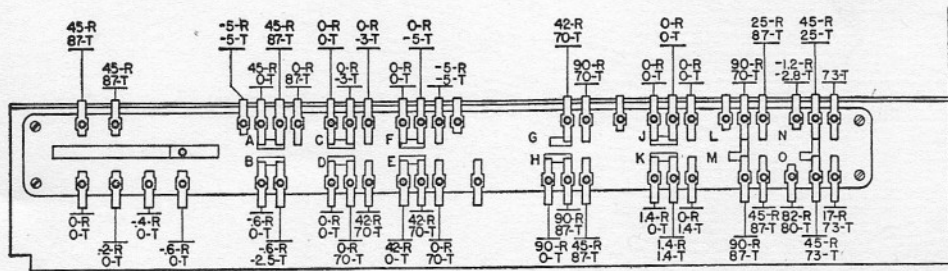


Figure 63. Test Unit I-135-(), showing battery compartment.



NOTE:--VOLTAGES WITH SUFFIX "R" MEASURED IN RECEIVE POSITION
 VOLTAGES WITH SUFFIX "T" MEASURED IN TRANSMIT POSITION
 FILAMENT AND BIAS VOLTAGES MEASURED ON 30 VOLT RANGE OF VOLT-OhMMETER
 UNIT OF TEST SET I-56-A. ALL OTHER VOLTAGES MEASURED ON 300 VOLT
 RANGE.
 A BATTERY VOLTAGE 1.4V. B BATTERY VOLTAGE 90V.

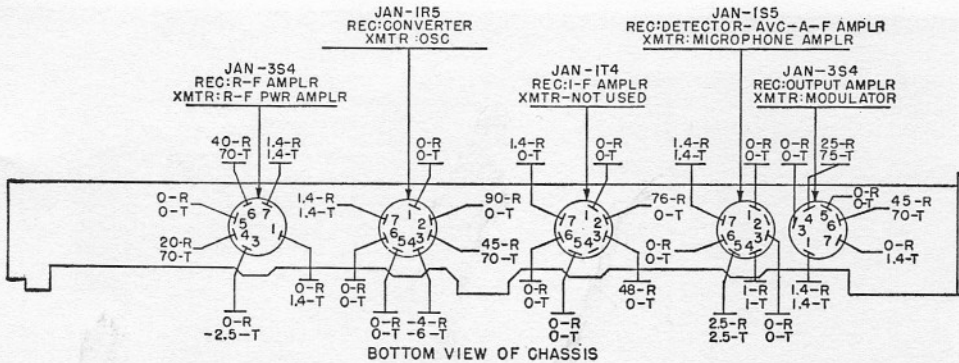


FRONT VIEW OF CHASSIS

NOTE: SECTIONS "E" AND "F" HAVE BEEN TRANSPOSED
 ON SETS CODED CZE. DUMMY LUGS ADDED TO SECTIONS
 "D" AND "F" ON SETS CODED CZE AND ON QM BC-611-D,
 AND -E.

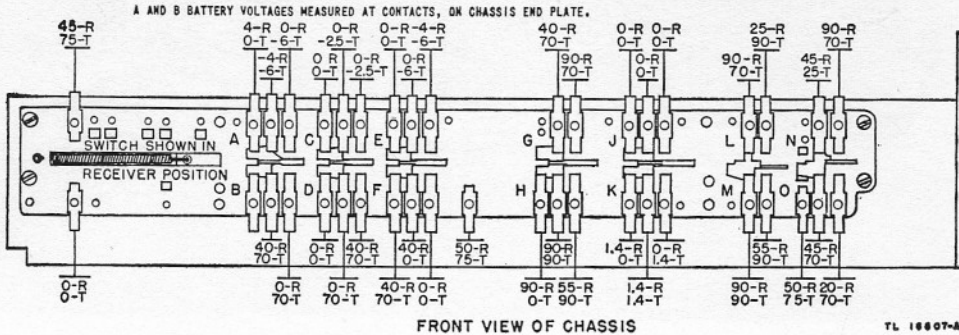
TL 11871-A

Figure 64. Radio Receiver and Transmitter BC-611-A through -E, voltage measurements.



BOTTOM VIEW OF CHASSIS

NOTE:--VOLTAGES WITH SUFFIX "R" MEASURED IN RECEIVE POSITION.
 VOLTAGES WITH SUFFIX "T" MEASURED IN TRANSMIT POSITION.
 FILAMENT AND BIAS VOLTAGES MEASURED ON 30 VOLT RANGE OF VOLT-OhMMETER UNIT OF TEST
 SET I-56-A. ALL OTHER VOLTAGES MEASURED ON 300 VOLT RANGE.
 A BATTERY VOLTAGE 1.4 V. B BATTERY VOLTAGE 90 V.



FRONT VIEW OF CHASSIS

TL 11887-A

Figure 65. Radio Receiver and Transmitter BC-611-F, voltage measurements.

in which position the meter indicates the grid current of the crystal oscillator to show the condition of the crystal. The MODULATE TESTER switch must be OFF when crystal activity is being checked.

f. The switch marked MODULATE TESTER is used to modulate the r-f oscillator with a 1,000-cycle-per-second tone when the test unit is to be used for receiver alignment purposes.

g. The switch marked MODULATE TRANSMITTER applies a 1,000-cycle-per-second audio voltage across the microphone input circuit of the transmitter as a test of the modulation capability of the transmitter.

Note. The MODULATE TESTER switch must be ON and a crystal must be in place in the compartment socket when this test is made.

h. Test Unit I-135-() also contains an earphone and a microphone which are mounted in the front panel of the case. These are used to listen to the audio output of the receiver or to modulate the transmitter by speaking into the microphone.

83. Trouble-shooting Procedures

a. When trouble shooting take the following precautions:

(1) Do not check filament continuity with an ohmmeter unless the highest scale is used. Failure to observe this caution may result in burning out of filaments.

(2) Although low voltages are used in Radio Set SCR-536-(*), do not make careless voltage checks. Shorting voltages to ground when taking measurements causes damage to circuit elements and reduces battery life.

(3) Exercise great caution when removing tubes, as they break easily. Use a rod inserted through the metal tube in the center of the tube socket on the bottom of the chassis and gently force the tube out.

84. Sectionalizing Trouble in Radio Set SCR-536-(*)

Symptoms	Probable trouble	Corrections
1. Click of on-off switch not heard when antenna is raised or lowered.	1. Broken switch or actuating parts.	1. Replace broken parts.
2. Set dead in both receive and transmit positions (no background noise or sidetone); usual click of switch heard when antenna is raised.	2. Weak batteries. Dirty contact points. Improper or damaged tubes. Earphone jack. Defective earphone. Bad output amplifier-modulator tube V4, or amplifier tube V5, or defect in these circuits.	2. Insert fresh batteries with positive ends out. Clean contact points on bottom cover, spring contacts at top of housing, and on the batteries. Inspect to insure that the proper tubes are correctly installed and that they are undamaged. Make certain that the PHONE jack is properly inserted. Check and replace earphone. Check and replace tubes; check circuits.

Be sure to first remove the locking clip on top of the tube.

(4) Handle crystal holders carefully and do not remove the crystals from the holders.

(5) Never replace any tube or circuit element known to be faulty until the cause of failure of the damaged element has been determined and corrected. Instructions for replacing parts are given in paragraphs 88 to 98.

(6) When making voltage and resistance measurements on a set which has been moistureproofed and fungiproofed, use a sharp probe to make good contact, while causing as little damage to the protective coating as possible. Retouch any spots where varnish is removed.

b. The trouble-shooting charts (pars. 84 through 87) and the voltage charts (figs. 64 and 65) will assist in testing and trouble shooting. Signal tracing and signal substitution may be used to localize trouble that cannot be found by inspection and voltage and resistance checks.

c. The trouble-shooting chart in paragraph 84 is used by the operator to aid in sectionalizing trouble in Radio Set SCR-536-(*). The operator, if properly familiar with the normal operating indications, may take corrective steps within his authority, and report other faults to a qualified repairman. Most of the trouble shooting in this chart may be accomplished by inspection and replacement of circuit elements without making instrument checks.

d. The charts in paragraphs 85 and 86 are used by the repairman to assist in sectionalizing trouble in the receiver and transmitter circuits.

e. The chart in paragraph 87 will aid in localizing trouble in the receiver and transmitter circuits. In this chart, common troubles and their remedies are listed for quick reference.

Symptoms	Probable trouble	Corrections
	Faulty change-over switch.	Correct any improper change-over switch operation.
3. Background noise and sidetone heard, but no reception or transmission.	3. Antenna shorted. Defective or incorrect ANTENNA coil, TANK coil, or crystals.	3. Correct any shorted condition. Check and replace parts.
4. Background noise weak; excessive sidetone; no reception or transmission.	4. Bad r-f amplifier tube V1, or open circuit in r-f amplifier in transmit position.	4. Check and replace tube; check circuit.
5. Background noise weak; sidetone normal; no reception or transmission.	5. Bad converter tube V2, or open circuit in converter stage.	5. Check and replace tube; check circuit.

85. Sectionalizing Trouble in Receiver Circuit

Symptoms	Probable trouble	Corrections
1. No reception; transmitter circuit operative; background noise heard; sidetone in transmit position.	1. Bad i-f amplifier tube V3 or circuit. Defective or incorrect receiver crystal. Improper alignment and presetting. Defective circuit element; short or open circuit.	1. Check and replace tube; check circuit. Inspect and replace crystal. Align and preset the receiver. Use signal tracing or signal substitution; make voltage and resistance checks.
2. Background noise level low.	2. Weak batteries. Weak tubes. Defective earphone (also indicated by loss in sidetone level).	2. Check and replace batteries. Check and replace tubes. Check and replace earphone. Be sure the PHONE jack is correctly inserted.

86. Sectionalizing Trouble in Transmitter Circuit

Symptoms	Probable trouble	Corrections
1. No transmission; receiver circuit operative; sidetone and receiver background noise normal.	1. Incorrect or defective transmitter crystal. Improper presetting. Defective circuit element; short or open circuit.	1. Check and replace crystal. Preset the transmitter. Make instrument checks.
2. No sidetone, or sidetone level low.	2. Weak batteries. Defective earphone (also indicated by loss in receiver background noise). Defective microphone. Poor microphone amplifier tubes or modulator tubes.	2. Check and replace batteries. Check and replace earphone. Be sure the PHONE jack is correctly inserted. Check and replace microphone. Be sure the MIKE jack is correctly inserted. Check and replace tubes.
3. Circuit not converted when press-to-talk switch is depressed.	3. Broken press-to-talk switch.	3. Replace switch.

87. Localizing Trouble in Receiver and Transmitter Circuit

Symptoms	Probable trouble	Corrections
1. Excessive r-f amplifier plate current in the transmit position.	1. Poor crystal. Burned out converter tube. Capacitor C9 open. Oscillator not functioning. (If the r-f amplifier grid excitation is low, insufficient bias voltage will be developed across grid resistor of R6, and plate current will be excessive.) Improper r-f amplifier TANK COIL, or short-circuited turns in coil.	1. Replace crystal. Check and replace tube; check circuit. Shunt capacitor C9 with a good capacitor and replace if necessary. Check circuit. See the transmitter characteristics, paragraph 71. Replace with good coil of correct frequency.

Symptoms	Probable trouble	Corrections
2. No reception and transmission; oscillator does not function (improper reading obtained when d-c voltmeter is placed across R4). (See figs. 63 and 64.)	<p>(Will show up in the inability to get a dip in the plate current reading of the r-f amplifier tube when tuning this stage.) Leaky or short-circuited coupling capacitor C9.</p> <p>2. Weak crystal.</p>	<p>Test and replace capacitor.</p> <p>2. Check crystal as described in paragraph 81e(8). Replace if necessary.</p>
3. Audio oscillation in transmit position.	<p>Low battery voltage.</p> <p>Defective switching. (Moving blade of section A of the changeover switch must make contact with the switch lug connected to the transmitter crystal at the same time or before the moving blade of switch section M short circuits resistor R17. Otherwise, the energy pulse necessary to start crystal activity will not reach the crystal and the oscillator will not function. As a result of the high screen voltage and no bias, the oscillator tube will become paralyzed.)</p>	<p>Check batteries under load. Replace if low.</p> <p>Check switching. If necessary, move lug on switch section A connected to the transmitter crystal so that it does make contact at the same time or before switch section M short circuits resistor R17. Replace tube if necessary.</p>
4. Oscillation or noise due to excessive regeneration. (A small amount of regeneration is permissible, as it increases the selectivity and sensitivity of the receiver.)	<p>3. R-f amplifier tube inoperative. (Removes load offered to modulator tube. Plate load is then the high impedance of the modulation choke. Under this condition, sufficient coupling exists between the input of the audio amplifier and the output of the modulator to cause oscillation.)</p>	<p>3. Check r-f amplifier tube V1 for open filament, gas, or loss of vacuum due to a crack in the glass. A milky color near the exhaust tip of the tube indicates a cracked or gassy tube. Replace if necessary.</p>
5. Poor sensitivity.	<p>4. Coupling between circuit elements due to close spacing of parts on the chassis. (Trouble may become evident when tubes are changed, as tubes of the same type vary somewhat in gain characteristics.)</p>	<p>4. Change tubes. On BC-611-A through -E, reduce receiver sensitivity to a value which permits an allowable noise level. Bias resistors R25, R7, and R5, connected across oscillator grid-leak resistor R4 provide an adjustable bias arrangement. Move the lead connecting detector load resistor R14 to the bias point to a position one step up on the voltage divider to decrease sensitivity. This increases the bias on tubes V1, V2, and V3. The lead is normally grounded, but in sets of abnormal sensitivity will be found connected to one of the taps on the divider. Make the connection to the lowest point on this divider which provides a satisfactory noise level. Radio Set SCR-536-F has fixed bias.</p>
6. Loose or tight adjustment of antenna trimmer capacitor.	<p>5. Weak tubes or batteries.</p> <p>Circuit failures. Sensitivity adjustment incorrect.</p>	<p>5. Test tubes and batteries, making any necessary replacements. Check circuit for defective elements. Make adjustment of sensitivity control (see item 4 above). Reduce bias by connecting the lead closer to the ground end of the divider.</p>
7. Set noisy when tapped gently.	<p>6. Incorrect or defective coil.</p>	<p>6. Check coil and replace if necessary.</p>
7. Set noisy when tapped gently.	<p>7. Loose connection.</p>	<p>7. Check sections of antenna rod, tension between batteries and their contacts. Inspect for poor connections. Check for tube with loose internal element. (Make checks by gently tapping at various places with the insulated handle of a small screw driver.)</p>