WAR DEPARTMENT TECHNICAL MANUAL TM 11-620

RADIO SETS

SCR-608-A AND SCR-628-A

WAR DEPARTMENT • 1 JANUARY 1944

SECTION IV. MAINTENANCE

Special Notice to Maintenance Personnel: Before making replacement of any parts in this equipment, read Section V and particularly Paragraph 43 for changes in circuit components.

28. General Maintenance Information.

a. Precautions. Use care in servicing this equipment. Servicing should be done only by competent personnel who are supplied with adequate tools and test equipment. An inexperienced operator, in attempting to locate and repair a minor trouble which a competent serviceman could care for in a few moments, might misalign or damage the equipment to such an extent as to require its being sent to a repair depot.

When working with the transmitter, either in use or in testing, make sure that one of the push buttons is *always* depressed when the dynamotor is running. Also, turn the transmitter off whenever possible.

In the following instructions it is necessary in some cases to give values of voltage and current for certain conditions. Because of variations in tubes and other apparatus items, consider such values to be only approximations in most cases. As long as the result obtained does not differ greatly from the typical figure, it is probable that the unit in question is not in trouble.

Several drawings will be useful in connection with maintenance work on this equipment, particularly the location of trouble. The following are included in addition to those mentioned in previous paragraphs:

Fig. 51. Radio Receiver BC-683-A: Location of Alignment and Tuning Controls. This shows where the various knobs and screws are located for use in aligning the tuned circuits and in making other necessary adjustments.

Fig. 52. Radio Transmitter BC-684-A: Location of Alignment and Tuning Controls. This shows where the various adjustments are located for use in aligning the tuned circuits and in making other necessary adjustments.

Fig. 57. Radio Receiver BC-683-A: Voltage Diagram. This shows the voltages to be expected under normal conditions from various points to the chassis.

Fig. 58. Radio Receiver BC-683-A: Resistance Diagram. This shows the resistance values to be expected from various points on the receiver to the chassis. All resistance measurements are made with the *dynamotor removed* from the receiver.

Fig. 59. Radio Transmitter BC-684-A: Voltage Diagram. This shows the voltages to be expected under normal conditions from various points to the chassis.

Fig. 60. Radio Transmitter BC-684-A: Resistance Diagram. This shows the resistance values to be expected from various points on the receiver to the chassis. All resistance measurements are made with the *dynamotor in place* in the transmitter.

Fig. 61. Mounting FT-237-(*): Schematic Diagram.

Fig. 62. Mounting FT-237-(*): Wiring Diagram.

b. General Information. The cleaning, inspecting, and testing procedures contained in this section are intended to prevent development of faults in field service. Operation failures are usually caused by dirt, loose connections, bad vacuum tubes, defective wiring or component parts, misalignment, or incorrect tuning.

Unless otherwise specified, make the following routine checks of the major components after every 300 hours of service. (Check the vehicle battery, charging generator, and voltage regulator prior to making tests of equipment installed in the vehicle.)

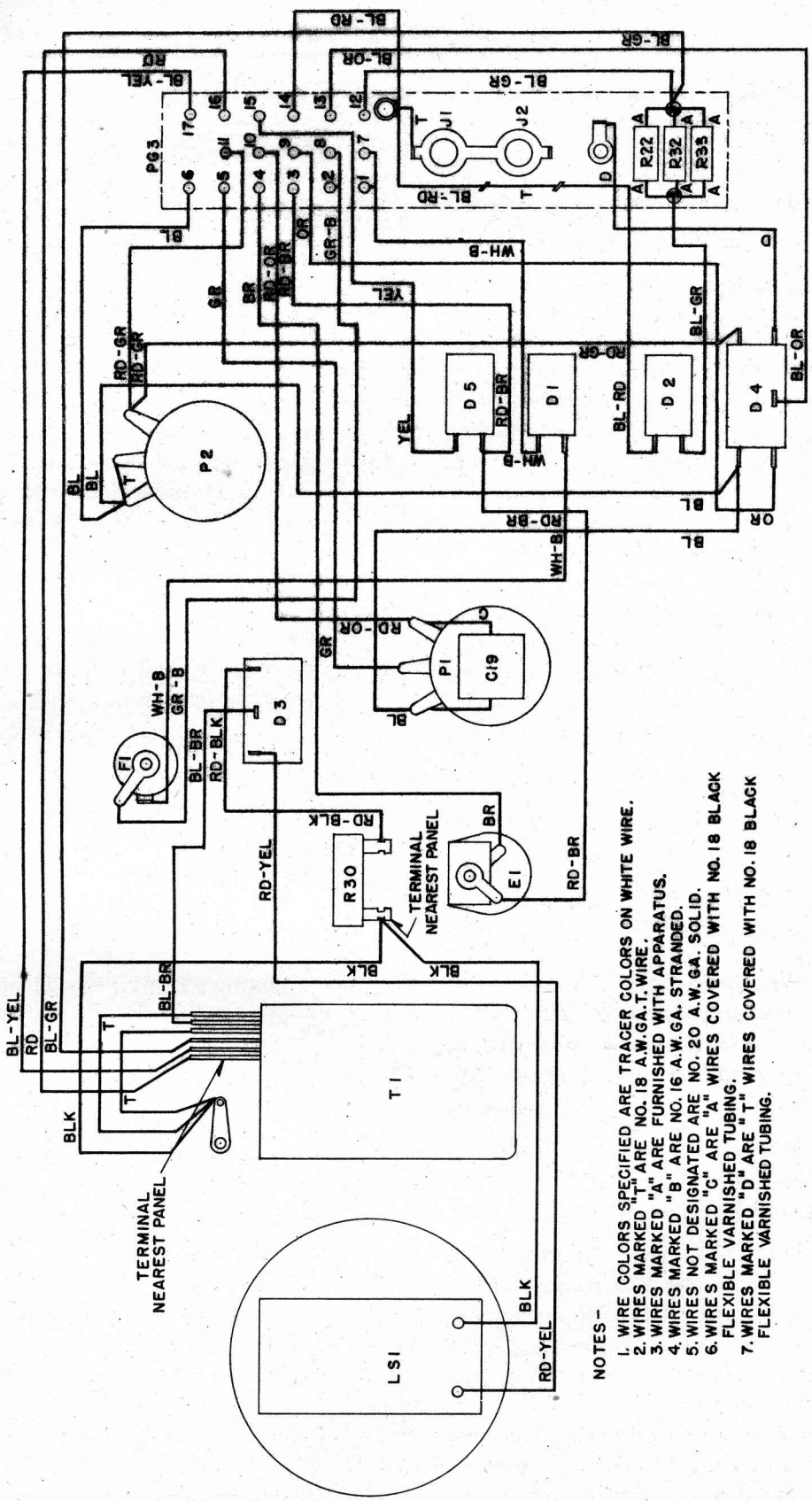


Fig. 43. Radio Receiver BC-683-A: Wiring Diagram of Front Panel

29. Routine Check of Mounting. Check the mounting and prepare it for testing of the radio set as follows:

a. Be sure that the main fuse is intact and that the screws are tight.

b. See that the spare fuse is in place.

c. Inspect the transmitter and the receiver receptacles. Repair or replace any that are damaged.

d. Inspect the insulators and the lead-in, and the connection at the left-hand end of the mounting.

30. Routine Check of Radio Receiver BC-683-A.

a. Cleaning and Inspecting.

(1) Remove the receiver from the mounting.

(2) Clean the outside of the cover and the front panel.

(3) Remove the cover and see that the circuit label is secure.

(4) Clean and inspect plug PG1. Make sure that there is a slight play in the plug mounting.

(5) Carefully shake or blow out dust and dirt from the interior of the receiver. Avoid bringing a rag in contact with receiver parts as this may damage them.

Note: If an air hose is used be sure that any water condensed in it is blown out before applying the air stream to the equipment. Use only air intended for cleaning purposes and do not blow hard enough to misplace or damage any apparatus.

(6) Inspect the set for:

(a) Loose or broken connections.

(b) Damaged parts.

(c) Evidence of excessive heating, such as burned resistors or melted wax. Such troubles can often be located by the sense of smell. Use your nose as well as your eyes.

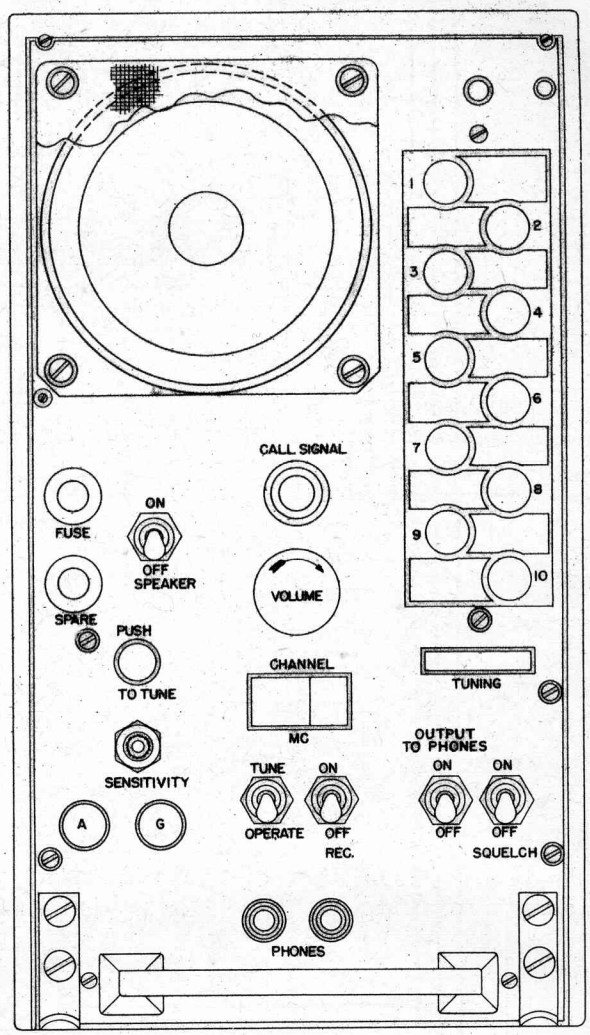


Fig. 44. Radio Receiver BC-683-A: Apparatus Location Diagram, Front View of Panel

(7) Check both fuses and replace if necessary.

(8) Dust off the push-button assembly with compressed air or a bellows.

(9) Lubricate the push-button assembly as directed in Paragraph 30*f*.

Caution: Do not get oil on the locking wedge or friction washers.

(10) Make sure all screws and nuts are tight. Check each socket mounting screw and each grounding screw with a screwdriver.

Caution: Do not use abnormal force when tightening screws. Take it easy.

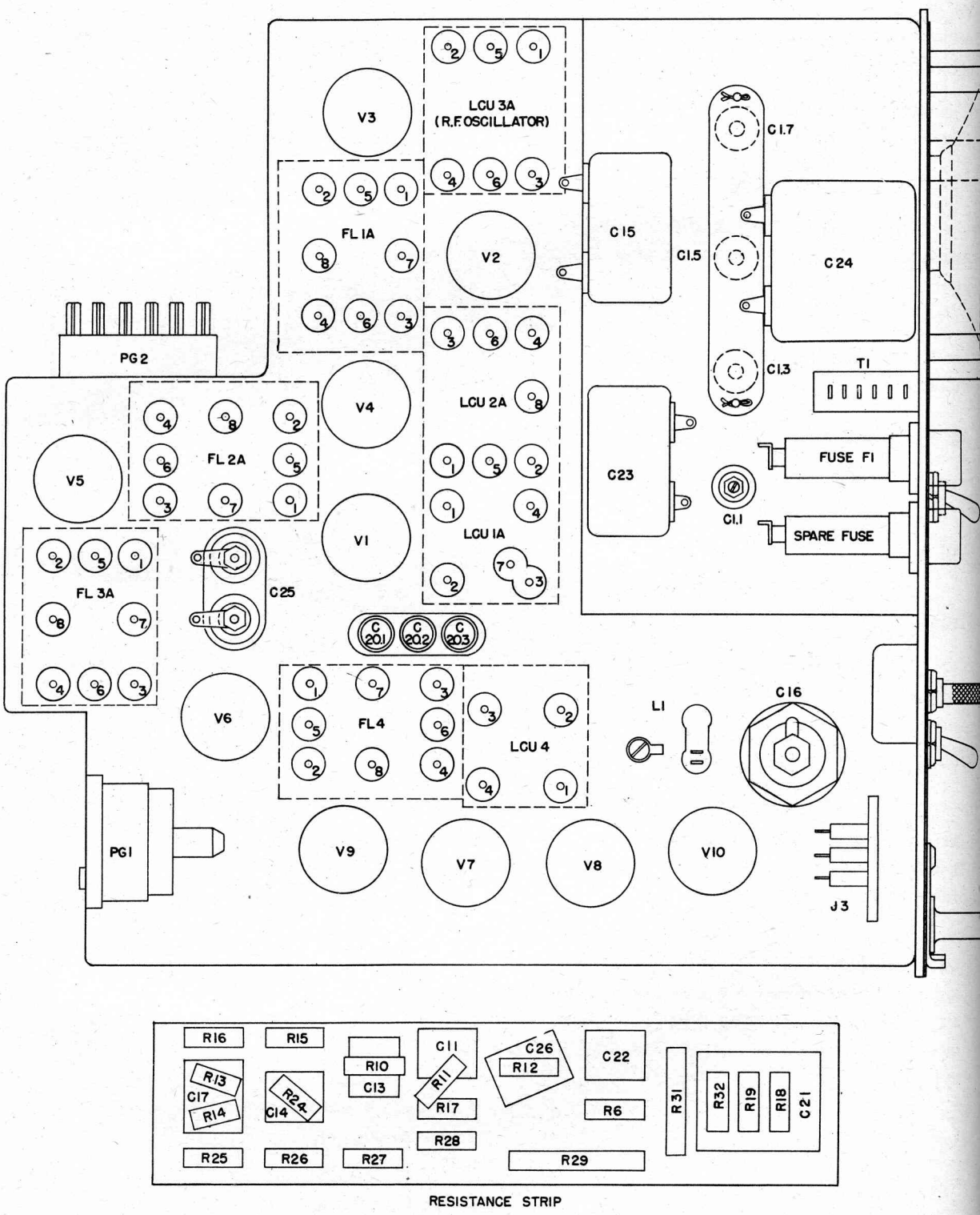


Fig. 45. Radio Receiver BC-683-A: Apparatus Location Diagram, Left-side View

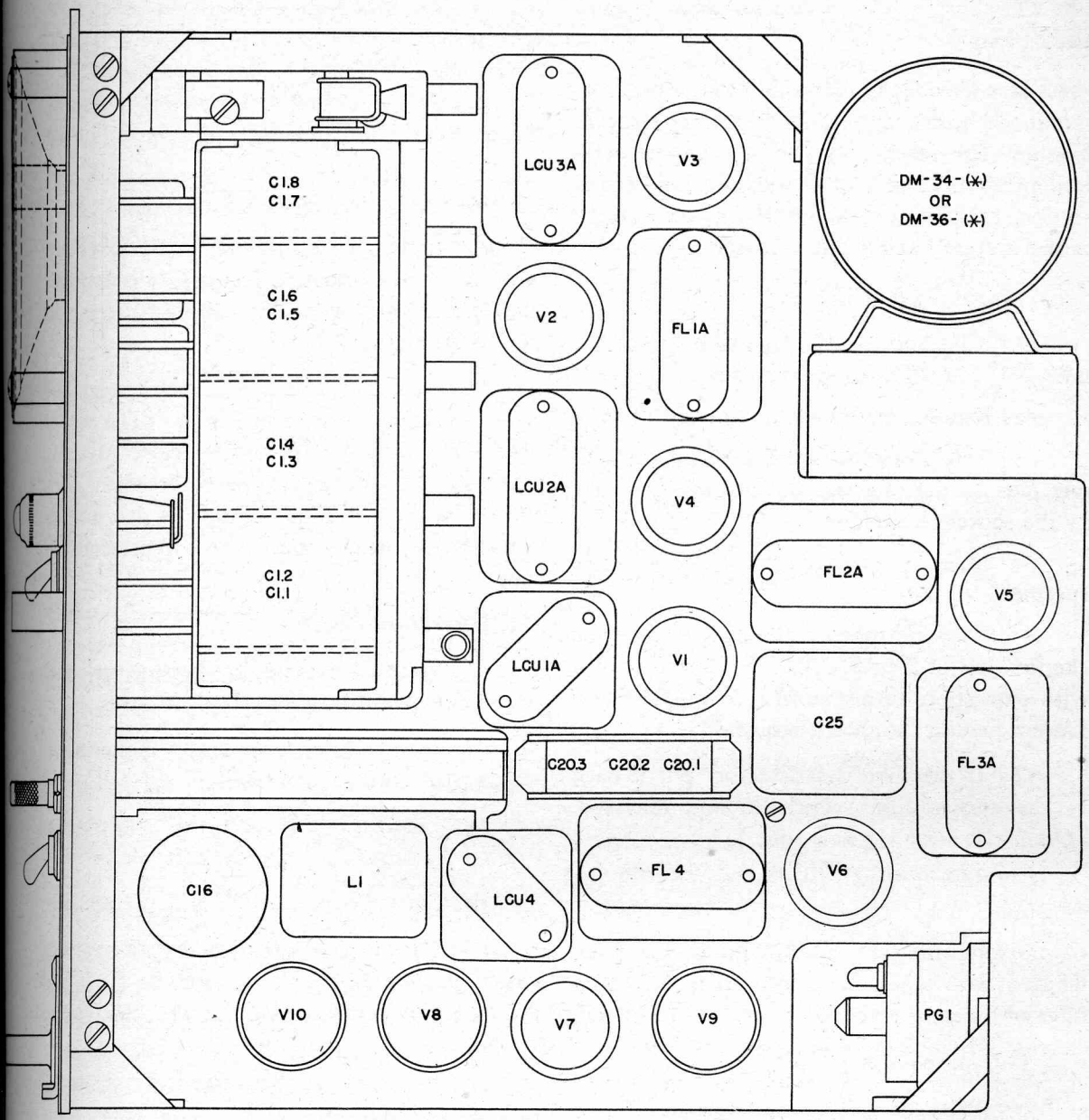


Fig. 46. Radio Receiver BC-683-A: Apparatus Location Diagram, Right-side View

(11) Inspect the sockets for dirty or damaged prong grips.

b. Dynamotor Routine. Remove the dynamotor end bells and dust off the commutator and brushes. The receiver dynamotor may be serviced in accordance with Paragraph 41 of this section. Make sure that the dynamotor voltage rating is correct for the vehicle battery.

c. Vacuum Tube Check.

(1) Check the radio-frequency amplifier tube, V1, for tightness in its socket.

(2) Remove the tube and clean the prongs.

(3) Repair or replace the socket if the contact pins on the tube are not gripped properly by the socket receptacles.

(4) Make sure that the tube is of the type specified, VT-112.

(5) Test the tube, if possible, in the tube checker unit of Test Set I-56-(*) in accordance with instructions furnished with the tube checker. Do not neglect the short-circuit test.

(6) If the tube is satisfactory put it back in the socket from which it was removed. (Otherwise install a new tube.)

(7) Repeat steps *(1)* through *(6)* for the remaining tubes.

Caution: Return each tube to the socket from which it was taken. It is important that even tubes of the same type shall not be interchanged.

d. Voltage Check.

(1) Place all switches on the receiver panel in the downward position. Remove cover.

(2) Connect the receiver to power, preferably with a test cord (such as Cord CD-786, one end of which plugs into a receptacle on the mounting and the other into the receiver under test). Otherwise insert the receiver into a mounting.

(3) Connect a 1000-ohms-per-volt voltmeter or a vacuum-tube voltmeter (250- or 300-volt scale) across capacitor C25, minus (—) to the blue lead and plus (+) to the red-white lead.

(4) Turn the REC switch to ON. Observe the wiring side of the chassis for smoke or *sparks.* If any are observed, turn the REC switch to OFF at once and check the set completely to remedy the trouble. Then proceed with the following tests:

Caution: High voltages are exposed.

(5) Make sure that, after the tubes are warmed up, the potential across C25 is approximately 200 volts when the supply battery is in good condition.

(6) Check the voltages at each terminal of V6 (limiter) as shown in Fig. 57. The values obtained should be reasonably close to those specified for V6. Approximate agreement with the values given in Fig. 57 indicates that normal voltages are being supplied to a representative tube.

e. Operation Check.

(1) Place all switches on the receiver panel in the downward position. Replace cover.

(2) Insert the receiver into a mounting in which a transmitter is mounted.

(3) Depress the first channel selector buttons on the transmitter and the receiver.

(4) Start the transmitter and the receiver.

(5) Throw the RECEIVER TUNE-OPERATE switch on the transmitter to RECEIVER TUNE and the TUNE-OPERATE switch on the receiver to TUNE.

(6) Throw the SPEAKER switch to ON. If the receiver is in the proper adjustment, and set for the same frequencies as the transmitter, the dial reading should agree with the channel in use; and a beat note should be heard in the loudspeaker.

(7) If no beat note is heard, check the transmitter and receiver controls to be sure that they are in the positions specified and set for the same frequency. If not, tune the receiver as described in Paragraph 21*b*. If the settings are correct and no beat note is heard, check the receiver in accordance with Paragraph 39.

(8) Throw the SQUELCH switch to ON and observe that the CALL SIGNAL lamp remains lighted. If necessary, adjust the SENSITIVITY control as described in Paragraph 20*a(2)*.

(9) Repeat steps *(5)* through *(7)* for each channel set up on the receiver. Turn the RECEIVER TUNE-OPERATE switch on the transmitter back to OPERATE whenever the output is not needed.

(10) Check the operation of the manual tuning mechanism.

(11) Throw the RECEIVER TUNE-OPERATE switch to OPERATE.

(12) Throw the RECEIVER TUNE-OPERATE switch of the transmitter to RECEIVER TUNE. Operate the microphone push button and speak into the microphone. Check the loudspeaker output for normal volume and quality.

Note: The receiver output will be short-circuited by the disabling relay S103 in the transmitter if the RECEIVER TUNE-OPERATE switch is at OPERATE.

(13) Check the sidetone volume in the headset (OUTPUT TO PHONES switch in the OFF position) while talking into the microphone. If sidetone is not heard there may be trouble in either the receiver or the transmitter. Check them in accordance with Paragraph 39 or 40.

(14) Throw the RECEIVER TUNE-OPERATE switch on the transmitter to OPERATE, operate the microphone push button, and speak into the microphone. The sidetone volume should be satisfactory in the headset when the OUTPUT TO PHONES switch is set to ON.

(15) Release the microphone push button and check the volume of noise in the headset. Turn the SPEAKER switch to OFF and note that the noise volume in the headset remains the same.

f. Lubrication of Push-button Mechanism. Inspect the push-button mechanism occasionally. The push-button plungers should be lubricated with a very small amount of Univis 40 oil, or its equivalent. The rack and gears should be lubricated with Univis 115 oil, or its equivalent. Use only a slight amount of oil, since too much oil may cause the plungers to stick under low-temperature conditions. If it is found necessary to clean the push-button mechanism, kerosene is the preferred cleaning fluid. Under field conditions, where the recommended lubricants may not be available, cleaning should be done with great care and lubricant omitted if the equipment is to be used under low-temperature conditions. *Do not get oil on the locking wedge or the friction washers.*

31. Routine Check of Radio Transmitter BC-684-A.

a. Cleaning and Inspecting.

(1) Remove the transmitter from the mounting.

(2) Clean the case and the panel.

(3) Clean and inspect plug PG101. Make certain that there is a slight play in the plug mounting.

(4) Turn the transmitter upside down and remove the bottom cover plate.

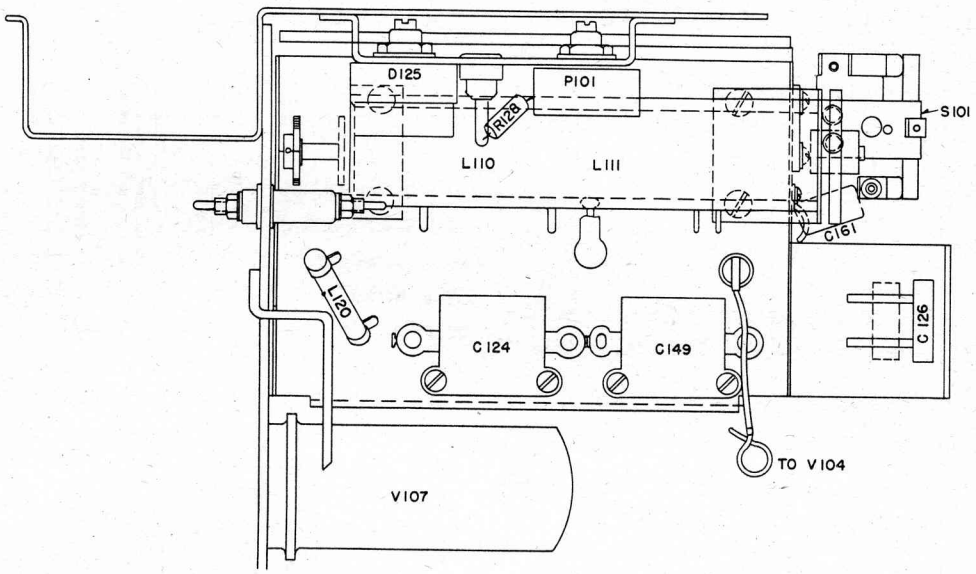
Important: After any repair, adjustment, or replacement of parts is made inside Radio Transmitter BC-684-A, always take a reading with an ohmmeter between coil L119 and ground. If the reading is zero resistance you will burn out resistor R119 as soon as you apply power. *Be careful.*

(5) Inspect the bottom of the transmitter for:

(a) Loose nuts, bolts, or screws.
(b) Loose or broken connections.
(c) Damaged or worn parts.
(d) Dirt.
(e) Excessive heating. Use your nose as well as your eyes.

(6) Carefully inspect relays S102 and S103. If either relay requires servicing, refer to Paragraph 31*f*.

(7) Inspect the spring and roller guides which keep the gang capacitor gear rack in place.



SECTION A-A (See Fig. 48)

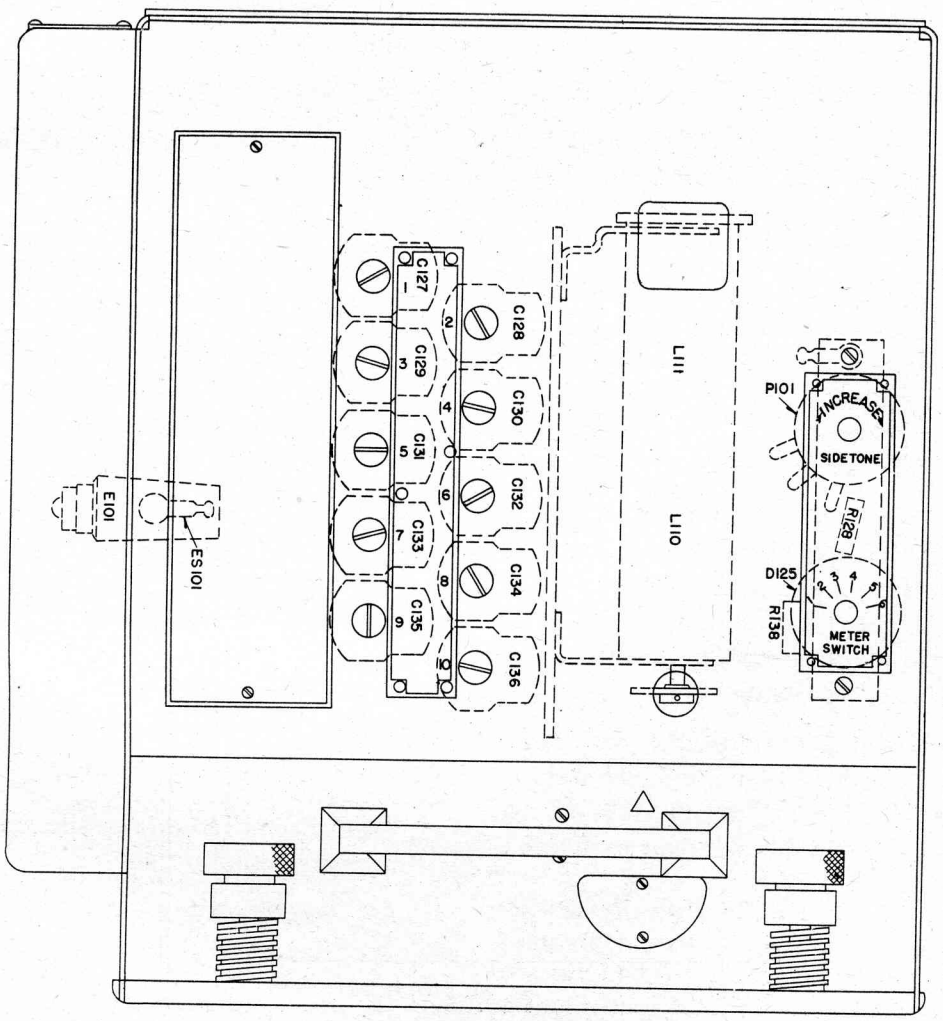


Fig. 47. Radio Transmitter BC-684-A: Apparatus Location Diagram, End View and Detail Through Section A-A

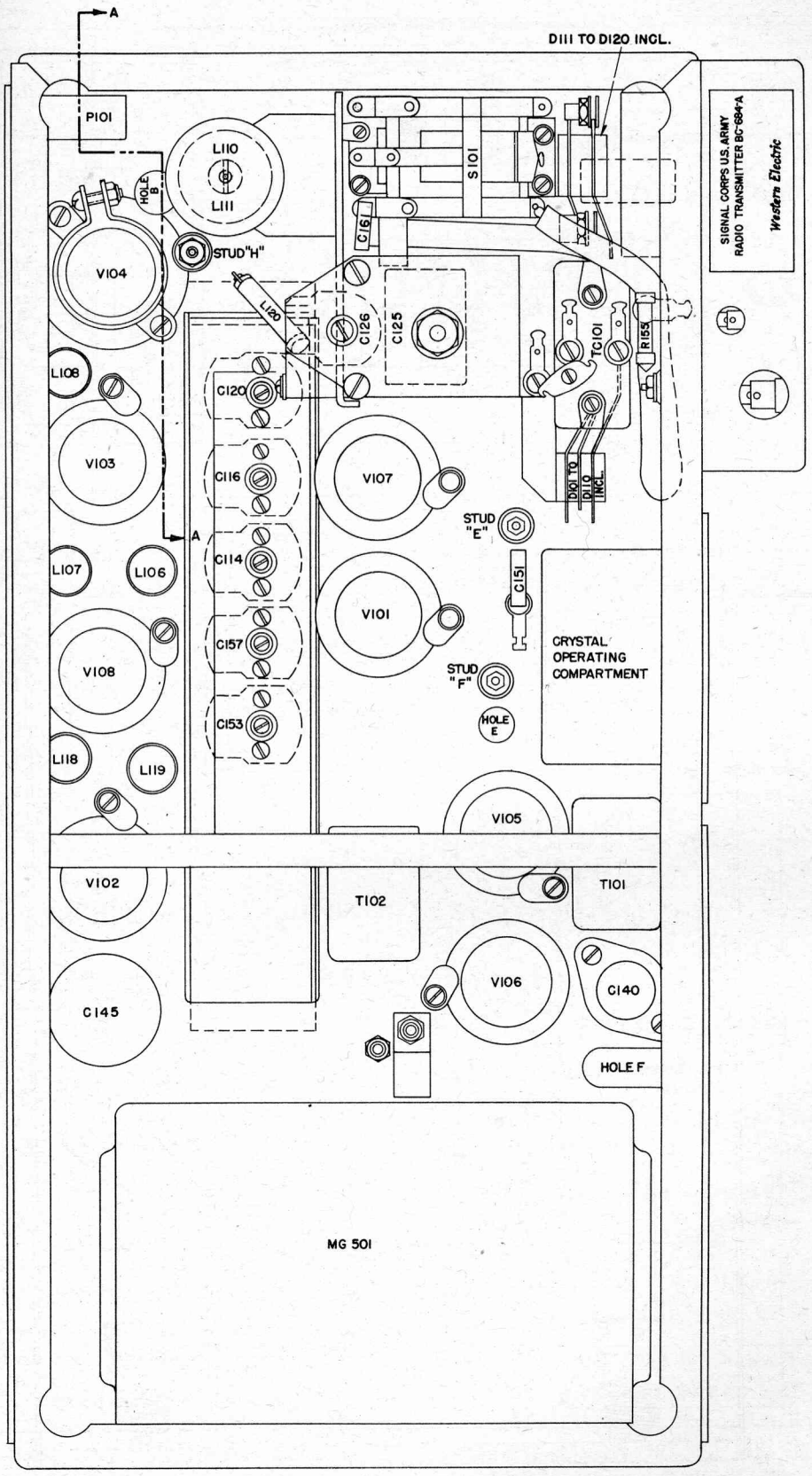


Fig. 48. Radio Transmitter BC-684-A: Apparatus Location Diagram, Top View

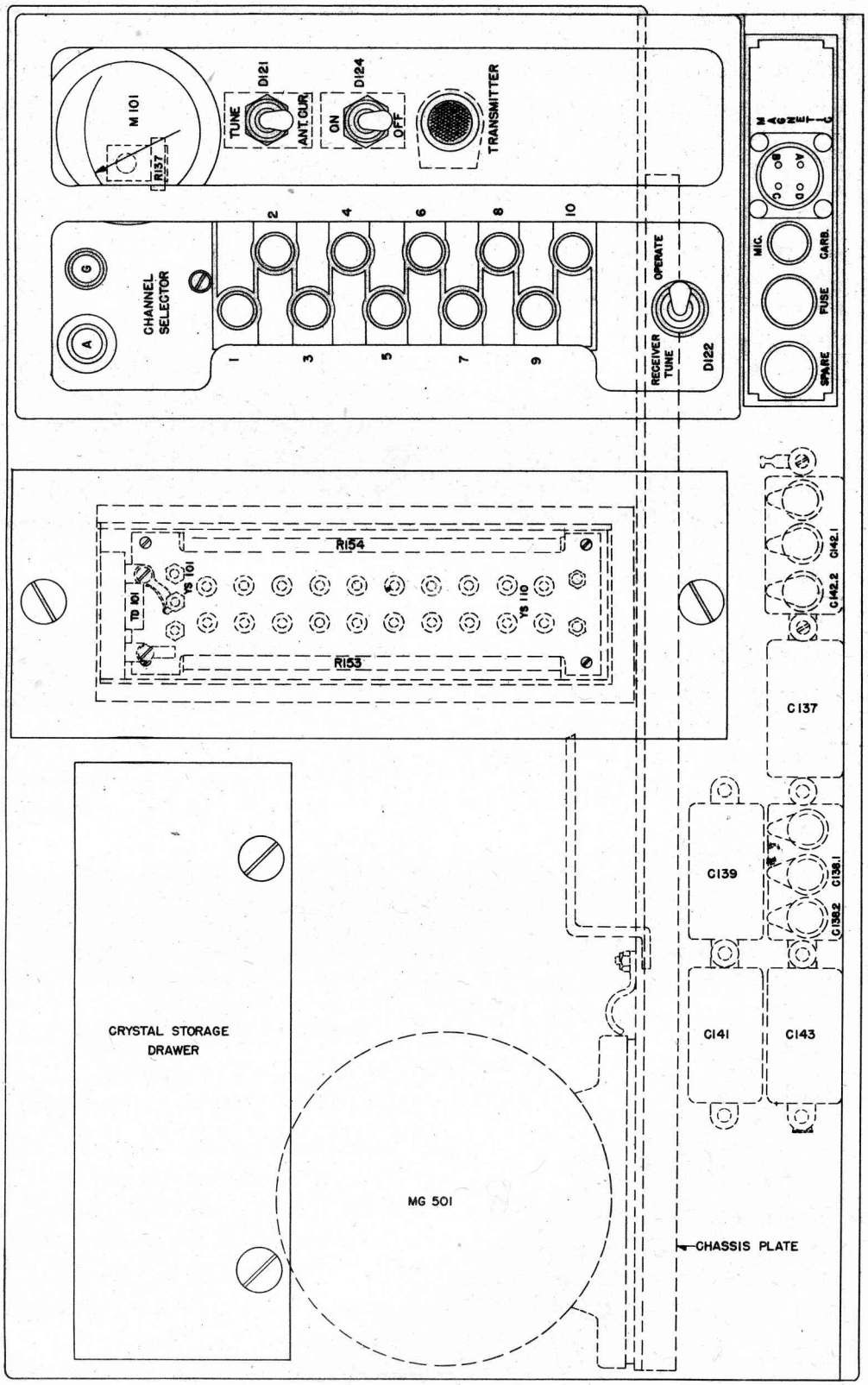


Fig. 49. Radio Transmitter BC-684-A: Apparatus Location Diagram, Front View

(8) Clean the bottom of the transmitter.

(9) Replace the bottom cover plate and turn the transmitter right side up.

(10) Remove the top cover plate and the crystal storage drawer. See that the circuit label is secure. (When the drawer has been pulled out to its most extended position it can be removed by raising the back portion and then rotating the front upwards to clear the catch under the back of the drawer.)

(11) Inspect the top of the transmitter for:

(a) Loose nuts, bolts, or screws.
(b) Loose or broken connections.
(c) Damaged or worn parts.
(d) Dirt.
(e) Excessive heating.

(12) Carefully inspect relay S101. If this relay requires servicing, refer to Paragraph 31*f*.

(13) Clean the push-button assembly with compressed air or a bellows. Use of an air hose requires caution as noted in Paragraph 30*a(5)*.

(14) Lubricate the push-button assembly as directed in Paragraph 31*g*.

Caution: Do not get oil on the locking wedge or friction washers.

(15) Check each socket mounting screw with a screwdriver.

Caution: Do not use abnormal force when tightening the screws.

(16) Check the security of the grounding points.

(17) Inspect the tube clamps.

b. Dynamotor Routine. The transmitter dynamotor may be serviced in accordance with Paragraph 41. Make sure that the dynamotor voltage rating is correct for the vehicle battery.

c. Vacuum Tube Check.

(1) Loosen the tube clamp and check the power amplifier tube, V104, for tightness in its socket.

(2) Remove the tube and clean its prongs.

(3) Repair or replace the socket if the contact pins on the tube are not gripped properly by the socket receptacles.

(4) Make sure that the tube is of the specified type, VT-165.

(5) Check the tube with a tube tester. Do not neglect the short-circuit test.

(6) If the tube is satisfactory, put it back in the socket from which it was taken and retighten the tube clamp. (Otherwise install a new tube.)

(7) Repeat steps *(1)* through *(6)* for the remaining tubes. The tubes in the remaining sockets are marked VT-164. Replace each tube in the socket from which it was removed.

d. Crystal Check.

(1) Open the crystal storage drawer and the crystal operating compartment and check the number of crystal holders issued.

(2) See that the required crystal holders are properly placed in the crystal operating compartment.

(3) Check each operating crystal for firmness in its socket.

(4) Replace the crystal storage drawer and the crystal operating compartment cover plate.

e. Operation Check.

(1) Remount the transmitter and associated receiver on the mounting in the vehicle.

(2) If radio transmission is not authorized, remove the antenna lead from the TR binding post on the mounting and connect Antenna A-83 (phantom) to the A and G terminals on the transmitter with short leads.

Note: If Antenna A-83 is not available, an antenna constructed according to Fig. 77 may be used. If, in an emergency, neither of these is available, a 40-watt, 115-volt Mazda lamp may be used. Notice, however, that neither the lamp nor the antenna according to Fig. 77 closely

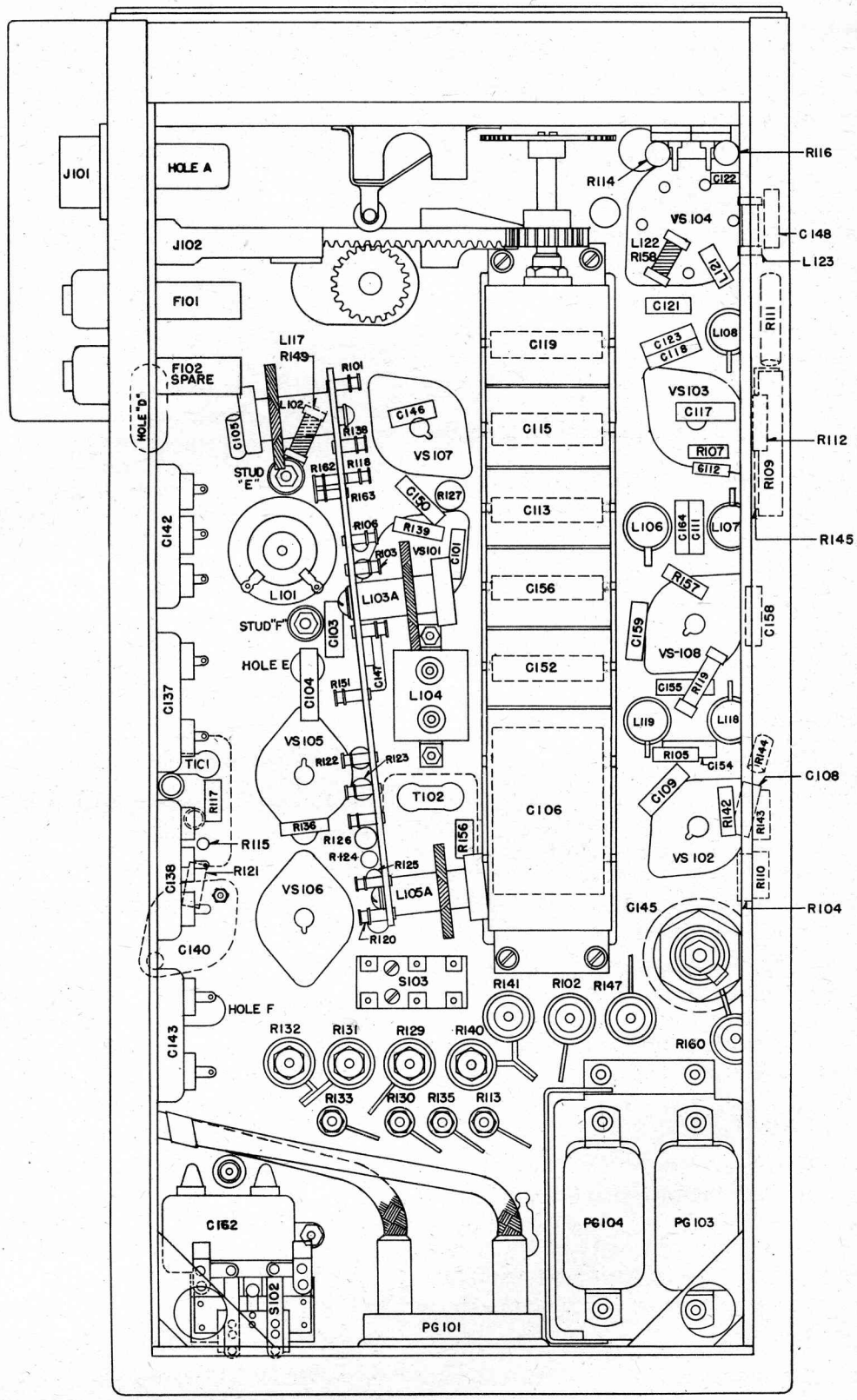


Fig. 50. Radio Transmitter BC-684-A: Apparatus Location Diagram, Bottom View

simulates the actual antenna; it is therefore doubly important to readjust the antenna trimmers, as covered in paragraph *(11)* following, after connecting to the real antenna.

(3) Plug in a microphone and a headset.

(4) Turn the transmitter and the receiver on and note that the transmitter pilot lamp lights.

(5) Throw the transmitter RECEIVER TUNE-OPERATE switch to OPERATE and the receiver OUTPUT TO PHONES switch to OFF.

(6) Press the microphone button, observe that the dynamotor starts, and talk into the microphone.

(7) Note that sidetone is heard in the headset and that its volume may be varied by adjusting the transmitter SIDETONE control.

(8) Tune the transmitter and the receiver to the same channel and throw the OUTPUT TO PHONES switch on the receiver to ON.

(9) Speak into the microphone and observe that the speaker's voice is heard in the headset.

(10) Turn the SPEAKER switch to ON and see that the speaker's voice is not heard. Throw the RECEIVER TUNE-OPERATE switch on the transmitter to RECEIVER TUNE and note the speech output is then obtained from the loudspeaker. Return to OPERATE at the transmitter.

(11) For each push button, check the meter readings in accordance with Paragraph 19*b*, Table V, for each of the METER SWITCH positions (TUNE-ANT CUR switch on TUNE) and for the ANT CUR position of the TUNE-ANT CUR switch. It may be necessary to adjust the antenna trimmers (C127 to C136) because of possible differences between the real antenna and the phantom antenna. There will be considerable variation in meter readings among different transmitters due to power supply, vacuum tube, and circuit variations. Experience with a number of transmitters is the best way to learn which readings are satisfactory and which are not. When the transmitter is set to RECEIVER TUNE the meter current for METER SWITCH position 5 will rise to about twice that shown in Table V and the current for METER SWITCH position 6 will drop to about half that shown in Table V. Paragraph 40*e* gives further information on these differences.

(12) If this check is made in cold weather, notice that the thermostat which controls the heaters in the crystal compartment operates at approximately 70 degrees Fahrenheit.

f. Relay Maintenance.

(1) General. Burnish the relay contacts with a burnishing tool or other thin flat piece of smooth metal. Never use abrasive papers or cloths. If the contacts become pitted, a fine file may be used to remove the rougher spots, after which the contacts should be burnished. Take precautions against metallic filings falling or being blown into the apparatus.

No provision is made for adjusting contacts and it should not be necessary under ordinary conditions. The contacts should be parallel when brought together. If some special situation makes it necessary to adjust the contacts, it is preferable to bend the contact arm rather than the spring (except for relay S101).

Warning: The spring assembly of S102 is connected to the vehicle battery even when the transmitter ON-OFF switch is in the OFF position and the green pilot light is extinguished. If you find it necessary to work on this relay be sure to disconnect the battery at plug PG101. If you don't, you are very likely to destroy the relay; you may also get a nasty burn on your hand.

(2) Antenna Switching Relay S101. The contact springs are mounted on Isolantite bars which are very brittle. Take care to avoid straining or deforming these bars. If any bending adjustment is required, it should be made on the springs. Keep the points clean.

(3) Dynamotor Starting Relay S102. Keep the points clean at all times. When the relay is released, the separation between points should be approximately the thickness of a thin dime. When the relay is operated, the armature travel

should be somewhat more than the amount necessary to close the points. Then the contact springs will be bent slightly and will exert some pressure to hold the points in good contact.

(4) Receiver Disabling Relay S103. The points should be kept clean.

g. Lubrication of the Push-button Mechanism. Inspect push-button mechanisms occasionally. Lubricate the push-button plungers with a very small amount of Univis 40 oil, or its equivalent, and the rack and gears with Univis 115 oil, or its equivalent. Use only a slight amount of oil. Too much oil may cause the plungers to stick under low-temperature conditions. (*Caution:* Do not get oil on the locking wedge or friction washers.) If necessary, clean the push-button mechanism with kerosene. Under field conditions, where the recommended lubricants may not be available, cleaning should be done with great care and lubricant omitted if the equipment is to be used under low-temperature conditions.

32. Routine Check of System.

a. Inspection of Antenna System.

(1) See that Wire W-128 or Coaxial Cord CO-282 between the antenna mast base and the binding post of the mounting is properly supported and that the connections are firm and not short-circuited.

(2) Be sure the proper antenna mast sections are installed and that their couplings are firmly joined.

(3) Inspect the antenna mast base carefully. Wipe off all dust and any vegetation that may have caught in the springs. Flex the base to be sure the springs are not broken and that the lead to the radio equipment is in good order.

(4) Carefully inspect all ground straps, if used, and all bolted connections in the ground system. Tighten or resolder any doubtful connections.

b. Talking Tests. Upon completion of the routine tests described in Paragraphs 28 to 32*a*, inclusive, it is desirable, if practicable to do so, to talk between two vehicles. Make this test with Antenna A-83 (phantom) instead of the regular radiating system to prevent excessive signal radiation from either equipment. (If no Antenna A-83 is available, use an antenna constructed according to Fig. 77; if this is not possible, use a 40-watt, 115-volt Mazda lamp.) A two-way conversation test should be made with vehicles equipped with Radio Set SCR-608-A or Radio Set SCR-628-A.

33. Emergency Check of Receiver Output Volume and Circuit Alignment.

a. General. When the testing equipment for precision servicing of a receiver is not available, make a rough check of the alignment of the receiver circuits. The tests described may be made with the receiver mounted in the vehicle. Misaligned circuits so found may be realigned with a minimum of testing apparatus by following the directions in Paragraph 34. The location of the alignment controls is shown in Fig. 51.

b. Testing Apparatus Required.

1—Radio Transmitter BC-684-A known to be in good condition.

1—Microphone T-17 or Microphone T-33.

1—Output meter of Test Set I-56-(*) equipped with a 3½-foot assembly of Cordage CO-144 and Plug PL-55.

1—Volt-ohmmeter of Test Set I-56-(*), or a 1000-ohms-per-volt voltmeter, or a vacuum tube voltmeter, 3-volt scale.

c. Check of Output Volume.

(1) Install the transmitter on the mounting.

(2) Plug in a microphone and adjust the transmitter and the receiver to the same channel (the transmitter not operating).

(3) Connect the plug and cord assembly of Test Set I-56-(*) to the ± and VM terminals of the output meter, adjust the meter for the 15-volt scale, and insert the plug into one of the PHONES jacks on the receiver.

(4) Turn the SPEAKER switch to ON, throw the TUNE-OPERATE switch to OPERATE, the OUTPUT TO PHONES switch to ON, and the SQUELCH switch to OFF. Adjust the SENSITIVITY and VOLUME controls to the extreme right (maximum volume).

(5) Turn on the transmitter and the receiver and, after the vacuum tubes are hot, throw the RECEIVER TUNE-OPERATE switch on the transmitter to RECEIVER TUNE.

(6) Operate the microphone switch and whistle or shout for about three seconds into the microphone. The output meter should indicate 12 volts or more; if it does not, check the receiver in accordance with Paragraph 39. (Tune the receiver to the transmitter frequency.)

(7) Check the receiver VOLUME control by turning the control to the extreme left while whistling or shouting. The output meter reading should decrease uniformly to 1.0 volt or less; if it does not, it indicates that the VOLUME control may be defective or the amplifiers may be noisy.

d. Check of Circuit Alignment.

(1) Remove the receiver dust cover and place the receiver in the right-hand position of the mounting. Leave the left-hand position vacant.

(2) Turn the SPEAKER switch to ON, throw the TUNE-OPERATE switch to TUNE, and the SQUELCH switch to ON. Adjust the SENSITIVITY and VOLUME controls to the extreme right.

(3) Press any convenient channel push button on the transmitter. Operate both transmitter and receiver ON-OFF switches to ON. Operate the RECEIVER TUNE-OPERATE switch to RECEIVER TUNE.

(4) Manually tune the receiver to zero-beat with the transmitter frequency. Make sure that the CALL SIGNAL lamp lights. Read the setting of the receiver dial.

(5) Carefully adjust the tuning dial to each side of the zero-beat setting until the CALL SIGNAL lamp goes out. Note the two dial readings at which the lamp goes out. The lamp should remain lighted over approximately three channel divisions, and the zero-beat setting should be close to the center of this tuning range.

(6) Set the SENSITIVITY control to the extreme left (minimum sensitivity) and carefully adjust the tuning dial to each side of the zero-beat setting. The lamp should remain lighted over approximately two channel divisions; and the zero-beat setting should be at the center of this tuning range, within plus or minus one-half channel.

(7) If the zero-beat setting is found to be not centered, in steps *(5)* and *(6)*, obtain the "reduced-voltage" points as described in Paragraph 33*e* following and realign the circuits as outlined in this paragraph.

e. Reduced-voltage Points.

(1) Connect the voltmeter across the limiter cathode choke (L1), with the minus (—) terminal of the meter connected to ground. (See Fig. 51.)

(2) Turn the SPEAKER switch to OFF, set the TUNE-OPERATE switch on OPERATE, and throw the SQUELCH switch to OFF.

(3) With the transmitter operating on RECEIVER TUNE, manually tune the receiver dial for a maximum deflection of the voltmeter. Note the voltmeter reading and the dial setting.

(4) Carefully adjust the tuning dial to each side of the maximum voltmeter deflection until the voltmeter indicates three fourths of the maximum deflection. Note the two dial readings so obtained. These are the "reduced-voltage" points. The dial should be found adjustable to between plus or minus one-half and plus or minus one channel division without reducing the voltmeter indication to less than three fourths of its maximum deflection.

(5) Throw the SPEAKER switch and the SQUELCH switch to ON, and the TUNE-OPERATE switch to TUNE.

(6) Tune for zero beat with the transmitter frequency. The zero-beat setting of the dial should be centered between the "reduced-voltage" points. If the zero-beat setting is not centered, the intermediate-frequency oscillator should be adjusted as described in Paragraph 34. If the zero-beat setting is centered with respect to the "reduced-voltage" points but not centered with respect to the dial settings at which the CALL SIGNAL lamp goes out, realign the discriminator circuit, FL4, as described in Paragraph 34.

34. Emergency Alignment of Radio Receiver BC-683-A.

a. General. When a receiver is found to be out of alignment it can be put into serviceable condition if another receiver or another transmitter in good condition is available. Whenever possible, check such emergency alignment in accordance with Paragraph 37. The method using a good receiver is described first as it permits alignment of all stages.

b. Method Using Good Receiver.

(1) Testing Apparatus Required. The following testing equipment is required:

1—Radio Receiver BC-683-A known to be in good condition.

1—Mounting FT-273-(*).

1—Insulated 1/4-inch hexagon socket wrench.

1—Resistor, 1000 ohms (not critical), equipped with clips. (To avoid accidental short circuits, the clips should be insulated, if possible.)

1—Voltmeter of Test Set I-56-(*) or other voltmeter of 1000 ohms or more per volt, equipped with approximately 3-foot leads (preferably twisted), and clips.

1—Twisted pair (one wire with tracer) about 3 feet long, with clips on both ends, one wire to have a capacitor of 0.001 microfarad or larger between the wire and the clip.

1—Wire about eight inches long, with clips at both ends.

3—Wires each about one inch long, with a clip at each end of each wire.

1—Cord CD-786.

Caution: When connecting or disconnecting these wires, turn the receiver off each time to avoid shocks or equipment damage.

(2) Preliminary Steps. The following steps in receiver alignment are divided functionally for convenience in description and understanding; but remember that in most cases a change in the alignment of any of the parts involves checking the adjustment of the other parts. The receiver under test will be referred to as the "trouble" receiver in the following discussion.

(a) Remove the covers from both receivers.

(b) Place all switches at OFF (or downward) in both sets. (The SQUELCH switch may have to be turned on subsequently as explained in paragraph *(3)*(a) following.)

(c) Secure the good receiver in the right-hand position of the mounting. Apply appropriate power to the trouble receiver by means of Cord CD-786 or equivalent.

(d) Turn both sets on and set the TUNE-OPERATE switches at TUNE.

(e) Allow both sets 10 to 15 minutes to warm up.

(f) Connect both chassis together using one wire of the above twisted pair. Use the wire which does *not* have the capacitor in series.

(3) Tuning of the I-f Oscillator and the I-f Amplifier Tuned Circuits FL1A, FL2A, and FL3A. A signal from the intermediate-frequency oscillator in the good receiver is picked up by connecting the 0.001-microfarad capacitor (which is attached to the twisted pair as just described) to terminal 7 of FL4 of the good receiver. The other end of the wire in series with the capacitor goes to the control grid (terminal 4) of the modulator (V2) in the trouble receiver, step (c). This tone passes through the intermediate-frequency amplifier and is used to beat with the intermediate-frequency oscillator in the trouble receiver. Thus this intermediate-

frequency oscillator can be tuned to zero-beat with that in the good receiver. As a quantitative indicator for tuning the intermediate-frequency circuits, a 3-volt (1000-or-more-ohms-per-volt) voltmeter is bridged across L1, step (e). A rough adjustment of FL1A, FL2A, FL3A, step (f), may be necessary in order to pass enough intermediate-frequency tone for beating with the intermediate-frequency oscillator. Unless the intermediate-frequency amplifier in the good receiver is shorted, step (b), noise will be superimposed on the test signal. In order to avoid undesirable interference in the alignment, the radio-frequency oscillator in the trouble receiver is disabled by increasing the bias on the grid, step (a). In order to avoid flattened response and consequent errors in alignment, the delayed-automatic-volume-control load resistor, R14, is shorted, step (a). It may be necessary to turn the SQUELCH switch to ON and adjust the SENSITIVITY control until an accurate tuning indication is obtained. In aligning the secondary of an FL unit a 1000-ohm resistor is connected across the primary to improve the accuracy of the adjustment. Similarly, in aligning the primary the resistor is connected across the secondary.

(a) Short-circuit R14 of the trouble receiver. Also connect terminal 5 of V3 to C25—the side to which blue-tracer wires are attached. (It may be necessary to turn the SQUELCH switch to ON and adjust the SENSITIVITY control to obtain a usable reading on the voltmeter when tuning the FL units.)

(b) Short terminals 1 and 2 of FL3A of the good receiver with a short clip lead.

(c) Connect terminal 7 of FL4 in the good receiver through the series capacitor to terminal 4 of V2 in the trouble receiver. Use for this the remaining wire of the twisted pair, the wire which has the capacitor in series. The untwisted part at the ends should be as short as possible. The capacitor should be nearest to the good receiver.

(d) Place the SPEAKER switch of the trouble receiver at ON.

(e) Clip the 3-volt meter across L1 of the trouble receiver with the negative side on the ground lug.

(f) If the receiver is seriously misaligned, obtain a rough alignment by adjusting the slugs in FL3A, FL2A, and FL1A, in that order, for maximum meter reading. (The 1000-ohm shunt is not used in this procedure.)

Note: If no change in meter reading is observed when the slugs of FL3A are adjusted, turn the good receiver on and off and note the deflection of the meter. If this does not cause any change in deflection the trouble receiver may be faulty and require service. If the deflection is too small for satisfactory reading, the connection at terminal 7 of FL4 may be moved to terminal 2 of FL4 to obtain a larger reading for the preliminary adjustment. After that preliminary adjustment it should be returned to terminal 7 of FL4 which gives a signal strength more appropriate for the subsequent tests.

Caution: The lock washers on the tuning slugs of the tuned circuits may be damaged by turning the slugs in too far. When any adjustment of these units is made, make sure that the tuning slugs bind sufficiently to insure permanency of setting. If they feel loose during adjustment, tighten the lock washers by turning them to the right with a small screwdriver.

(g) Align LCU4 of the trouble receiver for zero-beat and turn the TUNE-OPERATE switch to OPERATE.

(h) Clip the 1000-ohm resistor across terminals 3 and 4 of FL3A. Adjust the primary slug (P) for maximum meter reading.

(i) Remove the 1000-ohm resistor and clip it across terminals 1 and 2 of FL3A and adjust the secondary slug (S) for maximum meter reading.

(j) Repeat step (h) for FL2A.

(k) Repeat step (i) for FL2A.

(l) Repeat step (j) for FL1A.

(m) Repeat step (k) for FL1A and remove the 1000-ohm resistor when the alignment is completed.

(n) It is advisable to check all adjustments, especially that of LCU4.

(4) Tuning of FL4: The Discriminator Circuit. The voltmeter is connected across the discriminator load resistors, step (a). The secondary is adjusted for zero d-c output in this meter, step (b). As the secondary slug is adjusted through the proper point, the d-c reading will change polarity. The automatic volume control is restored to operation and the delay bias removed, step (c), and the meter is connected across the resistor (R38) in the plate circuit of V1, step (e), thus giving an indication of automatic-volume-control action amplified through V1. The primary of FL4 can then be adjusted for a minimum reading in the meter. The 1000-ohm shunt is used across the output of FL1A, step (d), to control the gain.

(a) Remove the meter and bridge it across terminals 3 and 7 of FL4. Polarity of the meter cannot be specified as it will depend on the adjustment.

(b) Align the secondary of FL4 for zero reading on the meter. Note that as the slug is varied in either direction from the zero reading, the alignment meter should move *up* scale for one direction and *down* scale for the other.

(c) Remove the short from R14, and ground terminal 1 of FL4.

(d) Place the 1000-ohm shunt between terminals 3 and 4 of FL1A.

(e) Remove the meter and bridge it between terminals 2 and 3 of LCU2A, the positive lead going to terminal 3. It may be necessary to use the 30-volt scale.

(f) Align the primary of FL4 for minimum meter reading.

(g) Remove both the 1000-ohm shunt and the meter.

(h) Remove the short between C25 and terminal 5 of V3.

(i) Remove the lead from terminal 4 of V2 of the trouble receiver, and from terminal 7 of FL4 of the good receiver.

(j) Remove the short between terminal 1 of FL4 and ground.

(5) Tuning of the R-f Oscillator, Assuming the Intermediate Frequency to be Exactly 2.65 MC. This involves beating the radio-frequency oscillator of the trouble receiver with that of the good receiver to give zero-beat in the loudspeaker. The stray pickup in the trouble receiver from the good receiver is sufficient so that no direct connection of the radio frequency between the two receivers is required. The intermediate-frequency oscillator of the trouble receiver has been adjusted and is thus suitable for beating purposes. The meter is bridged across L1, step (a), as an indicator to show when the current through the intermediate-frequency amplifier is increasing even though the frequencies are not close enough together to give an audible beat. It is left in this position to show when LCU1A and LCU2A are properly adjusted. The short is placed across R14, step (b), to avoid a flattened response curve, as discussed in Paragraph 34*b(3)*. The intermediate-frequency oscillator is turned on, step (c), to provide a beat-note. At the upper end of the scale the oscillator is set by adjusting the trimmer C1.7 to give zero-beat in the loudspeaker. Since the intermediate frequency is nominally 2.65 megacycles, there must be a corresponding difference between the two oscillators involved in order to produce a beat tone which will pass through the intermediate-frequency amplifier. For the high-frequency end of the scale, set the trouble receiver dial at 39 megacycles and set the good receiver dial at (39 — 2.65 =) 36.35 megacycles. Then the trimmer, C1.7, is set for zero-beat in the loudspeaker. For the low-frequency end of the scale set the good receiver dial at 27 megacycles and the trouble receiver at 29.65 megacycles. With this setting the slug in LCU3A is set for zero-beat. These two adjustments are then made alternately until the oscillator "tracks" satisfactorily at both ends of the band.

(a) Bridge the meter across L1 (negative terminal toward ground).

(b) Place a short across resistor R14.

(c) Place the TUNE-OPERATE switch of the trouble receiver at TUNE and throw the TUNE-OPERATE switch in the good receiver to OPERATE.

(d) Assuming the intermediate frequency to be 2.65 megacycles, set the good re-

ceiver at (39 — 2.65 =) 36.35 megacycles and the trouble receiver at 39 megacycles.

(e) Adjust the radio-frequency oscillator trimmer capacitor C1.7 of the trouble receiver to give zero-beat in the loudspeaker.

(f) Still assuming the intermediate frequency to be 2.65 megacycles, set the good receiver at 27 megacycles and the trouble receiver at (27 + 2.65 =) 29.65 megacycles, and, in the same way, adjust the slug in LCU3A for zero-beat.

(g) Repeat the preceding two steps until the radio-frequency oscillator tracks at both ends of the band.

(6) Check of the Intermediate Frequency and Readjustment of the R-f Oscillator. In the foregoing procedure it was assumed that both the intermediate-frequency amplifier stages and the intermediate-frequency oscillator were adjusted to exactly 2.65 megacycles. Actually, a variation in this frequency over a moderate range will not interfere with satisfactory operation as long as the adjustment of the radio-frequency oscillator is consistent with the intermediate frequency. For example, if the dial of the trouble receiver is set at 39 when the intermediate-frequency amplifier (and oscillator) circuits of the good receiver and the trouble receiver are tuned for 2.5 megacycles, then set the dial of the good receiver at (39 — 2.5 =) 36.5 megacycles for aligning the radio-frequency oscillator in the trouble receiver. Otherwise, the dial calibration will not be correct. For this reason, it is desirable to make the following tests which supplement Paragraph 34*b(5)* rather than supersede it. The trouble receiver is set (in the middle of the range) at 33 megacycles and the good receiver is adjusted to a frequency which will give zero-beat with the intermediate-frequency oscillator in the trouble receiver. The reading on the dial of the good receiver should be very close to (33 — 2.65 =) 30.35 megacycles. (This reading serves as a guide. The second beat, to be obtained near 35.65, is a better indication of the accuracy of adjustment.) A similar beat, though not so strong, can be obtained by tuning the good receiver the same distance above the trouble receiver. (If the beat note cannot be found readily, due to insufficient pickup, connect the bared end of a piece of insulated wire to the A post of the trouble receiver and extend it across the top of the good receiver to act as an antenna. Remove this wire when the observation is complete.) This dial setting should be between 35.6 and 35.7 megacycles. This allows for the 0.05-megacycle tolerance at (33 + 2.65 =) 35.65 megacycles. If it falls within that range, the radio-frequency oscillator is properly tuned and no further work on it is necessary. If not, steps (d) through (g) should be followed. Assume, as an example, that the two dial settings giving zero-beat were 30.35 and 35.35 megacycles. Half the difference between these frequencies represents the true intermediate frequency which, in this example, comes out as 2.5 megacycles. This figure is then used instead of 2.65 in steps (d) to (g). Ordinarily, the necessary correction will be obtained by a slight change in the trimmer C1.7 at the high end of the scale. The procedure to be followed if a correction is necessary is described in steps (a) through (g).

(a) Set the dial of the trouble receiver to 33 megacycles.

(b) Adjust the dial of the good receiver to give zero-beat at approximately 30.35 megacycles and note the dial reading at which it occurs.

(c) Leaving the trouble receiver tuned to 33 megacycles, retune the good receiver to obtain the (somewhat weaker) beat note between 35 and 36 megacycles. Note the dial reading.

(d) By subtraction, obtain the difference between the two dial readings obtained in steps (b) and (c).

(e) Divide this difference by two.

(f) The value obtained in this way is the actual intermediate frequency.

(g) Repeat the alignment procedure, *(5)*(d) through (g), for the radio-frequency oscillator, using this value in place of 2.65 megacycles.

(h) Make certain that the radio-frequency oscillator tracks at both ends of the band.

(i) Remove the short from terminals 1 and 2 of FL3A in the good receiver.

(j) Replace the cover on the good receiver.

(7) Adjusting LCU1A and LCU2A. In tuning the radio-frequency circuits a shunt is placed across FL1A, step (a), to avoid limiting action. Also, R14 is shorted and the SQUELCH switch turned to ON for the reasons just discussed. If the trouble receiver is not in a mounting, the ground on the primary at LCU1A is floating. Therefore, terminal 2 of LCU1A must be shorted directly to ground, step (b). Also, short the antenna post (terminal 3 of LCU1A) to terminal 2 and ground, step (b), as its effect on the adjustment of the secondary would be noticeable if it were allowed to float. Without the ground, this floating condition would exist as there is no termination across the primary of LCU1A when we are relying on stray pickup for the test signal. For preliminary alignment, at the top of the frequency band, adjust the trimmers C1.1, C1.3, and C1.5 to give maximum reading in the meter; at the bottom of the band, adjust the slugs of LCU1A and LCU2A for maximum meter reading. For final alignment, the 1000-ohm shunt should be removed, the good receiver turned off, and the final alignment of LCU1A and LCU2A made on noise alone at both ends of the scale. This procedure is given as step (k).

(a) Place a 1000-ohm shunt between terminals 1 and 2 of FL1A. Connect the 3-volt meter across L1 of the receiver with the negative side on ground lug. Short R14.

(b) Short terminals 3 and 2 of LCU1A to ground, using the shortest wires.

(c) Set the dial of the trouble receiver to 39 megacycles.

(d) Tune the good receiver at approximately 36.35 megacycles on the dial to give a beat note on the loudspeaker.

(e) Align C1.1, C1.3, and C1.5 for maximum reading on the meter.

(f) Set the dial of the good receiver at 27 megacycles.

(g) Tune the trouble receiver at approximately 29.65 megacycles to give a beat note.

(h) Adjust the slugs in both the primary and secondary of LCU2A and the slug in LCU1A for maximum reading of the meter.

(i) Repeat steps (c) through (h) until these units track at both ends of the band. (This completes the rough adjustment.)

(j) Turn the good receiver off. Turn the SQUELCH switch of the trouble receiver to OFF. Remove the 1000-ohm shunt from FL1A of the trouble receiver.

(k) Repeat the alignment steps for LCU1A and LCU2A using noise background alone for maximum meter reading at both ends of the dial (27 and 39 megacycles).

(l) Remove the short circuit from R14. Remove also the meter, and the short circuits from terminals 3 and 2 of LCU1A to ground.

(m) Replace all cover plates securely.

(n) Replace the dust cover.

(o) Reset the push buttons using a transmitter as described in Paragraph 21*a*.

(p) Place the set in its installation and trim C1.1.

c. Method Using Transmitter.

(1) General. One, or possibly two, misaligned circuits in a receiver can be roughly aligned with the remaining circuits of the receiver, in an emergency, by using an associated transmitter, or the transmitter in a nearby vehicle, as a source of testing frequency. Such an emergency alignment should be checked in accordance with Paragraph 37 as soon as practicable. Alignment of the radio-frequency oscillator unit (LCU3A) should not be attempted by this method. In the instructions which follow, it is assumed that the radio-frequency oscillator is functioning properly.

It is also assumed here that the source of radio-frequency testing frequency is the associated transmitter. Modifications to adapt the method to the use of a transmitter in a nearby vehicle are obvious. (For example, when the local transmitter is used, the RECEIVER TUNE-OPERATE switch is turned to RECEIVER TUNE, whereas it it is turned to OPERATE when another vehicle is used.)

Note: During the following tests, operate the

transmitter dynamotor only when reading the meter or making an adjustment which requires power from the dynamotor.

(2) Testing Apparatus Required.

1—Radio Transmitter BC-684-A known to be in good condition.

1—Mounting FT-237-(*).

1—Volt-ohmmeter of Test Set I-56-(*), or a 1000-ohm-per-volt voltmeter, or a vacuum-tube voltmeter. Meter to have a 3-volt scale and also a 10- or 30-volt scale.

1—Insulated ¼-inch hexagon socket wrench.

1—IRC BT-½, 5000-ohm resistor or its equivalent with clips and short leads.

1—500-micromicrofarad mica capacitor with small clips and very short leads.

2—Wires, each 1½-inches long, with a small clip on each end of each wire.

1—Wire, 6-inches long, with small clip on each end.

(3) Emergency Alignment of I-f Oscillator. Align a defective or replacement LCU4 tuning unit as follows:

(a) Install transmitter and receiver on the mounting. Place the receiver in the right-hand position.

(b) Find the "reduced-voltage" points as directed by Paragraph 33*e*, and make your setting halfway between.

(c) Remove the cover plate which permits access to the adjusting screw in LCU4.

(d) Vary the setting of this screw until a beat note is heard. Carefully adjust for zero-beat. This step brings the replacement tuning unit, LCU4, into alignment with the intermediate-frequency amplifier.

(4) Emergency Alignment of I-f Amplifier. Emergency alignment of an intermediate-frequency filter unit (FL1A, FL2A, FL3A) may be accomplished as follows:

(a) Install the transmitter and the receiver in the mounting, with the receiver in the right-hand position.

(b) Connect the voltmeter (3-volt scale) across the limiter cathode choke, L1, as shown in Fig. 51.

(c) Disable the automatic-volume-control circuit by short-circuiting resistor R14. Use the short jumper wire with a clip on each end.

(d) Using the 6-inch jumper, wind a coil of four turns of ¼-inch diameter about ½-inch long. Connect this coil between terminal 4 (control grid) of modulator tube V2 and the adjacent socket ground terminal. This shunt is to reduce the input to the intermediate-frequency amplifier to a point where the action of the limiter circuits will not mask the tuning point during tests. It may be found necessary to adjust the number of turns or the spacing to secure suitable values, step (h).

(e) Turn the receiver ON-OFF switch to ON; the TUNE-OPERATE switch to TUNE; the SPEAKER switch to ON; the SQUELCH switch to OFF; the VOLUME control to the extreme right. Release the tuning dial by depressing one of the CHANNEL SELECTOR push buttons part way.

(f) Adjust the transmitter to a channel near the 27-megacycle end of its frequency range. Turn the transmitter on. Place the RECEIVER TUNE-OPERATE switch on RECEIVER TUNE.

(g) After the receiver has had time to warm up, carefully adjust the receiver dial (use the same setting as on the transmitter) for zero-beat with the transmitter signal and note the maximum deflection of the voltmeter as the dial is tuned through the zero-beat point. The meter deflection should decrease as the dial is varied to either side of zero-beat. Restore the zero-beat adjustment after completing the observation.

(h) Remove the coil from V2 and note the reading of the voltmeter. The voltmeter reading with the coil in place should not be more than three fourths of the reading with the coil removed. If it is more, adjust the spacing of the turns or change the number of turns until a satisfactory reading is obtained.

(i) Replace the coil.

(j) Detune the receiver by several channels (to a point where no signals are being received) and note the minimum voltmeter read-

ing. (The voltmeter is effective as a tuning indicator only if its deflection is kept between the minimum value and the "three-fourths" reading, step (h). Therefore, keep the deflection within this range at all times during this procedure.)

(k) Remove the cover plates from the tuning unit (FL1A, FL2A, or FL3A) to be aligned.

(l) Adjust the P (primary) and S (secondary) adjusting screws of the tuning unit for a rough approximation of the maximum voltmeter deflection.

(m) Connect the 5000-ohm resistor between terminals 3 and 4 of the tuning unit being adjusted.

(n) Adjust the P screw for a maximum voltmeter reading. See the Note following step (p).

(o) Remove the resistor from terminals 3 and 4 and connect it between terminals 1 and 2.

(p) Adjust the S screw for maximum voltmeter reading.

Note: Check the zero-beat setting occasionally as the work progresses. Also, keep the voltmeter within the limits given in step (j) by adjusting the shunting coil as necessary. Remove the coil and the 5000-ohm resistor.

(5) Emergency Alignment of R-f Amplifier. Make an emergency alignment of a radio-frequency tuning unit (LCU1A or LCU2A) as follows:

(a) Install the transmitter and the receiver in the mounting, with the receiver in the right-hand position.

(b) Connect the voltmeter (3-volt scale) across the limiter cathode choke, L1, as shown in Fig. 51.

(c) Disable the automatic-volume-control circuit by short-circuiting resistor R14. Use the short jumper wire with a clip on each end.

(d) Connect the 500-micromicrofarad capacitor between terminals 1 and 2 of filter unit FL1A. (The capacitor reduces the signal input to the intermediate-frequency amplifier sufficiently to prevent limiter action from masking the desired tuning point in the test.)

(e) Remove the cover plates from the LCU1A and LCU2A tuning units and from the trimmer capacitors, C1.3, C1.5, and C1.7. (The cover plate of C1.7 is beside C24.)

Caution: Do not disturb the setting of the oscillator trimmer capacitor C1.7 during this alignment.

(f) Turn the SPEAKER switch to ON, set the TUNE-OPERATE switch to TUNE, and turn the SQUELCH switch to OFF. Turn the VOLUME control to the extreme right.

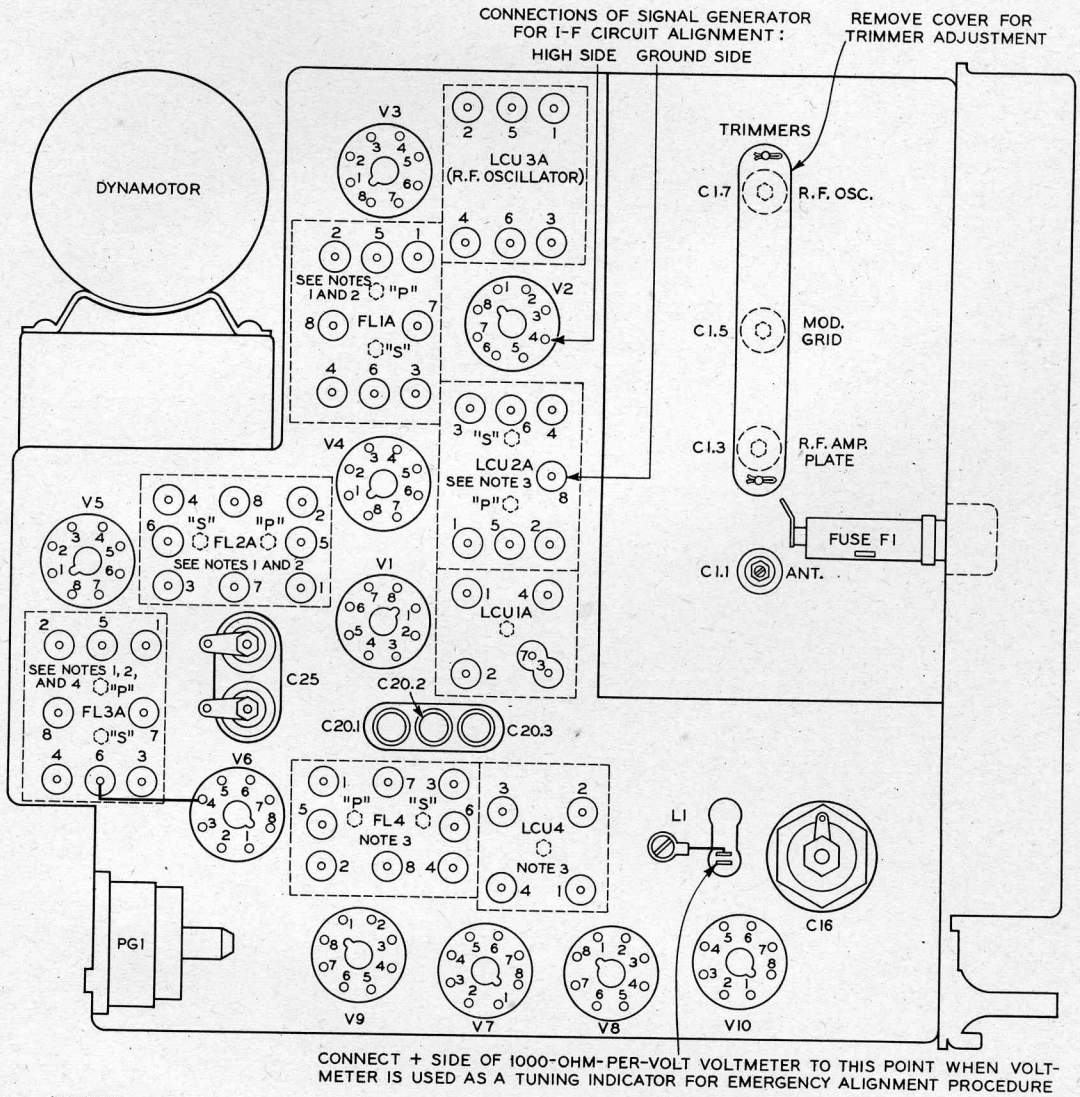
(g) Adjust the transmitter for operation near the 39-megacycle end of its frequency range and start the transmitter and the receiver. Place the transmitter in the RECEIVER TUNE condition.

(h) After the receiver has warmed up, carefully adjust the receiver dial for zero-beat with the transmitter (the receiver dial should read the frequency to which the transmitter is set). Adjust each of trimmer capacitors C1.1, C1.3, and C1.5, for maximum voltmeter deflection. If the 500-micromicrofarad capacitor bridged across terminals 1 and 2 of FL1A has not reduced the signal strength (from the transmitter) sufficiently to obtain a good range of meter deflection, a further reduction may be obtained by connecting that capacitor across terminals 1 and 2 of either FL2A or FL3A instead of FL1A. When the trimmers are properly set, the voltmeter deflection decreases as the set is detuned from the zero-beat point.

(i) Remove the 500-micromicrofarad capacitor shunt from terminals 1 and 2 of the filter unit shunted as called for in step (g). The voltmeter reading with the capacitor in place should be not more than three fourths of the reading with the capacitor removed. If it is more, the capacitor leads are too long, or the clips are not making good contact.

(j) Replace the capacitor and trim the settings of C1.1, C1.3, and C1.5, if necessary.

(k) Operate the transmitter near the 27-megacycle end of its frequency range and carefully adjust the receiver to zero-beat with the transmitter. The reading of the receiver dial should correspond with the transmitter frequency.



NOTES:

1. WHEN THE SHUNTING RESISTOR IS CONNECTED ACROSS TERMINALS 1 AND 2, ADJUST SCREW "S".
2. WHEN THE SHUNTING RESISTOR IS CONNECTED ACROSS TERMINALS 3 AND 4, ADJUST SCREW "P".
   (THE ADJUSTING SCREWS REFERRED TO IN NOTES 1 AND 2 ARE ACCESSIBLE THROUGH THE TOP OF THE FILTER COVER ON THE OTHER SIDE OF THE CHASSIS, AND THE SHUNTING RESISTOR IS CONNECTED AS DESCRIBED IN PARAGRAPHS 34b, 34c, AND 37d).
3. ADJUSTING SCREWS ARE ACCESSIBLE THROUGH THE COVER ON THE OTHER SIDE OF THE CHASSIS.
4. CONNECT THE HIGH SIDE OF THE SIGNAL-GENERATOR OUTPUT TO TERMINAL 6 OF FL3 THROUGH A 0.006-MF MICA CAPACITOR FOR DISCRIMINATOR (FL4) ADJUSTMENT.
   CONNECT THE LOW SIDE OF THE SIGNAL GENERATOR TO CHASSIS.

Fig. 51. Radio Receiver BC-683-A: Location of Alignment and Tuning Controls

(l) Adjust the P (primary) and S (secondary) adjusting screws in tuning unit LCU2A and the single adjusting screw in LCU1A for maximum deflection of the voltmeter.

(m) Readjust the transmitter and receiver to the higher test frequency and trim C1.1, C1.3, and C1.5 for maximum voltmeter deflection.

(n) Check back and forth between the two test frequencies, repeating steps (l) and (m) until no further improvement can be made.

(o) Restore the receiver to normal and check the antenna trimmer capacitor as described in Paragraph 19*a*.

(6) Emergency Alignment of Discriminator. Align a discriminator filter unit (FL4) in an emergency as follows:

(a) Install the transmitter and the receiver in the mounting, with the receiver in the right-hand position.

(b) Connect the voltmeter (3-volt scale) across the limiter cathode choke, L1, as shown in Fig. 51.

(c) Disable the automatic-volume-control circuit by short-circuiting resistor R14. Use the short jumper wire with a clip on each end.

(d) Connect the 500-micromicrofarad capacitor between terminals 1 and 2 of filter unit FL2A. (The capacitor reduces the signal input to the intermediate-frequency amplifier sufficiently to prevent limiter action from masking the desired tuning point in the test.)

(e) Remove the cover plate from filter FL4.

(f) Turn the SPEAKER switch to ON, turn the TUNE-OPERATE switch to TUNE, and turn the SQUELCH switch to OFF. Turn the VOLUME control to the extreme right.

(g) Adjust the transmitter for operation near the 27-megacycle end of its frequency range and start the transmitter and the receiver. Place the transmitter in the RECEIVER TUNE condition.

(h) After the receiver has warmed up, carefully adjust the receiver tuning dial for zero-beat with the transmitter frequency. Observe that zero-beat occurs at maximum deflection of the voltmeter and note the maximum reading.

(i) Remove the capacitor from FL2A and note the new voltmeter reading. The voltmeter reading with the capacitor connected to FL2A should not exceed three fourths of the reading with the capacitor removed. If it does, the capacitor leads are too long, or the clips are not making good contact.

(j) Reconnect the capacitor to terminals 1 and 2 of FL2A.

(k) Ground terminal 1 of FL4 to the chassis with a short jumper wire. Remove the voltmeter from across L1 and connect it between terminals 3 and 7 of filter FL4 (10-volt or 30-volt scale, + terminal to terminal 3 of the filter).

(l) Check the zero-beat setting of the dial while observing the voltmeter. The meter should read zero at zero-beat and reverse polarity as the receiver is tuned through the zero-beat point. If this is not the case, align the secondary by adjusting the S (secondary) adjusting screw for zero voltmeter reading.

(m) Remove the voltmeter from FL4 and connect it (3-volt scale) between terminals 2 and 3 of tuning unit LCU2A (+ terminal of voltmeter to terminal 3 of LCU2A). Remove the short circuit from resistor R14.

(n) Adjust the P (primary) screw in filter FL4 for a minimum deflection of the voltmeter.

(o) Reconnect the voltmeter (10-volt or 30-volt scale) to terminals 3 and 7 of FL4 and recheck the adjustment of screw S in FL4 as in step (l).

(p) Restore the receiver to normal.

35. Emergency Alignment of Radio Transmitter BC-684-A.

a. General. The test procedures described hereafter are intended to apply when it is necessary to replace one or more transmitter components which are likely to affect alignment of the transmitter tuned circuits and a precision wavemeter is not available for use. The critical components are: coils L101, L103A, L104, L105A, L106, L107, L108, and L110; the ganged adjustable capacitor assembly C106, C113, C115,

C119, C125, C152, and C156; and trimmer capacitors C107 (if used in the transmitter under test), C114, C116, C120, C126, C153, and C157. Replacement of capacitor C147 or the channel selector assembly also necessitates checking alignment of the circuits. The location of the alignment controls for the transmitter is shown in Fig. 52.

Note: During the following tests operate the dynamotor only when reading the meter or making an adjustment which requires power from the dynamotor. Paragraph 20*b* should be read and understood before the following or other servicing tests are made.

b. Testing Apparatus Required.

1—Narrow-blade (1/8-inch) screwdriver or, preferably, a long-handled hexagon adjusting tool.

1—Rule (6-inches long x 3/16-inch wide).

c. Preliminary to Alignment. It is desirable to check the operation of the oscillator and metering circuits prior to emergency alignment of the transmitter circuits. This may be done as follows:

(1) Insert a low-numbered and a high-numbered crystal (preferably Channel 270 and Channel 389) in sockets numbered 1 and 10, respectively, in the crystal operating compartment.

(2) Set the METER SWITCH to position 2 (first radio-frequency amplifier grid current), turn the TUNE-ANT CUR switch to TUNE, and unlock the channel selector. This is described in Paragraph 21*a*.

(3) Press CHANNEL SELECTOR push button no. 1, start the transmitter, and operate the RECEIVER TUNE-OPERATE switch to RECEIVER TUNE.

(4) Observe the reading on the panel meter.

(5) Repeat steps *(3)* and *(4)* for push button no. 10. If meter readings are noted for both these frequencies the oscillator is operating properly.

d. Emergency Alignment of R-f Amplifier.

(1) In later transmitters C107 has been omitted, but if there is a C107 in the transmitter under test, see that it is set to the minimum capacitance position (open end of slot to left as viewed from the front of the transmitter).

(2) Press CHANNEL SELECTOR push-button no. 10. Set the METER SWITCH to position 3 (grid current of rectifier) and the RECEIVER TUNE-OPERATE switch to RECEIVER TUNE.

(3) Adjust the gang capacitor assembly for maximum deflection of the meter.

(4) Press push button no. 1 and repeat step *(3)*.

(5) Carefully release push button no. 1, carefully turn the gang capacitor control to the extreme front, and lock the selector unit as also described in Paragraph 21*a*.

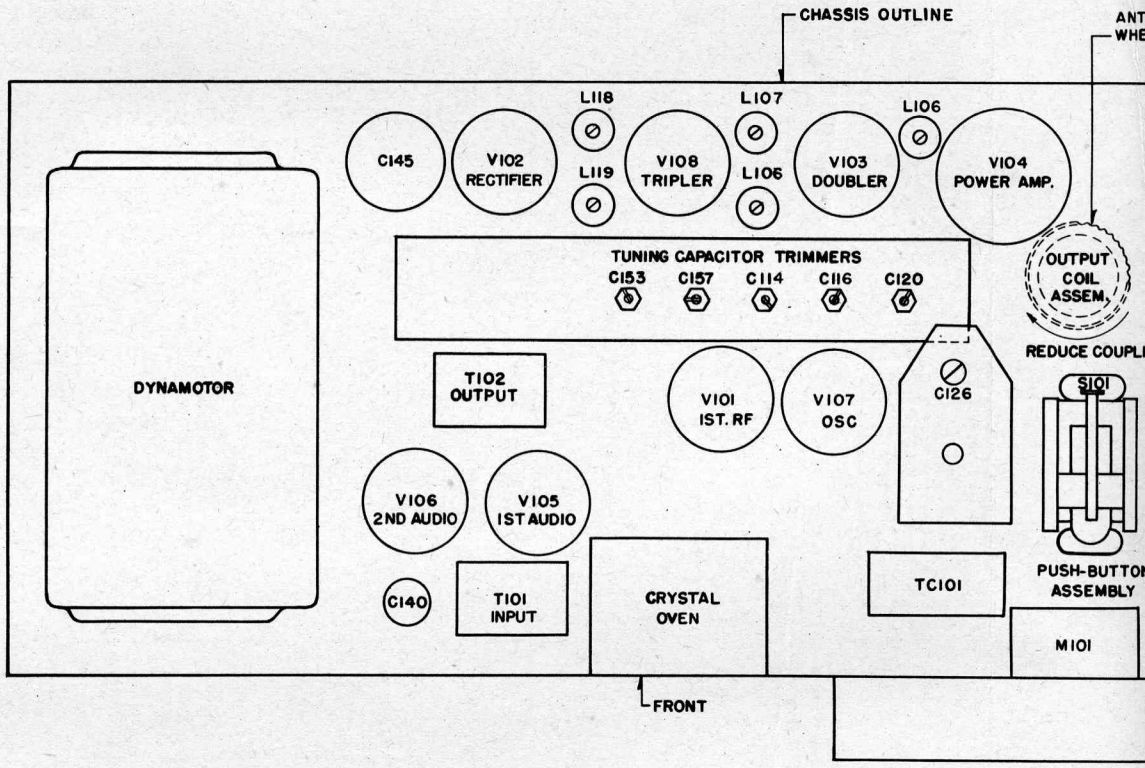
(6) Check the CHANNEL SELECTOR adjustments by pressing the no. 1 and no. 10 push buttons and observing the maximum meter deflection at each frequency as the gang capacitor assembly is rotated slightly against the restoring force of the selector. *Do not attempt to rotate the capacitor assembly more than a few degrees.* The test meter should indicate a maximum at the settings determined by the selector. If this is not the case, repeat steps *(2)* through *(6)* until you obtain the proper adjustment of the selector.

e. Emergency Alignment of Rectifier. Since the filters following the rectifier are primarily intended for selection of the correct crystal harmonic frequency, it is important that these circuits be disturbed as little as possible when replacing components which affect the alignment.

(1) If L118 or L119 has been replaced, adjust the tuning slugs to about 3/4 inch from the open end of the coil as measured with the scale mentioned in Paragraph 35*b*.

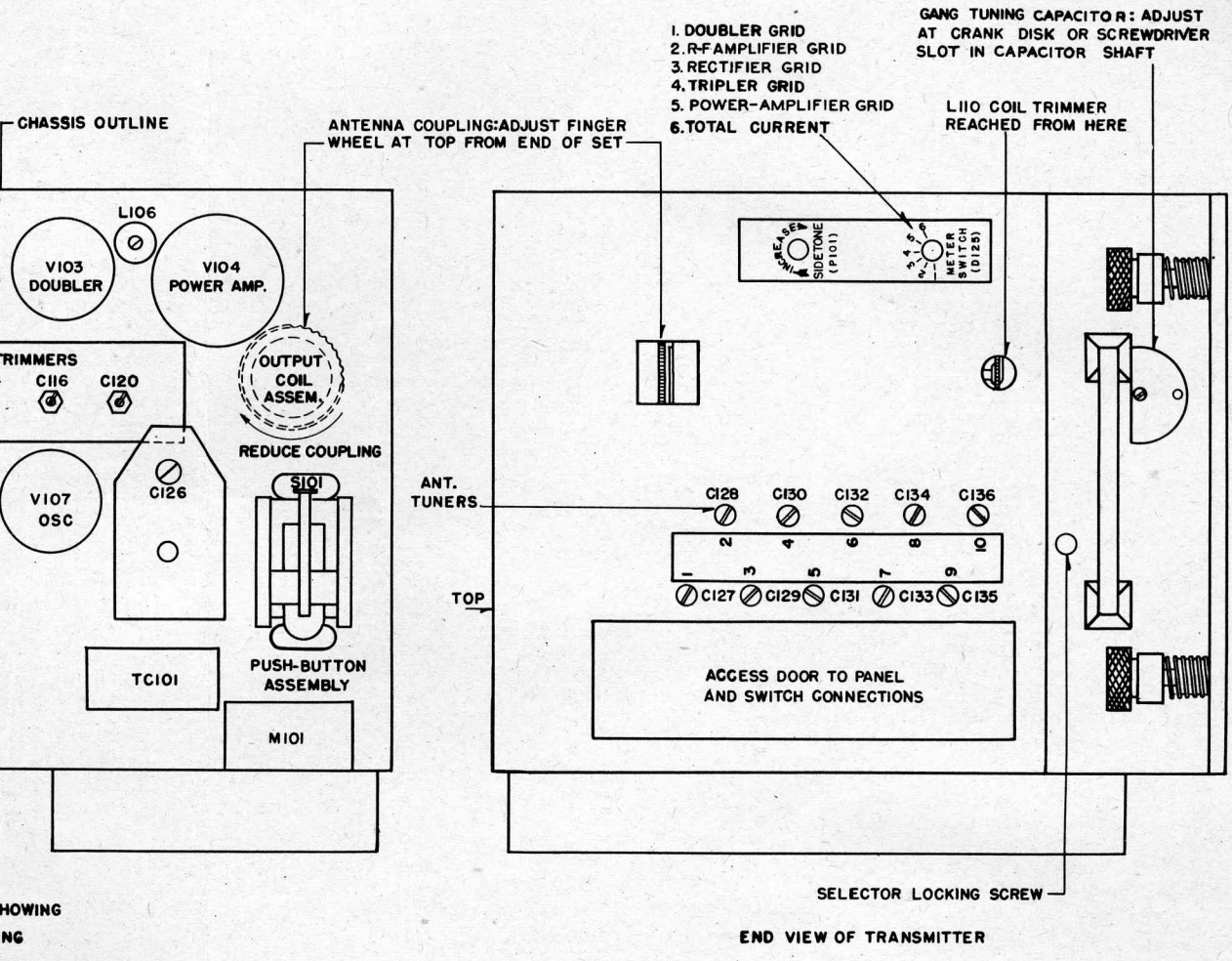
(2) Set the METER SWITCH to position 4 (grid current of tripler).

(3) Start the transmitter at the high-frequency end of its range (by pressing the appropriate CHANNEL SELECTOR push button and



TOP VIEW OF TRANSMITTER, COVER REMOVED, SHOWING
LOCATION OF GANGING ADJUSTMENTS AND TUNING

Fig. 52. Radio Transmitter BC-684-A: Location of A



smitter BC-684-A: Location of Alignment and Tuning Controls

throwing the RECEIVER TUNE-OPERATE switch to RECEIVER TUNE).

(4) Adjust C153 and C157, respectively, for maximum deflection of the meter.

(5) Adjust the transmitter to the low-frequency end of its range (by pressing the appropriate CHANNEL SELECTOR push button and throwing the RECEIVER TUNE-OPERATE switch to RECEIVER TUNE) and adjust L119 and L118, in turn, for maximum meter deflection.

(6) Repeat steps *(3)*, *(4)*, and *(5)* until no further increase in meter deflection can be obtained.

(7) Start a nearby receiver, throw the SPEAKER switch to ON, the TUNE-OPERATE switch to TUNE, and the SQUELCH switch to ON. Adjust the SENSITIVITY control so that the receiver is operated by only one frequency from the transmitter. This frequency, as determined from the receiver dial calibration, should be that for which the transmitter is tuned. If it is not, readjust the filter circuits but with a somewhat different initial setting of the tuning slugs in L118 and L119 until the receiver (used as a wavemeter) indicates that this stage has been aligned properly and the correct harmonic has been chosen by the L118, L119 and C153, C157 circuits.

f. Emergency Alignment of Tripler.

(1) If L106 or L107 has been replaced, adjust the tuning slugs to about three-fourths inch from the open end of the coil.

(2) Set the METER SWITCH to position 1 (grid current of doubler).

(3) Adjust the transmitter at the high-frequency end of its range. (See Paragraph 35*c*.)

(4) Adjust C114 and C116, in turn, for maximum deflection of the meter.

(5) Adjust the transmitter to the low-frequency end of its range and adjust L106 and L107 for maximum meter deflection.

(6) Repeat steps *(3)*, *(4)*, and *(5)* until no further increase in meter deflection is obtainable.

g. Emergency Alignment of Doubler.

(1) If L108 has been replaced, adjust the tuning slug to about 3/4 inch from the open end of the coil.

(2) Set the METER SWITCH to position 5 (grid current of power amplifier).

(3) Adjust the transmitter at the high-frequency end of its range and adjust C120 for maximum meter deflection.

(4) Adjust the transmitter to the low-frequency end of its range and adjust L108 for maximum deflection of the meter.

(5) Repeat steps *(3)* and *(4)* until no further increase in meter deflection is possible.

h. Emergency Alignment of Power Amplifier.

(1) If the L110-L111 coil assembly has been replaced, adjust the tuning slug at the bottom of L110 to the center of its range of variation.

(2) Set the METER SWITCH to position 6 (total plate and screen current) and make sure the RECEIVER TUNE-OPERATE switch is at OPERATE and left there for the following power amplifier tests.

(3) Set for minimum coupling of L111 to L110 (rotation of the coupling control to the right). Detune C136 by setting it to the maximum capacitance position and detune C127 by adjusting it to the minimum capacitance position.

(4) Start the transmitter at the high-frequency end of its range. (For this test the dynamotor must be started by operating a microphone switch.) Adjust C126 for a *minimum* deflection of the meter. If a tuning point cannot be found, try a different setting of the L110 adjusting slug.

(5) Adjust the transmitter to the low-frequency end of its range. Adjust the slug in L110 for a *minimum* deflection of the meter. Adjust this slug by inserting a screwdriver through the hole in the end of the transmitter and turning the slug adjusting gear.

(6) Adjust C126 at the higher frequency and L110 at the lower frequency until no further reduction in the meter deflection can be made at either end.

36. **Emergency Sources of Test Tones.** In the absence of a test oscillator, test tones can be obtained from a receiver or a transmitter known to be in good condition. The methods of doing this are discussed in detail in Paragraph 39*g(6)* for the receiver and Paragraph 39*g(7)* for the transmitter. Signal sources other than a signal generator may be summarized as follows:

a. A-f Signal.

(1) A good receiver will provide audio-frequency noise when there is no input signal.

(2) If two good receivers are available they can be used together to provide a beat note.

(3) A good transmitter may be used with a microphone into which the operator hums or whistles. The resulting audio output can be picked up for test purposes.

b. I-f Signal. This may be obtained from a good receiver.

c. R-f Signal. This may be obtained from either a receiver or a transmitter.

d. Atmospheric Noise. Atmospheric noise may be used as a signal source in the absence of other signal source. Since noise is an indefinite sort of signal (no precise frequency) and the intermediate-frequency band width is considerably wider than the range of frequency which may be heard, the number of circuits aligned by this means should be a minimum.

e. Signals from Distant Vehicle. Signals from a vehicle about 10 miles distant may be used as a rough check of receiver sensitivity, particularly when such signals are compared to the noise background when the distant transmitter is off the air.

f. Signals from Nearby Vehicle. Signals from a nearby vehicle which is operating into Antenna A-83 (phantom), or the antenna shown in Fig. 77, or a 40-watt Mazda lamp, instead of the regular antenna structure, are strong enough for testing purposes.

37. **Precision Alignment of Radio Receiver BC-683-A.**

a. General. Whenever a complete inspection of a receiver is made, check alignment of the tuned circuits in accordance with the following procedure:

b. Testing Apparatus Required.

1—Adapter FT-384-(*).

1—Insulated 1/4-inch hexagon socket wrench.

1—Output meter from Test Set I-56-(*), or its equivalent.

1—Volt-ohmmeter I-107-(*), or its equivalent.

1—Signal generator (frequency-modulated).

1—Cornell-Dubilier capacitor, Type 1W, 0.006-microfarad, or its equivalent, with suitable clips.

1—IRC resistor, Type BT-1/2, 1000 ohms, or its equivalent, equipped with insulated clip connectors.

Caution: When connecting or disconnecting these wires, turn the receiver off each time to avoid shocks.

Adapter FT-384-(*) is a switching box for connecting test meters in various parts of the circuit to facilitate alignment procedure. Photographs and a circuit diagram are shown in the following figures:

Fig. 53. Adapter FT-384-(*): Front View.
Fig. 54. Adapter FT-384-(*): Back View.
Fig. 55. Adapter FT-384-(*): Application to Radio Receiver BC-683-A.
Fig. 56. Adapter FT-384-(*): Schematic and Wiring Diagram.

c. Alignment of Discriminator Circuit (FL4) and I-f Oscillator Circuit (LCU4). When aligning the intermediate-frequency amplifier or discriminator, if no shielded room is

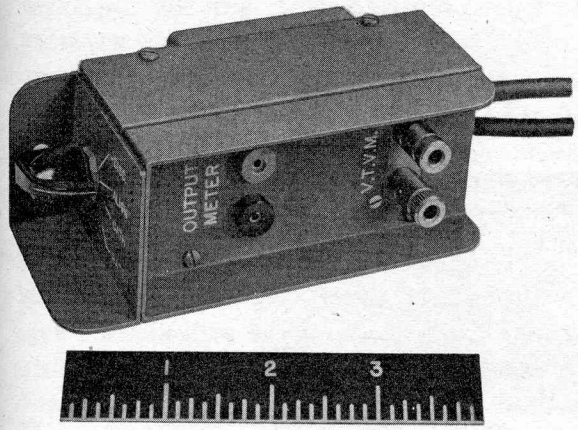


Fig. 53. Adapter FT-384-(*): Front View

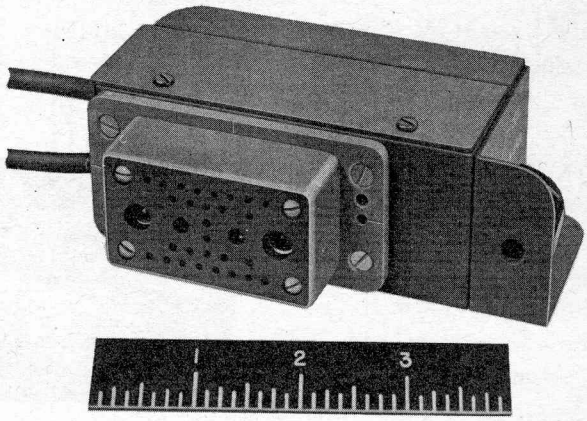


Fig. 54. Adapter FT-384-(*): Back View

available and disturbing interference from nearby electrical equipment is observed, this interference can be minimized by connecting a short strap lead from terminal 5 of V3 to C25 (the terminal to which blue-tracer wires are connected), whenever using the intermediate frequency.

(1) Remove the dust cover from the receiver.

(2) Make sure that a dynamotor of the correct primary voltage rating is in place.

(3) Loosen the cover plates from LCU1A, LCU2A, FL1A, FL2A, FL3A, FL4, and LCU4. (The plates may be loosened by removing the cotter pin at one end.)

Caution: Do not remove the cover from LCU3A.

(4) Set the receiver controls as follows: The SPEAKER switch at ON, the SENSITIVITY and VOLUME controls to the extreme right, the TUNE-OPERATE switch at OPERATE, the REC switch at OFF until ready, the OUTPUT TO PHONES switch at ON, and the SQUELCH switch at OFF.

(5) Set up Volt-ohmmeter I-107-(*) as follows: Connect the battery plug attached to the short cable at the bottom of the volt-ohmmeter to a Battery BA-40. Set the SELECTOR switch for —VOLTS and the RANGE switch for 3 V.D.C. Short the COMMON and D.C. VOLTS leads together and turn the ZERO ADJ knob for zero indication on the meter. It is advisable to leave Volt-ohmmeter I-107-(*) on for approximately five minutes before using it, to allow the zero adjustment of the meter to become stable. Connect the volt-ohmmeter leads to the V.T.V.M. posts of Adapter FT-384-(*).

(6) Connect the high side of the signal generator output through the 0.006-microfarad capacitor to the limiter control grid (terminal 6 of FL3A) and connect the low side of the generator to the chassis.

(7) Adjust the generator for an output of between 1.0 and 2 volts at 2.65 megacycles.

(8) Plug Adapter FT-384-(*) into receptacle PG1 of the receiver and connect to the battery. Turn the switch of the adapter to DISC (discriminator output voltage).

(9) Turn the receiver to ON and, after allowing sufficient time for the vacuum tubes to heat, adjust screw s (secondary) in filter FL4 for zero current in the voltmeter. The meter should reverse polarity as s is varied to either side of the zero-current point. The selector switch of Volt-ohmmeter I-107-(*) can be turned from —VOLTS to +VOLTS to note this effect. This is an accurate indication of frequency and can be used as a check during the test. A check may be made from time to time to make sure that this meter still reads zero. If it does not, the signal generator should be readjusted to restore the reading to zero.

(10) Throw the TUNE-OPERATE switch to TUNE. Adjust the slug in tuning unit LCU4 for

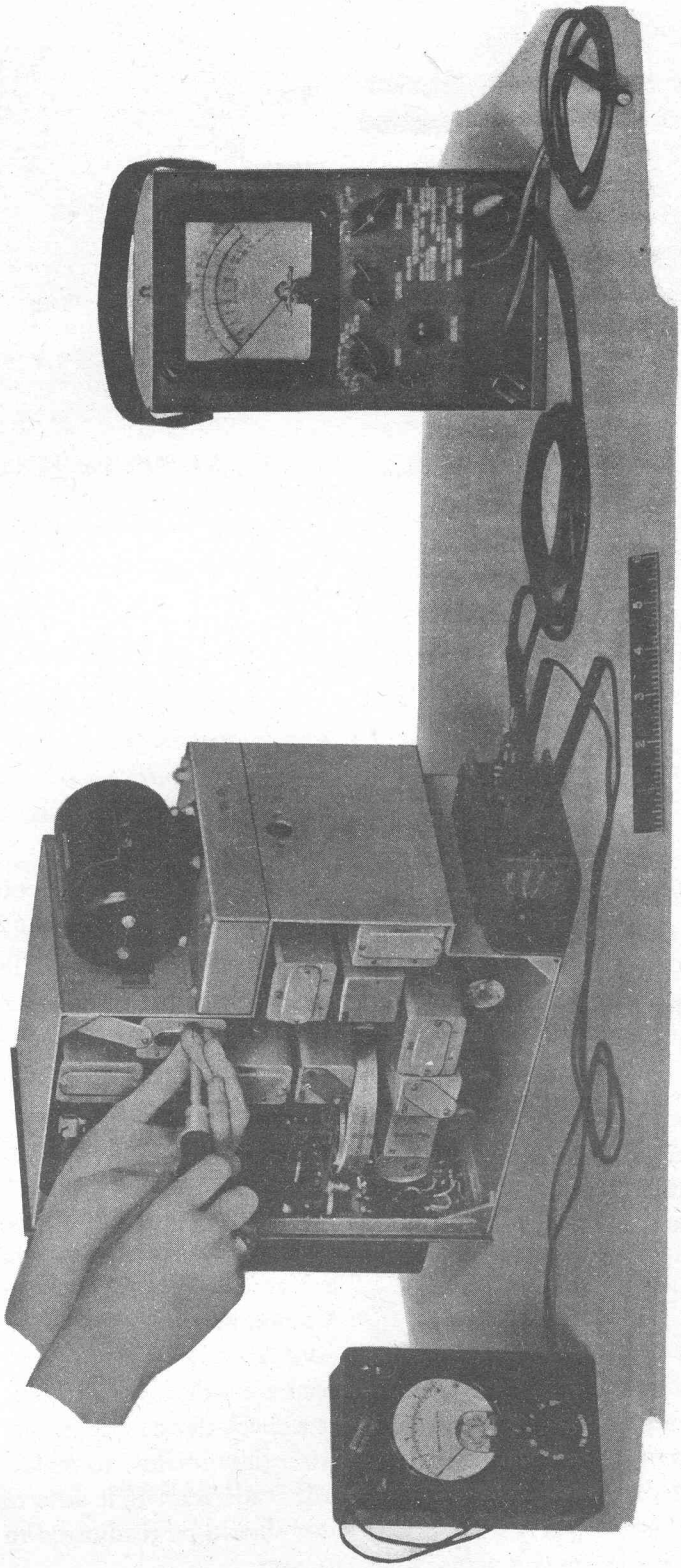


Fig. 55. Adapter FT-384-(*): Application to Radio Receiver BC-683-A

zero-beat. Set the TUNE-OPERATE switch to OPERATE.

(11) Turn the switch of the adapter to ALIGN and adjust the P (primary) adjusting screw in FL4 for maximum indication on the volt-ohmmeter.

(12) Restore the adapter switch to DISC and trim the S screw setting for zero meter current. Adjust the signal generator 50 kilocycles above and 50 kilocycles below 2.65 megacycles and make sure that the readings of the volt-ohmmeter are approximately the same (but of opposite polarity).

(13) Vary the signal generator frequency *above* 2.65 megacycles until the test meter deflection is greatest. Note the meter reading and the generator frequency. The frequency should be between 2.725 and 2.745 megacycles.

(14) Repeat step *(13) below* 2.65 megacycles. The meter reading should be within 0.75 volt of the previous reading and the frequency should be between 2.560 and 2.580 megacycles.

(15) Place the switch of the adapter at CATH, with the signal generator set for 1.0-volt output at 2.65 megacycles and note the reading of the volt-ohmmeter for later use in testing the intermediate-frequency amplifier.

d. Alignment of I-f Amplifier.

(1) Reduce the signal generator output to zero and connect its shielded cord to the control grid of the modulator (terminal 4 of V2). Exposed unshielded wires are dangerous and should be kept as short as possible, preferably less than 2 inches, *including the clip.*

(2) Adjust the generator to a small output at 2.65 megacycles and adjust it for zero-beat with the intermediate-frequency oscillator when the TUNE-OPERATE switch is set at TUNE. Then restore the switch to OPERATE.

(3) With the switch of the adapter at CATH, increase the generator output sufficiently to cause a reading of 0.9 on the volt-ohmmeter. Adjust the generator output from time to time during the following alignment to maintain a meter reading of between 0.6 and 0.9 volt.

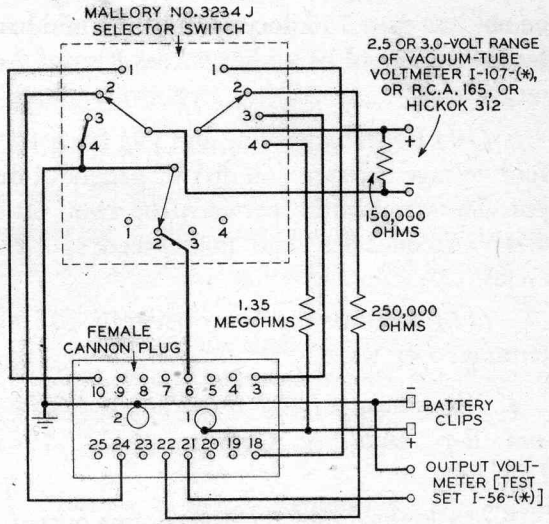


Fig. 56. Adapter FT-384-(*): Schematic and Wiring Diagram

(4) Connect the 1000-ohm resistor between terminals 3 and 4 of filter unit FL3A and adjust the primary of FL3A designated P, for maximum voltmeter reading.

(5) Connect the resistor between terminals 1 and 2 of FL3A and tune the secondary of FL3A, designated S, for maximum voltmeter indication.

(6) Repeat steps *(4)* and *(5)* for filter units FL2A and FL1A, respectively. Upon completion of these adjustments, note the signal generator output required to obtain the same meter deflection as in Paragraph 37*c(15)*. It should not be necessary to increase the signal generator output beyond 50 microvolts to obtain this reading.

(7) Vary the signal generator frequency through the 2.65-megacycle setting and note that the selectivity is approximately symmetrical about the mid-frequency.

(8) Adjust the generator frequency to 2.65 megacycles and the generator output as required for a meter current of 0.9 volt.

(9) Double the signal generator output voltage (6 db increase) and determine the frequencies above and below 2.65 megacycles at which 0.9 volt is obtained. The band width between the two "6 db down" frequencies should

be not less than 75 kilocycles and the mid-band frequency should be within 5 kilocycles of 2.65 megacycles.

(10) Repeat steps *(8)* and *(9)* for a 1000-fold voltage increase (60 db) of generator output. The band width between the two "60 db down" frequencies shall not exceed 350 kilocycles.

(11) Remove the strap between C25 and terminal 5 of V3.

e. Alignment of R-f Oscillator (LCU3A) and R-f Amplifier Circuits (LCU1A and LCU2A).

(1) Reduce the signal-generator output to zero and connect its shielded output cord directly to the A and G binding posts on the receiver, with short leads. (This will be a test through the whole receiver except the connections from the front A and G binding posts to the regular A and G terminals in the plug PG1. It may be wise, therefore, to test for continuity between these two sets of terminals.)

(2) Rotate the tuning dial to the stop at the 27-megacycle end of the scale. The reference line on the dial should be in approximate alignment with the tuning index. If the error is 1/8 inch or more, repair the unit. This involves removing the front panel and adjusting the glass with the hairline on it. It should be done only if unavoidable.

(3) Adjust the dial and the signal generator to 39 megacycles.

(4) Loosen the cover plate (near C24) from C1.3, C1.5, and C1.7 and the cover plate of LCU3A.

(5) Turn the switch of Adapter FT-384-(*) to DISC.

(6) Place the TUNE-OPERATE switch of the receiver at TUNE.

(7) Adjust the trimmer C1.7 for zero-beat in the loudspeaker. The (discriminator) voltmeter should read zero when the frequency is correct. This is an additional check on the frequency of the intermediate-frequency oscillator.

(8) Set the signal generator and the receiver dial at 27 megacycles and adjust the slug in LCU3A for zero-beat.

(9) Repeat steps *(7)* and *(8)* until the oscillator tracks satisfactorily at both ends of the band.

(10) When the oscillator is satisfactory at both ends of the band, check the 36-, 33-, and 30-megacycle points also. Zero-beat should be obtained within one-half dial division at each of these frequencies. If tracking at these frequencies is not satisfactory repeat step *(7)* using 38 megacycles and step *(8)* using 28 megacycles. After the dial tracking is regarded as satisfactory, take care to avoid touching C1.7 and the slug of LCU3A, when making further adjustments.

(11) Turn the switch of Adapter FT-384-(*) to CATHODE and restore the TUNE-OPERATE switch to OPERATE.

(12) Increase the signal generator output sufficiently to cause a meter reading of 0.9 volt. Adjust the generator during the course of the following procedure to maintain a reading of between 0.6 and 0.9 volt on the meter.

Note: During the final alignment adjustments it is usually impossible to keep the meter deflection below 0.9 volt by reducing generator output. Under these conditions modulate the generator with 400 cycles and a frequency swing of ± 15 kilocycles. Connect the output meter of Test Set I-56-(*) to Adapter FT-384-(*), and supplement the test meter deflection by observing the output meter deflection.

(13) With the signal generator at 39 megacycles, tune the receiver dial for zero-beat at 39 megacycles. Adjust, in turn, trimmer capacitors C1.5, C1.3, and C1.1 for maximum test meter deflection.

(14) Adjust the generator and the receiver to 27 megacycles as in step *(13)*.

(15) Adjust, in turn, the slugs in the LCU1A and LCU2A shield cans for maximum deflection of the meter.

(16) Readjust the trimmer capacitors at 39 megacycles and the inductance trimmers at 27 megacycles alternately until no further improvement can be obtained.

f. Check of Sensitivity and Stability.

(1) Set the signal generator to 39 megacycles and adjust the receiver to zero-beat at 39 megacycles. Then reduce the signal generator to zero output.

(2) Switch the SQUELCH control to ON and adjust the SENSITIVITY control so that the CALL SIGNAL lamp is *barely* extinguished.

(3) Increase the generator output sufficiently to illuminate the CALL SIGNAL lamp. A signal of 1.0 microvolt or less should suffice.

(4) Repeat steps *(2)* and *(3)* at 27 megacycles.

(5) Set the signal generator to give 3 microvolts output at 39 megacycles. It should be possible to extinguish the CALL SIGNAL lamp by turning the SENSITIVITY control to the left. Repeat this test at 27 megacycles.

(6) Throw the TUNE-OPERATE switch to TUNE and adjust the tuning dial for a low-pitched beat note.

(7) Vary the signal-generator output from about 1.0 to 1000 microvolts. The pitch of the beat note should remain within audibility over the entire range of signal voltage.

g. Output Power Measurement.

(1) Adjust the signal-generator frequency to 27 megacycles and 1.0-microvolt output.

(2) With the SPEAKER switch at ON, and the TUNE-OPERATE switch at TUNE, set the OUTPUT TO PHONES switch to ON, and the SQUELCH switch to ON. Turn the SENSITIVITY and VOLUME controls to the extreme right.

(3) Tune to zero beat with the signal generator and operate the TUNE-OPERATE switch to OPERATE. Turn the SPEAKER switch to OFF.

(4) Modulate the signal generator with 400 cycles with a frequency deviation of 15 kilocycles and read the output meter. The meter should read over 18 volts.

h. Noise Test. With the signal-generator output at 1.0 microvolt, remove the modulation from the signal. The output meter should not read more than one fifth of the reading obtained in Paragraph 37*g(5)*.

i. Check of Limiter Action.

(1) With conditions as in Paragraph 37*g*, increase the signal-generator output to 10 microvolts and observe the reading of the output meter.

(2) Increase the signal-generator output to 100, 1000, and 10,000 microvolts successively. The voltmeter reading should stay within ± 5 volts of the reading obtained in *(1)*.

j. Volume Control. Remodulate the signal with 400 cycles with a frequency deviation of 15 kilocycles and 1.0-microvolt input, and gradually rotate the VOLUME control to the left. The output meter should decrease progressively to less than 1.0 volt. After restoring the volume to maximum, turn the SPEAKER switch to ON. The output meter reading should remain approximately constant. Observe the tone from the loudspeaker as a check on its operation. A very weak response or a bad rattle may indicate that the speaker cone has been damaged.

38. Precision Alignment of Radio Transmitter BC-684-A.

a. General. Whenever a complete inspection of a transmitter is made, check alignment of the tuned circuits as follows:

b. Testing Equipment Required.

1—Antenna A-83 (phantom), or an artificial antenna (Fig. 77), or, if radiation is permissible, a vehicle antenna of correct dimensions (including lead-in and ground).

1—Sensitive precision wavemeter, 4- to 20-megacycle range.

1—Narrow-blade (⅛-inch) screwdriver or long-handled hexagon socket wrench for adjusting the trimmer capacitors and coil slugs.

1—$\frac{3}{16}$-inch screwdriver for locking the selector, etc.

1—6-inch rule (narrow blade).

1—Cord CD-786 for connection of the transmitter under test to the power supply through a convenient mounting or equivalent.

c. Preliminary to Alignment.

(1) Throw the TRANSMITTER switch to OFF, the RECEIVER TUNE-OPERATE switch to OPERATE, and the TUNE-ANT CUR switch to TUNE.

(2) Insert Crystal Holder FT-241-A, Channel 270, into socket no. 1 and Crystal Holder FT-241-A, Channel 389, into socket no. 10 in the crystal operating compartment. If these particular crystals are unavailable, others within five channels of these may be used.

(3) Remove the top and bottom cover plates from the transmitter and lay the transmitter on its back so the bottom and top sections are accessible. Plug one end of Cord CD-786 into the left end of the transmitter and the other end into the left connector of the mounting which is connected to a large 12- or 24-volt battery supply. Make sure a dynamotor of the correct input voltage rating has been inserted in the transmitter.

(4) Unlock the channel selector (see Paragraph 21*a*) and then set the gang capacitor for minimum capacitance (plates all out).

d. Alignment of First R-f Amplifier.

(1) Set the METER SWITCH to position 2 (grid current in the first radio-frequency amplifier) and turn the TRANSMITTER switch to ON.

(2) Set C107 to the minimum capacitance position (open end of slot at left as viewed from front of the transmitter).

Note: Capacitor C107 has been omitted from later transmitters.

(3) Press push button no. 10 and start the dynamotor by placing the RECEIVER TUNE-OPERATE switch on RECEIVER TUNE. If the oscillator and metering circuit are working, the meter will deflect, indicating current in the first radio-frequency amplifier grid circuit. Stop the dynamotor by throwing the RECEIVER TUNE-OPERATE switch to OPERATE. Do not let the dynamotor run for long periods of time during the following tests.

(4) Set the METER SWITCH to position 3 (grid current in rectifier).

(5) Start the dynamotor (RECEIVER TUNE-OPERATE switch to RECEIVER TUNE). Adjust the gang capacitor for maximum meter deflection and observe the relative position of the capacitor plates. Rotate the gang capacitor by inserting a screwdriver in the slot on the end of the gang capacitor shaft (located near the handle on the right end of the transmitter) or by the associated small knob.

(6) Press push button no. 1 and repeat step *(5)*. The observed rotation of the gang capacitor in passing from no. 10 to no. 1 should be at least 75 per cent of the total possible rotation.

(7) Carefully release push button no. 1, turn the gang capacitor to the extreme right, and lock the selector unit.

(8) Start the transmitter (dynamotor). Check the selector adjustment by pressing the no. 1 and then the no. 10 push button. Observe the maximum meter deflection at each frequency as the gang capacitor is varied slightly against the restoring force of the selector springs. *Do not attempt to rotate the capacitor control more than a few degrees.* The meter should indicate a maximum deflection at the capacitor setting determined by the selector. If the gang capacitor has not been properly positioned at each frequency, repeat the procedure, Paragraphs *(5)* through *(8)*, until the proper adjustment is obtained or the trouble is located.

e. Alignment of Rectifier.

(1) Set the METER SWITCH to position 4 (grid current in tripler).

(2) Adjust the tuning slugs in L119 and L118 to about ¾ inch from the open end of the coils. This may be measured with the 6-inch narrow blade rule inserted in the open end of the coil form.

(3) Set C153 and C157 to the mid-capacitance position (open end of slot toward rear of set).

Note: Steps *e(2)* and *e(3)* are unnecessary if there is reason to believe that there has been no major change in the coils or capacitors in this stage.

(4) Adjust the wavemeter to one sixth of the output frequency (38.9/6 = 6.48 megacycles) and place the pickup coil near L118 and L119.

Caution: The wavemeter may affect the tuning of L118 and L119 if it is coupled too closely to these coils.

(5) Press push button no. 10, start the dynamotor, and adjust C153 and C157 for a maximum deflection of the transmitter panel meter at the wavemeter frequency. *Take care that the circuits are being tuned to the correct frequency.* Wavemeter resonance is indicated by a dip in panel meter reading. If the circuits cannot be tuned, try a different setting of the L119 and L118 tuning slugs. Repeat this procedure until a panel meter deflection is obtained, and with the wavemeter determine the frequency to which the circuits are tuned. If the tuned frequency is higher than the correct frequency, increase the tuning inductance or capacity, or both; if the tuned frequency is lower than the correct frequency, decrease the tuning inductance or capacity, or both, until the correct frequency is obtained. The transmitter employs copper tuning slugs in the coils and, therefore, the coil inductance is decreased as the slug is inserted farther into the coil winding.

(6) Press push button no. 1 and adjust the slugs in L119 and L118, respectively, for maximum deflection of the panel meter. Do not adjust C153 and C157. Check the frequency being tuned (27.0/6 = 4.50 megacycles) with the wavemeter and proceed as in step *(5)* if the frequency is incorrect.

(7) Repeat step *(5)* (adjusting only the capacitance trimmers on button 10) and step *(6)* (adjusting only the coil slugs on button 1) until no further adjustment is required. In some cases where the circuits do not appear to align properly at both ends of the band it may be desirable (with the METER SWITCH in position 3) to adjust and lock selector button 5 at some frequency near the middle of the band (say 33 megacycles) and align between buttons 10 and 5 to get the coil slugs and capacitors near their correct positions. Then finally align between buttons 10 and 1 as described.

f. Alignment of Tripler.

(1) Set the METER SWITCH to position 1 (grid current in doubler).

(2) Adjust the tuning slugs in L106 and L107 to about ¾ inch from the open end of the coils.

(3) Set C114 and C116 to the mid-capacitance position (open end of slot toward rear of set).

Note: Steps *f(2)* and *f(3)* are unnecessary if there has been no major change in the coils or capacitors in this stage.

(4) Adjust the wavemeter to one half of the output frequency (38.9/2 = 19.45 megacycles) and place the pickup coil near L106 and L107.

(5) Press push button no. 10, start the dynamotor, and adjust C114 and C116 for a maximum deflection of the panel meter at the wavemeter frequency. Take care that the circuits are being tuned to 19.45 megacycles. If the circuits cannot be tuned to the proper frequency, try a different setting of the L106 and L107 tuning slugs.

(6) Depress push button no. 1 and adjust the slugs in L106 and L107 for maximum deflection of the meter. Check the frequency being tuned (27.0/2 = 13.5 megacycles) with the wavemeter. If the frequency is incorrect, it will be necessary to recheck the frequencies to which the rectifier stage has been aligned in accordance with Paragraphs 38*e(4)* and 38*e(6)*.

(7) Repeat step *(5)* (adjusting only the capacitance trimmers on button 10) and step *(6)* (adjusting only the coil slugs on button 1) until no further adjustment is required.

g. Alignment of Doubler.

(1) Set the METER SWITCH to position 5 (grid current in power amplifier).

(2) Adjust the tuning slug in L108 to about ¾ inch from the open end of the coil.

Note: This step is unnecessary if there has been no major change in the coil or capacitor in this stage.

(3) Press push button no. 10, start the dynamotor, and adjust C120 for a maximum deflection of the meter. If a tuning point cannot be found, try a different setting of the L108 tuning slug. Frequency measurements are not required in this stage if the alignment of the preceding circuits has been done correctly.

(4) Press push button no. 1 and adjust the slug in L108 for a maximum meter deflection.

(5) Repeat step *(3)* (adjusting only C120 on button 10), and step *(4)* (adjusting only L108 on button 1), until no further adjustment is required.

(6) Replace the bottom cover plate of the transmitter and trim all alignment adjustments previously made, by repeating the procedure described in Paragraphs 38*d, e, f,* and *g*. The bottom cover makes only small changes in the circuit capacitances or inductances and so only small changes in the trimmer capacitors or coil slugs will be required. They are necessary, however, if most satisfactory performance and tube life are to be obtained.

h. Alignment of Power Amplifier.

(1) Set the METER SWITCH to position 6 (total plate current).

(2) Throw the RECEIVER TUNE-OPERATE switch to OPERATE.

(3) Adjust the coupling of L111 to L110 until the center of coil L111 is opposite the top of coil L110 as seen through the vertical slot in L110. This may be accomplished by rotation of the knurled finger wheel accessible through a rectangular hole in the right end panel. (See Fig. 52.)

(4) Connect an antenna (artificial or real; see Paragraph 38*b*) to the transmitter. (During manufacture this stage is adjusted with the artificial antenna (Fig. 77) plugged into the A and G posts on the front panel of the transmitter.)

(5) Press push button no. 10, plug in a microphone, and start the dynamotor by operating the microphone switch. Immediately adjust C126 on top of the selector unit for minimum deflection of the panel meter (minimum plate current).

(6) Adjust antenna trimmer capacitor C136 (marked as no. 10 on the right-end panel of the transmitter) for maximum antenna current in the artificial antenna meter.

Note: If an Antenna A-83 (phantom) or a real antenna is used for these coupling adjustments it will be necessary, in order to have an indication of antenna current, to throw the TUNE-ANT CUR switch to ANT CUR and observe the deflection of the panel meter. Restore the TUNE-ANT CUR switch to the TUNE position whenever adjustments are to be made to capacitor C126 or to the inductance trimmer of L110.

(7) Adjust the coupling between L110 and L111 for maximum antenna current, then reduce the coupling to lower the antenna current to approximately 60 per cent of maximum and readjust the antenna capacitor, C136, for maximum antenna current.

(8) Press selector button no. 1 and adjust the tuning slug (inductance trimmer) of L110 for *minimum* plate current (with the TUNE-ANT CUR switch at TUNE). The tuning slug is operated by a toothed wheel which is turned by inserting a screwdriver through the hole opposite the bottom of L110 in the right-end panel of the transmitter.

(9) Adjust the antenna trimmer, C127 (no. 1), for maximum antenna current.

(10) Shift alternately between selector buttons no. 1 and no. 10, making the proper adjustment of L110 and C126 for minimum plate current until no further adjustment of L110 and

C126 is required. When on button no. 1, adjust the tuning slug L110 for *minimum* plate current, and adjust the antenna trimmer, C127, for *maximum* antenna current. When on button no. 10, adjust the trimmer capacitor, C126, for *minimum* plate current and adjust the antenna trimmer, C136, for *maximum* antenna current.

As the minimum meter reading may not be sharply defined when the inductance trimmer is turned, it is sometimes easier to adjust the capacity trimmer C126 for *minimum* plate current when on selector button no. 10, then operate selector button no. 1, and again adjust C126 for *minimum* plate current. Then adjust the inductance trimmer by a few turns and repeat the procedure already outlined, noting the position of C126 for each selector button. Turn the inductance trimmer of L110 one way or the other until the position of C126 for *minimum* plate current is the same at both ends of the band (selector buttons 1 and 10).

The radio-frequency stages have now been ganged and should track satisfactorily at all frequencies.

i. Coupling to the Antenna Circuit. When the procedure in Paragraph 38*b* has been properly accomplished, the transmitter is ready for coupling to a suitable antenna. The method of making coupling adjustments is described in Paragraph 21*a*.

39. Location of Trouble in Radio Receiver BC-683-A.

a. General. The following tests aid in isolating the source of trouble. *To be effective the procedure should be followed in the order given here.* A faulty receiver will be referred to hereafter as the "trouble" receiver.

Refer to the following figures to aid in the locating of trouble in the receiver:

Figs. 44-46.	Apparatus Location Diagrams.
Fig. 51.	Location of Alignment and Tuning Controls.
Fig. 57.	Voltage Diagram.
Fig. 58.	Resistance Diagram.
Figs. 43, 72.	Wiring Diagrams.

Remember first, servicing procedure should cause no further injury to the receiver. Second, trouble should be localized to a single stage or circuit. Third, the trouble may then be isolated within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The relationship of the various steps of this suggested procedure to these considerations, graphically illustrated in Charts 2 and 3 at the end of Paragraph 39, may be summarized as follows:

The purpose of inspection is to locate any visible trouble. Through this inspection alone, you may frequently discover the trouble, or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the receiver which might occur through improper servicing methods, and in forestalling future failures.

The power supply test prevents further damage to the receiver or the dynamotor from certain possible short circuits. Since this test gives an indication of the operation of the dynamotor and filter circuits, its function is not merely preventive.

The operational test is important as it frequently indicates the general location of the trouble. In many instances the information gained will determine the exact nature of the fault. To utilize this information fully, interpret all symptoms in relation to each other.

The principal advantage of the signal tracing method is that it usually enables you to localize a trouble accurately and quickly to a given stage when the general location of this trouble is not immediately evident from the above tests.

In all these tests the possibility of intermittents should not be overlooked. If present, this type of trouble may be made to appear in most cases by tapping or jarring the set. It is possible that no trouble will be found in the receiver itself but that the trouble is in the installation (mounting, interphone system, or vehicle), or, possibly, is due to external conditions. In this event, test the installation, if possible.

b. General Precautions. Whenever a receiver is to be serviced, observe the following general precautions very carefully.

(1) With the cover removed, dangerous voltages are exposed when the set is operating.

(2) Whenever a receiver is suspected of being in trouble, make the inspection and power supply test. Be sure to remedy the cause of any abnormal heating before continuing the procedure.

(3) Don't allow the dynamotor to run for any appreciable period of time at the start of the inspection until you are sure there are no short circuits which will cause burning of receiver parts.

(4) When making resistance and continuity measurements, first remove the power plug *and dynamotor.*

(5) Don't remove the shield can of the tuned units (LCU or FL) from any unit unless you definitely know that trouble exists within that unit. Whenever one part of the tuned circuit is replaced, realign the unit.

(6) Whenever you suspect intermittent trouble, make a thorough check of wiring and parts. In many cases you can make intermittent troubles appear by jarring the receiver.

(7) Take care, when inspecting wiring and soldered connections, not to damage the insulation. Don't leave the insulation in a broken or frayed condition. Don't pull or bend wires unnecessarily, nor pry cable open to trace wiring.

(8) Don't remove more than one vacuum tube from a receiver at one time. Remember to return each tube to the socket from which it was removed, unless it is defective.

c. Inspection. When a receiver is brought in from the field for check or repair, remove the cover and make the following inspection.

(1) Examine for burnt insulation and resistances. Examine for wax leakage and any discoloration of apparatus and wire. Notice any odor caused by overheated apparatus.

Note: These symptoms may have been caused by a trouble previously repaired and serve only as a guide. In general, confine examination to parts readily visible with the cover removed. Usually more harm than good will be caused by the removal of the front panel, the FL or LCU can covers, and other enclosed parts. Trouble in these parts should be localized by signal tracing and voltage and resistance measurements.

(2) Inspect for broken connections to tube sockets, plugs, and other apparatus as well as for defective soldered connections. Examine for bare wires touching the chassis or other wires.

(3) Be sure that the labels on the tubes in the various sockets correspond to the correct tube numbers given in the technical manual for these positions. Replace any tubes which have the wrong numbers. Inspect for loose tube sockets.

(4) Inspect the active and spare fuses. Check carefully for short circuits whenever a receiver with a blown fuse is encountered.

(5) Inspect the selector mechanism for loose or bent parts. Be sure that the dial turns smoothly and that the push buttons operate satisfactorily.

(6) Inspect the power plug and replace or repair it if there are any bent or broken prongs.

(7) Inspect for loose or missing screws, especially those which fasten the tube sockets in place.

d. Power Supply Test. This test assumes that a voltmeter of at least 1000-ohms-per-volt with a range of at least 250 volts, and an ohmmeter, are available.

Throw all switches to OFF, or downward. Remove the cover from the receiver for the following procedure.

(1) The dynamotor marking must agree with the battery voltage available.

(2) Remove the dynamotor and examine it for loose or badly worn brushes and worn or dirty commutators. Test the continuity of the dynamotor plug. Clean and replace the dynamotor in the set.

(3) Connect the appropriate battery to the

receiver, using Mounting FT-237-(*) or Cord CD-786.

(4) Throw the SPEAKER switch to ON.

(5) Place the voltmeter across C25 (the positive side should go to the terminal to which the wire with the red tracer is attached). Turn the power switch to ON. Note that the meter rises immediately to approximately 200 volts when the switch is turned on. If it does not, turn the set off quickly and check C25 and C16 for a possible short circuit. Also, check the voltage divider, the dynamotor, and the associated equipment. A low reading of the voltmeter may indicate a faulty dynamotor or a short circuit in the system.

(6) If the dynamotor fails to start or if the fuse blows, turn the set off, and inspect the dynamotor and the associated equipment, as well as the fuse, plug PG2, the filament wiring, etc.

(7) Assuming that the dynamotor starts correctly and that the voltage is satisfactory, inspect the inside of the receiver with the dynamotor running. See that no sparks occur and that nothing smokes. Stop the dynamotor immediately and repair the fault if trouble is indicated.

(8) After the dynamotor has been running for a few moments, feel the tubes cautiously to see if they are all warm. No other tube should be as hot as V8, which is a VT-107-A (6V6-GT) tube. No tube should remain cold. If a tube remains cold after the others have warmed up, examine the wiring associated with the tube socket in question and examine the socket contacts. If there is no wiring trouble and the tube does not warm up, test it (or replace it if no vacuum-tube test set is available).

e. Vacuum Tube Testing Procedure. As the space around a vacuum tube is often small it is desirable either to use a tube extractor or to rock the tube with the fingers at the top while pushing it up gently from the bottom. To test a vacuum tube, use a test set if available. If not, try the tube in a receiver which is operating satisfactorily. If another receiver is not available, try replacing the tube by another one.

f. Operational Test. To make an operational test, you will need a headset and a weak signal between 27 and 39 megacycles. A signal generator, or a transmitter with its RECEIVER TUNE-OPERATE switch at RECEIVER TUNE, is a good signal source. The transmitter requires no metallic connection with the receiver. A second receiver with a lead to bring the radio frequency to the A (antenna) post of the receiver under test is satisfactory. See Paragraph 39*g(6)* (c).

Serious distortion and abnormally low output are trouble indications. Compare with a good receiver for output, if the condition of the trouble receiver permits. Irregularities of operation help to localize the trouble. Operating personnel may supply useful *supplementary* data.

(1) Turn the trouble receiver to ON and allow it sufficient time to warm up. All other switches should be at OFF (down).

(2) CALL SIGNAL Lamp. With the SQUELCH switch at OFF, the CALL SIGNAL lamp should be lighted.

(3) Noise from Loudspeaker. Turn the SPEAKER switch to ON, and with the VOLUME control turned to the extreme right, listen for a rushing noise from the loudspeaker.

(4) VOLUME Control. The speaker output should vary smoothly from maximum until the noise has vanished at the extreme left position of the control.

(5) Headset Sidetone. With the OUTPUT TO PHONES switch at OFF, plug the headset into one of the PHONES jacks. There should be no sound in the headset.

(6) Noise in Headset. With the VOLUME control adjusted for normal output from the speaker, turn the OUTPUT TO PHONES switch to ON. There should be a rushing noise in the headset.

(7) Noise in Headset, Second Jack. Repeat step *(6)* for the second PHONES jack.

(8) Headset Volume. Turn the SPEAKER switch on and off. The headset volume should remain constant if R30 is intact.

(9) Turn on a source of radio-frequency signal and wait for it to warm up.

(10) Beat-Note Indication. Now place the TUNE-OPERATE switch at TUNE. Roughly check the tuning of the receiver, both manual and push-button, against the radio-frequency test signal, using the beat note produced by the intermediate-frequency oscillator as a tuning indication. The dial should turn freely.

(11) Beat-Note Indication, with Squelch. With the SQUELCH switch at ON and the SENSITIVITY control adjusted for maximum sensitivity (full right rotation), repeat the beat-note test at one frequency.

(12) Squelch Operation. With conditions as in *(11)*, the CALL SIGNAL lamp should light when the signal is tuned in. If it does not go out when the signal is tuned out, turn the SENSITIVITY control to the left to reduce the sensitivity until it does. The noise from the loudspeaker should cease whenever the CALL SIGNAL lamp is extinguished. When the signal is tuned in again the lamp should light.

(13) Sensitivity Control. Reduce the signal, with conditions as in *(12)*, just short of the frequency where the CALL SIGNAL lamp would go out. Turn the SENSITIVITY control to the left and the lamp should go out.

(14) Intermittents. Test the receiver for intermittents by jarring it while listening to a beat note.

(15) Tests Involving Transmitter and Receiver. If the tests are being made in a mounting with a transmitter as a source of radio frequency, the following checks may be made quickly:

(a) Disabling Action.—Turn the transmitter RECEIVER TUNE-OPERATE switch to OPERATE. Pressing the microphone button should cut off the rushing noise in the receiver.

(b) Sidetone.—Plug into either PHONE jack and set the SIDETONE control on the right end of the transmitter (Fig. 14) to give sufficient headset volume. Sidetone should be heard when someone is speaking into the microphone.

g. Signal Tracing.

(1) General. Signal tracing tests require one of the following signal sources, listed in order of preference:
A signal generator.
A good receiver. (See *(6)* of this paragraph for instructions.)
A good transmitter (provides audio and radio frequencies only). (See *(7)* of this paragraph for instructions.)

Caution: When connecting or disconnecting these sources, turn the receiver off each time to avoid shock or equipment damage.

You will also need a voltmeter (not less than 1000-ohms-per-volt), an ohmmeter, and a headset. If no vacuum-tube test set is available, check the tubes in a good receiver, or substitute new tubes. (See Paragraph 39*e*.) This recommended procedure begins at the output and works back. For the location of parts, see Figs. 43, 45, 46, 51, and 72. An output meter plugged into one of the PHONES jacks, as described in Paragraph 33*c(3)*, or an alignment meter bridged across L1 as described in Paragraph 33*e(1)*, helps greatly in judging the performance of the receiver. If a signal generator having a 1.0-volt output at 2.65 megacycles is used, test the discriminator circuits, as described in step *(3)*(i), as soon as step *(3)*(b) is completed. In this event, apply the signal generator output to the grid of the limiter (terminal 4 of V6). In all other cases, make this test in the following order:

(a) At the beginning of the test, turn all switches to OFF (downward), and release all push buttons.

(b) *Don't remove the shield can of a tuned unit until the trouble has been traced to that particular unit. Don't remove the front panel of the receiver more often than necessary. Don't damage the wiring by pushing it back and forth during inspection. Do as little damage to the receiver as possible. Take it easy.*

(c) Use a dynamotor known to be in good condition, and of correct voltage, and place it in the set before the test.

(d) Except as otherwise noted, ground

one side of the signal generator and connect the other side to the receiver being tested.

(e) Note the volume, and listen for serious distortion from the loudspeaker at the various points in the signal tracing procedure. Experience helps. If possible, compare with a receiver known to be in good condition.

(f) Check the wiring and soldering in each stage as you proceed.

(g) Misalignment of one or more stages of the receiver will cause reduced output. Misalignment of the radio-frequency oscillator may, however, prevent *any* output.

(h) In this outline, "no signal" or "no beat note" means either no signal from the loudspeaker, a signal that is weaker than it should be, or a seriously distorted signal.

(i) When trouble is localized in a given stage, first test the tube if such a test is indicated in the procedure, then the voltage, and finally the resistance (Paragraph 39*b(4)*), at the tube socket of that stage.

(j) Trouble in a circuit or stage may not show in voltage and resistance measurements at the tube socket. Hints included in this section are merely a guide and should suggest other procedures, such as voltage and resistance measurements on individual parts.

(k) Remove only *one tube* at a time when testing. Check the number of the tube, test it, and return it to its proper socket before another tube is removed.

(l) If the receiver appears to be good, test the control circuits of the associated transmitter for short or open circuits. Check the wiring in Mounting FT-237-(*), as well as the remote circuit wiring.

(m) It frequently helps to connect (with a clip lead) terminal 5 of V3 to the negative side of C25 (to which blue-tracer leads are attached) when performing the audio- and intermediate-frequency tests outlined in Paragraphs 39*g(2)* and *(3)*. This stops the radio-frequency oscillator and reduces interference. *Be sure to remove this clip lead before proceeding with the radio-frequency tests.*

(n) Each step assumes you have satisfactorily completed all previous steps. Isolate and clear any trouble located before you proceed with the next step.

(o) When you have found all sources of trouble, follow the procedure for routine check of the receiver as described in Paragraph 30.

(2) A-f Tests. For reference to audio-frequency-test signal sources, see Paragraph 39*g (1)*.

(a) Secondary of T1 (Speaker Circuit).—Throw the SPEAKER switch to ON and connect an audio signal through a series capacitor to the blue-brown tracer (fifth terminal counting from the front panel) on the output transformer T1. Listen for noise output in the speaker. Notice that it is not necessary to remove the front panel in order to gain access to the terminals of transformer T1.

The volume of noise will be *very low.*

If no output is heard, check the circuit elements such as the SPEAKER switch D3, the output transformer, the loudspeaker, etc.

Note: In replacing the front panel (if it has been removed) be sure that the wires are all pushed down beside the potentiometers P1 and P2 and preferably tied in place.

(b) Secondary of T1 (Phones Circuit).—Throw the OUTPUT TO PHONES switch to ON and connect the signal to the blue-green tracer on the output transformer T1 (third terminal counting from the front panel). Try the headset in both PHONES jacks. Noise should be heard when the headset is plugged into either jack. If no signal is heard, remove the front panel and test (by resistance measurements if possible) such items as resistors R22, R23, and R33, switch D2, the jacks, and terminals 12 and 14 of PG3 and J3. Jacks and headsets may be at fault, or a permanent ground may exist on the receiver disabling lead.

(c) Primary Circuit of T1.—Place the audio signal on the blue-yellow tracer (second terminal counting from the front panel) on the output transformer T1 and listen for the signal from the speaker or headset. If no signal is present, C33 may be shorted or terminals 16 and 17 of plug PG3 may not be making good contact.

(d) Terminal 5 of V8 (Grid of Second Audio Amplifier).—Turn the receiver on. Put the signal on terminal 5 of V8. Listen for output in the speaker. If there is no output, test the tube and the voltages at the socket terminals (see Figs. 57 and 58). C21, R19, or R18 may be faulty. Check continuity to terminals 5, 6, and 10 of PG3 or J3.

(e) Terminal 2 of V10 (Plate of First Audio Amplifier).—Introduce the signal at terminal 2 of V10, and listen for a signal from the loudspeaker. If there is no signal, R18, C19, or C21 may be at fault. Check terminals 5, 6, and 10 of PG3 or J3 for continuity.

(f) Terminal 1 of V10 (Grid of First Audio Amplifier).—Put the signal on terminal 1 of V10. Reduce the signal input. If there is no signal from the loudspeaker, test the tube. Circuit elements such as C11, C12, C13, C26, or R10 may be faulty. Note that when the SQUELCH switch is at OFF it should connect ground to R12 —the side away from the tube.

(g) Terminal 5 of V10 (Plate of the I-f Oscillator).—Place the signal on terminal 5 of V10. Throw the TUNE-OPERATE switch to OPERATE. If there is no signal from the loudspeaker, R6, C26, C10, or D5 may be faulty.

(h) Junction of C11 and R10.—Put the signal at the junction of C11 and R10. If the signal is not heard from the speaker, R10 or C11 may be faulty.

(i) Terminal 4 of V7 (Output of the Discriminator).—Place the signal across the output resistance (R81 in series with R83) of the discriminator (terminal 4 of V7). If there is no signal in the loudspeaker, check circuit elements such as V7, C81, C82, R81, R82, R83, or R84.

(3) I-f Tests. For reference to intermediate-frequency-test signal sources, see Paragraph 39*g (1)*.

(a) Terminal 8 of V6 (Plate of the Limiter).—With the intermediate-frequency signal applied through a series capacitor to the plate of the limiter (terminal 8 of V6), place the SQUELCH switch at OFF and the TUNE-OPERATE switch at TUNE and listen for a beat note from the loudspeaker. If this beat note is not heard, note the setting and then vary the slug adjustment in LCU4 to obtain a beat note. If the beat note cannot be obtained, such circuit elements as C10, LCU4, FL4, or D5 may be faulty. Retune the slug in LCU4 for a beat note with the intermediate-frequency source after the trouble has been cleared.

(b) Terminal 4 of V6 (Grid of the Limiter).—Put the signal on terminal 4 of V6. If there is no beat note from the speaker, with the TUNE-OPERATE switch at TUNE, test V6 and other circuit elements. Voltage and resistance measurements at the tube socket terminals may be useful. (See Figs. 57 and 58.)

(c) Terminal 8 of V5 (Plate of the Second I-f Amplifier).—With the signal on terminal 8 of V5 repeat the procedure given for the preceding stage. If there is no signal, FL3A may be misaligned or faulty. If the alignment is not at fault, test such elements as V5, R13, C14, C15 or C7. If the alignment has been altered, re-align FL3A after the trouble has been corrected.

(d) Terminal 4 of V5 (Grid of the Second I-f Amplifier).—Place the signal on terminal 4 of V5. Repeat the procedure which was followed on the limiter stage. If the test of the tube is satisfactory, there may be trouble in circuit elements such as FL2A, C7, or R8.

(e) Terminal 8 of V4 (Plate of the First I-f Amplifier).—Feed the signal to terminal 8 of V4. If no beat note is obtained from the speaker, test the tube. FL2A may be misaligned or may be faulty.

(f) Terminal 4 of V4 (Grid of the First I-f Amplifier).—Introduce a signal on terminal 4 of V4. If no beat note is obtained and the tube is satisfactory, the trouble may be in FL1A, C6, or associated circuit elements.

(g) Terminal 8 of V2 (Plate of the Modulator).—With the signal on terminal 8 of V2, listen for a beat note from the loudspeaker. If none is obtained, test the tube and make voltage and resistance measurements. (See Figs. 57 and 58.) FL1A may be misaligned or faulty. Check the associated circuit elements.

(h) Terminal 4 of V2 (Grid of the Modulator).—Place the signal on terminal 4 of V2.

If a beat note is not obtained, test the tube. The trouble may be in LCU2A. Check for a short circuit of C1.5 or C1.6.

(i) Terminal 4 of V2 (Discriminator Test).—With the intermediate-frequency signal still on the grid of the modulator (terminal 4 of V2), measure the voltage across the series combination of R81 and R83 (between terminals 4 and 8 of V7, or between 3 and 7 of FL4). Turn off the intermediate-frequency oscillator by setting the TUNE-OPERATE switch at OPERATE. Align the secondary of FL4 to obtain a zero reading on the voltmeter. As the alignment is varied either way from this point, the reading of the voltmeter should change polarity. In order to test the primary of FL4, connect the meter between terminals 3 and 8 of FL4. Adjust the primary slug of FL4 for maximum reading on the voltmeter. This is not an alignment but merely a check on the alignment capability of this circuit. Leave the circuit in approximate alignment after clearing any trouble that may have been present in FL4 or associated circuits.

(4) R-f Tests. For reference to radio-frequency-test signal sources, see Paragraph 39*g (1)*.

(a) Terminal 4 of V2 (Grid of the Modulator). — Apply a radio-frequency signal through a capacitor to the grid of the modulator (terminal 4 of V2). Set the TUNE-OPERATE switch to TUNE. Manually set the dial of the trouble receiver to approximately the frequency of the radio-frequency source and tune for a beat note. If it is impossible to obtain a beat note, either the source of radio frequency is not providing voltage on the grid of V2 or the radio-frequency oscillator of the trouble receiver is not functioning. In the latter case check V3, LCU3A, R4, R5, C5, and associated circuit elements. C1.7 and C1.8 may be shorted. Make resistance and voltage measurements at the tube socket terminals. (See Figs. 57 and 58.) In order to isolate the trouble in the oscillator stage, put the radio-frequency signal on the suppressor grid of the modulator (terminal 3 of V2). If the characteristic no-signal rushing noise is heard from the loudspeaker with the test signal but is not heard when the test signal is absent, then the oscillator stage is faulty. However, if the oscillator stage is operating but not properly aligned, the rushing noise may be present, but a weak beat note may appear more than one channel away from the proper setting. A realignment of the oscillator is indicated.

Caution: Any attempt to vary the adjustment of the slug in LCU3A will result in a change in the tracking of the oscillator stage. This stage probably will then require careful alignment. This procedure is described in Paragraphs 34*b(5)* and 37*e*. No adjustment of LCU3A and C1.7 should be attempted until the method is fully understood.

(b) Terminal 8 of V1 (Plate of the R-f Amplifier).—Place the signal on terminal 8 of V1. If no beat note is heard in the speaker, test V1. It may be that LCU2A, C1.3, or C1.4 are shorted. Make voltage and resistance measurements.

(c) Terminal 4 of V1 (Grid of the R-f Amplifier).—Place the signal on terminal 4 of V1 and listen for the beat note. If no beat note can be obtained and the tube is not at fault, check LCU1A, C1.1, and C1.2 for short circuits. LCU2A may be misaligned.

(d) Antenna Post.—Put the signal on the A (antenna) post. If there is no beat note, LCU1A may be misaligned or faulty. Test the antenna connections to LCU1A.

(e) Squelch Circuit and Sensitivity Control.—Check these functions as described in Paragraphs *f(12)* and *f(13)* preceding. If operation of the squelch circuit and sensitivity control is not normal, test V9. Circuit elements such as R15, R16, R17, C17, C18, C20.2, or C12 may be faulty.

Note: The voltage divider circuits bear an important relation to proper squelch action. See Figs. 57 and 58.

(f) Tuning.—When all troubles have been removed, the tuning for all channels should be checked. If an LCU or an FL unit has been repaired or replaced or if its adjustment has been changed, that unit should be realigned. If several

units have been changed or there is any question of alignment, the whole receiver should be realigned.

(5) Short Cuts. Signal tracing procedure may be simplified by determining at the outset, whether the trouble is in the audio-, intermediate-, or radio-frequency circuits. This may be determined in the following order:

(a) A-f Circuits.—Put an audio-frequency signal on the output of the discriminator (terminal 4 of V7). If output from the speaker is missing or weak, the trouble is probably located in the audio-frequency circuit.

Caution: Unless you are familiar with these sets, you may fail to recognize a loss of amplification in the set in these tests. It's a good idea to make a comparison with a receiver known to be in good condition.

(b) I-f Circuits.—Put an intermediate-frequency signal on the grid of the modulator (terminal 4 of V2). When the TUNE-OPERATE switch is at TUNE, a beat note should be heard. If step (a) gave a beat note but none is heard now, the trouble is probably in the intermediate-frequency part of the circuit.

(c) R-f Circuits.—Place a radio-frequency signal on the A (antenna) post. Tune the receiver to the frequency of the test signal. Throw the SQUELCH switch to ON. The squelch circuit should operate satisfactorily with the SENSITIVITY control near its minimum or extreme left position. Throw the SQUELCH switch to OFF; a beat note should be heard from the speaker. The tuning dial setting should agree approximately with the test signal frequency. Test the squelch and sensitivity control operation as described in Paragraphs *f(12)* and *f(13)* preceding.

(6) Use of a Second Receiver as a Signal Generator. If you have no signal generator, it will help a lot to have a second receiver handy. Keep it in good operating condition at all times to use as a source of test signals. The audio-, intermediate-, and radio-frequency signals may be obtained from the following points in the good receiver, in the following manner:

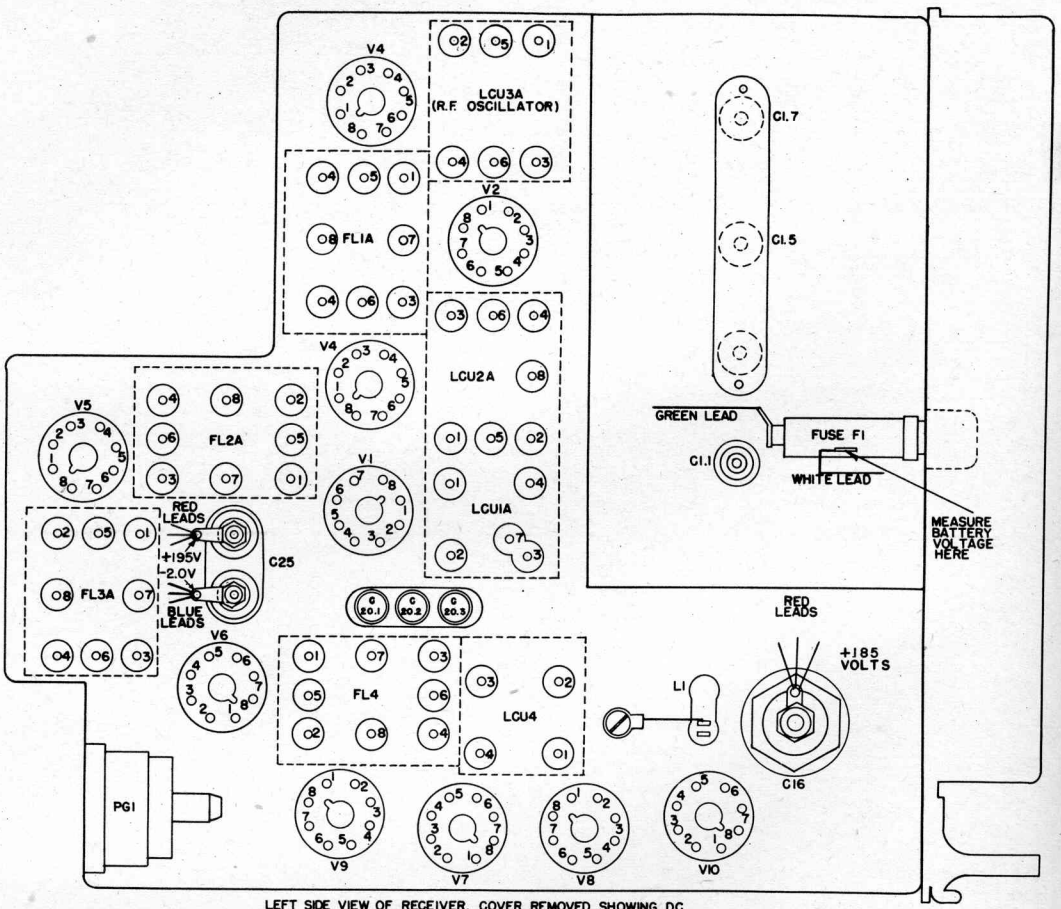
(a) Audio Frequency.—Audio-frequency signals may be obtained from one of the PHONES jacks of the good receiver. The VOLUME control of this receiver may be adjusted to give a satisfactory level of no-signal noise for use in testing the audio stages of the trouble receiver. If the signal strength is too great, the audio stages of the trouble receiver may be overloaded, thereby giving deceptive results. Connect the *tip* of a plug to a capacitor of 0.001 microfarad or greater capacitance. Insert the plug into one of the PHONES jacks to obtain an audio-frequency source. Connect the chassis of the two receivers together to complete the circuit. Throw the OUTPUT TO PHONES switch to ON.

(b) Intermediate Frequency.—You may obtain the intermediate frequencies from the second receiver, with the TUNE-OPERATE switch at TUNE, at terminal 7 of FL4. You can pick up a somewhat higher output on terminal 2 of FL4; use the former (lower level) point for all cases except where the circuits are badly misaligned. In all cases make the connection through a capacitor, preferably 0.001 microfarad or larger, located close to the source of test tone. If you have no capacitor, twist two *insulated* wires for about 18 inches, making sure that there is *no metallic connection between the wires.* These two wires (at the far end) form the two ends of the lead which carries the test frequencies. In order to prevent unwanted pickup and singing, combine this lead (in a twisted pair) with the ground wire which forms the circuit return. Mark each wire so it may be identified, equip each end of the pair with clips, and run it directly from the signal source to the point of use, preferably under the bottom of the good receiver (if it is at the left side). Leave the untwisted part as short as possible. This twisted pair for pickup and test frequency will then consist of:

(1) An insulated wire about 3-feet long used for connecting the chassis of the trouble receiver to the chassis of the source.

(2) Another insulated wire about 4-feet long cut in the middle and with the two

CAUTION: DANGEROUS VOLTAGES ARE EXPOSED



LEFT SIDE VIEW OF RECEIVER, COVER REMOVED, SHOWING DC POTENTIALS BETWEEN THE DESIGNATED TERMINALS AND THE RECEIVER CHASSIS ON METER OF 1,000 OHMS PER VOLT.

NOTES:

1. ALL VOLTAGES SHOULD BE MEASURED BETWEEN THE DESIGNATED TERMINAL AND THE RECEIVER CHASSIS.
2. ALL SWITCHES EXCEPT THE TUNE-OPERATE AND THE ON-OFF SHOULD BE IN THE DOWNWARD POSITION.
3. VOLTAGES GIVEN ARE AVERAGE READINGS. A RECEIVER WHICH IS OPERATED SATISFACTORILY NEED NOT BE SERVICED JUST BECAUSE CERTAIN READINGS DIFFER FROM THOSE GIVEN AS DIFFERENCES IN MANUFACTURED EQUIPMENT CAUSE VARIATION IN VOLTAGES.
4. FIGURES GIVEN ARE BASED ON 12 OR 24 VOLTS FROM THE BATTERY. FOR OTHER BATTERY VOLTAGES THE READINGS GIVEN SHOULD BE ADJUSTED IN PROPORTION.
5. ACCURACY REQUIRES THAT ON MEASUREMENTS WITH A METER OF 1000 OHMS PER VOLT, FULL-SCALE READING MUST BE HIGHER THAN THE EXPECTED VOLTAGE.
6. VACUUM TUBE VOLTMETER MEASUREMENTS ARE BASED ON A VOLT-OHMMETER 1-107 OR EQUIVALENT.
7. ◊ MEANS NOT TO EXCEED 0.5 VOLTS ON METER OF 1,000 OHMS PER VOLT.

Fig. 57. Radio Receiver BC-6

STAGE-BY-STAGE GAIN DATA FOR TROUBLE LOCATION

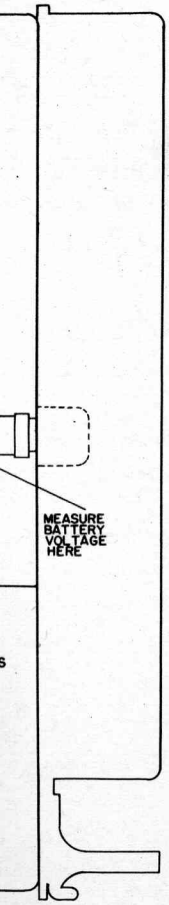
INPUT CONNECTION *	TEST FREQUENCY	INPUT REQUIRED TO OPERATE SQUELCH	INPUT REQIRED FOR EQUIV. CATHODE METER READINGS**	OUTPUT METER READING * **
TERM. 4 OF V6 AND CHASSIS	2.65 MC		1 VOLT	16 VOLTS (APPROX.) 400 CPS.
" " " " " "	"	2 VOLTS (MAX.)		
TERM. 4 " V5 " "	"		0.05 VOLT (APPROX.)	16 VOLTS (APPROX.) 400 CPS.
" " " " " "	"	0.1 VOLT (APPROX.)		
" " " V4 " "	"		1500 MICROVOLTS (APPROX.)	16 VOLTS (APPROX.) 400 CPS.
" " " " " "	"	3000 μV (APPROX.)		
" " " V2 " "	"		50 MICROVOLTS (MAX.)	16 VOLTS (APPROX.) 400 CPS.
" " " " " "	"	100 μV (MAX.)		
" " " " " "	39 MC		300 MICROVOLTS (APPROX.)	16 VOLTS (APPROX.) 400 CPS.
" " " " " "	"	600 μV (APPROX.)		
TERM. 8 " V1 " "	"		100 MICROVOLTS (APPROX.)	16 VOLTS (APPROX.) 400 CPS.
" " " " " "	"	200 μV (APPROX.)		
TERM. 4 " V1 " "	"		1.5 MICROVOLTS (APPROX.)	16 VOLTS (APPROX.) 400 CPS.
" " " " " "	"	3 μV (APPROX.)		
ANT. AND GND. TERMINALS	27 MC	1 μV (MAX.)		
" " " "	39 MC	1 MICROVOLT INPUT		11 VOLTS (APPROX.) 150 CPS.
" " " "	"	1 " "		20 " " 400 CPS.
" " " "	"	1 " "		20 " " 1000
" " " "	"	1 " "		11 " " 2500
" " " "	"	1 " "		4 " " 5000
TERM 5 OF V8 AND CHASSIS	1000 CPS. Δ	1 VOLT "		2 " " 1000
" 1 " V10 " "	"	1 "		18 " " 1000

* THE SIGNAL GENERATOR CONNECTION SHALL ALWAYS BE MADE THROUGH A .006 MF SERIES CONDENSER.

** APPLY 1 VOLT OF 2.65 MEGACYCLES BETWEEN TERMINAL 4 OF V6 AND CHASSIS TO OBTAIN THE EQUIVALENT "CATHODE" METER (FIG. 65) READING. BETWEEN 4 AND 8 MICROAMPERES SHOULD BE OBTAINED.

*** SQUELCH SWITCH OFF AND VOLUME CONTROL IN MAXIMUM CLOCKWISE POSITION. A FREQUENCY MODULATED SIGNAL GENERATOR (±15 KC DEVIATION) IS REQUIRED FOR OUTPUT MEASUREMENTS INVOLVING R.F. AND I.F. INPUTS. SPEAKER SWITCH SHOULD BE IN OFF POSITION WHEN MEASUREMENTS ARE MADE.

Δ THIS MEASUREMENT MAY BE MADE IF AN AUDIO FREQUENCY SOURCE IS AVAILABLE.



VOLTAGES AT TERMINALS OF FL AND LCU UNITS

FL UNITS			LCU UNITS		
TERMINAL	VOLTAGE		TERMINAL	VOLTAGE	
	1000 OHM PER VOLT METER (NOTE 5 & 7)	VACUUM TUBE VOLTMETER (NOTE 6)		1000 OHM PER VOLT METER (NOTE 5 & 7)	VACUUM TUBE VOLTMETER (NOTE 6)
FL1A			LCU1A		
1	70	75	1	◊	-2
2	70	75	2	0	0
3	0	0	3	0	0
4	0	0	4	0	0
5	185	185			
6	◊	-2	7	◊	-2
7	◊	-2			
8	◊	-2			
FL2A			LCU2A		
1	175	180	1	175	180
2	175	180	2	175	180
3	0	0	3	185	185
4	0	0	4	0	0
5	185	185	5	0	0
6	◊	-2	6	0	0
7	-	-2	8	175	180
8	-2	-2			
FL3A			LCU3A		
1	55	60	1	0	0
2	55	60	2	135	145
3	0	0	3	0	0
4	0	0	4	135	145
5	60	60	5	2	-10
6	◊	-2	6	◊	-2
7	-	-2			
8	-2	-2			
FL4			LCU4		
1	25	25	1	185	185
2	55	60	2	0	0
3	5.5	25	3	135	160
4	5	20	4	◊	-0.5
5	55	60			
6	5	20			
7	5.5	25			
8	5	20			

VOLTAGES AT VACUUM TUBE SOCKET TERMINALS

1000 OHM PER VOLT VOLTMETER MEASUREMENTS (SEE NOTES 5 & 7)

12 VOLT BATTERY

TERM. NOS.	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
1	0	0	0	0	0	0	0	0	◊	0
2	0	12	0	12	12	6	12	6	0	70
3	0	◊	135	0	0	0.5	5	185	15	0.5
4	◊	0	0	◊	◊	◊	5.5	170	◊	◊
5	0	1.2	◊	0	0	0.5	5	◊	◊	135
6	145	40	0	115	90	55	0	0	5	0
7	6	6	6	0	0	12	6	0	6	6
8	175	70	0	175	55	55	5.5	6	0	12

24 VOLT BATTERY

1	0	0	0	0	0	0	0	0	◊	0
2	0	12	0	12	12	18	12	18	0	70
3	0	◊	135	0	0	0.5	5	185	15	0.5
4	◊	0	0	◊	◊	◊	5.5	170	◊	◊
5	0	1.2	◊	0	0	0.5	5	◊	◊	135
6	145	40	0	115	90	55	0	0	5	0
7	6	6	6	0	24	12	18	24	18	6
8	175	70	175	175	55	55	5.5	6	24	12

VOLTAGES AT VACUUM TUBE SOCKET TERMINALS

VACUUM TUBE VOLTMETER MEASUREMENTS (SEE NOTE 6)

12 VOLT BATTERY

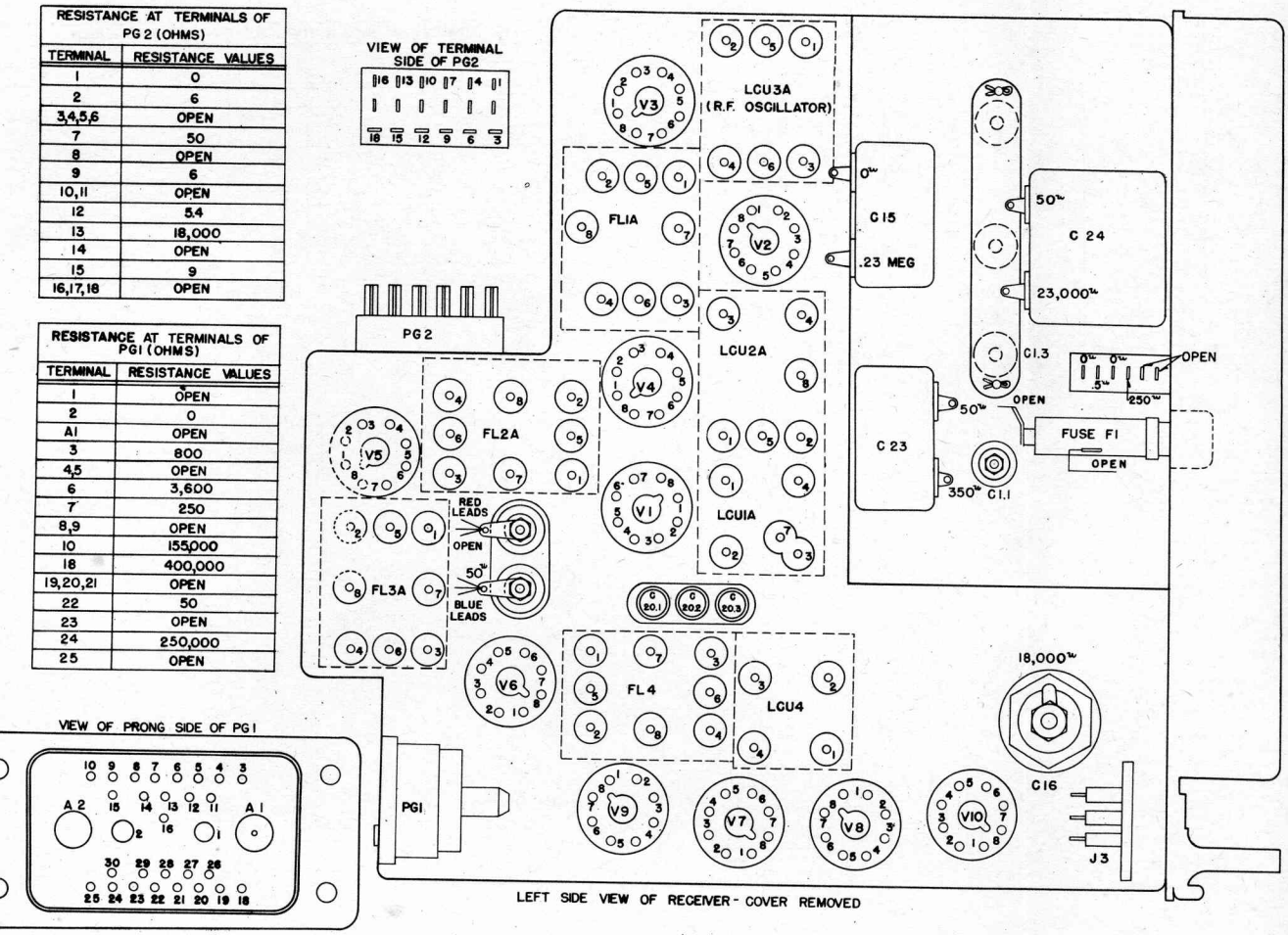
TERM. NOS.	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
1	0	0	0	0	0	0	0	0	15	0
2	0	12	0	12	12	6	12	6	0	75
3	0	-2	145	0	0	0.5	20	190	15	1
4	-2	0	0	-2	-2	-2	25	180	-2	-1.5
5	0	1.3	-10	0	0	0.5	20	-2	-2	160
6	155	55	0	120	90	60	0	0	20	0
7	6	6	6	0	0	12	6	0	6	6
8	180	75	0	180	60	60	25	6	0	12

24 VOLT BATTERY

1	0	0	0	0	0	0	0	0	15	0
2	0	12	0	12	12	18	12	18	0	75
3	0	-2	145	0	0	0.5	20	190	15	1
4	-2	0	0	-2	-2	-2	25	180	-2	-1.5
5	0	1.3	-10	0	0	0.5	20	-2	-2	160
6	155	55	0	120	90	60	0	0	20	0
7	6	6	6	0	24	12	18	24	18	6
8	180	75	0	180	60	60	25	6	24	12

RESISTANCE AT TERMINALS OF PG 2 (OHMS)	
TERMINAL	RESISTANCE VALUES
1	0
2	6
3,4,5,6	OPEN
7	50
8	OPEN
9	6
10,11	OPEN
12	5.4
13	18,000
14	OPEN
15	9
16,17,18	OPEN

RESISTANCE AT TERMINALS OF PG1 (OHMS)	
TERMINAL	RESISTANCE VALUES
1	OPEN
2	0
A1	OPEN
3	800
4,5	OPEN
6	3,600
7	250
8,9	OPEN
10	155,000
18	400,000
19,20,21	OPEN
22	50
23	OPEN
24	250,000
25	OPEN



LEFT SIDE VIEW OF RECEIVER - COVER REMOVED

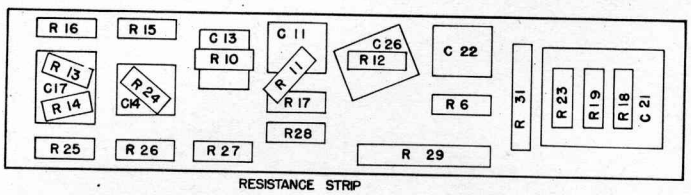
NOTES:

1. ALL RESISTANCE VALUES SHOWN ARE MEASURED BETWEEN THE RECEIVER CHASSIS AND DESIGNATED TERMINAL POINT.
2. A VARIATION OF ± 20% FROM THE INDICATED VALUES SHOULD NOT BE REGARDED AS AN INDICATION OF A DEFECTIVE RECEIVER.
3. CERTAIN DISCREPANCIES MAY BE OBSERVED BETWEEN THE SCHEMATIC DRAWING CONTAINED IN THESE INSTRUCTIONS AND THE CIRCUIT LABEL APPEARING ON THE RECEIVER. THESE DISCREPANCIES ARE DUE TO CHANGES MADE IN MANUFACTURE. IN SUCH CASES THE CIRCUIT LABEL APPLIES. NATURALLY, SUCH DISCREPANCIES MAY BE AFFECT THE RESISTANCE VALUES INDICATED.
4. THE DYNAMOTOR MUST BE REMOVED BEFORE MAKING ANY RESISTANCE MEASUREMENTS.
5. PLACE ALL SWITCHES IN THE "OFF" OR DOWNWARD POSITION EXCEPT THE TUNE-OPERATE AND THE OUTPUT TO PHONES SWITCHES WHICH SHOULD POINT UP.
6. TURN THE VOLUME AND SENSITIVITY CONTROLS TO THEIR MAXIMUM CLOCKWISE ROTATION.
7. TO CHECK THE VOLUME CONTROL, CONNECT THE OHMMETER TEST LEAD TO TERMINAL 5 OF J3. WITH THE VOLUME CONTROL AT MAXIMUM THE MEASURED RESISTANCE SHOULD BE APPROX. 100,000 OHMS AND SHOULD DECREASE TO 50 OHMS AS THE VOLUME CONTROL IS TURNED TO ITS EXTREME COUNTERCLOCKWISE POSITION.
8. TO CHECK THE SENSITIVITY CONTROL, MEASURE THE RESISTANCE FROM THE TERMINAL OF C25 TO WHICH THE BLUE LEADS ARE ATTACHED. THE RESISTANCE AT THIS POINT SHOULD VARY BETWEEN 50 AND 250 OHMS AS THE SENSITIVITY CONTROL IS ROTATED. WHEN THIS CHECK IS MADE THE SQUELCH SWITCH MUST BE IN THE "ON" POSITION ALL OTHER CHECKS ARE MADE WITH THIS SWITCH OFF

Fig. 58. Radio Receiver BC-683-A: R

RESISTANCES AT VACUUM TUBE SOCKET TERMINALS (OHMS)										
TERMINAL	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
1	0	0	0	0	0	0	0	0	2 MEG	1.1 MEG
2	0	4**	0	9**	9**	5**	5**	5**	0.25 MEG	.1 MEG
3	0	100,000	25,000	0	0	800	165,000	OPEN	2,500	2,000
4	500,000	0	OPEN	500,000	110,000	260,000	155,000	25,000	250,000	100,000
5	0	500	50,000	0	0	800	165,000	100,000	250,000	40,000
6	40,000	270,000	OPEN	50,000	90,000	10,000	OPEN	OPEN	165,000	0
7	2.5**	2.5**	4**	0	5**	4**	5**	5**	5**	4**
8	21,000	70,000	0	21,000	9,000	10,000	155,000	350	5**	5**

**TUBE FILAMENT RESISTANCE SUBJECT TO LARGE VARIATION WITH HEAT

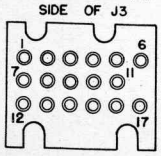


RESISTANCE STRIP

RESISTANCES AT RESISTANCE STRIP		
UNIT	LEFT SIDE (OR BOTTOM)	RIGHT SIDE (OR TOP)
R 16	2 MEG	1 MEG
R 13	0.25 MEG	0.25 MEG
C 17	0	1 MEG
R 14	50	0.25 MEG
R 25	0	2,500
R 15	1 MEG	165,000
R 24	50	0
C 14	0.25 MEG	0
R 26	2,500	3,700
R 10	0.155 MEG	0.4 MEG
C 13	0	1.2 MEG
R 27	3,700	6,000
C 11	0.4 MEG	1.1 MEG
R 11	0.25 MEG	1.1 MEG
R 17	0.25 MEG	0
R 28	6,000	8,700
C 26	1.1 MEG	150,000
R 12	0	2,000
R 29	8,700	17,000
C 22	OPEN	OPEN
R 6	150,000	40,000
R 31	17,000	20,000
R 23	23,000	20,000
R 19	1 MEG	20,000
R 18	1 MEG	1 MEG
C 21	0.1 MEG	1 MEG

RESISTANCES AT FILTER TERMINALS		
FILTER	TERMINAL	RESISTANCE
LCU1A	1	0.26 MEG
	4	0
	3,2	OPEN
	7	0.5 MEG
LCU2A	1,2,3,8	20,000
	4,5,6	0
LCU3A	1	0
	2	25,000
	3	OPEN
	4	25,000
	5	50,000
	6	0.1 MEG
LCU4	1	18,000
	2	2.5
	3	40,000
	4	0.1 MEG
FL1A	1,2	70,000
	3,4	0.5 MEG
	5	20,000
	6	0.26 MEG
FL2A	1,2	20,000
	3	0
	4	3.5
	5	18,000
	6	110,000
	7	10,000
	8	50
FL3A	1,2	10,000
	3	0
	4	3.5
	5	9,000
	6	260,000
	7	10,000
	8	50
FL4	1	3,700
	2	10,000
	3,4,6,8	150,000
	7	155,000
	5	8,700

VIEW OF TERMINAL SIDE OF J3



RESISTANCES AT TERMINALS OF J3 (OHMS)	
TERMINAL	RESISTANCE VALUES
1,2	OPEN
3	20 000
4	1 MEG
5	80 000
6	50
7,8	OPEN
9	6,000
10	100,000
11	50
12	250
13	0
14	OPEN
15	18,000
16,17	OPEN

3-A: Resistance Diagram

ends connected through a capacitor or wrapped together for about 18 inches where they overlap.

(c) Radio Frequency.—The radio frequency may be obtained from the good receiver at the suppressor grid of the modulator (terminal 3 of V2). For most alignment purposes, the stray pickup between two receivers placed about 2 feet apart is sufficient. For signal tracing, more pickup may be necessary. In this event, connection may be made by using a capacitor or two wires twisted together as described in (b). This frequency will be about 2.65 megacycles above the frequency indicated by the dial. Therefore, tune the receiver being tested to a frequency which is approximately 2.65 megacycles above that to which the good receiver is tuned.

(7) Use of a Radio Transmitter BC-684-A as a Signal Generator. If neither a signal generator nor a good receiver is available, you may use a transmitter in good operating order to provide a tone for tracing signals in the audio- or radio-frequency stages of a trouble receiver.

(a) Audio Frequency.—If the transmitter is in a mounting, an audio-frequency tone can be obtained from terminal 1 of the terminal strip TS401. You can see this terminal in the base of the mounting when the door in the mounting at the left receiver position is opened.

Caution: Use a 0.001 to 1.0-microfarad capacitor in series with the lead, as one side of the audio source is grounded.

If the receiver is placed in a Mounting FT-237-(*) with this transmitter, throw the OUTPUT TO PHONES switch of the receiver to OFF. Turn the transmitter on. Audio frequencies will be available if the operator presses the microphone button of the transmitter and whistles or hums into the microphone. Use a throat microphone if you have it.

(b) Intermediate Frequency.—Since no source of 2.65 megacycles is available in the transmitter, no direct method of signal tracing in the intermediate-frequency section is available with the transmitter.

(c) Radio Frequency.—In general no direct connection between transmitter and receiver is necessary for picking up test radio frequencies for alignment work. In signal tracing where direct connection may be needed, use a shielded wire, with one end connected to the antenna terminal and the other hung near the transmitter. Connect a capacitor in series with this wire to prevent accidental short circuits.

Chart I. Equipment Required for Servicing of Radio Receiver BC-683-A

1. Schematic Diagram of Circuit

2. Voltage Measurements
   Multirange d-c voltmeter of at least 1,000-ohms-per-volt

Maximum range required:	0-250	volts
Intermediate range:	0-30	volts approximately
Low range:	0-3	volts approximately

3. Resistance Measurements
   Ohmmeter with a maximum range of 5 megohms

4. Tube Tests
   a. Suitable tube tester with short circuit tests, *or*
   b. A second Radio Receiver BC-683-A in good condition, *or*
   c. Complete set of new tubes.

5. Signal Tracing
   a. Suitable signal generator, *or*
   b. A second Radio Receiver BC-683-A in good condition, *or*
   c. A Radio Transmitter BC-684-A in good condition.

Chart II. Servicing Procedure for Radio Receivers BC-683-A Not Mounted in a Vehicle

Inspection

Power Supply Check

Test Receiver Thoroughly to Discover *All* Symptoms

Noise

Replace dynamotor if possible.

Inspect for wires, broken parts, etc.

Test for:

(1) bad tubes (short circuits, etc.).
(2) bad resistors.
(3) leaky capacitors.

Watch for intermittents.

Oscillation

Inspect for:

(1) loose connections.
(2) tightness of sockets.
(3) tightness of ground connections to chassis.

Localize oscillations with switch in TUNE position by grounding grids of various stages through a 0.1-mf capacitor

When oscillations are localized, test for:

(1) bad resistors
(2) open capacitors.
(3) bad tubes.

Location of Trouble Suspected

Signal is received satisfactorily, but some feature does not operate correctly.

or

Signal is not received satisfactorily, but trouble has been localized to one stage by inspection.

(1) Check tube.
(2) Measure voltages in stage.
(3) Measure resistances in stage (dynamotor removed).
(4) Check for open capacitors by *bridging* suspected unit with good one.

Location of Trouble Unknown

Receiver is inoperative, or partially inoperative (signals weaker than normal, etc.), and location of trouble is not known

Use signal tracing to localize trouble in one stage

In case of low signal output, use a volume indicator

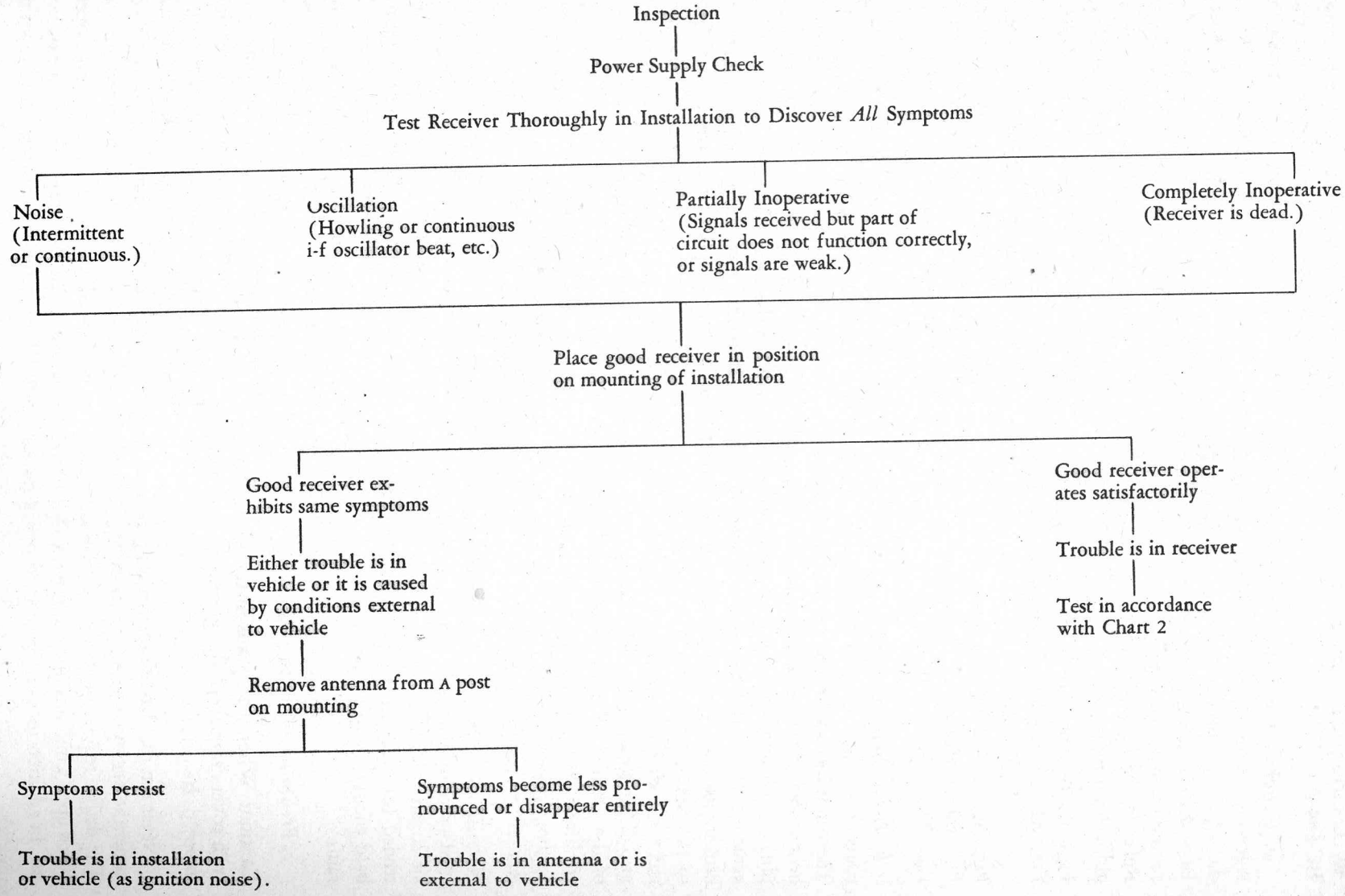
When in doubt, compare results with good receiver.

When trouble is localized in one stage:

(1) Check tube.
(2) Measure voltages in stage.
(3) Measure resistances in stage (dynamotor removed).
(4) Check for open capacitors by *bridging* suspected unit with good one.

Note: When trouble has been identified and cleared, continue with routine maintenance procedure.

Chart III. Servicing Procedure for Radio Receivers BC-683-A Mounted in a Vehicle



40. Location of Trouble in Radio Transmitter BC-684-A.

a. General. The following procedure is designed to locate trouble quickly and with as little damage as possible to the transmitter. A report from the operating personnel on the trouble experienced will usually aid in making repairs. Refer to the following figures as an additional aid in locating trouble:

Figs. 47-50. Apparatus Location Diagrams.
Fig. 52. Location of Alignment and Tuning Controls.
Fig. 59. Voltage Diagram.
Fig. 60. Resistance Diagram.
Fig. 75. Wiring Diagram.

b. Inspection. Remove all covers from the transmitter and inspect for obvious defects. These may include broken parts, burned resistors, bent capacitor plates, bent pins on the connection plugs, or loose pieces of wire or metal. Smell for evidence of overheated parts. There may be broken gears, or the rack connecting the selector to the tuning capacitors may be out of alignment. Check for loose tubes or looseness in the grip of the socket receptacles on the contact pins of the tubes. Check for loose wires and repair any broken leads. Clean the inside, both top and bottom, with compressed air, paying especial attention to the selector mechanism.

Note: If an air hose is used, be sure any water condensed in it is blown out before applying the air stream to the equipment. Use only air intended for cleaning purposes and don't blow hard enough to dislodge or damage any apparatus.

c. Preliminary Precautions.

Caution: When the transmitter is operated with covers removed, dangerous voltages are exposed. ***Be careful.***

Never run the dynamotor for long periods in either the RECEIVER TUNE or OPERATE position. The design requirements of the dynamotor are based upon 5 minutes operation with 15 minutes off. In addition to this, prolonged operation of the set may cause objectionable heating effects within the transmitter. Never start the dynamotor with the transmitter ON-OFF switch (filament switch). Start the dynamotor with the RECEIVER TUNE-OPERATE switch or the microphone switch after the filaments have been heated for about 5 seconds (by closing the ON-OFF switch).

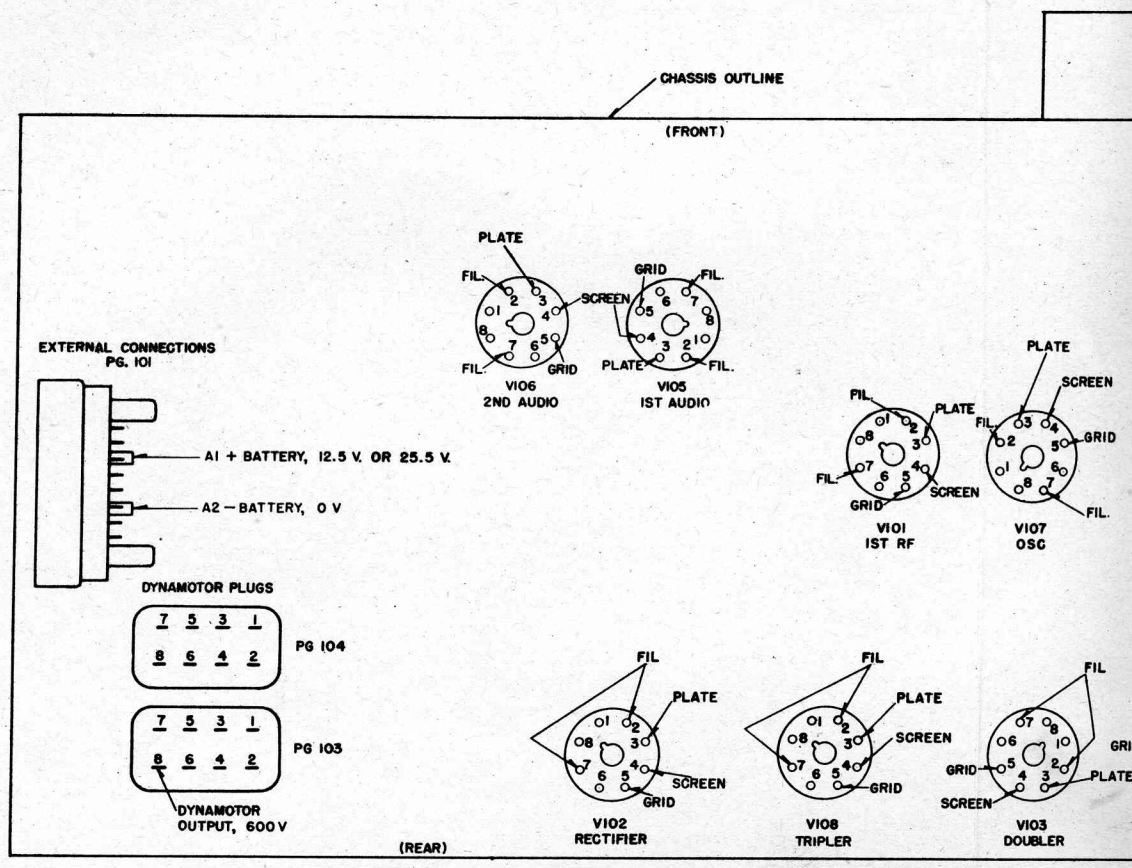
d. Power Supply Check. Lay the transmitter on its side with the panel up so you can read the meter and see the under chassis parts. Don't connect a microphone to the set.

Plug in auxiliary Cord CD-786 to connect the battery to the power receptacle on the transmitter. If the dynamotor starts, look for a stuck dynamotor relay or shorted relay contacts.

Turn the main ON-OFF switch to ON. The green signal lamp should light. If the lamp does not light, check for a burned-out pilot lamp or loose wiring at terminals 1 and 2 of PG101. Watch carefully for other obvious trouble as soon as the switch is turned on.

If desired, a voltmeter may be connected across the power supply during these tests. Operating the filament supply switch (Paragraph 40*c*) should not cause an appreciable change in the voltage reading if no trouble is present. If the dynamotor is short-circuited, the main fuse will open or there will be a continuous low-voltage reading when the dynamotor starts.

Assuming that the dynamotor does not start when the filament supply switch is operated and that no other trouble is noticed after operating the switch, connect a microphone to the set. Momentarily operate the microphone push button and note that the dynamotor starts. If the dynamotor does not start, inspect relay S102 for breakage, contact failure, or defective wiring. Inspect the dynamotor jacks and wiring. Check the dynamotor and also the microphone cord and jack. The dynamotor may start but may indicate by high-speed whine that it is operating at no load. Inspect for an open high-voltage fuse and other open-circuit trouble on the high-voltage supply leads. If the dynamotor starts but operates at low speed, check for a high-voltage overload. Remove the high-voltage fuse. If the dynamotor still labors, remove the battery cord from the set



CAUTION: DANGEROUS VOLTAGES ARE EXPOSED.

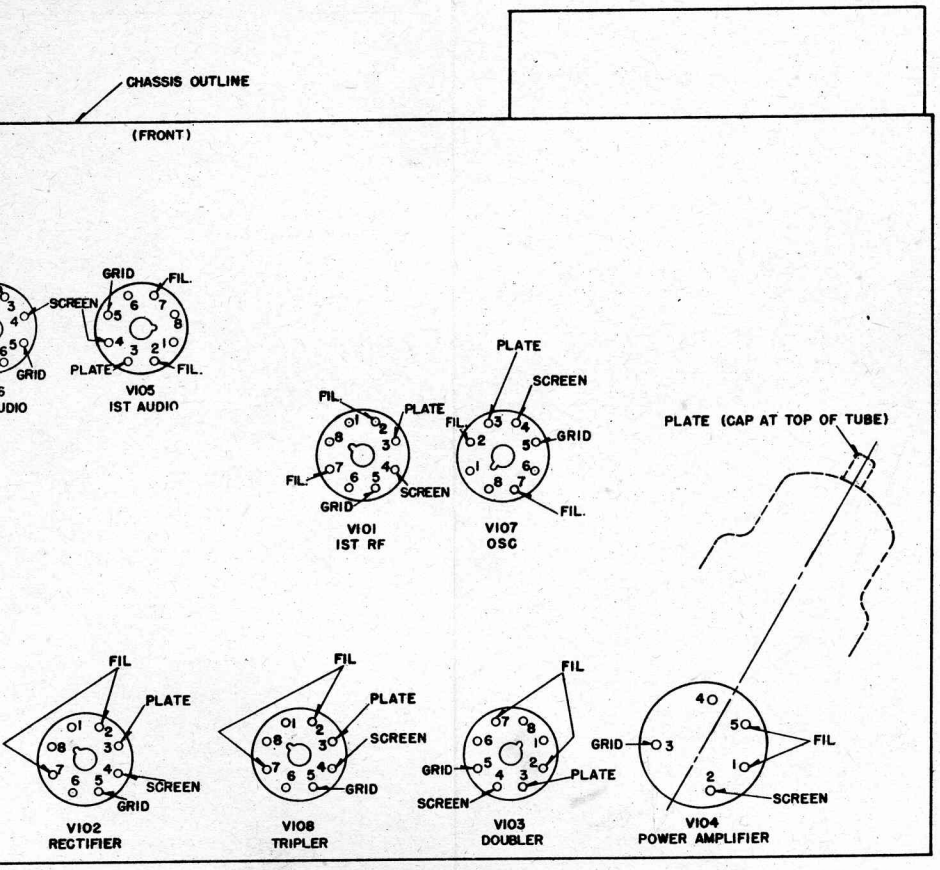
NOTES:

1. LAYOUT CORRESPONDS WITH BOTTOM OF TRANSMITTER. DATA TAKEN WHILE TRANSMITTER IS OPERATING ON CHANNEL 330 INTO A 4
   VOLTAGES ARE MEASURED FROM DESIGNATED POINTS TO FRAME OF TRANSMITTER.
2. OBSERVED METER READINGS MAY EXCEED THE VALUES SHOWN BECAUSE OF RF VOLTAGE SUPERIMPOSED ON DC VOLTAGE AT SO
3. MEASUREMENTS TO BE MADE WITH CRYSTAL OVEN THERMOSTAT UNOPERATED.
4. FOR VOLTAGE MEASUREMENTS, USE VOLTMETER SCALES AS FOLLOWS: 0-3 V., 3 VOLT SCALE
   3-30V., 30 VOLT SCALE
   30-300 V., 300 VOLT SCALE
   300-600 V., 600 VOLT SCALE

APPROXIMATE VOLTAGES AT VACUUM TUBE SOCKET TERMINALS

	MEASUREMENTS WITH VOLTMETER OF 1000 OHMS PER VOLT										MEASUREMENTS WITH VACUUM TUBE VOLTME					
TERM. NOS.	V101	V102	V103	V104	V105	V106	V107	V108			TERM. NOS.	V101	V102	V103	V104	VI
1	0	0	0	2.5	0	0	0	0			1	0	0	0	2.5	
2	10	7.5	2.5	300	2.5	12.5	2.5	7.5			2	10	7.5	2.5	340	2.
3	400	400	400	-13	200	345	100	400			3	400	400	400	-90	22
4	130	245	160	—	22	180	80	270			4	180	270	180	—	4
5	-75	-22	-15	0	0	0	-1.4	-4.5			5	-90	-45	-60	0	0
6	—	—	-22	—	—	—	—	370			6	—	—	-23	—	—
7	7.5	10	5	—	5	10	0	5			7	7.5	10	5	—	5
8	0	0	0	—	0	0	0	0			8	0	0	0	—	0
CAP	—	—	—	600	—	—	—	—			CAP	—	—	—	600	—

Fig. 59. Radio Transmitter BC-684-A: Voltage Diagr



APPROXIMATE VOLTAGES AT PLUG TERMINALS		
12.5 VOLT BATTERY		
TERMINAL NOS.	PG 103	PG 104
1	0	12.5
2	0	12.5
3	0	12.5
4	-22	12.5
5	0	0
6	—	12.5
7	0	0
8	600	0
25.5 VOLT BATTERY		
TERMINAL NOS.	PG 103	PG 104
1	0	25.5
2	0	12.5
3	12.5	25.5
4	-22	25.5
5	0	0
6	—	12.5
7	12.5	0
8	600	0

CAUTION: DANGEROUS VOLTAGES ARE EXPOSED.

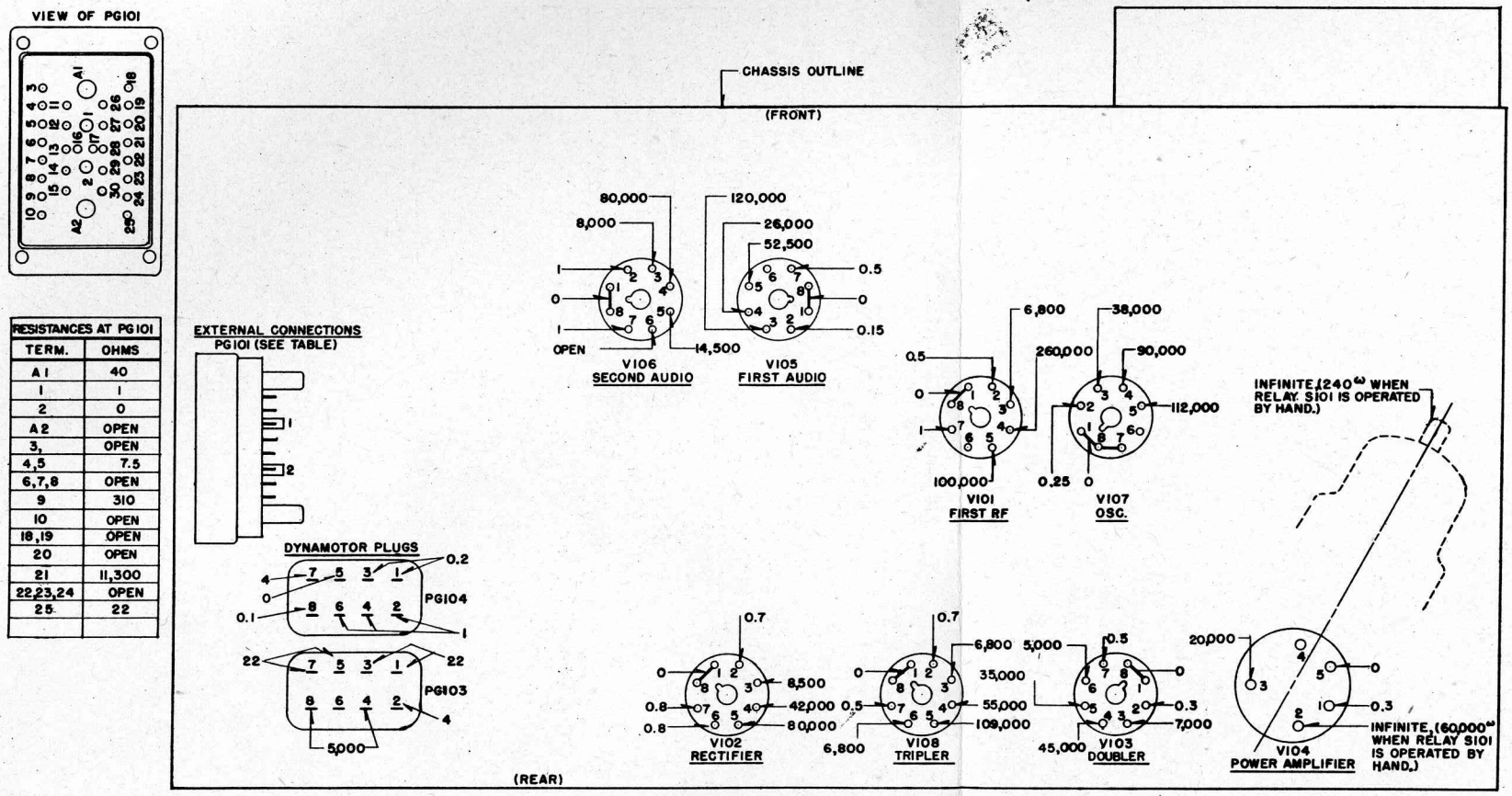
TTER. DATA TAKEN WHILE TRANSMITTER IS OPERATING ON CHANNEL 330 INTO A 40 OHM ANTENNA. ALL
OINTS TO FRAME OF TRANSMITTER.
VALUES SHOWN BECAUSE OF RF VOLTAGE SUPERIMPOSED ON DC VOLTAGE AT SOME TERMINALS.
VEN THERMOSTAT UNOPERATED.
R SCALES AS FOLLOWS: 0-3 V., 3 VOLT SCALE
3-30 V., 30 VOLT SCALE
30-300 V., 300 VOLT SCALE
300-600 V., 600 VOLT SCALE

XIMATE VOLTAGES AT VACUUM TUBE SOCKET TERMINALS

VOLT V108		
0		
7.5		
400		
270		
-4.5		
370		
5		
0		
—		

MEASUREMENTS WITH VACUUM TUBE VOLTMETER (RCA VOLTOHMYST OR EQUIVALENT)										
TERM. NOS.	V101	V102	V103	V104	V105	V106	V107	V108		
1	0	0	0	2.5	0	0	0	0		
2	10	7.5	2.5	340	2.5	12.5	2.5	7.5		
3	400	400	400	-90	220	370	120	400		
4	180	270	180	—	40	220	85	290		
5	-90	-45	-60	0	0	0	-9	-60		
6	—	—	-23	—	—	—	—	400		
7	7.5	10	5	—	5	10	0	5		
8	0	0	0	—	0	0	0	0		
CAP	—	—	—	600	—	—	—	—		

Fig. 59. Radio Transmitter BC-684-A: Voltage Diagram



RESISTANCES AT PG101	
TERM.	OHMS
A1	40
1	1
2	0
A2	OPEN
3,	OPEN
4,5	7.5
6,7,8	OPEN
9	310
10	OPEN
18,19	OPEN
20	OPEN
21	11,300
22,23,24	OPEN
25	22

CAUTION: REMOVE BATTERY BEFORE MEASURING RESISTANCE

BOTTOM VIEW OF TRANSMITTER WITH COVER PLATE REMOVED. ALL VALUES SHOWN ARE OHMS BETWEEN POINT INDICATED AND FRAME OF SET. NO BATTERY CONNECTED. DYNAMOTOR IN PLACE. ON-OFF SWITCH ON. ALL VACUUM TUBES IN PLACE. RECEIVER TUNE-OPERATE SWITCH IN OPERATE POSITION.

Fig. 60. Radio Transmitter BC-684-A: Resistance Diagram

Table VI. Meter Switch Readings*

Switch position	*1*	*2*	*3*	*4*	*5*	*6*
Circuit	*Doubler Grid*	*First R-f Grid*	*Rectifier Grid*	*Tripler Grid*	*Power Amplifier Grid*	*Total Plate and Screen*
Meter reading (27.0 mc)	30	30	20	20	30	30
Meter reading (38.9 mc)	20	25	25	25	30	30

*Transmitter RECEIVER TUNE-OPERATE switch at RECEIVER TUNE.

and determine where the short circuit is and check the dynamotor.

e. Check of R-f Stages. Assuming that the dynamotor starts satisfactorily and that no other trouble is noticed upon operating the microphone push button, proceed to a rough check of the operation of the radio-frequency stages.

Check that all crystals are in place.

Caution: High voltage is present on the crystal pin-jacks when the transmitter is operating. *Don't take chances.*

Operate the push button for the highest frequency channel. Place the RECEIVER TUNE-OPERATE switch on RECEIVER TUNE and the TUNE-ANT CUR switch on TUNE. Turn the METER SWITCH on the right end of the transmitter to position 2 and observe the oscillator output to the first radio-frequency stage. This current will be considerably different for crystals of different activity. Any reading is probably satisfactory. (*Note:* This current may be high for sets with a 1000-ohm resistor R106; see Paragraph 44.) Operate the METER SWITCH successively to positions 3, 4, 1, and 5, observing the grid current to the rectifier, tripler, doubler, and power amplifier. The current readings given in Table VI may be used as a guide, but it is recommended (on account of possible wide tube and circuit variations) that the normal current readings for each transmitter be recorded for use in locating trouble. (Also see Paragraph 31*e*.) If you obtain a considerably different reading from that shown in Table VI at one point, your trouble may be near the point of such reading. Voltage and resistance readings in accordance with Figs. 59 and 60 should be made at the stage in which trouble is suspected to be present; if necessary, replace the tube in that stage. Low-voltage readings indicate short circuits or high series resistance; high-voltage readings in general indicate defective tubes or open circuits or shorted series resistors.

Start the transmitter and check the selector adjustment by depressing the no. 1 push button and observing the maximum meter deflections with the METER SWITCH in positions 3, 4, 1, and 5, as the gang capacitor is varied slightly against the restoring force of the selector springs. *Do not attempt to rotate the capacitor control more than a few degrees.* The meter should indicate a maximum deflection at the capacitor setting determined by the selector. If the selector does not properly position the gang capacitor, it should be reset in accordance with Paragraph 21*a*. If the transmitter has been incorrectly tuned to the crystal frequency, incorrect peaking with METER SWITCH positions 1 and 3 will probably result. Improper alignment (assuming that the tuning was done properly) will probably result in low meter readings in positions 1 and 5.

Do not operate with the switch on RECEIVER TUNE for more than a few minutes at a time. If no trouble is indicated by the meter readings with the push button for the highest-numbered channel operated, take similar readings on the other channels in sequence.

f. Tuning Check. If your meter readings indicate need for tuning the channels, perform the tuning adjustments in accordance with Paragraph 21*a* and check as discussed in Paragraph 40*e* preceding.

g. Power Amplifier Check. To check the operation of the power amplifier, throw the RECEIVER TUNE-OPERATE switch to OPERATE. Throw the TUNE-ANT CUR switch to ANT CUR and see if the power output can be varied by

variation of the antenna trimmer capacitor. An antenna (see Paragraph 38*b*) must be connected for this test. Also read the plate current (METER SWITCH in position 6 and TUNE-ANT CUR switch on TUNE) with the RECEIVER TUNE-OPERATE switch first at RECEIVER TUNE and then at OPERATE (microphone button pressed). The difference in readings should give the normal power amplifier plate current. Watch for sparking and overheating in the power amplifier tube itself. If there is output from the preceding stage and none from the power amplifier, check the voltage and resistance readings for the stage and the tube itself. Also check alignment of the power amplifier stage.

b. Check of Audio Stages. Replace the bottom cover plate and place the transmitter on the mounting for check with the associated receiver. Turn the SIDETONE control to maximum. Speak into a microphone. Sidetone should be heard in the associated receiver. As an over-all check of the audio stages and the transmitter itself, operate the transmitter and listen on the receiver of another set. This should give a satisfactory check for both operation and noise in the transmitter. If there is trouble in the audio stages, make a voltage and resistance check of both stages. Operating the transmitter with its own receiver will also give you a satisfactory check of the operation of the control circuits.

i. Intermittent Trouble. Whenever a complete inspection of a transmitter is made, every effort should be made to locate and clear intermittent trouble. Do this by complete inspection of parts and wiring and by gently shaking or jarring the transmitter.

41. Maintenance of Dynamotors.

a. Service Tools. No special tools are required for the ordinary care of Dynamotors DM-34-(*), DM-35-(*), DM-36-(*), and DM-37-(*). The following tools and material are desirable:

1—3½-inch cabinet screwdriver.
1—Small pair of pliers.
1—Toothbrush.
1—Clean cloth.
1—Can of light machine oil.
1—Can or tube of Type S-58 lubricant, or its equivalent.
1—Light hammer.
1—Center punch.
A few sheets of grade 0000 (4/0) sandpaper.

b. Troubles and their Remedy.

(1) Failure to Start, or Dynamotor Stops:

Possible Cause	*Correction*
No d-c supply; open or loose connection.	Check d-c supply and tighten connections.
Brushes not seating properly; dirty, sticking, or worn brushes.	Remove brushes. Clean thoroughly and reseat or replace as required.
Poor commutation; dirty or rough commutator.	Clean commutator and brushes; if rough, sand with 4/0 sandpaper; turn commutator.
Worn bearings; armature strikes pole faces or connections.	Replace bearings.
Defective armature; short-circuited or open-circuited.	Replace dynamotor.

(2) Excessive Arcing at Brushes:

Possible Cause	*Correction*
Poor commutation; dirty or rough commutator.	Clean commutator and brushes; if rough, sand with 4/0 sandpaper; turn commutator.
Brushes not seating properly; dirty, sticking, or worn brushes.	Remove brushes. Clean thoroughly and reseat or replace as required.
Defective brush spring.	Replace brush assembly.
Short circuit between bars; dirty commutator.	Clean commutator, or replace dynamotor.
Open-circuited armature coil.	Replace dynamotor.

(3) Rapid Brush Wear:

Possible Cause	*Correction*
Excessive arcing.	See *(2)*.
High mica.	Replace dynamotor.
Dirty commutator.	Clean commutator and brushes; smooth with 4/0 sandpaper.

(4) Excessive Noise Picked Up in Radio Receiver BC-683-A:

Possible Cause	*Correction*
Sparking at commutator.	See *(2)*.
Loose connections.	Tighten connections.
Capacitor open- or short-circuited.	Replace capacitor.

(5) Excessive Noise and Vibration:

Possible Cause	*Correction*
Armature striking internal wiring.	Rearrange wiring.
Armature striking pole pieces.	Replace dynamotor.
Worn bearings.	Replace dynamotor.

*c. **Routine Maintenance.*** If the radio equipment is operating normally, the dynamotors should need servicing (including lubrication) only about every 300 hours of use. The life of the dynamotor will be extended substantially if the end bells are removed and the dust wiped from the commutators and the brush holders every 100 hours or oftener. Unnecessary dressing of commutators, manipulating of brushes, or excessive greasing is likely to be harmful.

Note: In the following paragraphs, numbers in parentheses correspond to numbers in Figs. 41 and 42, exploded views of the two dynamotors, which are found on pages 67-68.

(1) Lubrication. Remove the end covers (13) by cutting the safety wires on the ends of the dynamotor and removing screws (14), washers (16), and lock washers (15). Wipe out loose dust and dirt. Take out the screws (28) holding the bearing bracket end plate (27) and remove the end plate, being careful not to lose any shims from the end of the shaft. With the toothbrush and cloth remove all old and hardened grease. Apply two or three drops of light machine oil to the ball bearings, and repack the outer side of the bearing with a small amount of Type S-58 lubricant as made by the New York and New Jersey Lubricant Company, or the equivalent. Do not get oil or grease on the commutator or brushes.

If there is grit in the bearings, you can clean them temporarily by removing the armature and swishing the bearings back and forth in cleaning fluid, such as petroleum spirits, kerosene, gasoline, or carbon tetrachloride. Be careful not to insert the armature far enough into the fluid to permit the windings to become wet. After cleaning, shake off as much cleaning fluid as possible, then insert the bearings into a bath of light machine oil, remove, and allow to drain before repacking with grease as outlined in Paragraph 41*c(1)*.

(2) Commutators. A highly polished commutator surface is very desirable. Don't mistake a dark color for a burned condition. If the surface is smooth and is polished and the commutation satisfactory, leave it alone. Slight sparking does not necessarily mean poor commutation. If the surface of a commutator becomes dirty, wipe with a clean cloth. If necessary, wipe with a cloth moistened with cleaning fluid such as petroleum spirits, kerosene, or gasoline, followed by a dry cloth. Keep bearings and housing clean. Remove the covers and clean out the dust and dirt frequently. This cleaning should include removing the brushes and wiping the inside of the brush holders and the external surfaces of the brushes.

(3) Brushes. Each brush has a flexible pigtail and spring designed to limit the rotation of the spring and pigtail to a minimum when replacing a brush cap. Replace brushes when they are less than 1/4-inch long as measured from the bearing surface to the spring. Brush pressure is satisfactory if 1/4 inch or more of the spring extends out of the brush holder when the holder cap is removed and the end of the brush is bearing on the commutator. Run in new or re-dressed brushes for several hours at no load when possible, to obtain proper fit before the dynamotor carries full load. It is desirable that the brushes be so seated that they bear over 100 per cent of their arc and have at least 75 per cent of their area in contact with the commutator. When brushes are replaced after removal, be sure you return them to the same holders from which they were removed. Insert the brushes in their re-

spective holders with the polarity mark facing upwards. When checking or replacing brushes make sure they slide easily in the brush holder; if they do not, the spring cannot force the brush against the commutator.

It is very important to keep brush resistance as low as possible, so make sure the brush pigtail is in good condition. If a brush pigtail is broken or loose in the brush or end cap, the current has a tendency to go through the brush spring. This causes the spring to overheat, lose its temper, and give low brush pressure.