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US WAR DEPARTMENT

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1942

TECHNICAL MANUAL



**RADIO TRANSMITTERS BC-191-A,
BC-191-B, BC-191-C, BC-191-D,
BC-191-E, AND BC-AA-191**

November 12, 1942



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**RADIO TRANSMITTERS BC-191-A, BC-191-B, BC-191-C,
BC-191-D, BC-191-E, AND BC-AA-191**

Caution: This equipment employs high voltages which are dangerous and may be fatal if contacted by operating or repair personnel. Never operate the transmitter with the shields removed and the high voltage cord inserted in the PL-59 socket. Always momentarily short circuit every part to the chassis frame with an insulated wire or screw driver before working near it. Do this after all power supply equipment has been turned off or disconnected. The capacitors in this equipment retain their electrical charge for some time after the power source is removed and can give a dangerous shock if this precaution is not observed. Never change fuses with the high voltage power supply connected. Make the necessary ground connections to power supply equipment and transmitter, following cording instructions on the chests issued with the radio set.

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CHAPTER 1

GENERAL

Paragraph

Differences in models-----1

1. **Differences in models.**—*a.* Radio transmitters BC-191-(*) and BC-AA-191 with their associated equipment are designed for use as component parts of radio sets installed in aircraft, armored cars and other vehicles, as well as in portable ground stations. The basic circuit arrangements of the two types are similar. However, the older type BC-AA-191 requires the use of certain external equipment. In the BC-191-(*) transmitters the equivalent equipment is built into the transmitter case. In addition, the BC-191-(*) transmitters have greater frequency stability under varying temperatures and incorporate numerous circuit and mechanical refinements.

b. In general, the various BC-191-(*) types are alike. The BC-191-A, the first type issued, and the BC-191-B, are alike except for improvements in the latter in the rotary antenna loading coil 1170** and the switching relay 1165. The BC-191-C, the third type issued, has a toggle type OFF ON switch 1194 in place of the rotary type 1132 on the older sets. In addition, the A-C D-C and 12V. 14.2V. switches 1195 and 1190 respectively are of different design from the old switches 1136-1137 and 1139-1140 which they replace. A number of other minor changes distinguish the BC-191-C from older models. The faces of the panel meters are black with white lettering, while on the older models the faces are white with black lettering.

c. Radio transmitter BC-191-D is like BC-191-C except for a redesigned filament resistor connection board and a redesigned antenna loading switch 1198 replacing switch 1171. These parts are interchangeable electrically and mechanically with those in the BC-191-C. Radio transmitter BC-191-E includes the changes of the BC-191-D and in addition has a single unit filter capacitor block 1197a, 1197b, and 1197c, replacing three individual capacitors 1120, 1155, and 1163 in the older models. This part is interchangeable electrically, but not mechanically, with the three units it replaces.

For simplicity, radio transmitters BC-191-A, BC-191-B, BC-191-C, BC-191-D and BC-191-E will be referred to as BC-191-() in this manual when remarks are applicable to all such sets. The (*) indicates all five types. Radio transmitter BC-AA-191 is always referred to as BC-AA-191.

**Numbers refer to parts indicated by same numbers in illustrations and diagrams in this manual.

d. Radio transmitter BC-AA-191 makes use of transmitter tuning units with the designation TU-AA-(). There are eight of the units marked from TU-AA-3 to TU-AA-10 in consecutive order. Radio transmitters BC-191-A, BC-191-B, and some BC-191-C types use transmitter tuning units of the TU-()-A type. There are nine such units available for full frequency coverage. A typical unit is TU-5-A. Later models of the BC-191-C and all BC-191-D and BC-191-E transmitters are supplied with transmitter tuning units of the TU-()-B type. For example, TU-5-B. The only difference between the A and B types is that the B type does not have the two insulated binding posts found in the upper right-hand corner of the front panel of the A type. These posts are not required for operation of the equipment but are a convenience in some servicing operations. They are connected to the tapped secondary of the power amplifier tank circuit through control ANT. COUPLING SWITCH D.

e. Due to the differences in location of controls, appearance, adjustments, and operating procedure between radio transmitters BC-191-(*) and BC-AA-191, this manual has been divided into two parts, the first dealing with the newer BC-191-(*) types, and the second with the older BC-AA-191.

f. Following are tables of weights and dimensions of component parts:

TABLE OF WEIGHTS AND DIMENSIONS

Description	Dimensions in inches (Height by width by depth)	Weight in pounds
Antenna tuning unit BC-306-A	$17\frac{3}{4} \times 9\frac{1}{2} \times 9\frac{1}{8}$	9.75
Weight less mounting FT-142		9.062
Case CS-48	$7\frac{7}{8} \times 16\frac{3}{4} \times 7\frac{29}{32}$	4.375
Dynamotor unit BD-77-C	$10\frac{29}{32} \times 11\frac{1}{16} \times 7\frac{1}{2}$	38.7
Weight less mounting FT-107		37.25
Mounting FT-107	$1\frac{3}{16} \times 10\frac{5}{8} \times 7\frac{1}{2}$	1.45
Mounting FT-115-B	$1\frac{7}{32} \times 2\frac{1}{8} \times 2\frac{5}{16}$	0.195
Mounting FT-142	$1\frac{3}{32} \times 9\frac{1}{2} \times 8$	0.69
Mounting FT-151-A	$1.352 \times 22 \times 8$	3.75
Mounting FT-151-B	$1.352 \times 22 \times 8$	3.66
Radio control box BC-309	$3\frac{9}{16} \times 3\frac{1}{2} \times 2\frac{7}{32}$	0.418
Radio transmitter BC-191-C (without tubes or tuning units).	$21\frac{21}{32} \times 23\frac{1}{8} \times 9\frac{5}{16}$	55.00
Radio transmitter BC-191-D (without tubes or tuning units).	$21\frac{21}{32} \times 23\frac{1}{8} \times 9\frac{5}{16}$	55.00
Radio transmitter BC-191-E (without tubes or tuning units).	$21\frac{21}{32} \times 23\frac{1}{8} \times 9\frac{5}{16}$	55.00

TABLE OF WEIGHTS AND DIMENSIONS—Continued

Description	Dimensions in inches (Height by width by depth)	Weight in pounds
Weight less mounting FT-151-A	-----	51. 25
Transmitter tuning unit TU-3-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	13. 00
Transmitter tuning unit TU-5-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	14. 437
Transmitter tuning unit TU-6-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	12. 437
Transmitter tuning unit TU-7-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	11. 687
Transmitter tuning unit TU-8-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	11. 437
Transmitter tuning unit TU-9-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	11. 437
Transmitter tuning unit TU-10-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	11. 437
Transmitter tuning unit TU-22-B	7 ⁵ / ₈ x 16 ³ / ₄ x 8 ³ / ₄	12. 250
Tube VT-4-C	2 ⁵ / ₁₆ dia. x 7 ⁷ / ₈ long	0. 460
Tube VT-25	2 ³ / ₁₆ dia. x 5 ⁵ / ₈ long	0. 125
1 carton of maintenance parts. This carton contains	2 ³ / ₄ x 3 ⁷ / ₈ x 7 ⁷ / ₈	1. 75
4 brushes BR-5 (dynamotor, high voltage)		
4 brushes BR-6 (dynamotor, low voltage)		
2 fuses FU-12-A		
2 fuses FU-13		
2 fuses FU-18-A		
2 fuses FU-22		
6 fuse links M-141		
6 fuse links M-168		
4 setscrew wrenches		
¼ pint of glyptal varnish No. 1153	-----	-----
1 carton of socket caps. This carton contains	1 ¹ / ₂ x 3 ¹ / ₂ x 3 ¹ / ₂	0. 375
1 socket cap M-163-A		
1 socket cap M-164-A		
2 socket caps M-165-A		

CHAPTER 2

RADIO TRANSMITTERS BC-191-(*)

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SECTION I

GENERAL CHARACTERISTICS

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2. **Frequency range.**—*a.* The frequency range covered by this transmitter depends on the particular transmitter tuning unit in use. The over-all range is from 200 to 800 and from 1,500 to 12,500 kilocycles (kc). This frequency range is divided into nine bands, each covered by a plug-in transmitter tuning unit as indicated below.

<i>Tuning unit</i>	<i>Frequency range (in kc)</i>
TU-3-A or -B	400-800
TU-5-A or -B	1,500-3,000
TU-6-A or -B	3,000-4,500
TU-7-A or -B	4,500-6,200
TU-8-A or -B	6,200-7,700
TU-9-A or -B	7,700-10,000
TU-10-A or -B	10,000-12,500
TU-22-A or -B	350-650
TU-26 -B	200-500

b. Each radio set of which the radio transmitter BC-191-(*) is a component part is issued with only the tuning units necessary to cover its authorized frequency range. The authorized range informa-

tion is listed in the Technical Manual describing the complete radio set.

NOTE.—A few special radio sets have been issued with special transmitter tuning units TU-1-A or -B, 150 to 260 kilocycles; TU-2-A or -B, 260 to 400 kilocycles; and TU-4-A or -B, 800 to 1500 kilocycles. These are not standard equipment.

3. Types of transmission.—This equipment transmits signals of the following types:

- a. Unmodulated continuous wave telegraph signals (c. w.).
- b. Tone modulated, continuous wave telegraph signals (i. c. w. or tone). These are amplitude modulated signals.
- c. Voice modulated, continuous wave telephone signals (voice or phone). These are amplitude modulated signals.

4. Power.—*a. Input.*—Several different types of power supply equipment are supplied with the radio sets of which this transmitter is a component part.

(1) Some sets use a 12-volt storage battery floated across the charging generator of a motor vehicle. The battery (a component of the motor vehicle) supplies power directly to the vacuum tube filaments and the control circuits. A dynamotor operating from the same battery generates high voltage for the plate circuits of the transmitter.

(2) A second type of power equipment is a gasoline engine-driven generator which generates both 12 volts and high voltage, supplying all power required for transmitter operation.

(3) A third type of authorized power supply equipment is a rectifier type of unit operating from 110- or 220-volt a-c power supplies. Separate rectifiers in the equipment furnish low and high direct current voltages for transmitter's control and plate circuits, respectively. Transmitter tube filaments are heated by low-voltage alternating current supplied by a step-down transformer in the unit.

b. Output.—Normal power output on continuous-wave telegraph operation varies from 40 to 75 watts, depending on the transmission frequency.

5. Distance range.—The distance range of this transmitter depends on several factors, such as operating frequency, type of transmission (see par. 3), type of antenna system, and location (on ground, in a vehicle, or in aircraft). For this reason no figures are given in this manual. The Technical Manual describing each radio set contains data on the distance ranges over which the set may be expected to operate.

6. Components.—The transmitter BC-191-(*) comprises only the transmitter unit itself, mounting FT-151-A, three fuses FU-12-A,

one pilot lamp LM-27, one socket cap M-164-A, two socket caps M-165-A, and two setscrew wrenches for loosening the setscrews holding the various control knobs on their shafts. (See fig. 4.) Power supply equipment, transmitter tuning units, and antenna tuning unit BC-306-A (when required) are issued as parts of the radio set in which the transmitter is used. However, the tuning units are completely described in this manual because they are essential components of the transmitter in operation.

7. Transmitter.—*a.* The transmitter is housed in a shielded metal cabinet made up of panels fastened with buttonhead screws to the tubular steel frame of the transmitter. The front cover of the tube

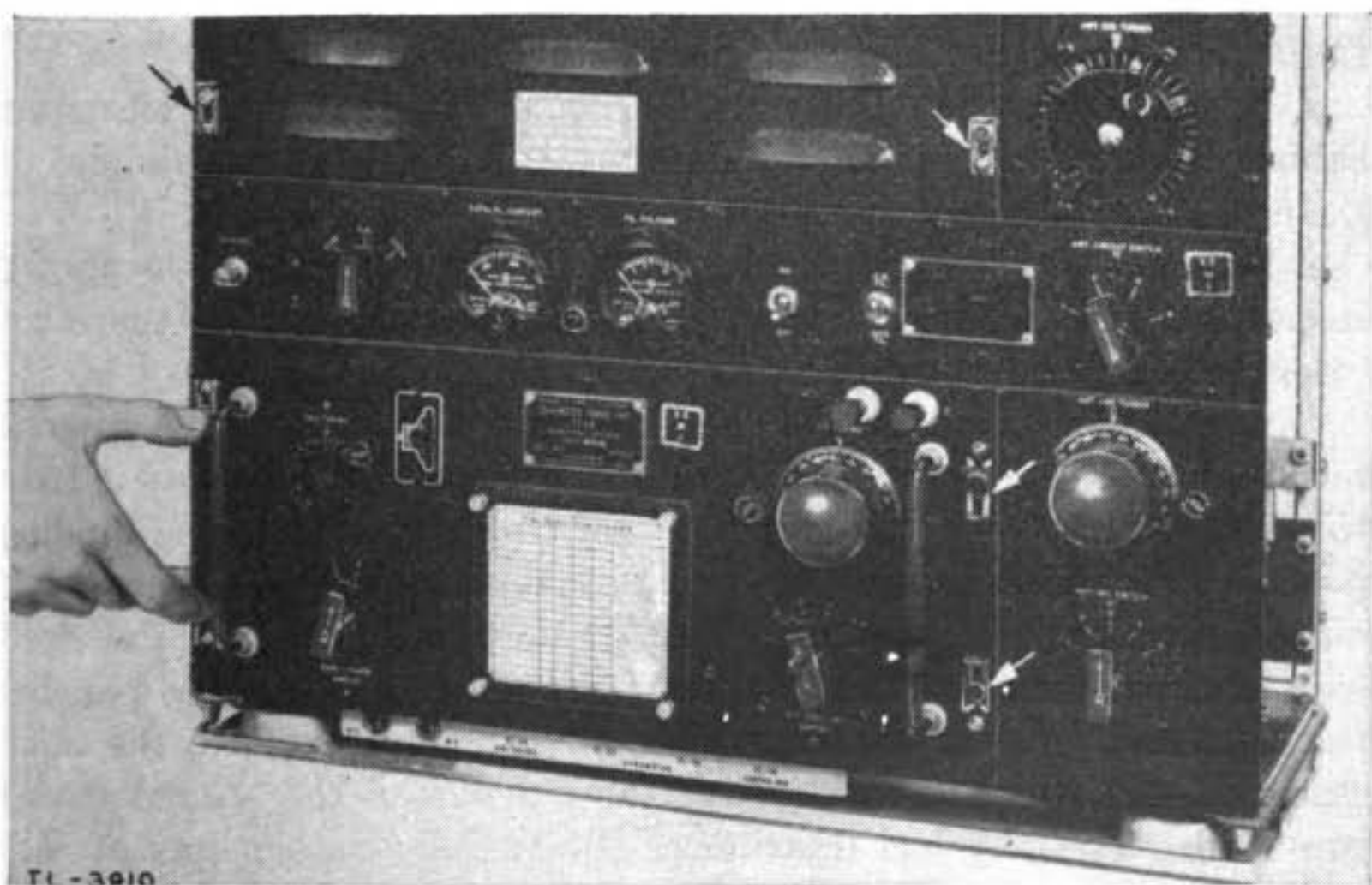


FIGURE 1.—Location and operation of snap slide catches on radio transmitter BC-191-(*)—front panel.

compartment, located at the upper left front of the transmitter, is secured by means of two snap slide catches. Remove the cover to expose the compartment for installation, inspection, and removal of vacuum tubes. Just behind the tubes, on the rear wall of the compartment, are several controls, adjustment of which is described in paragraphs 12 to 16 and 18*b*. Above the rear wall of the compartment is the filament resistor connection board. (See fig. 4.) Adjustment of this part is explained in paragraphs 14 to 16.

b. The right side of the transmitter front panel holds the antenna tuning controls. Adjustment is described in paragraph 17*c*.

Just below the tube compartment is a narrow panel running across the front of the transmitter. This panel mounts the test key, the signal selector switch, meters for filament voltage and plate current indication, and the voltmeter switch. The small covered port just to the right of the test key is for the insertion of a screw driver to reset the calibration capacitor. This operation is described in paragraph 35*d*.

c. Below this panel is a compartment provided with metal guides. A transmitter tuning unit inserted in this compartment connects to the transmitter circuits by means of jacks and plugs mounted on insulated strips. (See fig. 3.) When inserted, it is locked in place by means of four snap slide catches. (See fig. 1.) The front panel of the tuning unit is then flush with the transmitter front panel and the tuning unit becomes an integral part of the transmitter.

d. Extensions at the corners of the bottom plate of the transmitter cabinet secure the mounting FT-151-A. Release the snap slides of the mounting to free it from the cabinet.

e. Remove the transmitter back plate to expose circuit elements for inspection and repair. Remove the side plates to expose the other internal parts and wiring.

f. Connections are made to the antenna system and to the antenna terminals on the associated receiving equipment of the radio sets from the output terminal strip (fig. 21) which has six push-type binding posts. This strip is removable and can be plugged into either of two output terminal plug boards. One of these is located on the right side of the transmitter near the top; the other is on the top panel at the right end. Cover the one which is not being used with the small shield M-191 which is fastened to the panel with the special screws provided. The physical location of the various components of each radio set will determine in which of the two positions the output terminal strip should be mounted. Cording diagrams on the radio set chests and in the pertinent Technical Manual contain this information.

g. The output terminal strip has a marking FRONT at one end. Be sure to install the strip with this marking toward the transmitter front for proper operation. Connect a heavy wire jumper between the binding post LOAD A and LOAD B, unless the antenna tuning unit BC-306-A is used.

h. Sockets and jacks for making cording connections to power and control components are provided in duplicate, one set on the bottom (fig. 22), the other on the left side of the transmitter (fig 2). The physical location of components of a radio set determines which set

of sockets is used. Cover the unused sockets with the socket caps supplied with the transmitter.

8. Transmitter tuning units TU-3-A or -B, TU-5 to TU-10-A or -B, TU-22-A or -B, and TU-26-B.—These nine

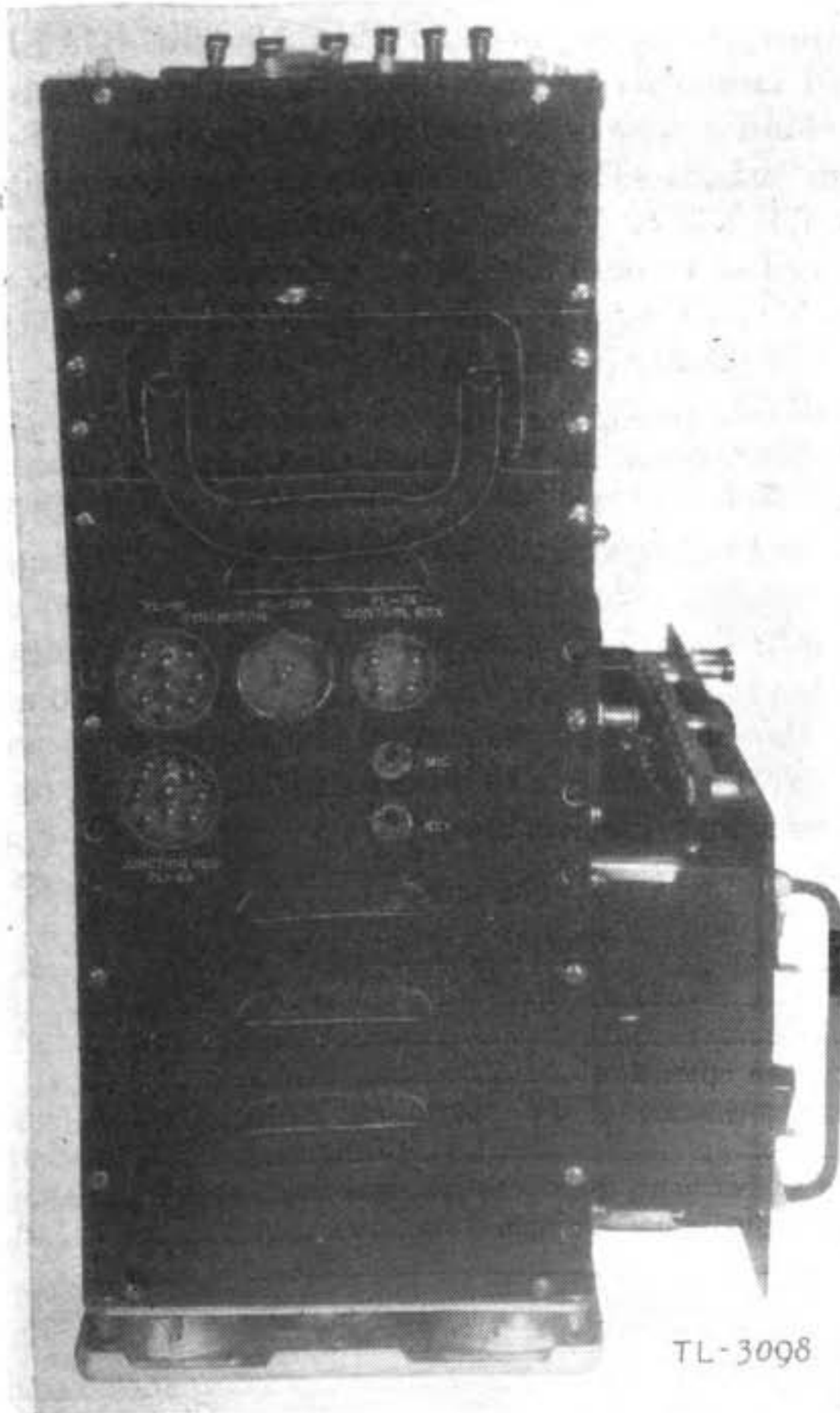


FIGURE 2.—Radio transmitter BC-191-(*) with transmitter tuning unit partially inserted, showing one set of sockets and jacks—left end view.

transmitter tuning units cover the frequency ranges given in paragraph 2. Each tuning unit consists of a dural case housing the tuning elements of the master oscillator and power amplifier stages. The circuits of these units are shown in figure 20, and their functioning is described in paragraph 27. Each tuning unit has the following

controls on its front panel: B M. O. TUNING; C P. A. TUNING; and ANT. COUPLING SWITCH D. Transmitter tuning units TU-3-A or -B, TU-5-A or -B, TU-6-A or -B, TU-22-A or -B, and TU-26-B also have a control marked BAND CHANGE SWITCH A. Concealed under the CALIBRATION CHART is a neutralizing capacitor adjustment control and lock. The CALIBRATION CHART may be removed for access to this control by unscrewing the four knurled thumbscrews at the corners of the chart. (See par. 35b.)

9. Vacuum tubes.—These transmitters use five vacuum tubes:

- 1 tube VT-4-C or VT-4-B as master oscillator (m. o.)
- 1 tube VT-4-C or VT-4-B as power amplifier (p. a.)
- 2 tubes VT-4-C or VT-4-B as modulators (mod.)
- 1 tube VT-25 as speech amplifier (s. a.)

NOTE.—VT-4-B tubes (Signal Corps General Catalog No. 2T4B) may be used to replace VT-4-C tubes. Do not use VT-4-B yellow label tubes. There is no advantage in the use of VT-4-C tubes in radio transmitters BC-191-(*) (see par. 36).

10. Antenna tuning unit BC-306-A (fig. 8).—This unit is supplied as a component of certain radio sets. It is used only when transmitting on frequencies below 800 kilocycles. The unit consists of a variometer housed in a dural case. There are three binding posts on the top of the case. The variometer is adjusted by two controls located on the front panel. The whole unit is fastened to mounting FT-142 by four snap slide fasteners.

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EMPLOYMENT

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11. Installation.—*Be particularly careful when unpacking or handling this equipment. When not protected by cabinets or shock mountings it may readily be damaged. Inspect the parts for damage when removing them from the shipping boxes. If necessary, clean*

with brush or blower before installing. A check of the items on hand against the items listed in paragraph 6 will show whether or not the shipment is complete. Complete all minor installations in the transmitter before connecting the cords to power supply units.

a. Minor installations.—(1) All control knobs, jacks, and switches on the transmitter are identified in this manual by their actual markings; for example, the three-position switch at the left end of the narrow front panel is marked TONE C. W. VOICE above the three positions of the switch pointer. In this manual this switch is designated as the TONE C. W. VOICE switch.

(2) If necessary, insert a pilot lamp LM-27 in the socket behind the ruby reflector located between the TOTAL PL. CURRENT meter and the FIL. VOLTAGE meter just above the transmitter tuning unit compartment. (See fig. 3.) Do this by slipping the lamp up behind the panel before inserting the tuning unit in the compartment. The bulb is inserted and turned to lock it in place.

(3) Remove the cover from the tube compartment by releasing the slide catch fasteners as shown in figure 1. Insert the five tubes in the sockets marked with the corresponding Signal Corps VT type numbers.

(4) Inspect the fuses located in the transmitter. There should be three fuses FU-12-A, one in use and two spare. The one in use fits in the clip located above the tuning unit receptacle and behind the pilot lamp socket at the rear of the transmitter frame. (See fig. 3.) It can only be inserted when there is no tuning unit in the receptacle. The two spares are mounted on clips on the bottom shelf just below the tuning unit receptacle and near the front of the transmitter. (See fig. 22.)

b. Actual installation.—(1) Interconnect all cording with power supply equipment turned off and the OFF ON switch on the transmitter front panel in the OFF position. If a separate control box is used be sure it is turned off. Do not connect the cord and plug from the power supply equipment to the DYNAMOTOR PL-59 socket on the transmitter.

(2) The sockets for cording are in duplicate, one set located on the left side of the transmitter and one set on the under side, accessible from below. The cording instructions for each radio set specify which set of sockets to use. Follow instructions. Also determine the proper location for the output terminal strip. (See par. 7.)

(3) After completing the minor installations described in a above, perform the interconnection cording with the other components of the radio set. Cording instructions are given in the Technical Manual covering the operation of the radio set and on the chests supplied with

the set, and vary according to the components. When installing the transmitter, provide at least 2 inches of clearance from the nearest wall for proper ventilation and sufficient clear space in front of the

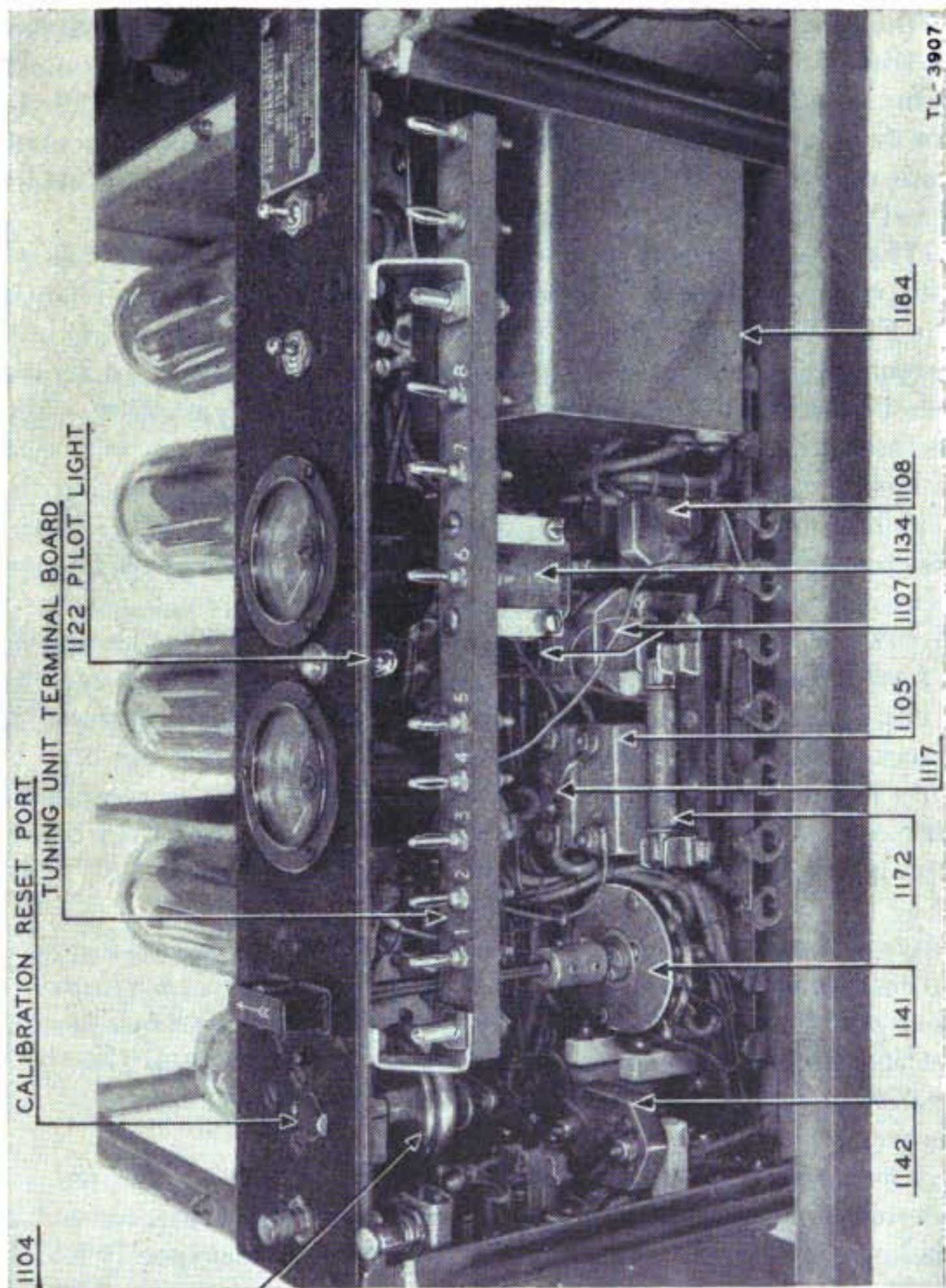


FIGURE 3.—Tuning unit receptacle in radio transmitter BC-191- (*) from front and below, showing pilot light and fuse holder location.

transmitter to permit changing of tubes, removal of transmitter tuning units, and adjustment of tuning controls.

(4) The transmitter mounting FT-151-A allows the equipment to float freely. For this reason the cording should not be fastened down

closer than 18 inches from the transmitter. This will prevent vibration from being transmitted to the unit through the cords.

12. Controls.—*a. On transmitter (fig. 4).*—(1) Transmission is accomplished or controlled by—

(a) An antenna and a counterpoise connected to the ANT. binding post and to the CPSE. binding post, respectively. These binding posts are located on the output terminal strip, which is installed as indicated in paragraph 7.

(b) A thermocouple type 0- to 8-ampere radio frequency ammeter marked ANT. CURRENT located in the upper right-hand corner of the front panel.

(c) An antenna inductance tuning dial marked ANT. IND. TUNING M used for tuning the antenna inductively. It is located immediately below the antenna current meter and is provided with a locking mechanism.

(d) An antenna circuit switch, marked ANT. CIRCUIT SWITCH N, used to accomplish the antenna circuit changes required for tuning the transmitter to various types of antennas. It is located directly below the antenna inductance tuning dial.

(e) An antenna capacitance tuning dial, marked ANT. CAP. TUNING O, located immediately below the antenna circuit switch. This control is used to adjust a tuning capacitor in the antenna circuit. It is provided with a locking mechanism so that its final position may be maintained.

(f) An antenna inductance switch, marked ANT. IND. SWITCH P, used for obtaining large variations in inductive antenna loading. This is a five-position switch, each position corresponding to a tap on the inductance coil, and is located in the lower right-hand corner of the front panel.

(g) A filament voltmeter switch, marked C. W. FIL. MOD. FIL., located to the left of the ANT. CIRCUIT SWITCH N. It is used to transfer the voltmeter to either the modulator tube filaments or the master oscillator and power amplifier filaments.

(h) A transmitter OFF ON switch located to the left of the filament voltmeter switch. It actuates the switching relay of the power unit and controls the low and high voltages from the power equipment at the transmitter. (See also par. 16g.) On transmitters BC-191-A and BC-191-B this is a rotary switch with a bar knob. On all other models it is a toggle switch.

(i) A 0- to 15-volt a-c d-c voltmeter marked FIL. VOLTAGE located to the left of the OFF-ON switch. This meter indicates the filament voltage of the modulator tubes or master oscillator

and power amplifier, as controlled by C. W. FIL. MOD. FIL. switch described in (g) above.

(j) A d-c milliammeter 0- to 500-milliamperes, marked TOTAL PL. CURRENT located to the left of the filament voltmeter. This

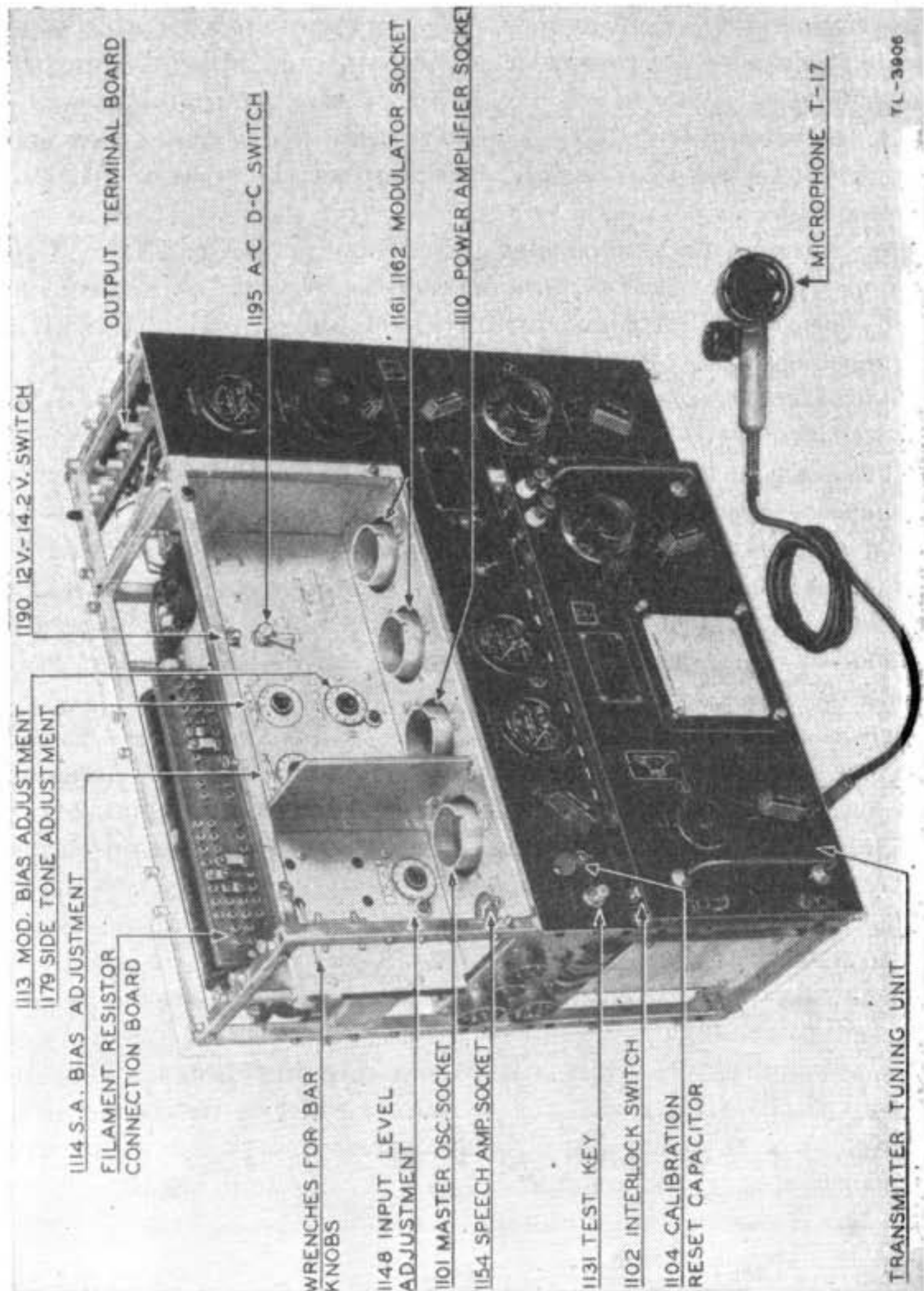


FIGURE 4.—Radio transmitter BC-191-(*) , top and side panels removed and transmitter tuning unit partially inserted—front view. Microphone plug is inserted in jack below transmitter tuning unit.

meter indicates the plate current drawn by the radio transmitter and is used to indicate resonance while tuning, for adjustment of the modulator circuit and for proper loading of the power amplifier circuit.

(k) A three-position selector switch with a pointer for indicating TONE C. W. VOICE positions. This switch is located to the left of the plate current meter. It sets the transmitter for tone, continuous wave telegraph, or voice transmission.

(l) A TEST KEY for keying the transmitter while tuning adjustments are in progress. This is a nonlocking push button and is located at the left of the TONE C. W. VOICE switch.

(2) The calibration reset capacitor is adjusted (see paragraph 35d) by an insulated screw driver inserted through a small port located to the right of the TEST KEY. Its purpose is to bring the settings of the tuning controls of the transmitter into agreement with the CALIBRATION CHART. Normally it is not adjusted during routine operation.

(3) Located in the tube compartments are the following controls which do not usually require adjustment during routine transmission. Ready access to them may be had by removing the tube compartment shield.

(a) In the left tube compartment is the INPUT LEVEL control. It is used to adjust the input to the speech amplifier when voice transmission is being used. (See par. 18b(3).)

(b) In the upper left corner of the right compartment is the control marked S. A. BIAS. This control is used to adjust the grid bias voltage on the speech amplifier tube. (See par. 18b(2).)

(c) To the right of the S. A. BIAS control is one marked SIDE TONE. This control is used to adjust the volume level of the side tone monitoring signal which is fed to the output of the receiver in some radio set installations. If the side tone circuits are not used in an installation, the control need not be adjusted.

(d) To the right of the SIDE TONE control is the 12V. 14.2V. toggle switch. (See pars. 13 to 16, inclusive, for its purpose and adjustment.)

(e) Below the 12V. 14.2V. switch is the switch marked A-C D-C. (In the BC-191-A and BC-191-B this switch is to the right of the 12V. 14.2V. switch.) Adjustment and use of this switch is covered in paragraphs 13 to 16, inclusive.

(f) Below the SIDE TONE control is the control marked MOD. BIAS. This is used to adjust the grid bias voltage on the two modulator tubes VT-4-C or VT-4-B. Proper adjustment procedure is described in paragraph 18b(1).

b. *On transmitter tuning units.*—(1) A band change switch located in the lower left corner of the tuning unit front panel marked BAND CHANGE SWITCH A is used to make the necessary circuit

changes in the master oscillator and power amplifier circuits to alter the frequency range of some tuning units.

NOTE.—There is no **BAND CHANGE SWITCH A** control on transmitter tuning units TU-7-A or -B to TU-10-A or -B.

(2) The master oscillator tuning control marked **B M. O. TUNING** is located in the upper left part of the tuning unit panel. It is used to tune the tank circuit of the master oscillator. The control consists of two dial mechanisms and a lock. The dial mechanism used to select the desired frequency also acts as a vernier and is divided into 100 divisions. The flat, fully exposed circular scale located to the left of the dial lock has 25 divisions and indicates hundreds, while the so-called vernier indicates tens and units, as related to the column marked **B** on the **CALIBRATION CHART**. For example, to set the control for 2,000 kilocycles when using tuning unit TU-5-A or -B, look under column **B** on the **CALIBRATION CHART** for the number opposite 2,000 kilocycles. If it happens to be 1,250, proceed as follows:

(a) Unlock **LOCK** control by turning counterclockwise.

(b) Rotate knurled knob at right of **LOCK** control. This will cause the round flat scale to revolve. Rotate in the direction which will bring the graduation on the round flat scale for 12 (two graduations above 10) directly under the marker.

(c) Slowly rotate knurled knob again, this time observing the numbers on its surface. When 50 is reached, stop.

(d) Check round scale again. It should read midway between 12 and 13.

(e) Lock control by turning **LOCK** knob clockwise. The control is now set at 1,250.

(3) The power amplifier tuning control located in the upper right corner is marked **C P. A. TUNING**. This control is used to tune the tank circuit of the power amplifier. It also is provided with a lock to hold its final setting. The dial calibrations are referred to in column **C** of the **CALIBRATION CHART**.

(4) The antenna coupling switch located in the lower right corner of the panel is marked **ANT. COUPLING SWITCH D**. It has six positions for selecting a different tap on the antenna coupling coil.

(5) Behind the **CALIBRATION CHART** is the control for the neutralizing capacitor. (See pars. 8 and 35b.) It is not adjusted in the normal operation of the transmitter.

13. Adjustments prior to operation.—Determine from the Technical Manual for the radio set of which the transmitter is a component the type of power supply equipment which will be used.

Paragraph 4 describes the several types of equipment authorized for use with this transmitter.

a. Filament circuit switches, d-c operation.—On the panel behind the vacuum tubes in the tube compartment are several knobs and switches. (See fig. 4.) Between tubes four and five (counting from the VT-25 at the left end) there are two switches, the 12V. 14.2V. switch and the A-C D-C switch. The proper operating position of these switches is determined by the power supply equipment used. Place the A-C D-C switch in the D-C position when using a battery-driven dynamotor or an internal combustion engine-driven generator for power supply. Operate the 12V. 14.2V. switch in the 14.2V. position when the power supply is a battery-driven dynamotor in which the battery is on charge while the equipment is in operation (a condition existing in virtually all vehicle and aircraft installations). Move the switch to the 12V. position when using a battery-driven dynamotor supply in which the battery is not on charge. When the transmitter is used with the engine-driven generator power supply, a fairly long connecting cord is used between the generator and the transmitter. The resistance of this cord and the resultant voltage drop are sufficiently high to require operation with the 12V. 14.2V. switch in the 12V. position, even though the generator output is 14.6 volts. The adjustment of the filament circuit for this condition is explained in paragraph 15.

b. Filament circuit switches, a-c operation.—Set the A-C D-C switch in the A-C position and the 12V. 14.2V. switch in the 14.2V. position when the transmitter is operated with a rectifier type power supply from a 110- to 120-volt a-c power source.

14. Filament voltage adjustment, d-c operation, storage battery-dynamotor supply.—When operating the transmitter from a storage battery-dynamotor power supply with battery on charge (the normal condition in vehicles and aircraft), adopt the following procedure of filament voltage adjustment:

a. Interconnect all cording between the transmitter and the dynamotor (*except the high voltage cords to sockets PL-59*). Place the transmitter OFF ON switch at OFF. If a radio control box is used, place its OFF ON switch at OFF. Now connect the two cables from the dynamotor to the storage battery. Be certain that proper polarity is followed in doing this.

b. Have the vehicle engine turning over so that the battery is charging.

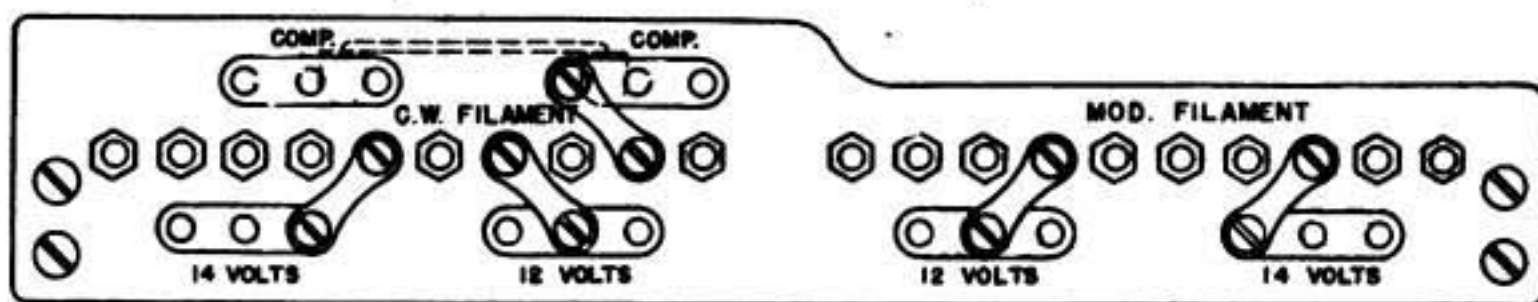
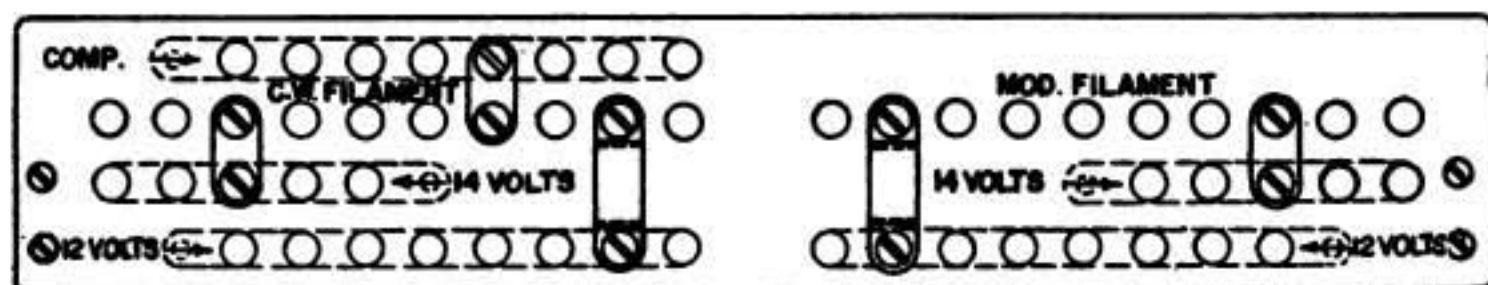
c. Remove the front cover from the tube compartment and place the A-C D-C switch in the D-C position. Also remove the 16 screws which fasten the transmitter top and remove the top.

d. At the top left of the tube compartment is the filament resistor connection board. (See fig. 4.) On the left end of the board are four rows of studs, beginning at the top of the board, labeled as shown in figure 5: COMP., C. W. FILAMENT, 14 VOLTS, and 12 VOLTS. (COMP. is abbreviation for compensator.) On the right are three rows of studs, MOD. FILAMENT, 14 VOLTS and 12 VOLTS. Links connect together the various rows of studs. Remove all links by unscrewing the holding screws.

e. Set 12V. 14.2V. switch in the 14.2V. position; set TONE C. W. VOICE switch in the C. W. position; and set C. W. FIL. MOD. FIL. switch in the C. W. FIL. position.

f. Set transmitter OFF ON switch in the ON position. This should start the dynamotor.

g. With a screw driver or short piece of wire W-128 (or larger), make a connection between the extreme left stud on the C. W. FILAMENT row and the stud on the 14 VOLTS row directly under it. The master oscillator and power amplifier tube filaments (two of the VT-4-C tubes) should light and the FIL. VOLTAGE meter should give a reading. Progress to the right, stud by stud, until a connection between rows of studs is found that causes the FIL. VOLTAGE meter to read about 10.5 volts.



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FIGURE 5.—Radio transmitter BC-191-(*), filament resistor connection board.

h. Set transmitter OFF ON switch in OFF position and connect one of the short links between the two studs just located, screwing it down securely.

i. Set TONE C. W. VOICE at VOICE, and C. W. FIL. MOD. FIL. switch on MOD. FIL. position.

j. Set OFF ON switch at ON.

k. In a manner similar to that described in *g* above, begin at the extreme right end of the MOD. FILAMENT row and successively make connections to the stud directly beneath on the 14 VOLTS row until a connection is found that will cause the FIL VOLTAGE meter to read about 10.5 volts.

l. Set the OFF ON switch in the OFF position and connect a short link between the two studs.

m. Set the C. W. FIL. MOD. FIL. switch on C. W. FIL.

n. Set the OFF ON switch to the ON position.

o. The continuous wave filament voltage will now be less than 10 volts. Using the method described in *g* above, but starting with the first stud to the right of the connection made in *g*, and moving to the right, determine a stud on the COMP. row and one on the C. W. FILAMENT row directly below which will cause the FIL. VOLTAGE meter to read about 10.5 volts.

p. Set the OFF ON switch in the OFF position and connect a short link between the two studs, screwing it down securely.

q. Shut off the vehicle's engine, so that the battery is no longer on charge.

r. Set the 12V. 14.2V. switch in the 12V. position, the TONE C. W. VOICE switch on C. W. and the C. W. FIL. MOD. FIL. switch on C. W. FIL.

s. Place the OFF ON switch in the ON position and allow the battery voltage to fall to a steady value on the FIL. VOLTAGE meter. It will be less than 10.5 volts. With a short piece of wire, beginning at the right end of the C. W. FILAMENT row, successively connect between a stud on the C. W. FILAMENT row and the stud directly below it on the 12 VOLTS row, working to the left, stud by stud until a connection is found which gives a reading of about 10.5 volts on the FIL. VOLTAGE meter.

t. Set OFF ON switch at OFF and connect a link between the two studs, securing it with the screws.

u. Set TONE C. W. VOICE switch on VOICE and C. W. FIL. MOD. FIL. switch on MOD. FIL. Place OFF ON switch at ON.

v. Starting at the left end of the MOD. FILAMENT and 12 VOLTS rows, and using the method described in *s* above, successively move to the right until a connection is found that will cause a reading of about 10.5 volts on the FIL. VOLTAGE meter.

w. Place OFF ON switch at OFF. Connect the link remaining between the studs just located.

x. Place 12V. 14.2V. switch in 14.2V. position once more.

y. Replace transmitter top and front cover of tube compartment.

z. The filament voltage is now adjusted so that the filament voltages will not require readjustment if the transmitter mode of operation is changed through TONE C. W. and VOICE in a given installation. If the charging generator, the storage battery, or the dynamotor is replaced or if the length of the power cords is changed, the adjustment indicated in *a* to *y* above must be repeated.

15. Filament voltage adjustment, d-c operation, gas engine-generator supply.—When operating this transmitter with a gasoline engine-generator type of power supply equipment in the field, where cord lengths of 100 feet or more are used to connect the power equipment to the transmitter, adapt the following procedure for filament voltage adjustment:

a. Interconnect all cording (*except the high voltage cord to sockets PL-59*) between power equipment and transmitter. Make sure OFF ON switch on transmitter and on control boxes (if used) is set at OFF.

b. Start power equipment, following instructions in the set or power unit Technical Manual. Allow it to operate for 5 to 10 minutes (preferably with a battery on charge across it) to be sure that a stable operating point of 14.6 volts is reached, as read on a voltmeter across the battery terminals or on the voltmeter in the power equipment itself.

c. Remove front cover from transmitter tube compartment, place A-C D-C switch in the D-C position and 12V. 14.2V. switch in the 12V. position. Also remove the 16 screws which fasten the transmitter top and remove the top.

d. At the top left of the transmitter is the filament resistor connection board. (See fig. 4.) On the left end of the board are four rows of studs labeled as shown in figure 5, beginning at the top of the board: COMP., C. W. FILAMENT, 14 VOLTS and 12 VOLTS. (COMP. stands for compensator.) On the right are three rows of studs marked MOD. FILAMENT, 14 VOLTS and 12 VOLTS. Links connect together the three rows of studs. Remove all links by loosening the holding screws with a screw driver.

e. Set TONE C. W. VOICE switch in the C. W. position and set C. W. FIL. MOD. FIL. switch in the C. W. FIL. position.

f. Connect a short link between a stud on C. W. FILAMENT row and stud directly under and at the extreme left end of the 14 VOLTS row.

g. Connect a short link between a stud on the MOD. FILAMENT row and the stud directly under at the extreme right end of the 14 VOLTS row.

h. Set transmitter OFF ON switch in the ON position.

i. With a screw driver or short piece of wire W-128 (or larger) make connections successively between studs on the C. W. FILAMENT row and studs on the 12 VOLTS row directly beneath, starting at the right end of the 12 VOLTS row. On each connection, the C. W. filaments should light and the FIL. VOLTAGE meter will give a reading. Progress to the left, stud by stud, until a connection is found that causes the meter to read slightly over 10 volts.

j. Set transmitter OFF ON switch in the OFF position and connect a link between the studs just located.

k. Set TONE C. W. VOICE switch on VOICE and C. W. FIL. MOD. FIL. switch on MOD. FIL. position.

l. Set OFF ON switch in the ON position.

m. In a manner similar to that described in *i* and *j* above, beginning at the left end of the 12 VOLTS row, connect a link between a stud on the MOD. FILAMENT row and the stud directly under on the 12 VOLTS row until a connection is found that will cause the FIL. VOLTAGE meter to read slightly over 10 volts.

n. Set transmitter OFF ON switch at OFF and connect a link between the studs just located.

o. Set C. W. FIL. MOD. FIL. switch on C. W. FIL.

p. Set OFF ON switch in the ON position.

q. The C. W. filament voltage will now be less than 10 volts.

r. In a manner similar to that described in *i* and *j* above, starting with the next stud to the right of the stud found in *f* above and working to the right, determine a connection between a stud on the COMP. row and one just below it on the C. W. FILAMENT row which will cause the FIL. VOLTAGE meter to read slightly over 10 volts.

s. Restore transmitter top and front cover to the tube compartment. As now adjusted, the filament voltages for the transmitter will not require readjustment if the mode of operation of the transmitter is changed through TONE C. W. and VOICE. However, if it is not possible to secure the above adjustment it will be necessary to readjust the output voltage of the power supply equipment. Consult the Technical Manual for the radio set or for the power supply equipment, if one has been issued.

16. Filament voltage adjustment, a-c operation.—When operating the BC-191-(*) transmitters from rectifier power supply equipment attached to a 110- or 220-volt a-c power source follow the procedure indicated below to adjust filament voltages.

a. Remove front cover from tube compartment on transmitter. Take out the 16 screws which hold the top plate and remove it. Set

A-C D-C switch at A-C, 12V. 14.2V. switch at 14.2V. and connect all power cords (*except the high voltage cord to sockets PL-59*) between power supply equipment and the transmitter.

b. Set transmitter OFF ON switch at OFF.

c. At the top left of the tube compartment is the filament resistor connection board (fig. 4). On the left half of the board are four rows of studs, marked as shown in figure 5: COMP., C. W. FILAMENT, 14 VOLTS and 12 VOLTS. (COMP. is an abbreviation for compensator.) Remove links connecting them by loosening the screws. Do not touch links and studs on the right half of the board. (When the A-C D-C switch is set at A-C, the studs on the right half are cut out of the circuit, making adjustment unnecessary.)

d. Place TONE C. W. VOICE switch at C. W. and C. W. FIL. MOD. FIL. switch in the C. W. FIL. position.

e. Set low voltage OFF ON power switch on the power supply equipment at ON. Set power equipment high voltage OFF ON switch at OFF.

f. Adjust filament voltage control on power equipment so that rectifier filament voltage meter reads 12 volts.

g. Turn TONE C. W. VOICE switch to VOICE. Leave C. W. FIL. MOD. FIL. switch at C. W. FIL. The filaments of all tubes should light. (On a-c operation, the transmitter OFF ON switch disconnects only the high voltage plate supply; it does not disconnect the filament voltage.)

h. Readjust the filament voltage control on the rectifier unit so that a reading of approximately 10.5 volts appears on the FIL. VOLTAGE meter on the transmitter.

i. Set TONE C. W. VOICE switch at C. W. All tube filaments should go out.

j. Using a screw driver or a short piece of wire W-128, make a connection between a stud at the left end of the C. W. FILAMENT row and one directly below it on the 14 VOLTS row.

k. Still maintaining this connection, take another short piece of wire, starting at the right end of the COMP. row, work to the left, stud by stud, successively connecting studs on the COMP. row and on the C. W. FILAMENT row directly beneath, until a connection is found that gives a reading of about 10.5 volts on the transmitter FIL. VOLTAGE meter.

l. If no connection will give this voltage reading, change the connection between the studs made in operation j above, moving the connection to the next set of studs to the right.

m. Now repeat operation *k* above with the second piece of wire, until a reading of 10.5 volts is secured. If voltage is still low, repeat operation *l* above, moving the connection to the next set of studs to the right and then repeating operation *k* above until the meter reads 10.5 VOLTS. When this adjustment is properly made, movement of the TONE C. W. VOICE switch through its three positions should cause practically no change in the reading of the FIL. VOLTAGE meter.

n. Turn off rectifier power supply equipment.

o. Replace temporary wire connections between studs with the short links provided.

p. Connect a link between the two studs at the right end of the C. W. FILAMENT and 12 VOLTS rows.

q. Replace top shield and tube compartment cover. This completes the adjustment. Minor voltage variations can now be adjusted for by use of the filament voltage control on the power supply equipment. If cording lengths are changed, or any major change made in the installation, repeat operations *a* to *p* above, if necessary.

17. Tuning.—*a. Preliminary checks.*—(1) Make certain that all power supply equipment is *turned off*. Check all cording to see that it follows the cording diagrams in the Technical Manual for the radio set. Set OFF ON switch at OFF.

(2) Connect high voltage cord into sockets PL-59 on the transmitter and power supply equipment.

(3) Connect antenna system to output terminal strip, following the diagrams in the radio set Technical Manual or the cording diagrams on the set chests. If transmission is to be made at frequencies of 800 kilocycles or lower, see *c*(7) below and figure 9 for method of connecting antenna tuning unit BC-306-A.

Caution: *When the power supply equipment is started or turned on, high voltage is present in the transmitter. BE CAREFUL!*

(4) Adjustment of the controls in the tube compartment can be made safely with high voltages connected, as there are no exposed high voltage elements, if all tubes are inserted in their sockets. Removal of the transmitter tuning unit from the transmitter operates the safety interlock switch 1102 (fig. 4) which disconnects all voltages from the transmitter.

(5) The transmitter can be operated for continuous wave telegraph, tone or voice transmission. *Adjust transmitter initially for continuous wave transmission.* Before the power is turned on, tune the transmitter approximately as described in (6) below.

(6) Insert transmitter tuning unit covering the frequency range in which transmission is to be carried out and lock it in place with the snap slide catches. (See figs. 1 and 6.) The tuning units cover frequency ranges given in paragraph 2.

NOTE.—The serial numbers of transmitter tuning units must be identical with the serial number of the transmitter and the **CALIBRATION CHART** with which they are used. Do not interchange transmitter tuning units with those of other transmitters. The **CALIBRATION CHART** figures apply only when the transmitter tuning unit, **CALIBRATION CHART** and transmitter have identical serial numbers.

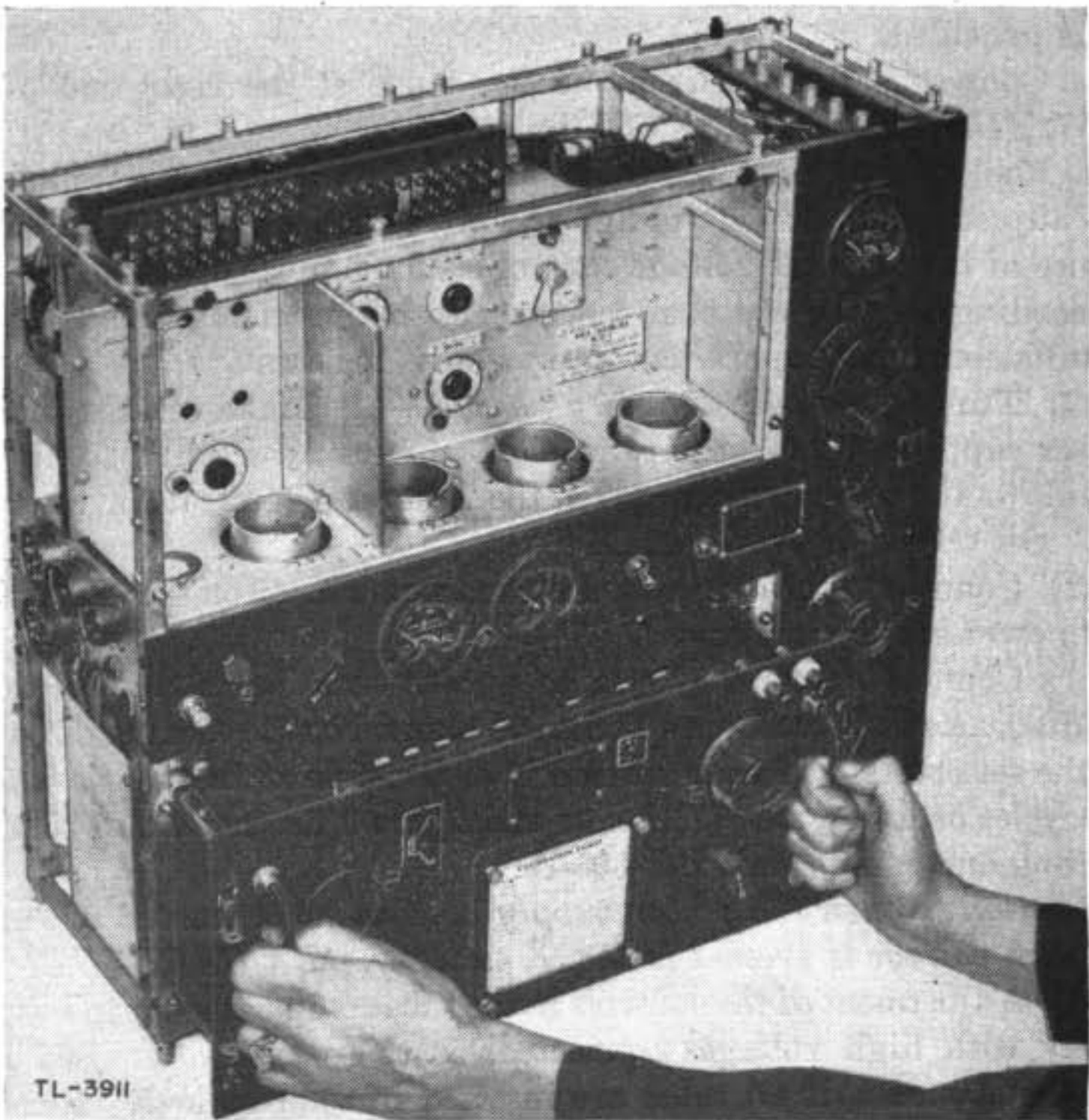


FIGURE 6.—Radio transmitter BC-191-(*)—removing transmitter tuning unit.

(7) On the front panel of each tuning unit is a **CALIBRATION CHART**. Note that some of the lines of numbers are printed in red. These indicate frequencies reserved for special purposes. *Do not transmit on them unless specifically authorized to do so by the local commander.* There are four columns of figures on the chart labeled

from left to right, FREQUENCY, A, B, and C. If the frequency on which operation is planned is exactly one of those on the chart, the transmitter can be preset to frequency as follows:

(a) In column marked A is a number opposite the frequency assignment. Set the BAND CHANGE SWITCH A to this number. (On TU-7-A or -B to TU-10-A or -B this control has been eliminated and column A is blank.)

(b) In column marked B there is also a number opposite the frequency assignment. Set this number on the control marked B M. O. TUNING as explained in paragraph 12b (2).

(c) In column marked C is another number opposite the frequency assignment. This number is the reading on the control marked C P. A. TUNING. Set control to the number just determined.

(d) Set switch marked ANT. COUPLING SWITCH D on position 1.

(e) If the exact frequency assignment is not listed on the calibration chart, make an interpolation of dial readings at the two closest frequencies above and below the frequency to which the transmitter is to be tuned. When the transmitter is turned on check this interpolation with a frequency meter.

(f) Never turn on transmitter without first making certain that the power amplifier tuning control C P. A. TUNING is approximately resonated with the master oscillator by using the calibration chart figures to set control C P. A. TUNING to the same frequency as controls BAND CHANGE SWITCH A and B M. O. TUNING. If this precaution is not taken, excessive plate current may flow, damaging the equipment or burning out fuses.

b. Tuning adjustments.—(1) If the power supply equipment is of the engine driven generator type or the a-c rectifier type, start it, following instructions given in the Technical Manual for the radio set. If the equipment is a battery-driven dynamotor in a vehicle or aircraft, start vehicle engine; this will place the battery on charge. (The equipment can be tuned up without having vehicle engine running by placing the 12V. 14.2V. switch on 12V. However, most field operation takes place with vehicle running, so it is best to tune up with engine running.) Regardless of the type of power equipment used, allow a few minutes for warming up.

(2) Accomplish all tuning with transmitter operating in the C. W. position of TONE C. W. VOICE switch. *Make certain that tube compartment cover is in place and snap slides locked.*

(3) Set transmitter OFF ON switch in the ON position. Filaments should light and the FIL. VOLTAGE meter should read approximately 10 volts with the C. W. FIL. MOD. FIL. switch in the C. W. FIL. position.

(4) Press TEST KEY.

(5) Tune power amplifier circuit to resonance by varying the control marked C P. A. TUNING until *minimum total plate current* is indicated on the TOTAL PL. CURRENT meter. When this circuit is properly tuned the total plate current will be from 80 to 110 milliamperes.

NOTE.—The tabular data in column C of the CALIBRATION CHART relating to the setting of the control C are given as a guide in pretuning. In any case, the final adjustment of the transmitter and the antenna tuning equipment may require a setting of control C somewhat different from that indicated on the CALIBRATION CHART.

(6) If a frequency meter is available, determine exact frequency setting for interpolated frequency and retune power amplifier to the new adjustment of the master oscillator circuit as in (5) above.

(7) Set OFF ON switch in the OFF position.

NOTE.—The calibration charts on the transmitter tuning units are reasonably accurate and normally the actual transmitted frequency will be within about 5 or 10 kilocycles of the figure given on the CALIBRATION CHART. To tune more exactly, always check the operating frequency with a frequency meter set such as the SCR-211-A, -B, or -C.

c. Antenna tuning.—The proper tuning of the antenna circuit controls is mainly dependent on the type of antenna system employed with the transmitter and on the operating frequency. The type of antenna and the frequency depend on the radio set of which the transmitter is a component. Therefore, only general rules and instructions about antenna tuning can be given here. Detailed instructions are found in the Technical Manual pertaining to each radio set.

(1) Tables I, II, and III below give data on approximate setting of antenna tuning controls for several types of antenna systems encountered in Army radio sets. The tables cover a number of operating frequencies and can be used as a guide in tuning these types of antennas.

Approximate antenna and plate current readings are also indicated. No setting for ANT. COUPLING SWITCH D is indicated in tables II and III. Start with this control on 1 and advance it step by step until proper current reading is obtained. Regardless of the antenna

type, when antenna tuning circuits are properly resonated and the transmitter is delivering rated output to the antenna, the total plate current on continuous wave operation should be from 180 to 220 milliamperes (no higher).

TABLE I

(Antenna tuning control settings, using 15½-foot fishpole antenna in vehicle installation. These are average values.)

Frequency (kc)	ANT. CIRCUIT SWITCH N	ANT. IND. TUNING M	ANT. CAP TUNING O	ANT. IND. SWITCH P	ANT. COUPLING SWITCH D	ANT. CURRENT (amp)	TOTAL PL. CURRENT (ma)
1, 500---	4	30	*	3	4	3	220
2, 000---	4	8½	*	2	3 or 4	3.3	220
2, 300---	4	20	*	1	2 to 4	4	220
2, 800---	3	31	*	*	2 to 4	4.5	220
3, 200---	3	25	*	*	2 to 4	4.5	210
3, 600---	3	20	*	*	2 to 3	4.5	200
4, 000---	2	26	100	*	1 to 3	4.8	185
4, 200---	2	23½	100	*	1 to 3	5	200
4, 500---	2	21	100	*	1 to 2	5	195

* This symbol indicates that control is disconnected from circuit, making its setting immaterial.

TABLE II

(For frequencies between 400 and 800 kilocycles, using crowfoot antenna and external antenna tuning unit BC-306-A.)

Frequency (kc)	ANT. CIRCUIT SWITCH N	CONTROL E on BC-306-A	CONTROL F on BC-306-A	ANT. IND. TUNING M	ANT. IND. SWITCH P	ANT. CURRENT (amp)	TOTAL PL. CURRENT (ma)
400-----	3	3	40	0	*	2.5	180
600-----	3	2	32	0	*	2.9	190
800-----	4	1	*	20.5	3	2.8	190

*Not in circuit.

TABLE III

(For frequencies between 1,500 and 4,500 kilocycles, using inverted L-antenna, and with antenna variometer switch E on position 1 or antenna tuning unit BC-306-A removed.)

Frequency (kc)	Antenna length (feet)	Counter-poise length (feet)	ANT. CIRCUIT SWITCH N	ANT. IND. TUNING M	ANT. IND. SWITCH P	ANT. CAP. TUNING O	ANT. CURRENT (amp.)	TOTAL PL. CURRENT (ma)
1,500-----	100	100	4	10.0	2	*	1.9	180
2,000-----	100	100	3	17.5	*	*	2.2	175
2,000-----	80	80	4	12.5	1	*	2.6	210
2,050-----	80	80	3	35	*	*	2.6	220
2,700-----	80	80	3	0	*	*	2.4	210
3,000-----	80	80	2	17.5	*	100	1.6	180
3,000-----	60	45	3	25.5	*	*	2.5	210
3,500-----	60	45	2	32.4	*	100	2.5	210
4,000-----	60	45	2	20.5	*	100	2.5	220
4,500-----	60	45	2	7.8	*	100	1.85	190

*Not in circuit.

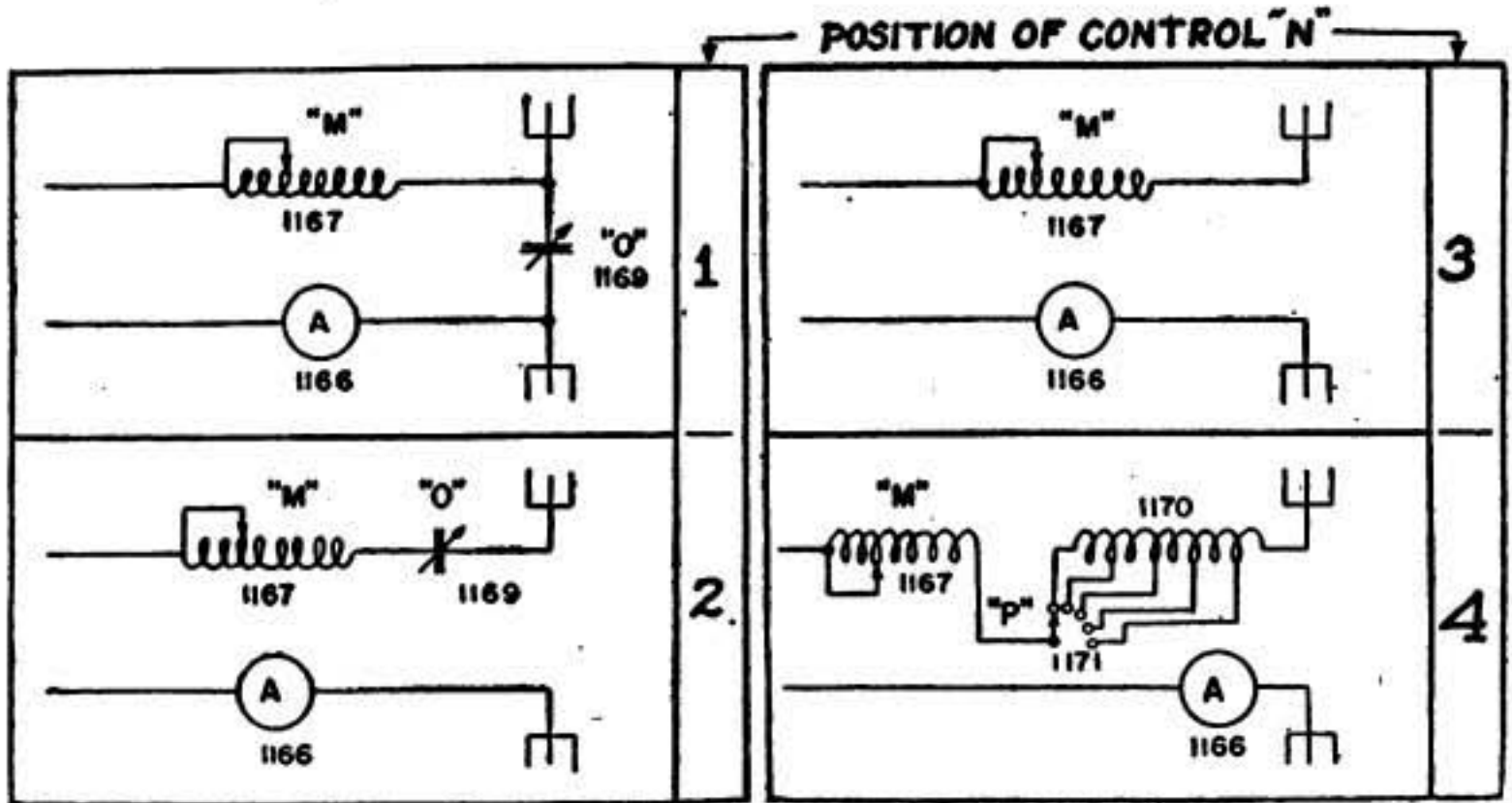
(2) There are four antenna networks (see fig. 7) selected by the control ANT. CIRCUIT SWITCH N located on the radio transmitter BC-191-(*), the adjustment and use of which are described below.

Caution: Continuously variable controls ANT. IND. TUNING M, ANT. CAP. TUNING O, and ANTENNA VARIOMETER F may be operated with the transmitter key closed, and adjusted as in *b* above. Operate ANT. COUPLING SWITCH D, ANT. CIRCUIT SWITCH N, ANT. IND. SWITCH P on the transmitter, and ANTENNA VARIOMETER SWITCH E on the BC-306-A with the transmitter key open.

(a) With the control marked ANT. CIRCUIT SWITCH N on position 1, the transmitter works into a resonant circuit, in which the high voltage built up across the antenna tuning capacitor is used to "voltage feed" the antenna. This circuit is generally used for high frequencies and fairly long antennas, and is seldom used in tuning the standard antennas used with most Army radio sets. The antenna feed circuit is maintained at resonance by means of control ANT. IND. TUNING M, while the voltage fed to the antenna is varied by means of the control ANT. CAP. TUNING O and resonance is indicated by the ANT. CURRENT meter. The current in the feed circuit is adjusted by ANT. COUPLING SWITCH D and should not exceed 6 amperes. The step-by-step tuning procedure is as follows:

1. Set control ANT. CAP. TUNING O at any scale reading.
2. Resonate circuit by means of control ANT. IND. TUNING M for a maximum reading on the antenna current meter.
3. Adjust ANT COUPLING SWITCH D so that antenna current reads slightly below 6 amperes.
4. Resonate the circuit again as in 2 above.

(b) Repeat above procedure, shifting the setting of ANT. CAP. TUNING O control each time until the proper power amplifier load-



Ant. Ind. Tuning, M
Ant. Circuit Switch, N
Ant. Cap. Tuning, O
Ant. Ind. Switch, P
Ant. Current, 1166

TL-2242

FIGURE 7.—Radio transmitter BC-191-(*), antenna tuning equipment—functional diagram.

ing is indicated on the total plate current meter (180 to 220 milliamperes on continuous wave telegraph operation). Under the same conditions of power amplifier load, the lower the dial reading on the control ANT. IND. TUNING M and the lower the reading on the ANT. CURRENT meter, the more power will actually be delivered to the antenna.

Caution: When operating ANT. CIRCUIT SWITCH N on position 1 always start with ANT. COUPLING SWITCH D on 1 and watch the ANT. CURRENT meter very closely. If the antenna is disconnected accidentally with ANT. CIRCUIT SWITCH N on 1, a high value of radio frequency current may flow through the meter, burning it out.

(3) With ANT. CIRCUIT SWITCH N on position 2 the transmitter works into a series resonant circuit. The antenna is current fed. The antenna circuit is resonated by means of controls ANT. IND. TUNING M and ANT. CAP. TUNING O. Resonance is indicated by a maximum reading on the ANT. CURRENT meter. This circuit is used generally for operation near the fundamental frequency of an antenna and therefore is not particularly efficient for tuning the standard antennas, except as indicated in table III. When this tuning network is selected the value of capacitance should be the maximum (control ANT. CAP. TUNING O set at a high number) for which an inductance value can be found that will give resonance. (This will be a minimum inductance value, with control ANT. IND. TUNING M set at a low number.)

(4) With ANT. CIRCUIT SWITCH N in position 3 the transmitter works into a series resonant circuit providing current feed and inductive loading. This circuit is used for operation at frequencies lower than the fundamental frequency of the antenna. It is used with aircraft trailing wire antennas.

(a) The antenna circuit is resonated by means of the continuously variable inductor 1167 adjusted by control ANT. IND. TUNING M.

(b) When operating with a trailing wire antenna in aircraft installations, set this control at zero and adjust the antenna circuit for resonance at the $\frac{1}{4}$ or $\frac{3}{4}$ wave length point by varying the length of the trailing wire. The table below gives the approximate length of wire required for various frequencies.

Frequency in kc	Length of antenna in feet for operation at —		Frequency in kc	Length of antenna in feet for operation at —	
	$\frac{1}{4}$ wave	$\frac{3}{4}$ wave		$\frac{1}{4}$ wave	$\frac{3}{4}$ wave
2, 000	123		7, 000	35	105
3, 000	82		8, 000	31	93
4, 000	62		9, 000	27	81
5, 000	49	147	10, 000	24	73
6, 000	41	123			

(c) Antenna resonance is indicated by a sharp rise on the TOTAL PL. CURRENT meter and a current indication on the ANT. CURRENT meter.

(d) Having found resonance, load transmitter by advancing ANT. COUPLING SWITCH D until the proper plate current (180 to 220 milliamperes on continuous wave) is indicated on the TOTAL PL. CURRENT meter.

Caution: Always use the lowest numbered position of the ANT. COUPLING SWITCH D which will give the total plate current reading indicated above. Overcoupling causes detuning of the power amplifier, lower radio frequency current in the antenna, indistinct transmission, and wide side bands on tone and voice.

(5) With ANT. CIRCUIT SWITCH N on position 4, the antenna circuit is identical with that of position 3 except that an additional inductor 1170, adjusted by ANT. IND. SWITCH P, is connected in series with the variable inductor 1167. This circuit is used when the operating frequency is relatively far below the fundamental frequency of the antenna, a condition which occurs when using a fishpole antenna in vehicle installations or when using an inverted L-antenna (table III) operating at 1,500 kilocycles or slightly above. The adjustment of this circuit is accomplished as follows:

(a) Set ANT. COUPLING SWITCH D at 1.

(b) Set ANT. IND. SWITCH P at 1.

(c) Rotate control ANT. IND. TUNING M through its limits, closely watching TOTAL PL. CURRENT meter for an indication of antenna circuit resonance. This will be indicated by a sharp increase in the reading of the meter. If resonance is found the transmitter is loaded to its proper value.

(d) If resonance is not found at this setting of ANT. IND. SWITCH P, advance P, little by little, to higher settings and repeat the variation of control ANT. IND. TUNING M for each position of P until resonance is found.

NOTE.—The change in antenna circuit constants as a result of tuning reflects into the tank circuit of the power amplifier. This necessitates a retuning of the power amplifier control C P. A. TUNING for minimum reading on the TOTAL PL. CURRENT meter. The tuning of an antenna is not complete until the power amplifier and antenna circuits are both resonated to the transmitter frequency. Always secure resonance with minimum inductance (low number setting of controls ANT. IND. TUNING M and ANT. IND. SWITCH P) if this is possible.

(6) When operating at frequencies above 4,500 kilocycles, the coil 1170 may resonate and cause absorption of useful radio frequency power from the transmitter by capacitive coupling, even when it is not connected in the circuit. To determine whether or not this is happening, shift ANT. IND. SWITCH P to several different settings, at the same time watching ANT. CURRENT meter. Do not permit the control to remain at a setting which causes a decreased reading on the ANT. CURRENT meter. Usually no difficulty will occur if the following settings are used: When using tuning unit TU-7-A or -B place ANT. IND. SWITCH P at position 2; when using tuning

unit TU-8-A or -B place ANT. IND. SWITCH P at position 5; when using tuning unit TU-9-A or -B place ANT. IND. SWITCH P at position 5; when using tuning unit TU-10-A or -B place ANT. IND. SWITCH P at position 5.

NOTE.—Coil 1170 is connected to the circuit only when ANT. CIRCUIT SWITCH N is set at position 4.

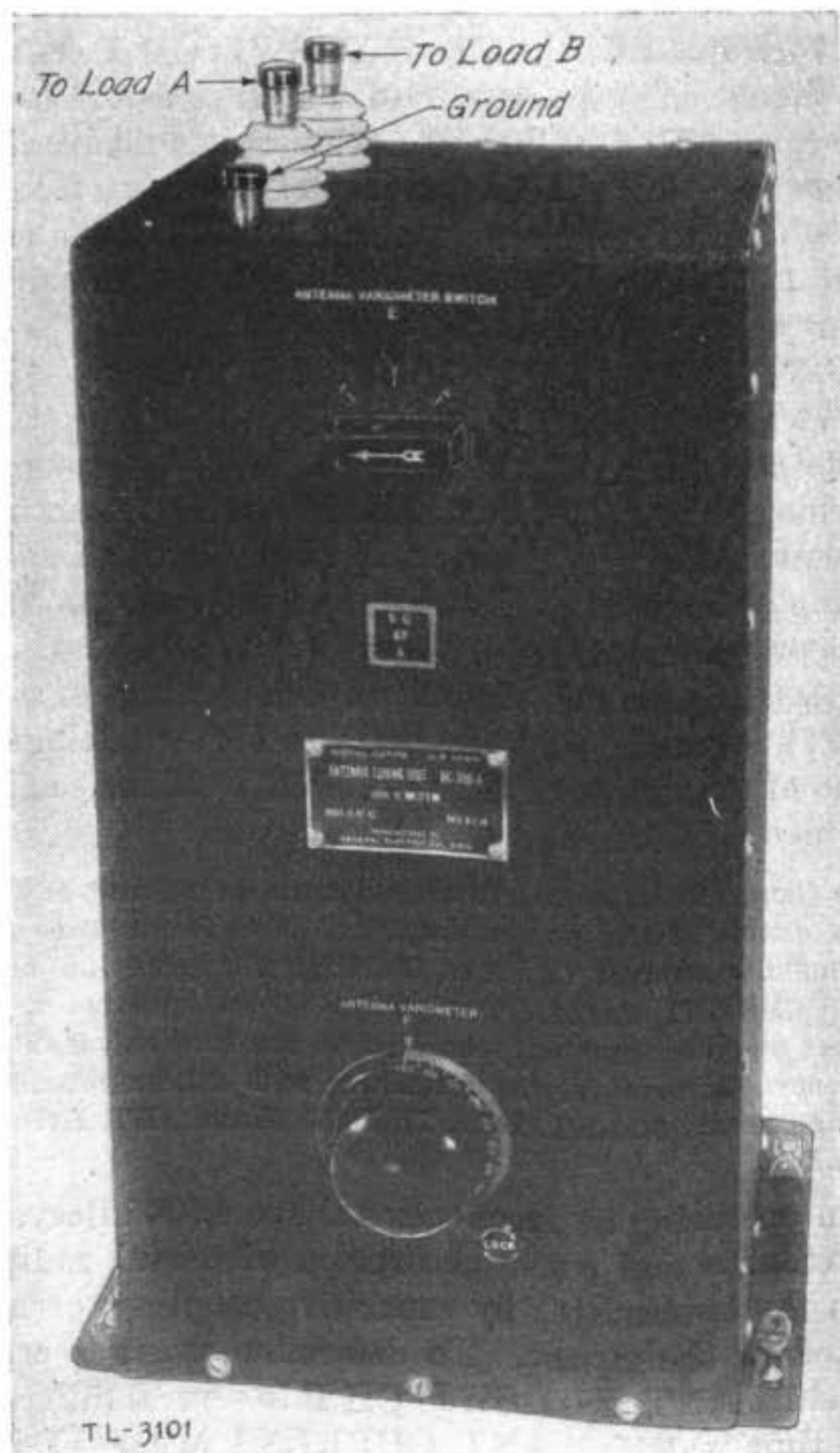
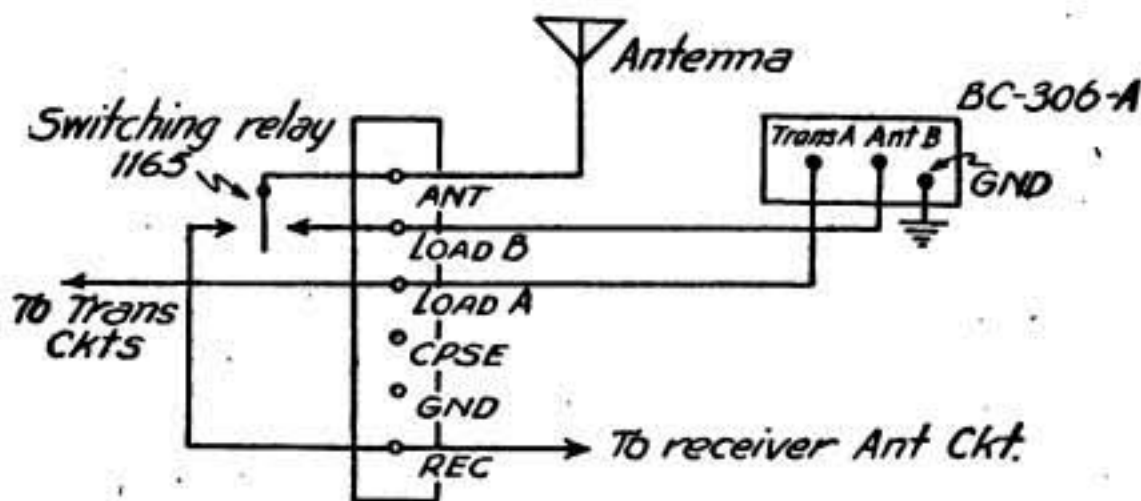


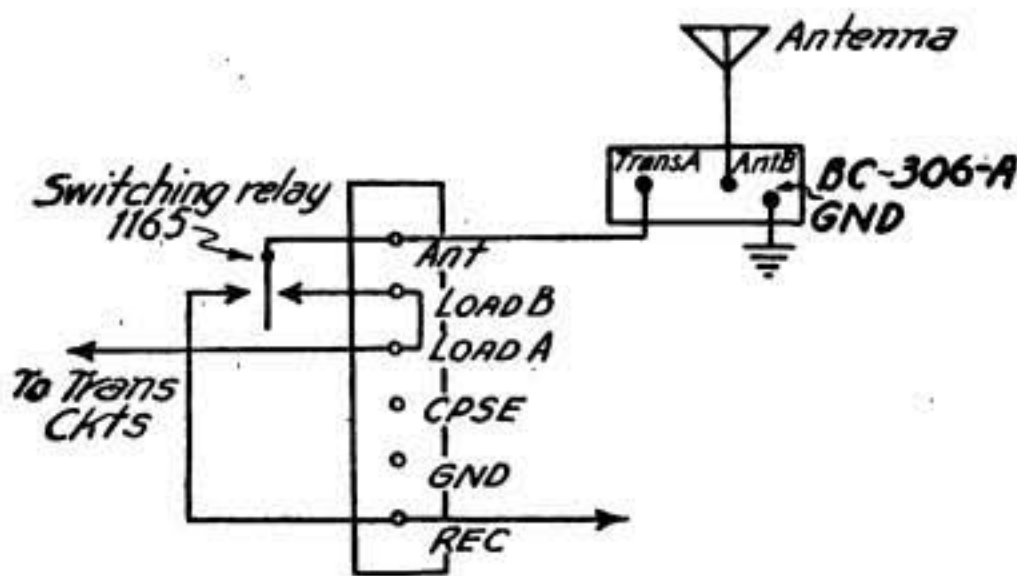
FIGURE 8.—Antenna tuning unit BC-306-A.

(7) The antenna tuning unit BC-306-A (figs. 8 and 19) is an external tuning equipment issued with radio sets which transmit on frequencies below 800 kilocycles. The control marked ANTENNA VAR-

ANTENNA VARIOMETER SWITCH E makes possible the addition of series inductance in large steps to the antenna circuit. The control marked ANTENNA VARIOMETER F permits the addition of continuously variable amounts of series inductance to the antenna circuit. Thus E is a rough control and F a fine or vernier control for adding more series inductance. The antenna tuning unit BC-306-A is used with the transmitter ANT. CIRCUIT SWITCH N on positions 3 and 4 in a manner very similar to that outlined in (5) above, except that the unit covers adjustments of antennas in the frequency range 200 to 800 kilocycles, and that controls ANTENNA VARIOMETER



① Connection for operation from 400 to 800 kilocycles.



② Connection for operation below 400 kilocycles.

FIGURE 9.—Methods of connecting antenna tuning unit BC-306-A to radio transmitter BC-191-(*).

SWITCH E and ANTENNA VARIOMETER F are adjusted instead of transmitter ANT. IND. SWITCH P and ANT. IND. TUNING M. (See table II.) However, these transmitter controls may also be used for fine adjustments. When ANTENNA VARIOMETER SWITCH E is set at position 1, the BC-306-A antenna tuning unit is completely disconnected from the antenna circuit.

(a) Two methods of connection to the transmitter are recommended. The first is for operation between 400 and 800 kilocycles. In this case connect the terminals marked TRANS. A and ANT. B on the BC-306-A to the transmitter as shown in figure 9①. With this connection

the antenna tuning unit is connected to the transmitter only, when using the same antenna for transmitting and receiving. The transmitter antenna switching relay 1165 transfers the antenna, but not the BC-306-A, to the receiver when the relay opens.

(b) The second method of connection is shown in figure 9(2). It is used when operating at frequencies below 400 kilocycles. With this connection the BC-306-A, as well as the antenna, is transferred from the antenna circuit of the transmitter to that of the receiver when the relay 1165 opens. The BC-306-A therefore aids reception as well as transmission at low frequencies by neutralizing the capacitive reactance of the antenna.

(8) On transmitter tuning units TU-5-A or -B, TU-22-A or -B, and TU-26-B it may be found that one setting of the ANT. COUPLING SWITCH D will not give sufficient loading, while the next higher setting will cause overloading (TOTAL PL. CURRENT reading too high). If this occurs, use the higher setting and slightly detune the antenna circuit controls from resonance, at the same time keeping control C P.A. TUNING adjusted for minimum total plate current, until normal continuous wave loading of 180 to 220 milliamperes is indicated on the TOTAL PL. CURRENT meter.

18. Operating procedure.—a. On C. W.—(1) When the tuning operations indicated in paragraph 17 and in the Technical Manual for the radio set have been completed, the transmitter is ready for continuous wave telegraph transmission.

Caution: A marked decrease in the life of the transmitter vacuum tubes results from applying over- or under-voltage to the filaments. Check filament voltage frequently and adjust if necessary, as prescribed in paragraphs 13 to 16, inclusive.

(2) Connect the key by inserting its plug into either of the key jacks on the transmitter (see figs. 2 and 22) or in the key jack provided on the associated components of the radio set. Turn the transmitter OFF ON switch to ON and if all meters still indicate normal readings when the key is closed, start transmission.

(3) If the radio set is corded so that side tone is introduced in the receiving equipment headset or loud speaker when the transmitter is keyed, plug in the headset or speaker at the proper receiver jack and press either the TEST KEY or the operating key. A steady tone having a frequency of 500 to 1,000 cycles should be heard on TONE or C.W. The volume of this side tone can be varied by adjusting the SIDE TONE control located at the left of the A-C D-C switch in the right tube compartment. To adjust, insert a screw driver in the slotted black dial and rotate through the four positions until a satisfactory volume level results. A higher setting is generally needed for

voice than for continuous wave or tone operation. On voice the side tone circuit feeds the operator's voice to the receiver.

b. On VOICE.—(1) *Modulator bias adjustment.*—Before operation on VOICE or TONE is attempted, modulator bias must be adjusted as follows:

Caution: Operation on VOICE or TONE requires more current from the power supply equipment than does continuous wave operation. The following adjustment should be made only when the power supply equipment is in a stable condition. If an engine-driven generator is used the engine should be thoroughly warmed up. If a battery-driven dynamotor is used the battery should be well charged and preferably actually on charge during the adjustment.

(a) Note the reading of TOTAL PL. CURRENT meter when the transmitter is tuned for continuous wave operation.

(b) Set OFF ON switch at OFF.

(c) Place TONE C. W. VOICE switch at VOICE.

(d) Set OFF ON switch at ON.

(e) Press TEST KEY and note the current indicated on the TOTAL PL. CURRENT meter. It should read a current 20 milliamperes higher than that noted in (a) above, as the modulator tubes are now connected. (One small scale division on the meter is equivalent to a 20-milliamperere current change.) In the event that the current change is greater or less than 20 milliamperes, the control marked MOD. BIAS, located at the rear of the tube compartment (see fig. 4) must be adjusted by rotation.

(f) Release TEST KEY.

(g) Set OFF ON switch at OFF.

(h) Remove tube compartment cover.

(i) Insert a screw driver in dial rotating device at the lower left on MOD. BIAS control. (Rotate control to a higher setting to reduce TOTAL PL. CURRENT or to a lower setting to increase current.) By successive small steps and following the procedure of (a) to (g) above, rotate MOD. BIAS control in the direction which finally causes the TOTAL PL. CURRENT reading to be 20 milliamperes higher on VOICE than C. W.

(j) Release TEST KEY.

(k) Set OFF ON switch at OFF and replace tube compartment cover.

NOTE.—When transmitter tuning units are changed to permit transmission on other frequency bands, the modulator bias adjustment should be rechecked because total plate current on voice operation may be changed, making voice transmission unsatisfactory. If this is the case, readjust MOD. BIAS control, following the procedure outlined in (a) to (k) above.

(2) *Speech amplifier bias adjustment.*—Above and to the left of the MOD. BIAS control is the S. A. BIAS control. This control normally is set properly by the manufacturer and usually needs no adjustment. In case adjustment is required see paragraph 35c for method.

(3) *Input level adjustment.*—This adjustment controls the voice level on voice operation. Proper adjustment is essential to prevent the transmission of broad signals which might cause interference with other stations operating on adjacent channels. If the level is set too high overmodulation will result, and transmission on voice will be distorted and broad; also, fuses in the transmitter may burn out. On the other hand, if the input level is set too low, the receiving station may be unable to hear the transmission through the usual amount of interference. Adhere to the following adjustment procedure:

(a) Insert microphone plug in one of the jacks marked MIC.

(b) Remove tube compartment shield and insert a screw driver in the dial rotating device located to the lower left of the INPUT LEVEL control at the back of the left tube compartment. (See fig. 4.) Turn on transmitter and press button switch on microphone. With no speech being impressed on the microphone, the TOTAL PL. CURRENT meter reading should be that indicated in (1) (i) above.

(c) Hold the microphone about 2 inches from the lips and speak in a normal, conversational tone. The meter reading should fluctuate with the voice. Using the screw driver, rotate INPUT LEVEL control until TOTAL PL. CURRENT meter swings to a peak of 300 milliamperes. (It should not stay at 300 milliamperes but should fluctuate between lower readings and a maximum of 300.)

NOTE.—It is desirable to check this adjustment by having another station listen to the test transmission and give a report on readability, distinctness of voice and any evidence of broadness of the transmitted signal. The other station should be at least 2 miles distant. If this is done, further adjustment of the input level can be made. When changing the installation to a different type of antenna system it is advisable to recheck the INPUT LEVEL adjustment, as it may require resetting. The adjustment should always be made after the transmitter and the antenna system have been tuned up properly for continuous wave operation. If equipment is to be operated in a location where the background noise is high (as in aircraft or tanks), the setting of the INPUT LEVEL control must be reduced. To make up for loss of sensitivity at this setting, place microphone close to the lips and talk in a loud voice. Adjust INPUT LEVEL control for the same indication on the TOTAL PL. CURRENT meter as directed in (c) above.

(d) Release microphone button switch.

(e) Turn transmitter OFF ON switch to OFF and replace tube compartment cover.

NOTE.—A microphone which has become "packed" (one in which the carbon granules have packed together), will sometimes cause voice transmission to sound weak and indistinct, even with the INPUT LEVEL control fully advanced. To clear this condition, lightly tap the microphone with a pencil or similar object, rotating the microphone at the same time. Do this with the transmitter in the OFF position. If this fails to clear the trouble, replace microphone with a serviceable one.

c. *On TONE.*—(1) Having completed the procedure directed in b (3) above—

(a) Insert key plug in one of the jacks marked KEY.

(b) Place TONE C. W. VOICE switch at TONE.

(c) Place transmitter OFF ON switch at ON.

(2) Keying for tone modulation is effected by using the microphone switch, the transmitting key or the TEST KEY. The TOTAL PL. CURRENT meter reading should be between 300 and 350 milliamperes.

19. Net operation.—a. In the absence of a frequency meter it is possible to net the transmitter with the net control station (NCS) by use of the receiver supplied with the radio set of which this transmitter is a part. The following procedure is suggested:

(1) Before tuning, warm up receiver for about 20 minutes so that frequency drift will not affect tuning accuracy. Set receiver for manual volume control (MVC) and tune it to the frequency of net control station with receiver beat frequency oscillator (BFO) tuned on. (It is assumed that the net control station is transmitting continuous wave signals.) A heterodyne whistle will be heard when the net control station is transmitting. Set receiver volume control at a low level and tune carefully for the loudest signal. From this point on do not touch receiver tuning controls.

(2) Rotate receiver C. W. OSC. ADJUST. or BEAT FREQ. control. The whistle pitch of the net control station signals will vary from below audibility through a low pitch up to a very high pitch and back down the scale to a low pitch and inaudibility once more as the control is turned. Adjust to the point where the heterodyne whistle has dropped in pitch to inaudibility. This is the point of *zero beat*. If this zero beat adjustment has been properly made, a slight movement of the C. W. OSC. ADJUST. or BEAT FREQ. control in either direction from the zero beat point should bring in a low-pitched whistle as shown in figure 10. When this check has been made, reset the control to the zero beat point.

(3) Using the calibration chart on the transmitter as a guide, tune transmitter (TONE C. W. VOICE switch set at C. W.) to approximate frequency of receiver (see pars. 17*a* and *b* for tuning procedure).

(4) Set receiver SEND RECEIVE switch on SEND.

(5) Set transmitter ANT. COUPLING SWITCH D on 1 and press TEST KEY. A heterodyne whistle should be heard in the receiver. If no whistle is heard, slowly adjust transmitter control B M. O. TUNING, keeping control C P. A. TUNING in step so that total plate current does not rise above approximately 110 milliamperes. Both controls should be moved about 5 or 10 divisions on either side of their original setting until a heterodyne whistle is picked up in the receiver. When the whistle is picked up, reduce receiver volume control setting to the lowest point at which the signal can be still heard. Then adjust transmitter controls B M. O.

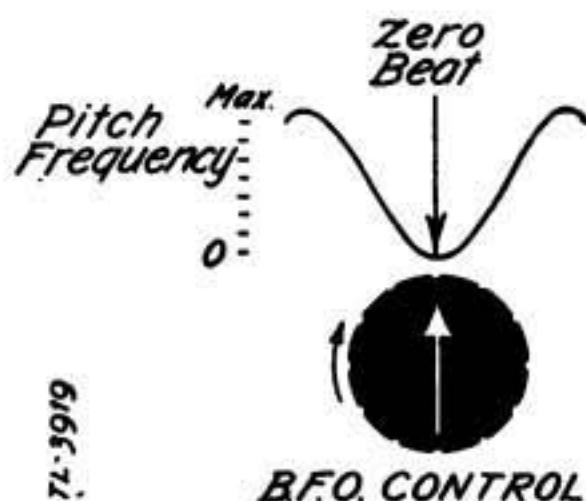


FIGURE 10.—Pictorial representation of zero beat position of receiver beat frequency oscillator control.

TUNING and C P. A. TUNING, until the zero beat point with the transmitter is heard in the receiver headset or loud speaker. Do not touch receiver tuning controls during this operation.

(6) Tune antenna circuits of transmitter, following the directions in paragraph 17*c*. If this operation changes the transmitter tuning so that it no longer zero beats with the receiver, all transmitter controls should be slightly readjusted until zero beat is again obtained. The transmitter is now tuned to the same frequency as the net control station and the receiver. Lock all transmitter tuning controls.

b. In some installations the cording arrangement is such that side tone from the transmitter is introduced into the receiver headset or loud speaker, blotting out the heterodyne whistle and zero beat point. Either of the two procedures described below will eliminate this trouble.

(1) The first procedure is as follows:

(*a*) Go through the operations in *a*(1) to (4) above.

(*b*) Turn transmitted OFF ON switch to OFF.

(c) Set TONE C. W. VOICE switch at VOICE.

(d) Set OFF ON switch at ON.

(e) Press TEST KEY and perform operation indicated in a(5) above. In this case, since operation is on VOICE, the reading on the TOTAL PL. CURRENT meter should be about 20 milliamperes higher than that indicated in a(5) above, or about 140 milliamperes, maximum. When zero beat is found, hold TEST KEY intermittently closed for several minutes to check for frequency drift.

(f) When the zero beat point no longer varies, tune antenna circuit as explained in paragraph 17c. If this operation detunes the transmitter so that it no longer zero beats with the receiver, slightly readjust all transmitter controls until zero beat is found again.

(g) Lock all controls. The transmitter is now tuned to the same frequency as the net control station and the receiver. If continuous wave transmission is desired, turn off transmitter and place TONE C. W. VOICE switch on C. W. Turn on transmitter again. It is now ready for continuous wave operation.

(2) The second procedure for eliminating side tone during netting is as follows:

(a) Remove tube compartment cover.

(b) With a screw driver set SIDE TONE control to a point midway between two numbers on its scale. (Between 2 and 3, for example.) In this position the side tone circuit is disconnected from the receiver.

(c) Before attempting to tune the transmitter, replace tube compartment cover. Now proceed with continuous wave tuning as indicated in a(1) to (6) above.

20. Summary of operation sequence.—The steps to be followed in placing this equipment in operation are—

a. Installation, which includes inserting tubes, inspecting equipment for shortages and damage, and checking fuses.

b. Preliminary adjustment of power supply equipment, setting A-C D-C and 12V. 14.2V. switches in proper position.

c. Connection of cords (except high voltage supply cord).

d. Adjustment of filament resistor connection board.

e. Connection of high voltage supply cord.

f. Tuning for continuous wave operation.

g. Antenna tuning.

h. Adjustment for tone and voice operation.

21. Operation in extreme climates.—A number of special problems are met under extreme climatic conditions in the field. Some general precautions and suggestions are given here.

a. *Extreme cold.*—(1) In extreme cold, trouble may be encountered with power supply units. Storage batteries are less efficient. They

should be kept fully charged, as they are less likely to freeze when charged. Place a battery in a warm room for several hours before adding distilled water; this will prevent the water from freezing in lumps as it strikes the cold electrolyte.

(2) Congealed oil on bearing surfaces may cause difficulties in generators and dynamotors. Keep them in a heated place if possible. Thin oil on the bearings will help.

(3) Switches on the transmitting equipment may operate stiffly for the same reason. Cold weather may also affect the accuracy of the calibration charts to some degree. If operation on specific frequencies is required with any degree of accuracy, the calibration should be checked against a known standard. It should be remembered that after the equipment has been in operation for an hour or so it will have warmed up considerably, possibly altering the transmission frequency a few kilocycles.

(4) Any metal equipment will sweat when brought into a warm place after prolonged exposure to low temperatures. In the case of the BC-191-(*) transmitter, moisture accumulation of this kind on the tuning inductors or capacitors may cause flash-overs if operation is attempted immediately. Allow the apparatus to warm gradually. A good circulation of warm air through the apparatus will aid in preventing moisture accumulation. (See note, par. 32.)

(5) Operating personnel should be careful not to touch the metal parts of the equipment with the bare skin in very cold weather, as the skin may freeze to the metal.

b. Tropical conditions.—The main problem of operation of this equipment in tropical climates is heat or moisture, or a combination of both. Excessive heat should not cause trouble in the transmitter, but it may cause overheating of the dynamotor or generator power supply units. They should be placed to take advantage of any available shade and should be in a well-ventilated spot if possible. Continuous operation of these units over long periods should be avoided if at all possible.

(1) In hot, humid climates collection of moisture may cause insulation break-down. To minimize this possibility, keep the transmitter unit well ventilated. Dry it thoroughly every few days by removing all shields and by exposing it for a short time to the sun or to a moving current of dry air. At the same time dust accumulations should be removed, as they also cause insulation break-down. The use of a fan to keep air circulating about the parts during the drying operation will be helpful. If an electric fan is not available, use a hand-operated fan. When the equipment is not in use, cover it well to

reduce the possibility of moisture accumulation. If weatherproof covering is not issued, improvise it. If the transmitter is damp, operating it on continuous wave will make it less likely to arc than operating it on voice or tone.

(2) Another possible source of trouble is insects. Short circuits can occur if insects get between plates of tuning capacitors. Some varieties of ants eat insulating material on electrical equipment, and render it useless. Make daily inspections to prevent this.

c. High altitudes.—The transmitter and associated equipment should work satisfactorily on continuous wave at altitudes up to 27,000 feet. When operation on tone or voice is attempted, however, insulation break-down may occur with transmitter tuning units TU-8-A or -B, range 6,200 to 7,700 kilocycles, above 25,000 feet and with tuning unit TU-9-A or -B, range 7,700 to 10,000 kilocycles, above 19,000 feet. These altitude limits may be slightly exceeded by careful tuning and by carefully guarding against accumulation of dust and other foreign matter in the equipment. Transmitter tuning units TU-3-A or -B, TU-22-A or -B, TU-26-B should give satisfactory service up to 15,000 feet.

22. Emergency operation.—In an emergency it is possible to operate the BC-191-(*) transmitter with several tubes missing. The only tubes actually required for continuous wave telegraph operation are two tubes type VT-4-C (VT-4-B), one for the master oscillator and one for the power amplifier. Insert tubes in first and second VT-4-C sockets, counting from the left. (See fig. 4.) The transmitter side tone circuit will not function, but this has no effect on transmission. Keying is done in the usual manner.

23. Removal from service.—Note any operating difficulties, failure of functions, broken or damaged parts, and make the inspections outlined in paragraph 30. See that provision is made to inform the maintenance personnel of needed repairs. Proceed to remove radio set from service as follows:

- a. Set all switches to the OFF position.
- b. Disconnect all cording.
- c. Disconnect antenna and counterpoise leads.
- d. Pack equipment in chests or cases supplied.

24. Care and maintenance.—To insure uninterrupted service, inspect the various components of each installation before and after each day's operation. Make a thorough inspection of each component after every 50 hours of operation. Detailed inspection instructions are contained in paragraph 30. Moisture is probably the most common source of trouble in the operation of field radio sets. All possible

care should be exercised to protect the equipment from direct rain and conditions of unusually high humidity. At all times when not in use, the components should be made secure in their respective chests and covers.

25. Storage.—If the transmitter is to be removed for storage, cover or wrap it securely against dust, place it in a dry, protected location, and safeguard it against accidental damage. Inspect it frequently for dust and rust, and clean and repair if necessary.

SECTION III

FUNCTIONING OF PARTS

	Paragraph
General circuit-----	26
Radio transmitters BC-191-(*) and transmitter tuning units TU-3-A or -B, TU-5 to TU-10-A or -B, TU-22-A or -B and TU-26-A or -B-----	27
Antenna tuning unit BC-306-A-----	28

26. General circuit.—*a.* The transmitter, together with the transmitter tuning units, contains the circuit elements for continuous wave, tone, and voice transmission. With the various transmitter tuning units, the transmitter covers a frequency range of 200 to 800 and 1,500 to 12,500 kilocycles. During the explanation of the detailed functioning of the transmitter, it will be assumed that transmitter tuning unit TU-6-A or -B (3,000 to 4,500 kc.) is being used.

b. The circuits of the various radio transmitters BC-191-(*) are for all practical purposes identical. The radio frequency circuit is of the master oscillator, power amplifier type. The audio frequency circuit consists of a push-pull modulator which is driven by an audio amplifier. The transmitter utilizes a tube VT-4-C for the oscillator, a tube VT-4-C for the power amplifier, two tubes VT-4-C in push-pull for the modulator, and a tube VT-25 for the audio amplifier (speech amplifier). (See fig. 11.) For continuous wave transmission, only the master oscillator, power amplifier, and speech amplifier tubes operate. For tone and voice transmission, all tubes operate. The power amplifier operates class C; the modulator tubes in push-pull operate class B; the audio amplifier driver tube operates class A. Sufficient audio frequency power is obtained from the modulator tubes for plate modulation of the power amplifier on tone or voice transmission. Side tone for monitoring purposes is supplied from the speech amplifier during continuous wave, tone, and voice transmission.

27. Radio transmitters BC-191-(*) and transmitter tuning units TU-3-A or -B, TU-5 to TU-10-A or -B, TU-22-A or -B and TU-26-A or -B.—*a. Oscillator circuit.*—The master oscillator circuit is schematically illustrated in figure 12. The oscillatory

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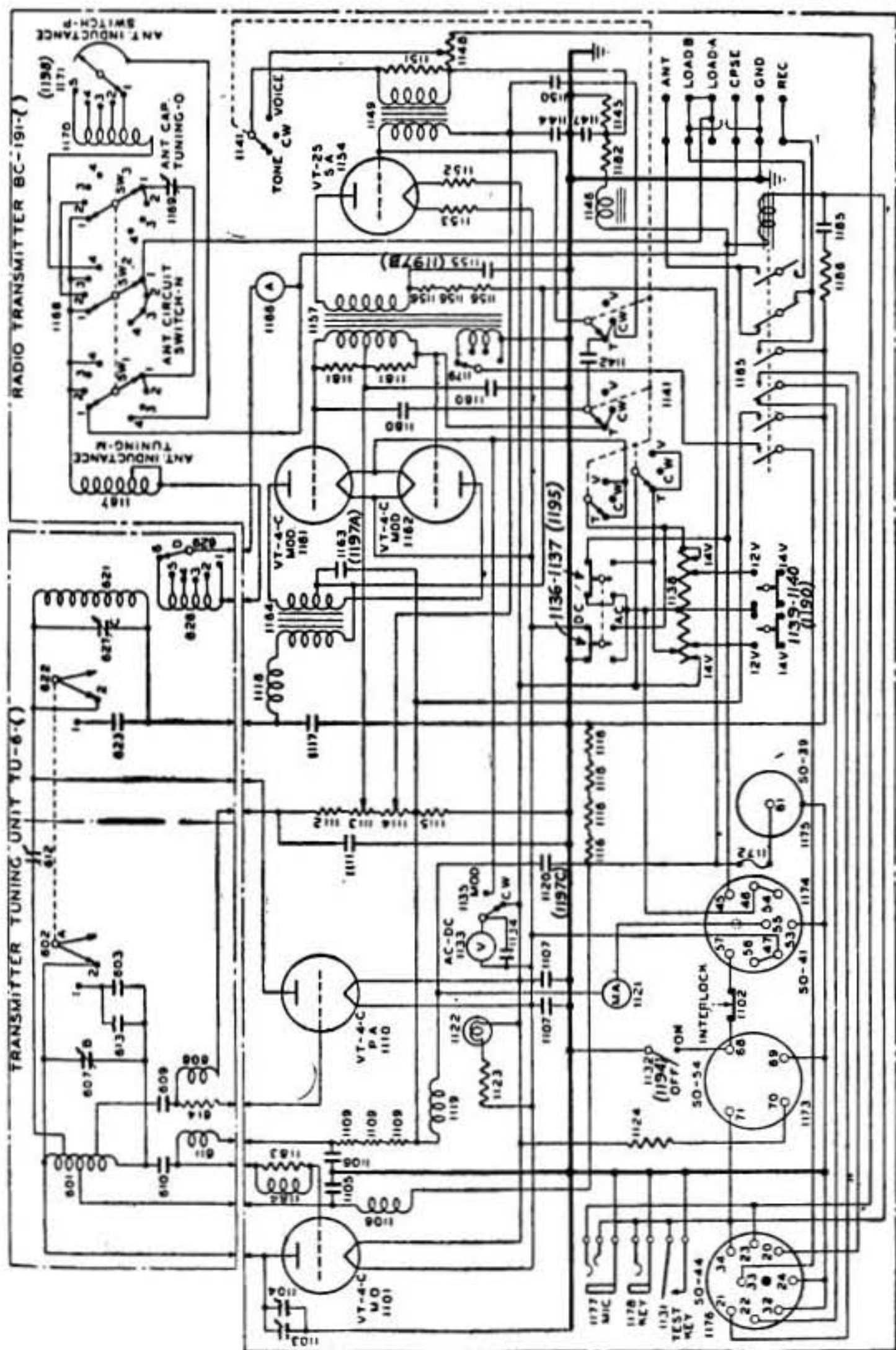


FIGURE 11.—Radio transmitter BC-191-(*) with transmitter tuning unit TU-6-A or -B—schematic diagram.
NOTE.—See note on page 1 for reference numbers in parentheses.

circuit by which the frequency of the transmitter is controlled is contained in the transmitter tuning unit being used. When the transmitter tuning unit TU-6-A or -B is employed and the BAND CHANGE SWITCH A is in position 2 (fig. 20), the oscillatory circuit comprises the tapped coil 601 and the variable capacitor 607. Moving the BAND CHANGE SWITCH A to position 1 places the fixed capacitors 603 and 613 in parallel with the variable capacitor 607, and enables this tuning unit to cover the lower ranges of its frequency band. Continuous adjustment of frequency is accomplished by means of the variable capacitor 607, control B. Controls, coil, and capacitors of the other transmitter tuning units (fig. 20) are arranged for similar operation on either one, three, or four bands, depending on the unit. In each tuning unit, both coils and capacitors are thermally compensated to reduce frequency variation due to normal changes in air temperature. Subsequent discussion of the master oscillator circuit is limited to the circuit shown in figure 12, which results when transmitter tuning unit TU-6-A or -B is used with BAND CHANGE SWITCH A on position 2. The radio frequency voltage across the lower half of the coil 601 provides the master oscillator grid excitation voltage. The coil is also tapped an equal number of turns on either side of the center tap. The grid excitation voltage for the power amplifier is furnished through capacitor 609. The master oscillator grid excitation voltage is obtained through capacitor 610, which also blocks the d-c plate voltage from the grid circuit. Resistor 1183 and choke 1184, in parallel, are connected in series with the grid of the master oscillator tube to prevent the generation of parasitic oscillations. The plate voltage for the master oscillator is fed to the tuning unit through radio frequency choke 1106, which, with capacitor 1105, prevents radio frequency current from flowing into the power supply. Resistors 1109 (three in series) function as the master oscillator grid leak which provides the required operating bias for the master oscillator tube from the rectified grid current. Part 1108 is a radio frequency bypass capacitor. Grid choke 611, in conjunction with resistors 1109, serves as the necessary d-c path from the grid to the filament, maintaining at the same time a high impedance to the radio frequency grid excitation voltage. Capacitor 1104 is the calibration reset by means of which the master oscillator tuning circuit can be adjusted to correspond to the calibration chart whenever the oscillator tube is changed. This capacitor is adjusted through a small port in the front panel to the right of TEST KEY. Capacitor 1103 is a sealed capacitor which provides the necessary thermal compensation for any frequency drift normally

caused during warming up or by variation of the temperature of the oscillator tube.

b. Power amplifier circuit.—(1) The power amplifier circuit is schematically illustrated in conjunction with the master oscillator circuit in figure 12. The power amplifier plate tank circuit, by means of which the plate load impedance is adjusted, is contained in the transmitter tuning unit. When the transmitter tuning unit TU-6-A or -B is employed and BAND CHANGE SWITCH A is in position 2, the plate tank circuit comprises the coil 621 and variable capacitor 627. Moving BAND CHANGE SWITCH A to position 1 places

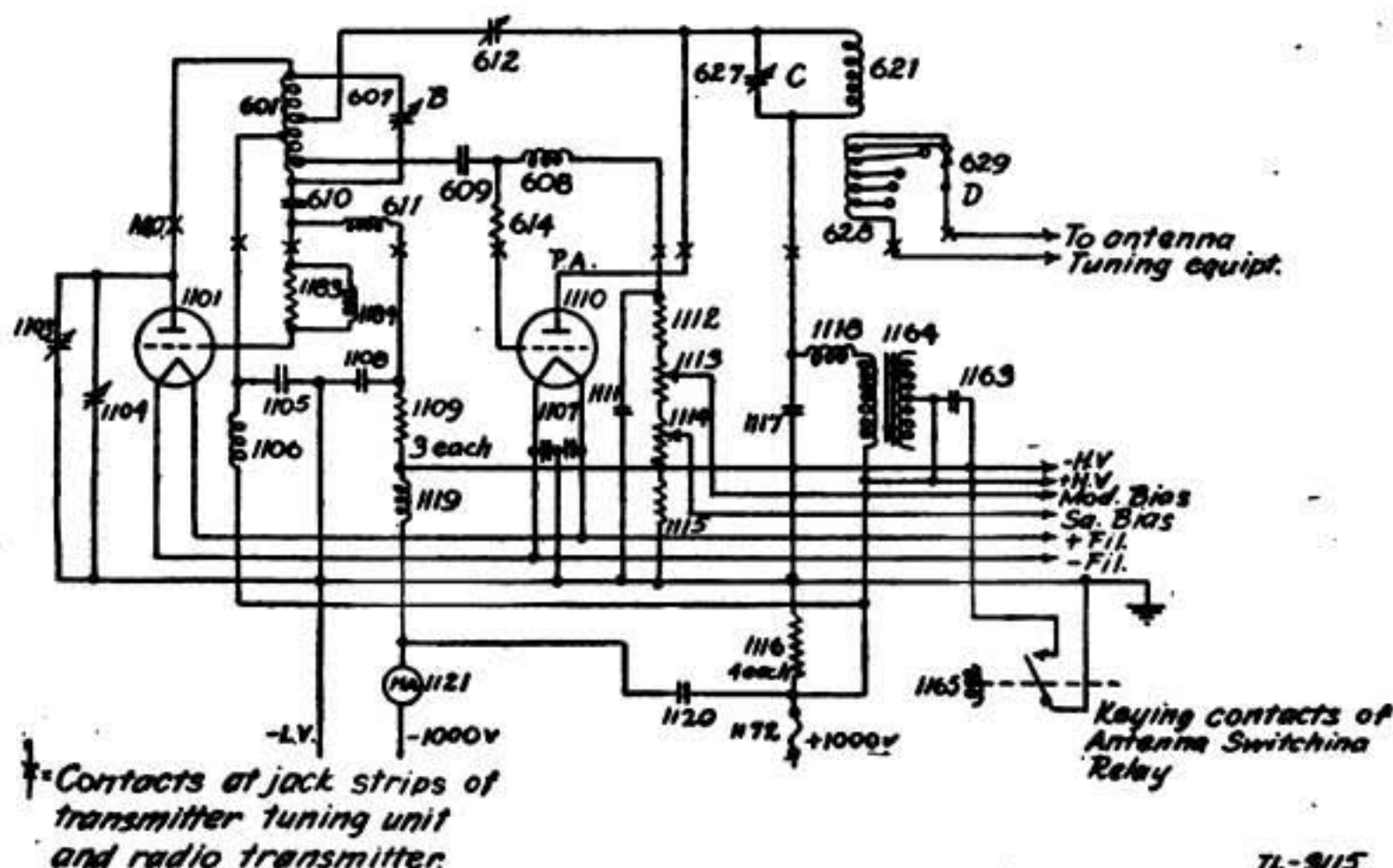


FIGURE 12.—Radio transmitter BC-191-(*), radio frequency and high voltage circuits—functional diagram.

the fixed capacitor 623 in parallel with the variable capacitor 627 and enables this tuning unit to cover its lower frequency range. Continuous frequency adjustment of the plate tank circuit is accomplished by means of the variable capacitor 627, control C, P. A. tuning controls, coil, and capacitors of the other transmitter tuning units are arranged for operation on either one, three, or four bands as mentioned in the discussion of the oscillator circuits in *a* above.

(2) Subsequent discussion of the power amplifier circuit is limited to the circuit shown in figure 12, which results when the transmitter tuning unit TU-6-A or -B is used with BAND CHANGE SWITCH A on position 2. The power amplifier grid receives excitation through capacitor 609 from the master oscillator tank coil. Capacitor 609 also keeps the master oscillator d-c plate voltage from the

power amplifier grid. The power amplifier negative grid bias is obtained from the flow of rectified grid current through resistors 614, 1112, 1113, and 1114. Choke 608 provides a low resistance path for the d-c grid current but a high impedance path at radio frequency.

(3) Plate voltage for the power amplifier is applied through the modulation transformer 1164, the radio frequency choke coil 1118, and the tank coil 621. The capacitor 1117, in conjunction with choke coil 1118, prevents radio frequency currents from flowing into the power supply. The neutralizing capacitor 612 in the tuning unit forms a part of a bridge circuit, including the power amplifier grid plate capacitance. Balancing this circuit by means of capacitor 612 prevents any interaction of the power amplifier on its grid input circuit, thus eliminating the possibility of self-oscillation of the amplifier. All transmitter tuning units are properly balanced or neutralized at the time of manufacture and should not require adjustment in service unless the setting is accidentally disturbed. The power amplifier is inductively coupled to the antenna circuit by means of a tapped inductor 628, the taps of which are selected by a panel-controlled tap switch 629, ANTENNA COUPLING SWITCH D. Sufficient variation in coupling is provided to allow operation into a wide range of antenna reactances.

c. Modulation.—Modulating voltage is applied to the plate circuit of the power amplifier by means of the modulating transformer 1164. The modulator tubes 1161 and 1162 are operated in a push-pull, class B circuit in which they are biased almost to plate current cut-off, drawing 20 milliamperes together. The modulator tubes receive excitation from the speech amplifier tube 1154, through an interstage transformer 1157. The secondary of this transformer is loaded by resistors 1181 to reduce the effective load variation caused by modulator grid current. Plate power for the speech amplifier is obtained from the positive high voltage supply through resistor 1156, which limits it to the proper value. Capacitor 1155 (1197b) serves as an audio frequency bypass for this power source. Receiver side tone for monitoring the transmitted signal is provided by a tapped winding on the interstage transformer 1157. Switch 1179 selects the proper tap on this transformer winding to give the proper side tone level if this feature is used.

d. Tone, continuous wave, and voice operation.—(1) The TONE C. W. VOICE switch, 1141 (fig. 11), serves to select the desired type of transmission. It performs the following functions:

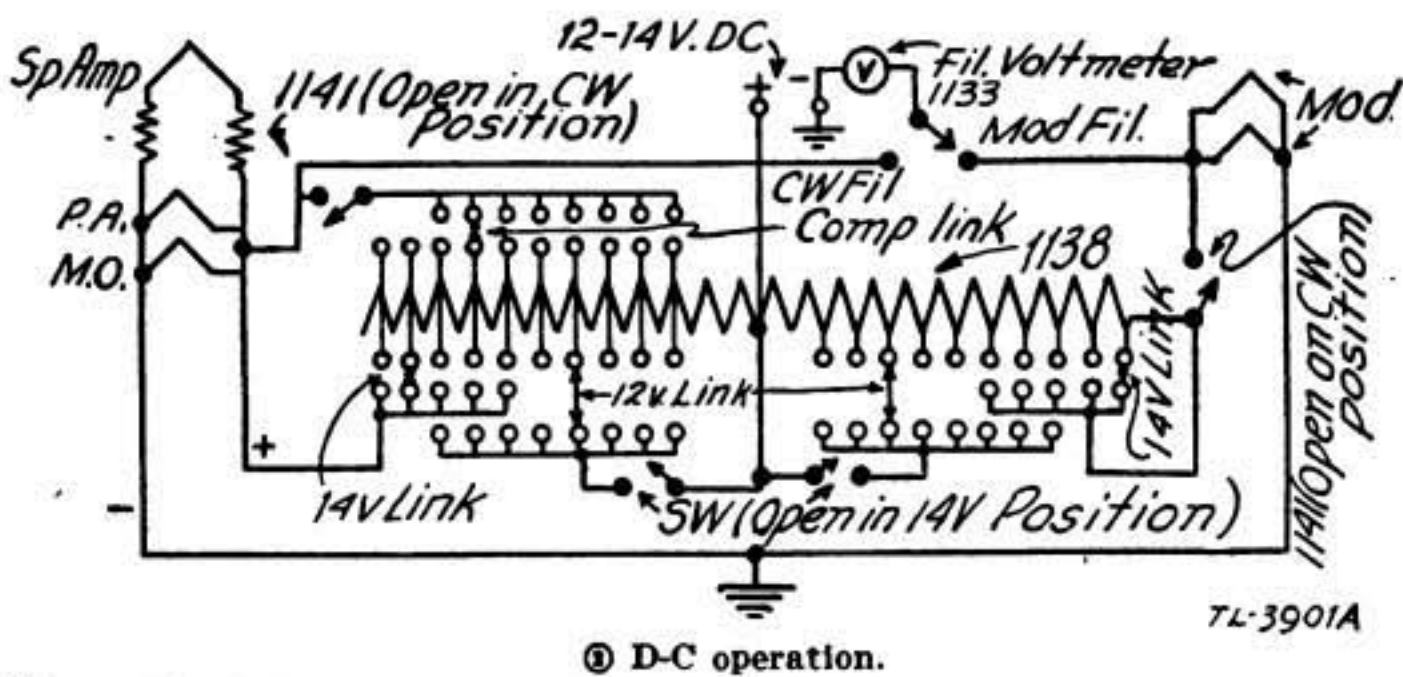
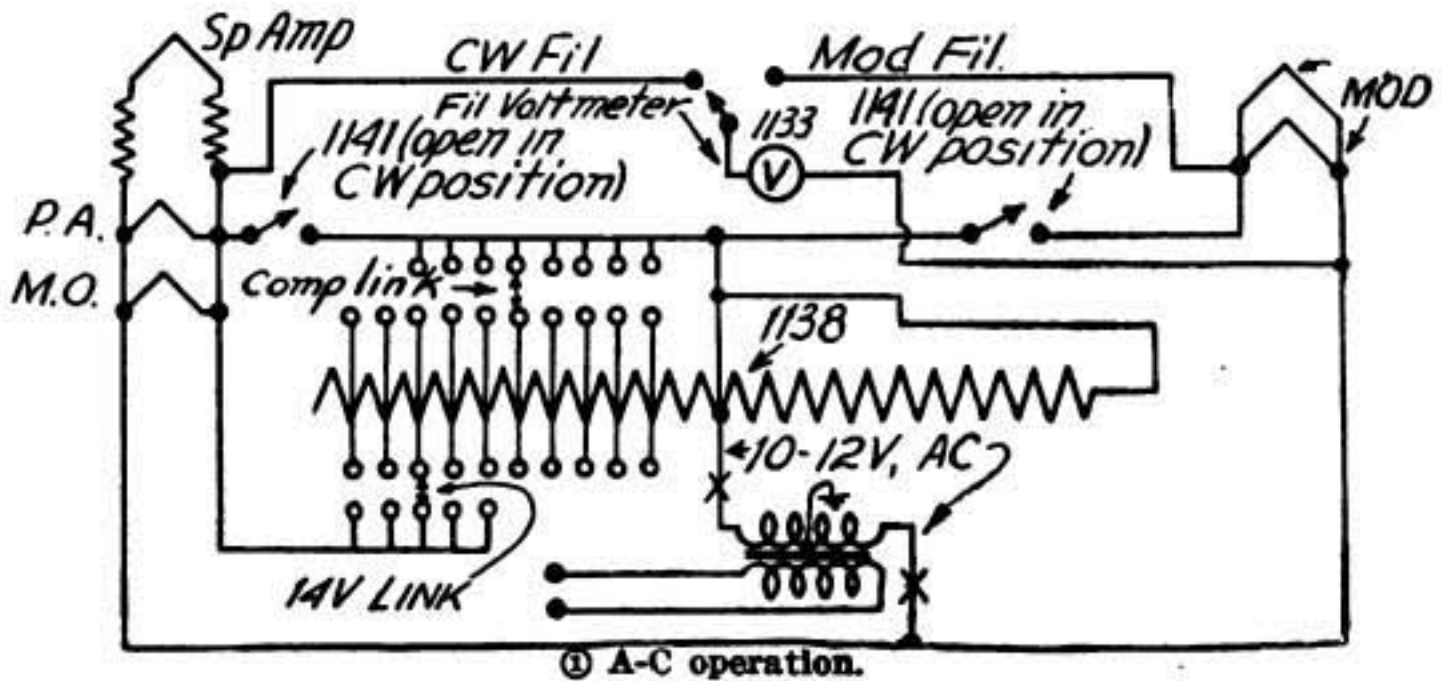
(a) Controls the modulator filaments.

(b) Controls a line-compensating section of the filament resistor (fig. 13).

(c) Controls the oscillator feed-back circuit for side tone on continuous wave and tone operation.

(d) Connects the microphone circuit to the input transformer 1149 for voice operation.

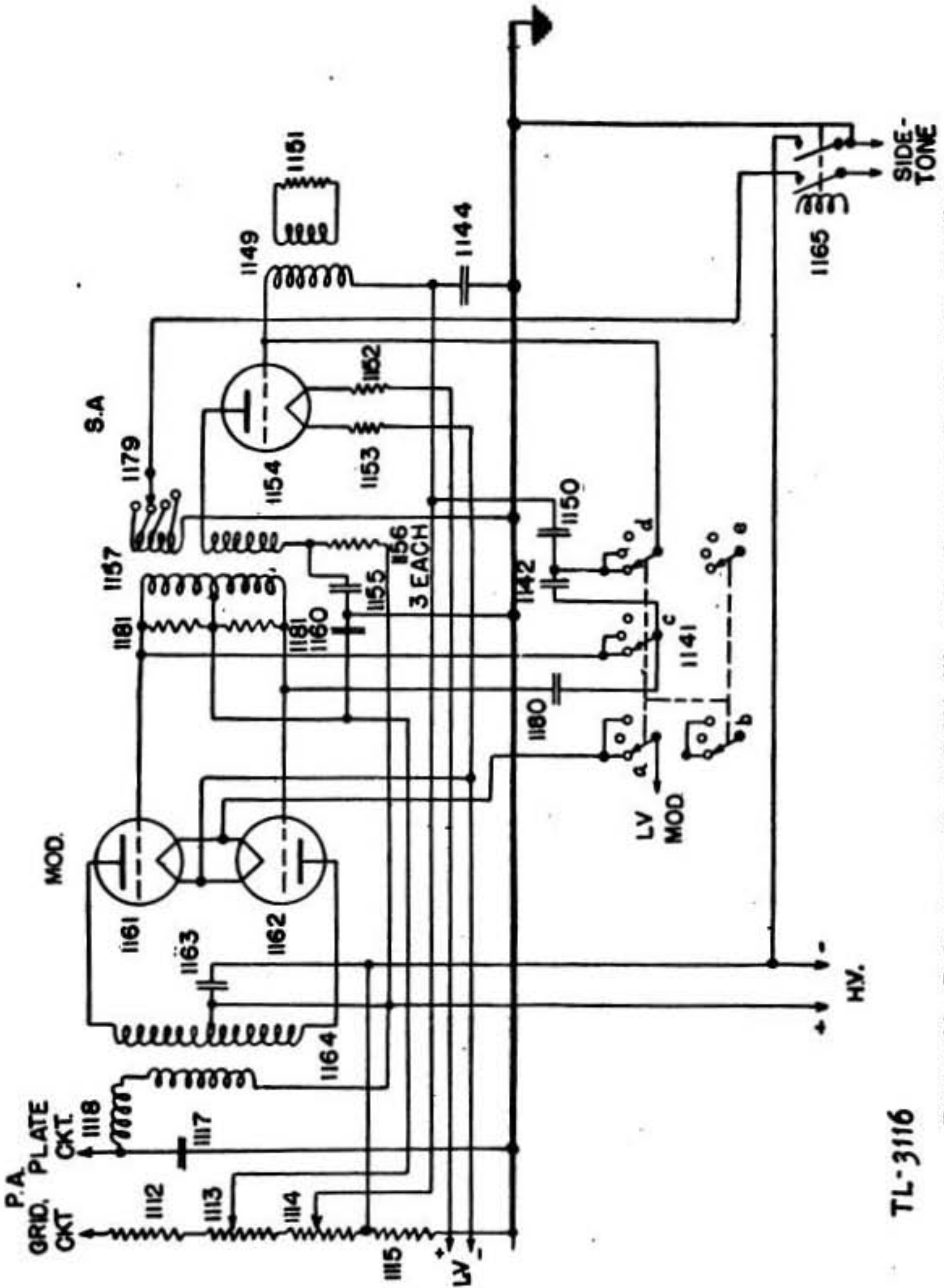
(2) With switch 1141 in the TONE position (fig. 14), capacitor 1142 feeds back energy from the speech amplifier plate to its grid in



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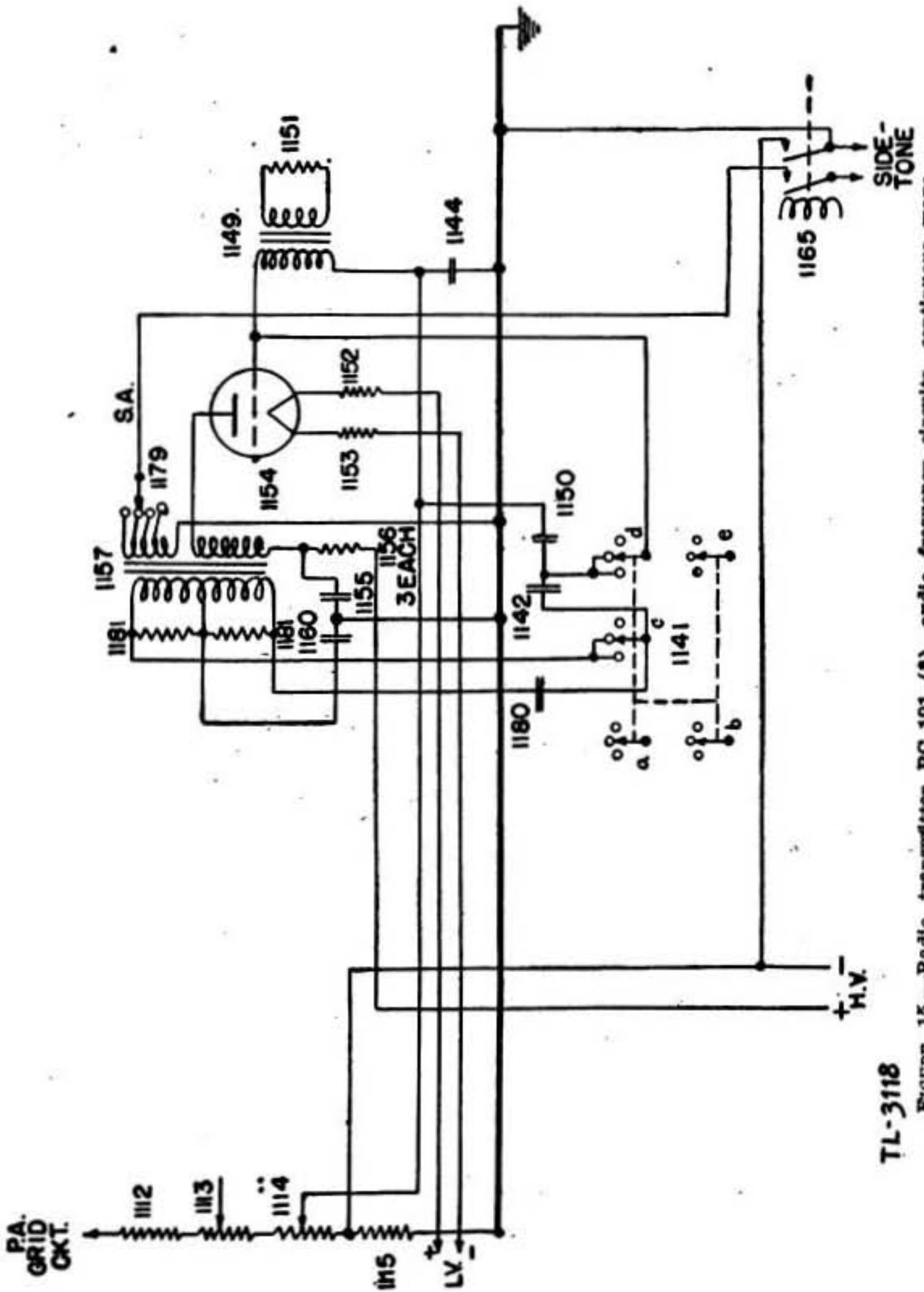
FIGURE 13.—Radio transmitter BC-191-(*) filament circuit—functional diagram.

the proper phase relation to cause oscillation at an audio rate, and thus the required tone voltage is generated. The secondaries of input transformer-1149 and interstage transformer 1157 are resonated by capacitors 1150 and 1180, respectively, to provide the required tuned circuits in both grid and plate circuits of the audio oscillator. The tuning of these circuits is such as to establish a frequency of oscillation of 500 to 1,000 cycles. Resistor 1151 on the primary of input transformer 1149 serves to stabilize the grid excitation of the speech amplifier tube.



TL-3116

FIGURE 14.—Radio transmitter BC-191-(*) audio frequency circuits, tone operation—functional diagram.



TL-3118

FIGURE 15.—Radio transmitter BC-191-(*), audio frequency circuits, continuous wave operation—functional diagram.

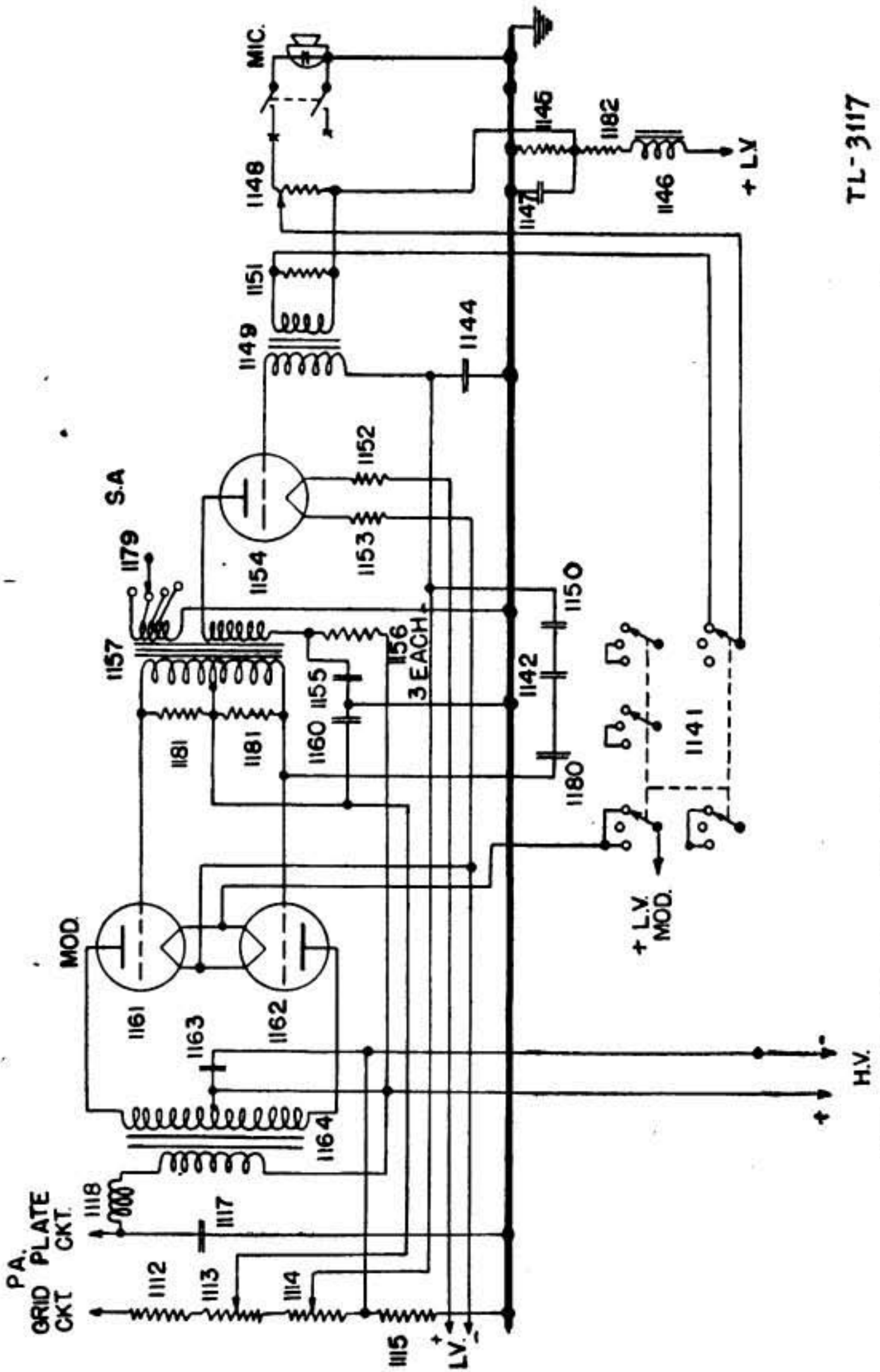
(3) When set at C. W. (fig. 15), switch 1141 shuts off the modulator tubes by removing the filament voltage. The speech amplifier functions the same as for tone operation, although it furnishes only the side tone audio frequency signal for monitoring the continuous wave transmission.

(4) Set at VOICE (fig. 16), switch 1141 disconnects the tone capacitors 1142, 1150, and 1180, connects the microphone circuit to the primary of the input transformer 1149, and makes the modulator tubes operative by connecting their filaments to the low voltage supply. Potentiometer 1148 is the speech INPUT LEVEL control. The speech amplifier will then receive its excitation from the microphone by means of input transformer 1149. The transmission is monitored through the receiver side tone circuit.

e. Bias voltages.—Bias for the modulator tubes is obtained from potentiometer 1113, and bias for the speech amplifier from potentiometer 1114 (fig. 14). These potentiometers form a part of the power amplifier grid leak, the voltage across them resulting from the rectified grid current of the power amplifier. Capacitors 1144 and 1160 serve as a low impedance bypass to ground for the speech amplifier and modulator bias, respectively, at audio frequencies. Both the modulator bias control (labeled MOD. BIAS), and the speech amplifier control (labeled S. A. BIAS), are accessible in the tube compartment. The speech amplifier grid bias is usually adjusted at the factory, and its value is not particularly critical.

f. Keying.—Keying of the transmitter (fig. 12) is controlled by means of resistor 1115, one end of which is connected to negative high voltage and to all grid circuit returns, and the other end to negative filament or ground potential. The keying contacts of relay 1165 are connected across this resistor. When the keying contacts are open, the voltage drop across 1115 is such that the grids of the tubes are negatively biased beyond plate current cut off, stopping oscillation. When these keying contacts are closed, resistor 1115 is shorted and normal grid biases on all tubes are reestablished. Operation of the keying contacts is accomplished by supplying power to the antenna switching relay 1165. (See fig. 17.) Power is supplied to this relay when the key, test key, or the microphone button switch is operated. Operation of the antenna switching relay performs the following additional functions:

- (1) Disconnects the receiving equipment from the antenna and grounds the receiver input circuit.
- (2) Connects the transmitter to the antenna circuit.
- (3) Keys the side tone circuit.



TL-3117

FIGURE 16.—Radio transmitter BC-191-(*) audio frequency circuits, voice operation—functional diagram.

g. Filament circuit.—The transmitter is so designed that it can be operated from either a d-c source or an a-c source in connection with a power supply unit consisting of a high voltage rectifier for plate supply, a low voltage rectifier for the control circuits, and a transformer to furnish a-c filament supply. The A-C D-C switch 1195 (1136-1137) (fig. 11) performs the circuit changes to allow the transmitter to be operated from either source.

(1) In the a-c position (figs. 13 and 18) the filament circuit is separated from the control circuit, and the normally grounded side of the filament is disconnected from ground. Capacitors 1107 then serve to maintain the tube filaments at ground potential with respect to radio frequency currents. When operating the filaments from an a-c source, the center tap of the transformer which supplies heating current to the filaments is grounded, providing a high voltage return circuit.

(2) Under the condition of d-c filament supply (fig. 17), resistor 1138 is used to adjust the filament potential to approximately 10 volts, as indicated by the red line on voltmeter 1133. The midtap of this resistor is connected to the power source. One side of the resistor is used for the adjustment of the filaments of the tubes used for continuous wave operation and the other side for the modulator tubes.

(3) Provision is made to short out a section of the continuous wave filament resistor by means of one section of switch 1141 (figs. 13 and 17) to compensate for the increased line drop which occurs when the modulator filaments are lighted. This arrangement makes it unnecessary to readjust the voltages when changing from continuous wave to tone or voice operation. A portion of the resistor may be short-circuited by the 12V. 14.2V. switch 1190 (1139, 1140) (fig. 17), so that the correct filament voltage may be applied both when the power supply storage battery is being charged and when it is not being charged. Switch 1135 connects filament voltmeter 1133 to either the continuous wave or modulator tube filaments. If the filaments are operated from an a-c source, resistor 1138 serves only as a compensating resistor to eliminate the need for readjusting the filament rheostat when changing from continuous wave to tone or voice transmission.

h. Antenna tuning equipment.—The antenna tuning equipment on the transmitter is capable of tuning practically any antenna to frequencies between 800 to 12,500 kilocycles. Inductive loading in series, and series and parallel capacitive loading is provided. The selection of a suitable tuning circuit and its subsequent tuning are readily accomplished by observation of the ANT. CURRENT meter and TOTAL PL. CURRENT meter. The latter meter by its sharp rise at resonance of the antenna circuit indicates most exactly the point of

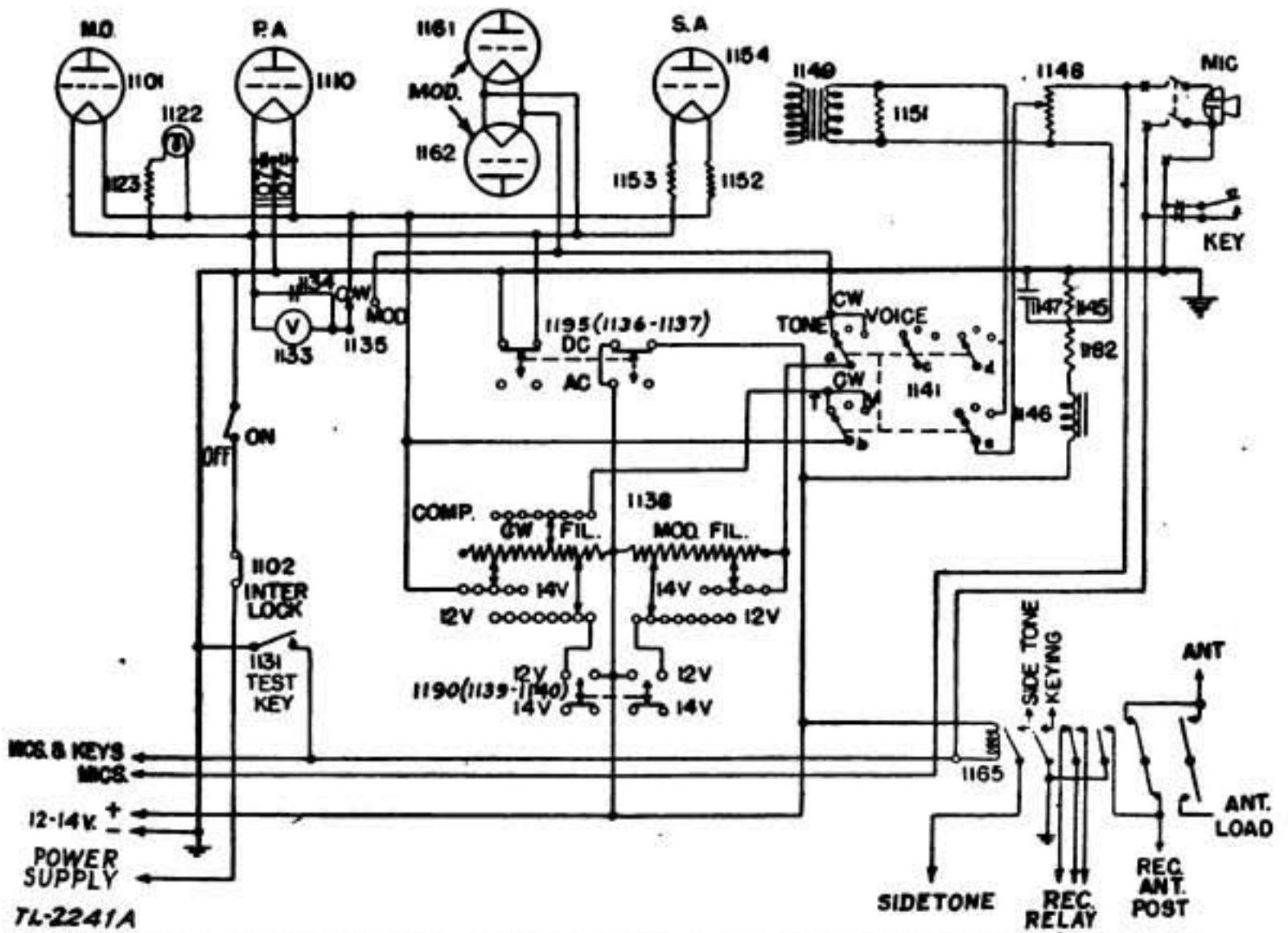


Figure 17.—Radio transmitter BC-191-(*), low voltage and control circuits, d-c operation—functional diagram.

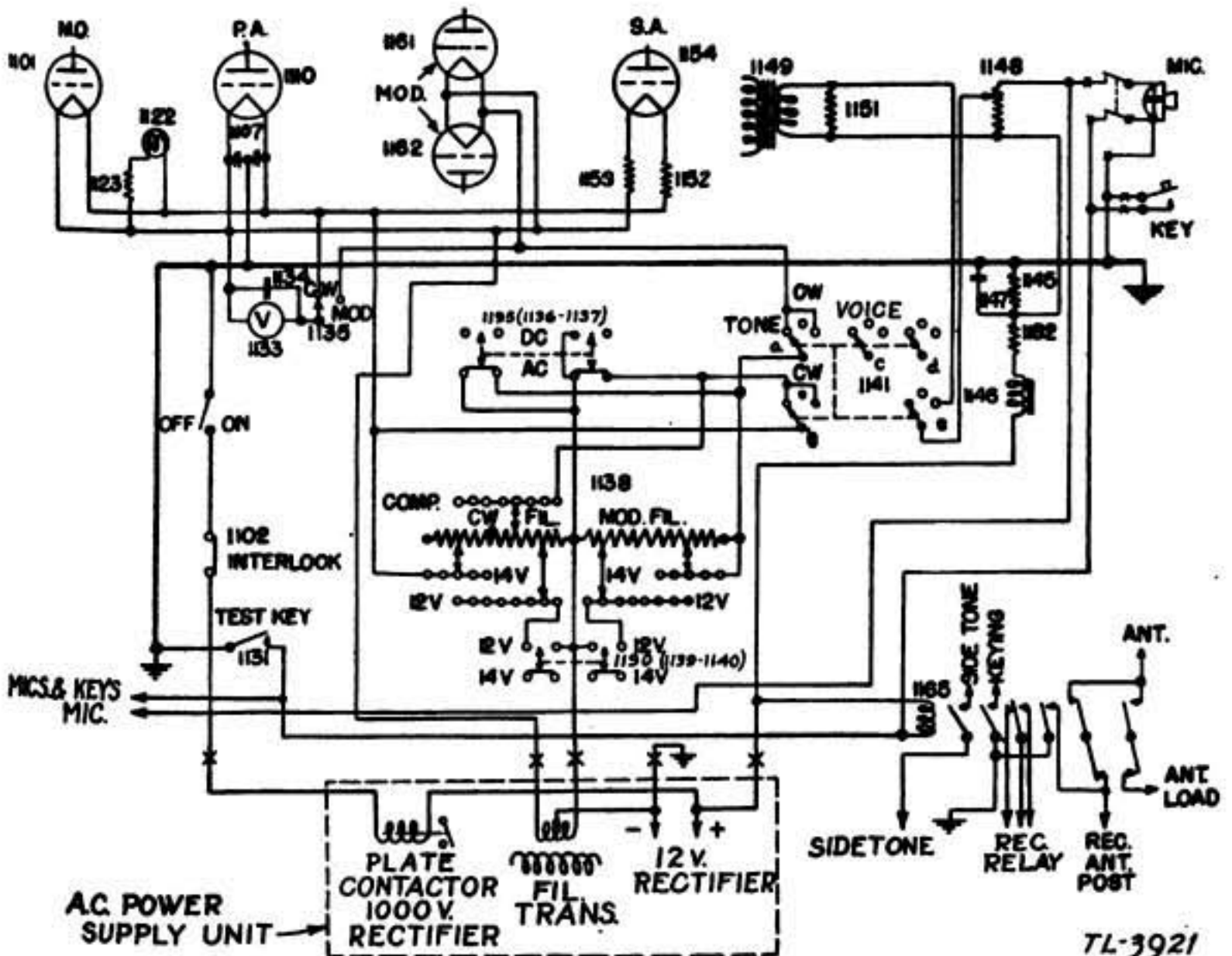


Figure 18.—Radio transmitter BC-191-(*), low voltage and control circuits, a-c operation—functional diagram.

resonance. Detailed data on adjustment of these controls are given in paragraph 17*c* which also describes the functioning of the circuits.

28. Antenna tuning unit BC-306-A.—This antenna tuning unit is a tapped variometer. (See fig. 19.) In operation it furnishes the additional series inductive reactance loading required for resonating the antennas used with tuning units TU-3-A or -B, TU-22-A or -B, and TU-26-B on frequencies below 800 kilocycles. The antennas used at these frequencies are largely capacitive in their loading effect on the transmitter. The amount of inductive reactance required is

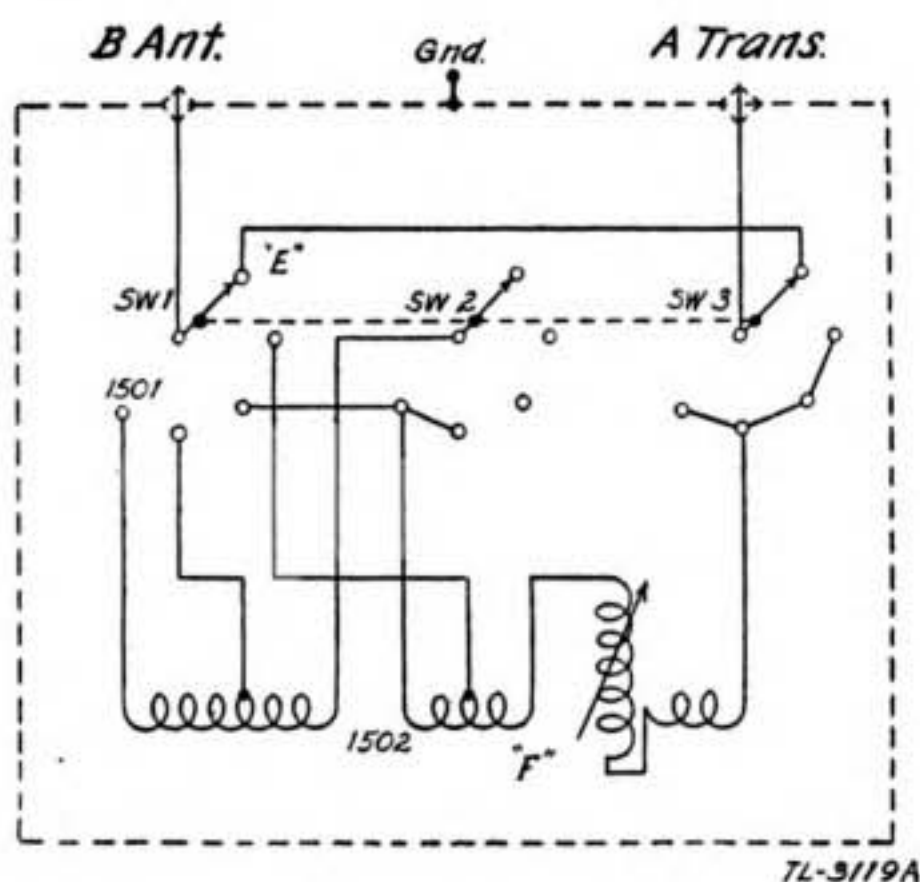
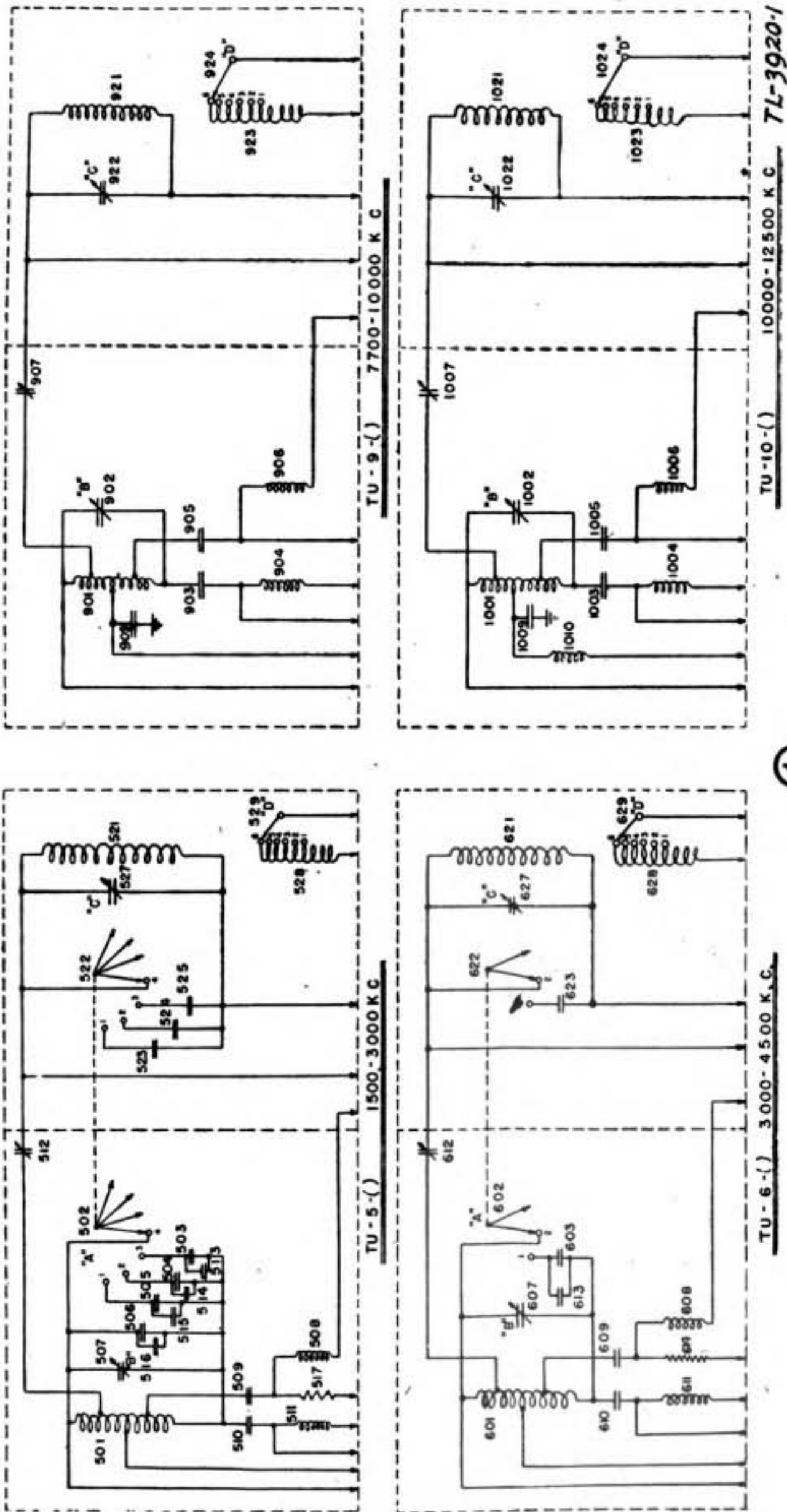


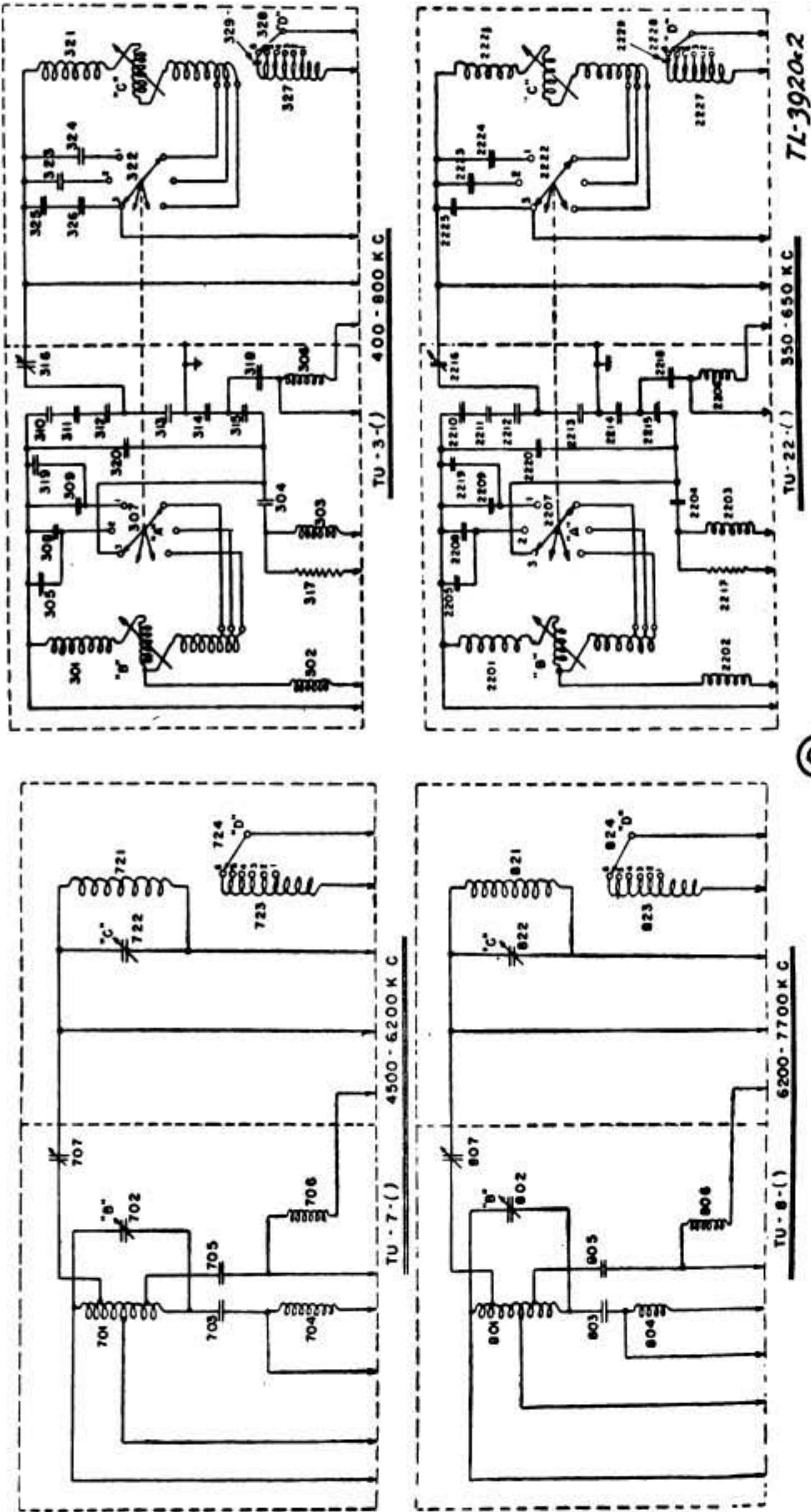
FIGURE 19.—Antenna tuning unit BC-306-A—schematic diagram.

selected and adjusted by a variable rotor, control ANTENNA VARIOMETER F, and a three-gang tap switch 1501, control ANTENNA VARIOMETER SWITCH E. The three-gang type of switch construction allows arrangement of circuits so that the BC-306-A is cut out of the antenna circuit when control E is on tap 1. Three terminals are provided on BC-306-A. One, the ground terminal, is connected to the shield and frame of the unit. The other two, marked A-TRANS. and B-ANT., serve to connect the ANTENNA VARIOMETER F, 1502, in series with the antenna system of the set. (See fig. 9.)



1

FIGURE 20.—Transmitter tuning unit—schematic diagram.



2

FIGURE 20.—Transmitter tuning unit—schematic diagram—Continued.

SECTION IV

SERVICING AND REPAIR

	Paragraph
Servicing.....	29
Inspections.....	30
Lubrication.....	31
Procedure in locating trouble.....	32
Repairs.....	33
Normal voltage, current, and resistance readings.....	34
Special adjustments.....	35
Vacuum tube characteristics.....	36

29. Servicing.—*Caution:* Observe care in servicing this radio equipment. Make only such repairs as are indicated in paragraph 33. Servicing should be attempted only by competent personnel supplied with adequate test and repair equipment. An inexperienced operator, in attempting to locate and repair trouble which a competent man could do in a few moments, may damage the equipment to such an extent that it will require shipment to a depot for repair.

30. Inspections.—*a. Daily inspection.*—Give the equipment a thorough inspection before and after each day's operation to make sure that it is ready for use at any time. This inspection includes examination of all cordage for proper fastening and for damage. Examine all accessible components for dirt, and clean if necessary.

b. Fifty-hour inspection.—Make a thorough inspection of the complete installation after every 50 hours of operation. This materially aids in securing uninterrupted performance in the field. The procedure for this inspection is as follows:

(1) Clean accumulated dust and dirt from all units, using an air hose or bellows, paying particular attention to the loading coil 1170 in antenna compartment of the radio transmitter. (See fig. 21.) Inspect the rotating coil 1167 in this compartment, and clean the winding, contact roller, and roller shaft thoroughly with carbon tetrachloride and a clean cloth.

(2) Make certain that all wiring is in place, that all mounting brackets and supports are rigidly fastened, and that all nuts and machine screws are supplied with lock washers and are tight.

(3) Determine that cords are not damaged and that all ground connections are secure.

(4) Inspect plugs for proper fit and plug sockets for compressed pin springs. Pin springs which have taken a permanent set can usually be restored by a very light hammer blow at the end of the pin.

(5) Make certain that all cartridge fuses are held tightly in their clips. A loosely held fuse should be removed and the clips bent by

hand until they grip the fuse tightly. Clean clips and fuse ends. Clean all contact surfaces.

(6) Inspect high voltage fuses by removal from the mounting. Carefully clean all contact surfaces and replace fuses.

(7) Inspect keys and microphones for defective cords and damaged plugs.

(8) After the inspection is finished completely reengage all plugs and sockets. Insert all tubes all the way into their corresponding sockets.

31. Lubrication.—Lubricate transmitter in accordance with chart below. Do not use excessive amounts of oil or grease and do not allow electrical connections to become greasy. Make sure that lubricants and oilholes are clean and free from sand, grit, or dirt. These abrasives are the chief cause of bearing wear and the necessity for bearing replacement.

LUBRICATION CHART

Apparatus	Lubrication points	Lubricant used	Quantity used	When used
Radio transmitter BC-191-(*), BC-AA-191 and transmitter tuning units.	Switch shafts, vernier mechanisms, pivot bearings of keying re- lay.	SAE 20 min- eral oil.	Very thin film.	Immediately after appa- ratus is thor- oughly cleaned.
Radio transmitter BC-191-(*), BC-AA-191 and transmitter tuning units.	Switch con- tacts.	White pet- rolatum.	Very thin film.	Immediately after appa- ratus is thor- oughly cleaned.

32. Procedure in locating trouble.—*a.* Speed in locating trouble in equipment is essential. Frequently after much time has been wasted searching for the cause of equipment failure, the trouble is found to be so minor that only a few minutes are required to correct it. Follow a systematic process in eliminating possible causes of trouble when failure does occur. It is useless to remove the shields from the transmitter and to institute a thoroughgoing continuity check of the transmitter circuits when the symptom of trouble is a lack of voltage or current indication. The common-sense thing to do first is to check the cords, plugs, and fuses in the transmitter and power supply equipment. They often are sources of trouble. If they are not at fault, the simple act of checking, which takes a few minutes, eliminates them as a

possible cause of the trouble. When this has been done, and not before, it is time to undertake a close examination of the power supply equipment and the transmitter itself. Always check the obvious and simple things first. Make sure the cords are actually connected to the power supply, and be certain the plugs are making contact in their sockets. If batteries are used, check to see that they are not discharged and that cable connections are correctly made with respect to polarity. Daily inspection of the equipment will serve to minimize failures due to minor faults such as cordage breaks and discharged batteries.

NOTE.—When exposed to conditions of excessive humidity, the transmitter may fail to operate properly because of moisture accumulation across insulators or insulating structures. Take every precaution to keep the installation free from moisture. Many of the unit parts comprising these transmitters are readily damaged by excessive or abrupt applications of heat. A free flow of warm air through a chassis will accomplish the desired drying in less time than the application of very warm air without a free flow.

b. The trouble chart below lists a number of typical troubles which may occur in this equipment. Note that some of these are caused by failure to adjust the equipment properly when setting it up. Always recheck installation and tune-up procedure before operating the equipment.

TROUBLE CHART

Symptoms	Probable causes
No filament voltage. Cording properly connected.	Open fuse or breaker in power supply. Short-circuited power cord. Open power cord. Transmitter tuning unit not fully inserted in transmitter (safety interlock switch closes only when tuning unit is fully inserted). TONE C. W. VOICE switch defective. Filament resistor 1138 defective.
Filament voltage normal on C. W., high on TONE and VOICE.	Modulator tubes burned out. Filament resistor connection board connected improperly.
No plate current. Filament voltage normal. Cords connected properly.	Defective high voltage cord. Burned out high voltage fuse in power supply or in transmitter. Fuse failure is caused by failure to follow tuning procedure exactly (see par. 17) or by defective high voltage filter condensers 1120, 1163 (1197a, c), 1105. Open resistor 1115, defective plate current meter 1121 will cause lack of plate current also. Check action of keying relay 1165.

Symptoms	Probable causes
<p>Very high plate current on continuous wave operation. No radio-frequency output on any position of control D. Control C will not resonate.</p>	<p>M. O. tube not functioning. Replace if defective. Check high voltage and filament circuits of master oscillator circuit for continuity.</p>
<p>No pronounced plate current dip when control C is tuned. TOTAL PL. CURRENT meter reading is high. Tuning of control C shifts somewhat as antenna controls are tuned. ANT. CURRENT meter reading normal.</p>	<p>Antenna loading on power amplifier too great. Reduce by placing control D at a lower setting. (See also paragraph 17c(8).) Check P, A. tube. Check grid bias voltage on this tube. If low, check resistance from pin G of socket 1110 to frame. (See resistance chart, par. 34.)</p>
<p>Power amplifier will not load on continuous wave operation (total plate current does not increase with tuning of antenna). Tuning of control C is normal.</p>	<p>Check antenna for poor joints, leaky insulators. Check connections to output terminal strip. Check strip to see that it is properly inserted (see par. 7). Check pin jacks and plugs of terminal strip and board. See that they are clean and making good contact. Burn marks indicate arcing has occurred. Check air gap on back of terminal strip. Set gap clearance at 0.171 inch. Check antenna tuning circuits for broken insulation, dust and dirt.</p>
<p>Total plate current 150 milliamperes on continuous wave operation at resonance of control C. Control D set at 1. Antenna circuit detuned. TOTAL PL. CURRENT meter dips sharply at resonance of control C. Resonance setting of C is off calibration chart figures. Filament voltage and other checks are normal.</p>	<p>Power amplifier probably requires neutralization. To check, replace transmitter tuning unit with one for another frequency band and tune up M. O. and P. A. controls at a point near middle of frequency band covered by tuning unit. If operation is normal with the second tuning unit, replace first unit and neutralize, following instructions in paragraph 35a and b.</p>
<p>Total plate current high on continuous wave operation at all settings of control D. Low radio frequency output on ANT. CURRENT meter. Plate current dip at resonance of control C is very small. P. A. tube checks perfect. Condition exists with all transmitter tuning units supplied with set.</p>	<p>M. O. tube is oscillating weakly, indicating worn out tube or trouble in master oscillator circuit. Check tube by replacement. If trouble continues, make resistance check of tube socket 1101 with power turned off. See resistance values in paragraph 34c(2).</p>

Symptoms	Probable causes
<p>Tuning of control C normal. No radio frequency current indication on ANT. CURRENT meter. Transmitter inoperative by report from another station. Antenna correctly installed. Antenna switch N set at 1. Control D on any position. Operating frequency is above 3,000 kilocycles. Plate current about 110 milliamperes.</p>	<p>Check for burned out ANT. CURRENT ammeter 1166 and disconnected antenna or counterpoise. If meter is operative try working with control N on 2 or 3. With N on 1 at frequencies above 2,700 kilocycles the ANT. CURRENT meter can be easily burned out by high current surges if the antenna or counterpoise is disconnected from the transmitter. Always be sure that antenna system is properly connected.</p>

MODULATOR TROUBLES

(In all cases below, continuous wave operation has been tried and found to be normal.)

Symptoms	Probable causes
<p>Badly distorted signals on voice. Interference on adjacent channels reported when transmitting on tone.</p>	<p>Improper modulator or speech amplifier grid bias adjustment, or defective modulator tubes. Bad P. A. tube will cause modulator and speech amplifier bias to be of improper value. Check resistance of resistors 1112, 1113, and 1114.</p>
<p>No modulation on voice. Modulation satisfactory on tone. Plate current normal on tone.</p>	<p>Check INPUT LEVEL adjustment. If correct, check microphone, cord, and plug by replacement. Remove high voltage by disconnecting cord and plug PL-59. Place high resistance a-c voltmeter of test set across terminals 3 and 4 of transformer 1149 with tube filaments on. Speak into microphone, with microphone push button switch closed. On loud speech a reading of 1 or 2 volts is normal. Check microphone d-c voltage with d-c voltmeter between terminal 2 of transformer 1149 and transmitter frame. 4.5 to 5.3 volts (microphone plugged in) is normal.</p>

Symptoms	Probable causes
<p>No modulation on tone or voice. Plate current on tone and voice is same as on continuous wave operation.</p>	<p>Modulator tubes are not functioning as shown by lack of plate current increase on tone or voice. Check modulator tubes and value of modulator grid bias (see chart, par. 34a(2)) and continuity of high voltage circuits to plates of modulator tubes. Check TONE C. W. VOICE switch for open circuit. Make certain that modulator filaments light. If not, check connections on MOD. end of filament resistor connection board and check filament resistor 1138 for open circuit.</p>
<p>High plate current. Normal reading on ANT. CURRENT meter. Control C properly adjusted. Plate current <i>decreases</i> when voice or tone modulation is applied.</p>	<p>Check amount of antenna coupling. Operation with control D advanced too far may cause drop in plate current with modulation. Check filament voltages. Low voltage may sometimes cause the condition. Check MOD. BIAS adjustment. If condition still continues, modulation transformer 1164 may be defective.</p>
<p>Distortion on voice. Tone transmission normal. Plate current normal.</p>	<p>Check microphone. Check INPUT LEVEL adjustment for overmodulation. Normal setting of 7 to 8 should swing plate current to <i>peaks</i> of 300 milliamperes on voice. If distortion continues, adjust INPUT LEVEL to limit peak plate current swings to 280 milliamperes on voice. If trouble remains, check grid bias and plate voltages of S. A. tube using tube socket adapter from I-56 or I-56-A test set analyzer. Insert adapter in S. A. socket and VT-25 in adapter socket. Also check resistors 1181 across terminals 3-4 and 4-5 of transformer 1157 to see that they are making good contact and have correct resistance value.</p>
<p>High hum level on voice modulation reported by other stations.</p>	<p>Check for poor ground connections, if the set is grounded. Check capacitors 1147, 1144, 1160, 1120, 1163, 1155 (1197 a, b, c) for open circuit.</p>

33. Repairs.—Repairs other than those to cords and soldering of broken connections will not be attempted except by competent trained

repair personnel. Cords may become defective because of an open circuit in one or more conductors, a short circuit between two or more conductors, or between any conductor and ground. These defects occur most frequently at the point of attachment of the cord to its corresponding plug. These points should be examined and, where possible, necessary repairs made. In the event that the damage occurs

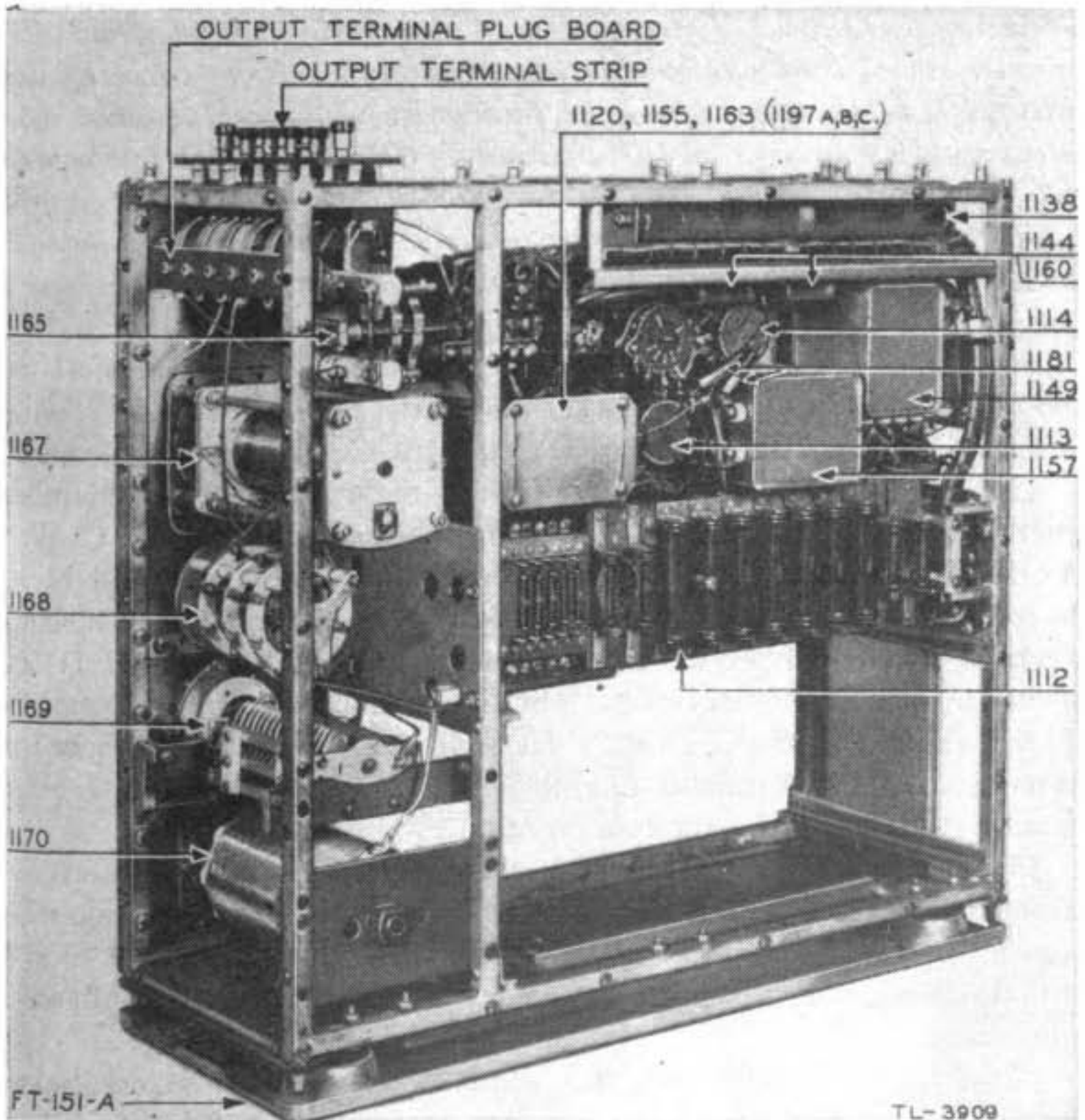


FIGURE 21.—Radio transmitter BC-191-(*), with panels and transmitter tuning unit removed to show location of parts—rear view.

any great distance from either end of the cord, it is normally impossible to make a serviceable permanent repair of the cord. A new cord should be obtained and installed. However, in an emergency, the defective section of the cord may be cut out and jumpers used to restore the necessary circuits until a new cord can be obtained.

34. Normal voltage, current, and resistance readings.—The normal voltage, current, and resistance readings presented in the fol-

lowing charts and tables are given to facilitate repairs on this equipment by servicing personnel. Note that these values are average values and may be expected to vary as much as 15 percent in different sets and when using different testing instruments.

a. Normal voltage values.—(1) *Filament.*—The low voltage filament current consumption is based on a filament voltage of 10 volts.

(2) *Plate and grid voltages.*—**Caution:** *These values are given for servicing personnel. Measurements of high voltages in the transmitter require removal of side shields, exposing high voltage circuits. Contact with these voltages can be fatal. Be very careful when using measuring equipment on these circuits. Clip one of the test leads to the transmitter frame and use the high voltage test prod supplied with the I-56 or I-56-A test set (or equal). When making measurements of high voltage use one hand only. Place the other hand in pocket to prevent accidental contact with the equipment.*

b. Normal plate, grid and filament currents.—(1) *S. A. plate current.*—Read by use of tube socket adapter. Should be 19 to 21 milliamperes. S. A. BIAS control 1114 is adjusted to secure this value.

(2) *Modulator plate current.*—Can be determined by observing the increase in total plate current reading when changing from C. W. to VOICE and impressing normal speech modulation. Should be 100 to 160 milliamperes for sustained tones. With no modulation it should average 20 milliamperes. First adjust MOD. BIAS control 1113 to secure proper adjustment of current for no modulation. (See par. 18b (1).) Then adjust the INPUT LEVEL control 1148 for proper current reading on sustained modulation. (Current measurements are made after tuning the antenna circuit.)

(3) *Master oscillator (M. O.) plate current.*—This is determined from reading of TOTAL PL. CURRENT meter with power amplifier and S. A. tubes removed, selector switch on C. W. Should be 30 to 75 milliamperes, depending on frequency at which master oscillator is operating.

(4) *Power amplifier (P. A.) plate current.*—This is determined by subtracting the sum of the currents drawn by the master oscillator and speech amplifier from the total plate current on C. W. Should be 100 to 150 milliamperes with full antenna loading.

(5) *Master oscillator grid current.*—Measured by connecting a 0 to 100 milliamperes d-c milliammeter in series with resistor 1109. Should be 30 to 50 milliamperes.

(6) *Power amplifier grid current.*—Measured by inserting a d-c milliammeter in series with resistor 1112. Correct value 15 to 25 milliamperes when power amplifier is resonated properly.

VOLTAGE CHART

[Using, 1,000 ohms per volt, or higher, voltmeter]

	Voltage (approx.)	Where measured	Ground polarity	Selector switch position	Notes
S. A. plate.....	425	At plate of VT-25 (socket 1154).	Minus.....	VOICE	Measured with tube in circuit. Use tube socket adapter.
S. A. grid bias.....	35-40	Across capacitor 1144.....	Plus.....	VOICE	
Mod. grid bias.....	72-75	Across capacitor 1160.....	Plus.....	VOICE	
Plate supply.....	1,000-1,100	Terminal of sockets SO-39 and ground.	Minus.....	TONE or VOICE	
Keying.....	200	Across resistor 1115.....	Plus.....	Any	Keying relay 1165 open.
Side tone:					Voltage is a-c. Frequency should be 600-1,200 cycles. Voltage is higher on continuous wave than on tone. Use I-56 or I-56-A output meter.
Position 1.....	17.5-30	Arm of switch 1179 to ground across an 8000-ohm resistor.	TONE or C. W.	
Position 4.....	3-9				
Microphone supply.....	4.5-5.3	Across resistor 1145.....	Minus.....	VOICE	Microphone plugged in. PL-59 disconnected. Filaments on. OFF ON switch at ON. Microphone button switch closed.

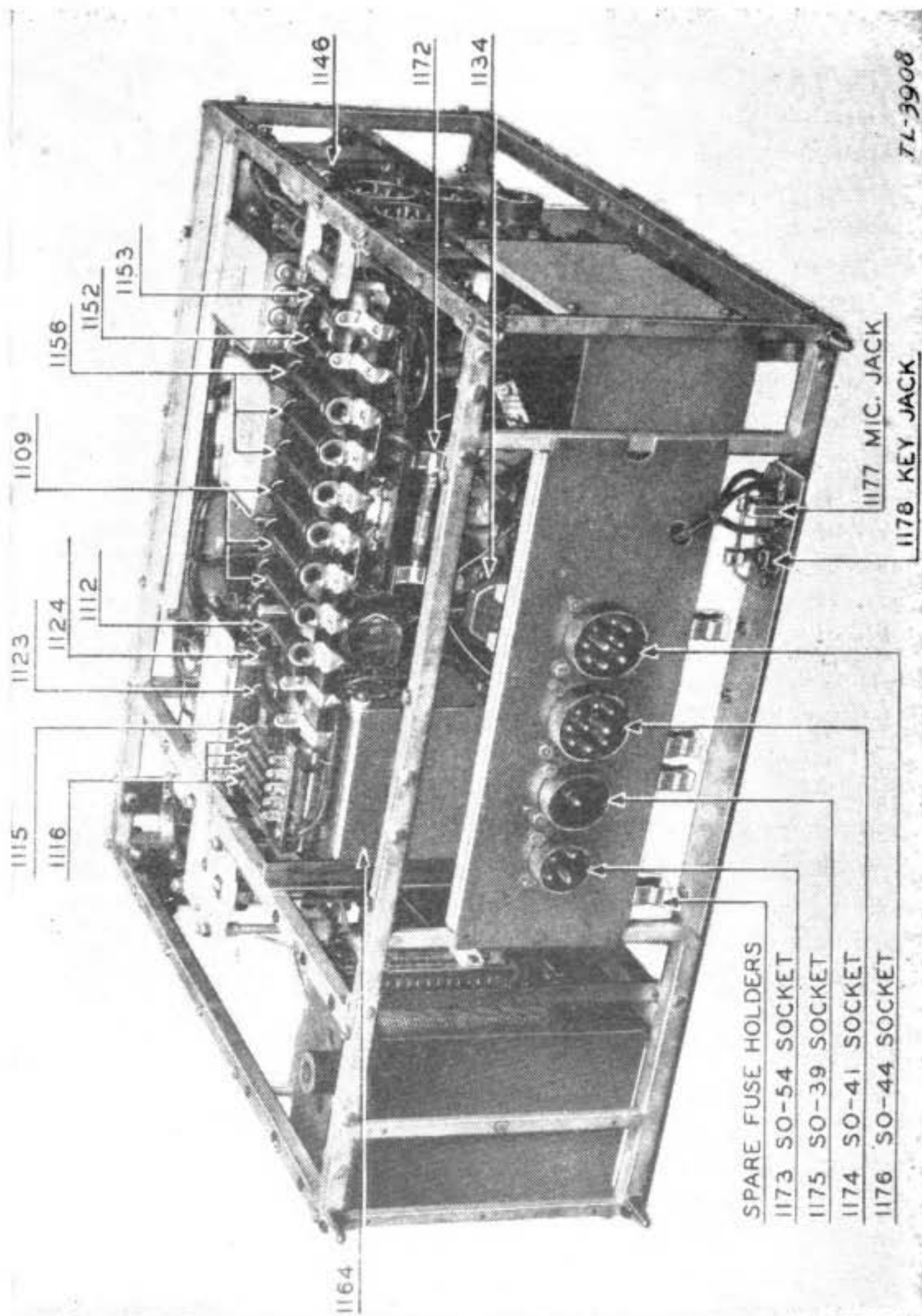


FIGURE 22.—Radio transmitter BC-191-(*), with panels and transmitter tuning unit removed to show location of parts and position of cording sockets on bottom plate—bottom rear view.

(7) *Filament current.*—For vacuum tubes VT-4-C and VT-4-B the filament current consumption is 3.25 amperes for each tube at 10 volts. VT-25 with series resistors 1152 and 1153 draws 1.25 amperes. Thus the total filament current requirements for continuous wave are 7.75 amperes, and for tone and voice, 14.25 amperes.

c. Normal resistance values.—(1) *General.*—Normal resistance values obtained by point-to-ground measurements on radio transmitter BC-191-(*) in a satisfactory condition are indicated below. Comparison of these data with similar measurements on faulty equipment, combined with a logical circuit analysis, will frequently disclose the source of trouble in inoperative or improperly operating transmitters. These data were taken under the following conditions, which must be

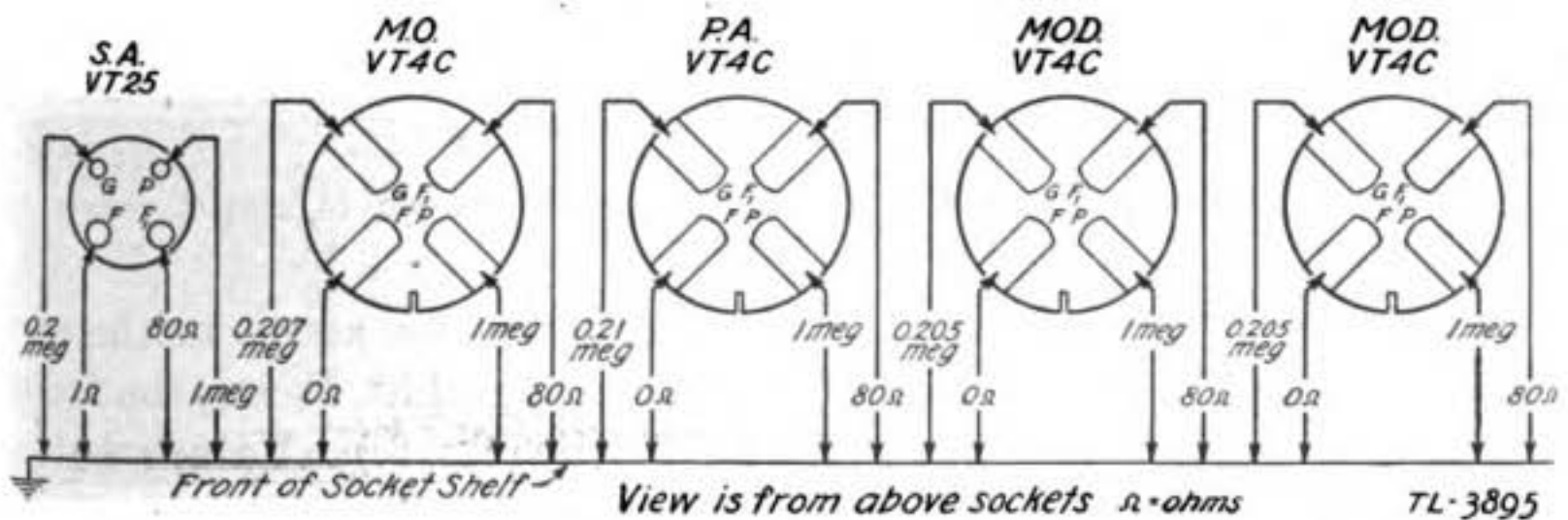


FIGURE 23.—Radio transmitter BC-191-(*), vacuum tube sockets pin to chassis resistance values.

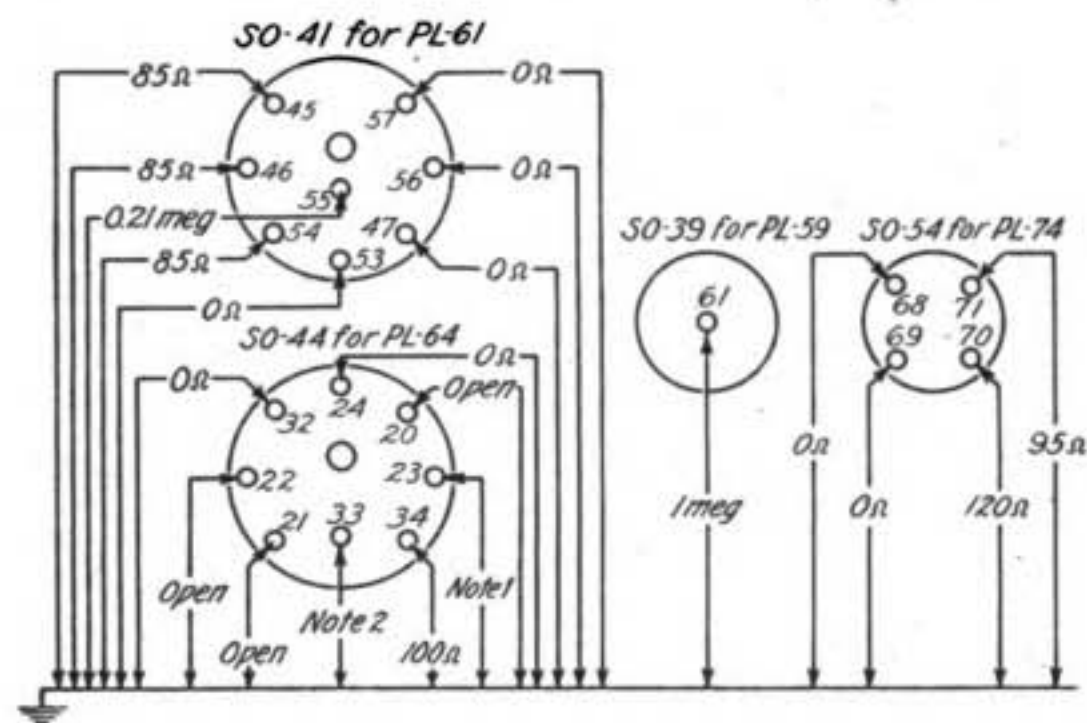
reproduced in making comparison measurements on a faulty transmitter:

- (a) All tubes and cords removed from the transmitter.
- (b) Pilot light LM-27 removed.
- (c) TONE C. W. VOICE switch set on VOICE.
- (d) Tuning unit TU-5-A or -B or TU-6-A or -B inserted.
- (e) OFF ON switch in the ON position.
- (f) Fuse FU-12 or FU-12-A in active mounting.
- (g) A-C D-C switch in D-C position.
- (h) MOD. FIL. C. W. FIL. switch in C. W. FIL. position.

(2) *Measurements from tube sockets.*—Tube socket pin to ground (chassis) resistance values are indicated in figure 23. Resistance values within 15 percent of these should be considered satisfactory.

(3) *Measurements from cord sockets.*—The cording sockets pin to chassis measurements of resistance are shown in figure 24. This figure represents the cord connecting sockets as viewed from the outside of the set. Sockets are easily identified by the number and arrangement of the pins therein.

(4) *Resistance measurements on tuning unit terminal plug board.*—
 The following charts give resistance measurements from the plug pins at the top of the tuning unit compartment on the front of the



Note 1- INPUT LEVEL control set at 0 gives 240Ω, and set at 10 gives 60Ω.

Note 2- SIDE TONE control set at 1 gives 30-40Ω, set at 2 gives 60-70Ω, set at 3 gives 90-100Ω, set at 4 gives 120-140Ω, with keying relay closed by hand.

Ω = ohms:

View is from left side of transmitter

7L-3896

FIGURE 24.—Radio transmitter BC-191-(*), cording sockets pin to ground resistance values.

transmitter. The tuning unit must be removed for access to the terminal board. The pin numbers run from left to right, facing the front of the transmitter, No. 1 pin at the left. (See fig. 3.) Values within about 15 percent of those indicated are satisfactory.

RESISTANCE TO GROUND

Pin No.	1	2	3	4	5	6	7	8
Resistance	open	1 meg	open	225,000	open	225,000	open	1 meg.

PIN TO PIN RESISTANCE

Pin to pin	1	2	3	4	5	6	7	8
1	0	open	open	open	open	open	open	open.
2	open	0	open	1.2 meg	open	1.2 meg	open	115.
3	open	open	0	open	open	open	open	open.
4	open	1.2 meg	open	0	open	18,000	open	1.2 meg.
5	open	open	open	open	0	open	open	open.
6	open	1.2 meg	open	18,000	open	0	open	1.2 meg.
7	open	open	open	open	open	open	0	open.

35. Special adjustments.—*a. Auxiliary equipment.*—The following auxiliary apparatus should be used to adjust radio transmitter BC-191-(*) properly. This auxiliary apparatus is not issued as a component of these sets but must be obtained separately.

- (1) One frequency meter set SCR-211-A, -B, or -C.
- (2) One radio frequency ammeter (0- to 1-ampere full scale).
- (3) One 100-micromicrofarad capacitor, either fixed or variable, capable of withstanding at least 2,500 volts and preferably 5,000 volts d-c.
- (4) One noninductive resistor of approximately 10 ohms, capable of carrying 1 ampere.

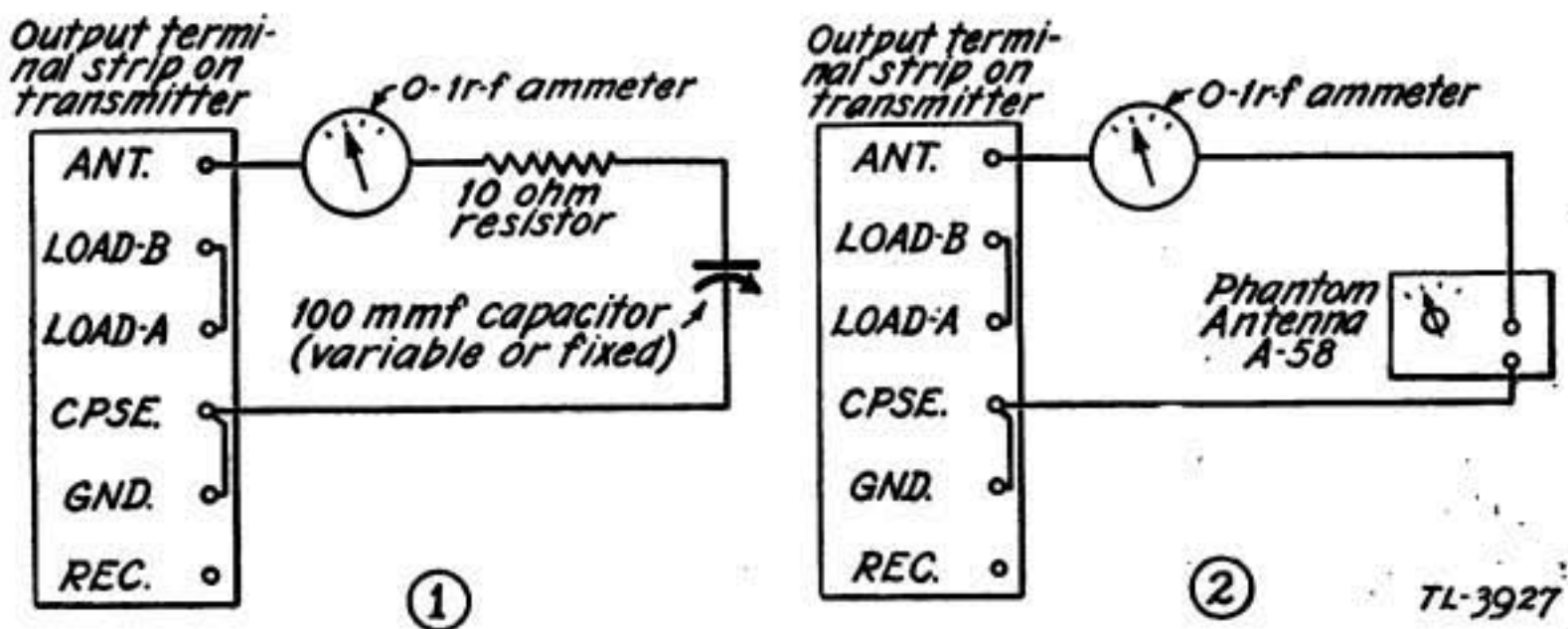


FIGURE 25.—Method of connecting phantom antennas to output of radio transmitter BC-191-(*) .

NOTE.—The capacitor, resistor, and radio frequency ammeter are connected in series, and the combination connected to the ANT. and CPSE. binding posts of the transmitter's output terminal strip to form a dummy antenna load for the transmitter. Terminals LOAD A and LOAD B are connected with a wire jumper. Terminals GND. and CPSE. are similarly connected. Phantom antenna A-58 issued to some organizations, may be substituted for items (3) and (4). In this event, the radio frequency ammeter is placed in series with A-58 (see fig. 25).

b. Neutralization.—Radio transmitters BC-191-(*) are adjusted for neutralization by the manufacturer and normally will not require adjustment in the field. When necessary, neutralization may be checked and adjusted as follows:

- (1) Connect dummy antenna (see note *a* above), in series with radio frequency ammeter, to transmitter (see fig. 25) and connect a shorting wire across the two ammeter terminals.
- (2) Tune up transmitter for continuous wave operation as indicated in paragraph 17, tuning to a frequency near the middle of the frequency band covered by the transmitter tuning unit which is to

be neutralized. Adjust ANT. COUPLING SWITCH D so that the TOTAL PL. CURRENT meter reads about 200 milliamperes.

(3) Turn transmitter OFF ON switch to the OFF position and disconnect the high voltage cord leading from transmitter to power equipment.

(4) Remove tube compartment shield.

(5) Remove power amplifier tube (VT-4-C) from its socket 1110 and cover one filament pin with a piece of paper or tape (see fig. 23 for location of filament pin) and replace the tube. (When transmitter is turned on now the filament of this tube should not light.)

(6) Place TONE C. W. VOICE switch on C. W.

(7) Set OFF ON switch at ON.

(8) The FIL. VOLTS meter will now read more than 10 volts when the C. W. FIL MOD. FIL. switch is set at C. W. FIL. Remove C. W. FILAMENT link (the 12 VOLTS or 14 VOLTS link, depending on power supply, see pars. 14 to 16, incl.) and adjust until a reading of a little over 10 volts is obtained.

(9) Place OFF ON switch at OFF and reconnect the high voltage cord. Remove piece of wire shorting the two terminals of the 0- to 1-ampere radio frequency ammeter.

(10) Set OFF ON switch to ON and press TEST KEY. If transmitter tuning unit is not neutralized properly, an appreciable deflection of the 0- to 1-ampere radio frequency ammeter will occur.

(11) Release TEST KEY and remove CALIBRATION CHART by unscrewing the four knurled screws at the corners.

(12) With a screw driver, unlock neutralizing capacitor lock by turning screw one-quarter turn counterclockwise.

(13) Press TEST KEY and rotate neutralizing capacitor control until the current indicated on the 0- to 1-ampere radio frequency ammeter is reduced to zero.

(14) Adjustment of this control reacts on the tuning of the power amplifier; therefore, slight readjustments must be made on the P. A. TUNING and antenna controls. If the 0- to 1-ampere meter shows a current indication after this adjustment, repeat operation (13). Repeat operation (14) once more and then operation (13) if necessary. This completes the neutralization. Release TEST KEY and set OFF ON switch at OFF.

(15) Lock neutralizing capacitor control in its final position by rotating screw lock one-quarter turn clockwise, using the screw driver. Replace CALIBRATION CHART.

(16) Disconnect high voltage cord again and remove paper covering the one filament pin of power amplifier tube.

(17) Set OFF ON switch at ON and replace C.W. FILAMENT link of filament resistor connection board in its original position so that filament voltage reads a little over 10 volts again.

(18) Set OFF ON switch at OFF and reconnect high voltage cord. The set is now ready for normal operation. Note that proper adjustment of the neutralizing control usually occurs when the neutralizing capacitor plates are about half meshed.

NOTE.—A very accurate method of checking neutralization is by use of a cathode ray oscilloscope. The dummy or phantom antenna and the radio frequency ammeter are not used. Disconnect the antenna and connect the vertical plates of the oscilloscope to the LOAD A and CPSE. terminals of the output terminal board. Perform operations (3) through (10). Place the ANT. IND. TUNING M at dial zero with the ANT. CIRCUIT SWITCH N on position 3. Select a point on the M. O. dial near the 2,000 reading if the tuning unit has no band switch, and near the 500 reading on the highest band if the unit has a band switch. Tune the power amplifier to resonance as shown by a maximum amplitude of radio frequency carrier on the oscilloscope. Proceed by tuning the neutralizing control, behind the tuning chart, for a minimum amplitude on the oscilloscope at the same time maintaining the power amplifier in tune. When the best minimum is reached with the power amplifier in tune, the tuning unit is neutralized. In the lower frequency tuning units, the oscilloscope pick-up will be practically zero at neutralization, while on the higher frequency units, considerable amplitude will still be noticed from stray ground currents. Now perform operations (15) through (18).

c. Speech amplifier grid bias adjustment.—The grid bias on the speech amplifier is adjusted by the manufacturer and seldom requires readjustment in the field. The adjustment is not critical. Should the initial setting become displaced, remove the tube compartment cover, and set the S.A. BIAS control between 6 and 7.5 by inserting a screw driver in the dial rotating device at the lower left of the S.A. BIAS control.

d. Calibration reset.—(1) The calibration of the transmitter should be checked periodically, employing the frequency meter set SCR-211-A, -B, or -C for the purpose. It is most important that the calibration be checked whenever the master oscillator tube is changed. If the check indicates that the transmitter varies more than 2.5 kilocycles from the frequency indicated on the calibration chart, the oscillator frequency should be adjusted as follows. (There is no reset adjustment on the BC-AA-191):

(a) Warm up transmitter for at least 30 minutes, with antenna tuned for rated output, prior to adjusting.

(b) Adjust transmitter for continuous wave operation, tuning to approximately the highest frequency which can be reached, using transmitter tuning unit which tunes over the highest frequency range

authorized for the radio set. Use data on calibration chart and approach this setting from the lower dial readings.

(c) Set frequency meter set SCR-211-A, -B, or -C to frequency corresponding to that of the transmitter.

(d) Open calibration reset port located to right of TEST KEY (fig. 4) by turning it, and with a screw driver adjust calibration reset capacitor 1104 slowly, until the transmitter zero beats with the frequency meter, as determined by listening with the phones of the frequency meter. (For a fuller explanation of zero beat adjustment, see par. 19 and TM 11-300.)

(e) Close calibration reset port.

(2) The calibration is now correct for this particular transmitter tuning unit and fairly accurate when using the other tuning units supplied with the transmitter.

36. Vacuum tube characteristics.—For the benefit of personnel servicing the transmitter, the following data on tube characteristics are given:

Tubes VT-4-B and VT-4-C	Tube VT-25
Commercial equivalent..... 211*	Commercial equivalent.. 210
Fil. current..... 3.25 amp	Fil. current..... 1.25 amp
Fil. volts..... 10	Fil. volts..... 7.5
As class C radio frequency amplifier (continuous wave):	As class A audio amplifier:
Plate volts..... 1,000	Plate volts..... 425
Grid volts..... -175	Grid volts..... -40
Grid current..... 18 ma	Plate current..... 18 ma
Maximum..... 50 ma	Plate resistance..... 5,000 ohms
Plate current..... 150 ma	Transconductance... 1,600 umhos
Maximum..... 175 ma	Mu..... 8
Maximum plate input..... 175 watts	
Maximum plate dissipation.. 100 watts	

*Tube VT-4-C is a specially selected 211 tube in which secondary emission is limited to a low value. Grid current is limited to between 30 and 75 milliamperes when plate voltage is 250 and grid voltage plus 100. VT-4-B is similar to the commercial type 211.

SECTION V

LIST OF PARTS

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37. Table of replaceable parts.—a. Radio transmitter BC-191-(*).

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
1101	2C6191/S2	Socket	For VT-4-C tube	Hold M. O. tube	GE	Cat. 7461594G1
1102	3Z9622	Switch	Pushbutton, nonlocking	Tuning unit power interlock.	GE	K-7870464P1
1103		Capacitor, variable.	Thermal compensator	Thermal compensation of M. O.	GE	ML7462641G1
1104		do	Part of 1103	Calibration reset	GE	ML7462641G1
1105	3DA6-4	Capacitor	0.006-mf, $\pm 10\%$, 2,500-v.	M. O. plate bypass	CD	P7761442Pt12
1106	2C6191A/D1	Coil	R. f. choke	M. O. plate filter	GE	ML7461859G1
1107	3DA20-6	Capacitor	0.02-mf, $\pm 10\%$, 100-v.	Filament r. f. bypass	CD	P7761443Pt22
1108	3D9100-12	do	0.0001-mf, $\pm 10\%$, 1,000-v.	M. O. grid, r. f. bypass	CD	P7761443Pt23
1109	3Z6250	Resistor	Wire-wound ceramic 2,500-ohms, $\pm 5\%$, 15-w.	M. O. grid bias	IRC	P7761526Pt7
1110	2C6191/S2	Socket	For VT-4-C tube	Hold P. A. tube	GE	Cat. 7461594G1
1111	3D9100-12	Capacitor	0.0001-mf, $\pm 10\%$, 1,000-v.	P. A. grid r. f. bypass	CD	P7761443P23
1112	3Z6400-1	Resistor	4,000-ohm, 15-w, wire-wound ceramic.	P. A. grid bias	IRC	P7761481Pt10
1113	2C6191A/R31	Resistor, variable.	3,000-ohm potentiometer, no taper.	Mod. grid bias	YAX	K7870710
1114	2C6191A/R31	do	do	S. A. grid bias	YAX	K7870710
1115	3Z6720	Resistor	200,000-ohm, $\pm 10\%$, 1-w, insulated.	Keying bias circuit	IRC	P7761481P27

1116	3Z6725	do	250,000-ohm, $\pm 10\%$, 1-w, insulated.	H. V. bleeder	IRC	P7761481P3
1117	3DA1-9	Capacitor	0.001-mf, $\pm 5\%$, 4,500-v.	P. A. plate, r. f. bypass	CD	P7761442P13
1118	2C6191A/D1	Coil	R. f. choke	P. A. plate, r. f. filter	GE	ML7461859G1
1119	2C6191A/D2	do	do	H. V. supply, r. f. filter	GE	ML7462675G1
^b 1120	2C6191A/C5	Capacitor	1-mf, 1,200-v, d-c	H. V. supply, filter	GE	K7870691P1
1121	3F222.1	Ammeter IS22	500-ma d-c, blocked in white from 210 to 220 ma.	TOTAL PL. CURRENT meter.	GE	ML7875379G2
1122	2Z5927	Lamp LM-27	Mazda 44, 6.3-v	Pilot lamp	GE	
1123	3Z6003-3	Resistor	30-ohm, $\pm 10\%$, 5-w wire-wound ceramic.	Limit pilot lamp current	IRC	P7761481P4
1124	3Z6003-3	do	30-ohm, $\pm 10\%$, 5-w wire-wound ceramic.	Limit pilot lamp current in control box.	IRC	P7761481P4
1125	2Z8754	Socket SO-54	Cording plug receptacle	For plug PL-74	GE	ML7761430G1
1126	2Z8741	Socket SO-41	do	For plug PL-61	GE	ML7761424G1
1127	2Z8739	Socket SO-39	do	For plug PL-59	GE	ML7761427G1
1128	2Z8744	Socket SO-44	do	For plug PL-64	GE	ML7761424G2
1129	2Z5533A	Jack JK-33-A	3-contact jack	Connect microphone	GE	ML7461866G1
1130	2Z5534A	Jack JK-34-A	2-contact jack	Connect key	GE	ML7461865G1
1131	3Z9622	Switch	Push button, nonlock- ing.	Test key	GE	K7870464P1
¹ 1132	3Z9623	Switch	Two position rotation	Power OFF ON		ML7761496G3
1133	3F7322	Voltmeter IS- 122	15-v, a-c, d-c white line at 10-v.	Read filament volts	GE	ML7875379G3
1134	3DA10-17	Capacitor	0.01-mf, $\pm 10\%$, 1,000- v.	Voltmeter bypass	CD	P7761443P24
1135	3Z8106	Switch	SPDT	Switch voltmeter from Mod. to c. w. fil.	H&H	K7878750P1
¹ 1136	3Z9624	Switch A-C D-C	DPDT	A-c or d-c filament oper- ation control.	GE	ML7463229G1
¹ 1137	3Z9624	do	DPDT ganged to 1136	do	GE	ML7463229G1

See footnotes at end of table.

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
1138	2C6191A/R5	Resistor	1.2-ohm, blue stick	Filament voltage adjustment.	GE	ML776199G1
1139	3Z9624	Switch 12V. 14, 2-V.	DPDT	Adjust for 12- or 14-v filament supply.	GE	ML7463229G1
1140	3Z9624	do	DPDT ganged to 1139	do	GE	ML7463229G1
1141	3Z9625	Selector switch	3-position rotary TONE C. W. VOICE.	Select tone, c. w. or voice operation.	GE	ML7463230G1
1142	3DA1-10	Capacitor	0.001-mf, $\pm 10\%$, 2,500-v.	Audio feedback on tone or c. w.	CD	P7761443P20
1144	3DB1.1A	do	1-mf, $\pm 10\%$, 300-v, d-c.	S. A. grid bypass	CD	K7870639P1
1145	3Z6005-2	Resistor	50-ohm, $\pm 10\%$, 5-w, wire-wound.	Voltage divider	IRC	P7761481P11
1146	2C6191A/K1	Coil	Iron core, filter choke	Microphone filter	GE	P7762353G1
1147	2C6191A/C9	Capacitor	Electrolytic, 25-mf, 25-v d-c.	do	CD	K7870437P1
1148	2C6191A/R32	Resistor, variable.	200-ohm potentiometer, $\pm 10\%$.	S. A. input level control	YAX	K7870693P1
1149	2C6191A/T3	Transformer	Microphone to grid	Input to S. A.	GE	P7762352G1
1150	3DA1-7	Capacitor	0.001-mf, $\pm 5\%$, 2,500-v	Resonating capacity on 1149.	CD	P7761443P8
1151	3Z6020-4	Resistor	200-ohm, $\pm 5\%$, 3-w, wire-wound.	S. A. input load	IRC	P7761526P10
1152	3Z5991-2	do	1-ohm, $\pm 5\%$, 5-w, wire-wound.	Current limiting, S. A. fl.	IRC	P7761481P8
1153	3Z5991-2	do	do	do	IRC	P7761481P8

1154	2Z8759	Socket	For VT-25 tube	Hold S. A. tube	Hamm	K7870442P1
⁵ 1155	2C6191A/C5	Capacitor	1-mf, 1,200-v, d-c	S. A. plate bypass	GE	K7870691P1
1156	3Z6611-1	Resistor	11,000-ohm, $\pm 5\%$, 15-w.	S. A. plate voltage drop	IRC	P7761526P8
1157	2C6191A/T2	Transformer	Interstage audio	S. A. to mod. grids	GE	P7761434G1
1160	3DB1.1A	Capacitor	1-mf, $\pm 10\%$, 300-v d-c.	Mod. grid bypass	CD	K7870639P1
1161	2C6191/S2	Socket	For VT-4-C tube	Hold mod. tube	GE	Cat.461594G1
1162	2C6191/S2	do	do	do	GE	Cat.461594G1
⁵ 1163	2C6191A/C5	Capacitor	1-mf, 1,200-v d-c	Mod. plate bypass	GE	K7870691P1
1164	2C6191A/T1	Transformer	Modulation	Mod. plates to P. A	GE	P7761432G1
1165	2C6191A/L1	Relay	Antenna switching	Ant. switching and trans- mitter keying.	GE	ML7660600G1
1166	3F289	Ammeter IS-89	8-amp., r. f. with ther- mocouple.	R. f. output meter	GE	ML7875379G1
1167	2C6191C/D3	Coil	Rotating variable	ANT. IND. TUNING	GE	ML7761938G1
1168	3Z9626	Switch	3-gang, 4-position ro- tary.	Antenna loading	GE	ML7463231G1
1169		Capacitor	Variable 22-118 mmf	Antenna tuning	Hamm	M7463009P1
1170		Coil	Tapped r. f. inductance	Antenna loading	GE	ML7761429G1
¹ 1171	3Z9627	Switch	5-position rotary	ANT. IND. SWITCH	GE	ML7760475G7
1172	3Z1912A	Fuse FU-12-A	0.5-amp., 1,000-v	High voltage supply	GE	Cat. 7871111P1
1173	2Z8754	Socket SO-54	Same as 1,125	See 1125	GE	ML7761430G1
1174	2Z8741	Socket SO-41	Same as 1,126	See 1126	GE	ML7761424G1
1175	2Z8739	Socket SO-39	Same as 1,127	See 1127	GE	ML7761427G1
1176	2Z8744	Socket SO-44	Same as 1,128	See 1128	GE	ML7761424G2
1177	2Z5533A	Jack JK-33-A	Same as 1,129	See 1129	GE	ML7461866G1
1178	2Z5534A	Jack JK-34-A	Same as 1,130	See 1130	GE	ML7461865G1
1179	3Z9610A	Switch	1 circuit, 4-point non- shorting.	SIDE TONE adjustment	YAX	K7870711P1
1180	3DA10-13	Capacitor	0.1-mf, $\pm 5\%$, 2,500-v	Tone oscillator resonating	CD	P7761443P26

See footnotes at end of table.

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
1181	3Z6630-4	Resistor	30,000-ohm, $\pm 5\%$, 1-w, insulated.	Mod. grid stabilizer	IRC	P7761526P12
1182	3Z6005-2	do	50-ohm, $\pm 10\%$, 5-w, wire-wound.	Microphone voltage divider.	IRC	P7761481P11
1183	3Z6010-6	Resistor	100-ohm, 1-w	M. O. grid parasitic suppressor.	GE	ML7871909G1
1184	3Z6010-6	Coil	R. f. choke, part of 1183.	do	GE	ML7871909G1
1185	3DB1.1A	Capacitor	1-mf, $\pm 10\%$, 300-v d-c.	Keying filter	CD	K78706391P1
1186	3Z5995	Resistor	5-ohm, $\pm 5\%$, 3-w, wire-wound.	do	IRC	P7761526P16
² 1190	NYGD#2678	Switch	DPST toggle	Adjust for 12- or 14-volt filament supply.	H&H	K7874607P1
³ 1194	NYGD#2678	do	DPST toggle	Power OFF ON	H&H	K7874607P1
³ 1195	NYGD#2683	do	Four-pole double throw	A-c or d-c filament operation control.	H&H	M7463954P1
³ 1197a		Capacitor	Part of 3-section capacitor, same as 1163.	Mod. plate bypass	GE	
³ 1197b		do	Part of 3-section capacitor, same as 1155.	S. A. plate bypass	GE	
³ 1197c		do	Part of 3-section capacitor, same as 1120.	H. V. supply filter	GE	
⁴ 1198		Switch	5-position rotary	Same as 1171	GE	

¹ Used only on BC-191-A and -B.

² Used only on BC-191-C, -D and -E.

³ Used only on BC-191-E.

⁴ Used only on BC-191-D and -E.

⁵ Used only on BC-191-A, -B, -C and -D.

b. Transmitter tuning unit TU-3-A or -B.

	2C8003A (B)	Transmitter tuning unit.	TU-3-A or -B		GE	
301		Coil	Variometer	M. O. tank	GE	ML7761803G1
302		do	R. f. choke	M. O. plate filter	GE	ML7463139G1
303		do	R. f. choke with resistor 317.	M. O. grid impedance	GE	ML7463144G1
304		Capacitor	0.002-mf, $\pm 10\%$, 5,000-v.	M. O. feedback	CD	P7761663P2
305	2C8003A/C1	do	Thermal compensator	M. O. plate tank	GE	K7872702
306	NYGD#2494	Coil	R. f. choke	P. A. grid impedance	GE	ML7463142G1
307	3Z9615	Switch	3-position (ganged to 322).	M. O. band change	GE	ML7659204G3
308	3D9100-11	Capacitor	0.0001-mf, $\pm 2\%$, 3,000-v.	M. O. tank tuning	CD	K7872594P3
309	3D200-1	do	0.0002-mf, $\pm 5\%$ 3,000-v.	do	CD	K7872594P4
310	3DA3	do	0.003-mf, $\pm 5\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P3
311	3DA3	do	do	do	CD	P7761663P3
312	3DA5	do	0.005-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P4
313	3DA2-8	do	0.002-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P11
314	3DA2-8	do	do	do	CD	P7761663P11
315	3DA5	do	0.005-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P4
316		Capacitor, variable.	26-mmF max., 8-mmF min.	P. A. neutralizing	Hamm	T7660443P8
317	3Z6001E5	Resistor	15-ohm, 4.5-w (with 303).	Parasitics suppressor	GE	QLK2155993
318		Capacitor	0.002-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P2

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
319	2C8003A/C2	Capacitor, variable.	Thermal compensator	M. O. plate tank	GE	K7872701
320	2C8003A/C3	do	do	do	GE	K7872700
321		Coil	Variometer	P. A. tank coil	GE	ML7761804G1
322		Switch	3-position rotary	P. A. band change	GE	ML7659203G3
323	309100-7	Capacitor	0.001-mf, $\pm 5\%$, 3,000-v.	P. A. tank	CD	P7761442P9
324		do	0.0002-mf, $\pm 5\%$, 3,000-v.	do	CD	P7761442P8
325	3DA1-3	do	0.001-mf, $\pm 5\%$, 3,000-v.	P. A. tank tuning	CD	P7761442P2
326	3DA1-3	do	do	do	CD	P7761442P2
327		Coil	Tapped r. f. inductance	Antenna coupling	GE	ML7761812G1
328		Switch	6-position rotary	do	GE	Cat. 7760475G8
329		Capacitor	0.002-mf, $\pm 2\%$, 5,000-v.	do	CD	P7761443P27

c. Transmitter tuning unit TU-5-A or -B.

	2C8005A (B)	Transmitter tuning unit.	TU-5-A or -B			
501		Coil	Tapped r. f. inductance	M. O. tank	GE	ML7761605G1
502	3Z9614	Switch	4-position rotary	BAND CHANGE SWITCH A.	GE	ML7659203G2

503	3D9100-11	Capacitor	0.0001-mf, $\pm 2\%$, 3,000-v.	M. O. tank tuning	CD	P7761662P3
504	3D9100-11	do	do	do	CD	P7761662P3
505	3D9100-11	do	do	do	CD	P7761662P3
506	3D9030-1	do	0.00003-mf, $\pm 5\%$, 2,000-v.	do	CD	P7761662P1
507		Capacitor, variable.	20-135-mmf	do	Hamm	P7761569P2
508	2C8005A/D10	Coil	R. f. choke	P. A. grid impedance	GE	ML7462657G1
509	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	P. A. grid blocking	CD	P7761663P1
510	3D9400-6	do	do	M. O. grid feedback	CD	P7761663P1
511	2C8005A/D11	Coil	R. f. choke	M. O. grid impedance	GE	ML7462706G1
512		Capacitor, variable.	8-26-mmf	Neutralizing	Hamm	T7660443P8
513		do	Thermal compensator	M. O. tuning	GE	ML7462769G1
514		do	do	do	GE	ML7462769G1
515		do	do	do	GE	ML7462769G1
516		do	do	do	GE	ML7462769G1
517	3Z6001E5	Resistor	15-ohm, 4.5-w	P. A. grid, parasitic suppression.	GE	QLK2155993
521		Coil	R. f. inductance	P. A. tank	GE	ML7761615G1
522	3Z9614	Switch	4-position, ganged to 502.	BAND CHANGE SWITCH A.	GE	P7659203G2
523	3D9090	Capacitor	0.00009-mf, $\pm 5\%$, 3,000-v.	P. A. tank tuning	CD	P7761442P15
524	3D9090	do	do	do	CD	P7761442P15
525	3D9090	do	do	do	CD	P7761442P15
527		Capacitor, variable.	20-156-mmf	do	Hamm	T7760443P6

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
528		Coil	Tapped r. f. inductance	Antenna coupling	GE	ML7462710G1
529	3Z9605A	Switch	6-position rotary	do	GE	Cat. 7760475G1

d. Transmitter tuning unit TU-6-A or -B.

	2C8006A (B)	Transmitter tuning unit.	TU-6-A or -B			
601		Coil	R. f. inductance	M. O. tank	GE	ML7761606G1
602	3Z9612A	Switch	2-position rotary	M. O. band change	GE	ML7659555G1
603	3D9050-3	Capacitor	0.00005-mf, $\pm 5\%$, 3,000-v.	do	CD	P7761662P2
607		Capacitor, variable.	15-77-mmf	M. O. tank tuning	Hamm	P7761569P3
608	2C8006A/D14	Coil	R. f. choke with resistor 614	P. A. grid impedance	GE	ML7462659G2
609	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P1
610	3D9400-6	do	do	M. O. feedback	CD	P7761663P1
611	2C8006A/D15	Coil	R. f. choke	M. O. grid impedance	GE	ML7462659G1
612		Capacitor, variable.	8-26-mmf	P. A. neutralizing	Hamm	T7660443P8
613		do	Thermal compensator	M. O. tank tuning	GE	ML7462707G1
614	3Z6001E5	Resistor	15-ohm, 4.5-w	P. A. parasitic suppressor	GE	QLK2155993
621		Coil	R. f. inductance	P. A. tank	GE	ML7761616G1

622	3Z9612A	Switch	2-position, ganged with 602.	P. A. band change	GE	ML7659555G1
623	3D9050-1	Capacitor	0.00005-mf, $\pm 5\%$, 3,000-v.	P. A. band change	CD	P7761442P11
627		Capacitor, variable.	19-116-mmf	P. A. tank tuning	Hamm	T7660443P1
628		Coil	Tapped r. f. inductance	Antenna coupling	GE	ML7461825G1
629	3Z9605A	Switch	6-position rotary	do	GE	Cat. 7760475G1

e. Transmitter tuning unit TU-7-A or -B.

	2C8007A (B)	Transmitter tuning unit.	TU-7-A or -B			
701		Coil	R. f. inductance	M. O. tank	GE	ML7761607G1
702		Capacitor, variable.	23-111-mmf	M. O. tank tuning	Hamm	P7761569P4
703	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v	M. O. feedback	CD	P7761663P1
704	2C8006A/D15	Coil	R. f. choke	M. O. grid impedance	GE	ML7462659G3
705	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P1
706	2C8007A/D3	Coil	R. f. choke	P. A. grid impedance	GE	ML7462639G1
707		Capacitor, variable.	8-26-mmf	Neutralizing	Hamm	T7660443P8
721		Coil	R. f. inductance	P. A. tank	GE	ML7761617G1
722		Capacitor, variable.	19-116-mmf	P. A. tank tuning	Hamm	T7660443P2
723		Coil	Tapped r. f. inductance	Antenna coupling	GE	ML7462759G1
724	3Z9605A	Switch	6-position rotary	do	GE	Cat. 7760475G1

f. Transmitter tuning unit TU-8-A or -B.

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
	2C8008A (B)	Transmitter tuning unit.	TU-8-A or -B		GE	
801		Coil	R. f. inductance	M. O. tank	GE	ML7761608G1
802		Capacitor, variable.	14-66-mmfd	M. O. tank tuning	Hamm	P7761569P5
803	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. feedback	CD	P7761663P1
804	2C8008A/D5	Coil	R. f. choke	M. O. grid impedance	GE	ML7462638G1
805	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P1
806	2C8008A/D12	Coil	R. f. choke	P. A. grid impedance	GE	ML7462658G1
807		Capacitor, variable.	8-26-mmfd	Neutralizing	Hamm	T7660443P8
821		Coil	R. f. inductance	P. A. tank	GE	ML7761618G1
822		Capacitor, variable.	15-81-mmfd	P. A. tank tuning	Hamm	T7660443P8
823		Coil	Tapped r. f. inductance	Antenna coupling	GE	ML7462672G1
824	3Z9605A	Switch	6-position rotary	do	GE	Cat. 7760475G1

g. Transmitter tuning unit TU-9-A or -B.

	2C8009A (B)	Transmitter tuning unit.	TU-9-A or -B			
901		Coil	R. f. inductance	M. O. tank	GE	ML7761609G1
902		Capacitor, variable.	15-77-mmfd	M. O. tank tuning	Hamm	P7761569P6

903	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. feedback	CD	P7761663P1
904	2C8009A/D6	Coil	R. f. choke	M. O. grid impedance	GE	ML7462662G1
905	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P1
906	2C8009A/D7	Coil	R. f. choke	P. A. grid impedance	GE	ML7463044G1
907		Capacitor, variable.	8-26-mmf	Neutralizing	Hamm	T7660443P8
909	3D9400-3	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. plate bypass	CD	P7761443P2
921		Coil	R. f. inductance	P. A. tank	GE	ML7761619G1
922		Capacitor, variable.	19-116-mmf	P. A. tank tuning	Hamm	T7660443P13
923		Coil	Tapped r. f. inductance	Antenna coupling	GE	ML7462770G1
924	3A9605A	Switch	6-position rotary	Antenna coupling	GE	Cat. 7760475G1

h. Transmitter tuning unit TU-10-A or -B.

	2C8010A (B)	Transmitter tuning unit.	TU-10-A or-B			
1001		Coil	R. f. inductance	M. O. tank	GE	ML7761610G1
1002		Capacitor, variable.	14-62-mmf	M. O. tank tuning	Hamm	P7761569P7
1003	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. feedback	CD	P7761663P1
1004	2C8010A/D7	Coil	R. f. choke	M. O. grid impedance	GE	ML7462661G1
1005	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P1
1006	2C8010A/D8	Coil	R. f. choke	P. A. grid impedance	GE	ML7463045G1
1007		Capacitor, variable.	8-26-mmf	Neutralizing	Hamm	T7660443P8

1009	3D9400-3	Capacitor	0.0004-mf, $\pm 5\%$, 5,000-v.	M. O. plate bypass	CD	P7761443P2
1010	2C8010A/D16	Coil	R. f. choke	M. O. plate filter	GE	ML7462679G1
1021		do	R. f. inductance	P. A. tank	GE	ML7761620G1
1022		Capacitor, variable.	19-116-mmf.	P. A. tank tuning	Hamm	T7660443P4
1023	3Z9605A	Coil	Tapped r. f. inductance	Antenna coupling	GE	ML7462755G1
1024		Switch	6-position rotary	do	GE	Cat. 7760475G1

i. Transmitter tuning unit TU-22-A or -B.

	2C8022A (B)	Transmitter tuning unit.	TU-22-A or -B			
2201		Coil	Variometer	M. O. tank tuning	GE	ML7761803G3
2202		do	R. f. choke	M. O. plate filter	GE	ML7463139G1
2203		do	do	do	M. O. grid impedance	GE
2204		Capacitor	0.002-mf, $\pm 10\%$, 5,000-v.	M. O. feedback	CD	P7761663P2
2205		Capacitor, variable.	Thermal compensator	M. O. tuning	GE	K7872696
2206	NYGD # 2494	Coil	R. f. choke	P. A. grid impedance	GE	ML7463142G1
2207		Switch	3-position rotary	M. O. band change	GE	ML7659203G3
2208	3D9100-11	Capacitor	0.0001-mf, $\pm 2\%$, 3,000-v.	M. O. tank tuning	CD	K7872594P3

2209	3D200-1	do	0.0002-mf, $\pm 5\%$, 3,000-v.	do	CD	K7872594P4
2210	3DA3	do	0.003-mf, $\pm 5\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P3
2211	3DA3	do	0.003-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P3
2212		do	0.0035-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P15
2213		do	0.0024-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P16
2214		do	0.0024-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P16
2215		do	0.0035-mf, $\pm 5\%$, 5,000-v.	do	CD	P7761663P15
2216		Capacitor, vari- able.	8-26-mmf	Neutralizing	Hamm	T7660443P8
2217	3Z6001E5	Resistor	15-ohm, 4.5-w (part of 2203).	M. O. parasitic suppres- sor.	GE	QLK2155993
2218		Capacitor	0.002-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	P7761663P2
2219		Capacitor, vari- able.	Thermal compensator	M. O. tuning	GE	K7872696
2220		do	do	do	GE	K7875316
2221		Coil	Variometer	P. A. tank tuning	GE	ML7761804G2
2222		Switch	Ganged with 2207	P. A. band change	GE	ML7659203G3
2223	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	P. A. tank	CD	P7761442P9
2224		do	0.0002-mf, $\pm 5\%$, 3,000-v.	do	CD	P7761442P8
2225		do	0.0008-mf, $\pm 5\%$, 3,000-v.	do	CD	P7761442P17
2227		Coil	Tapped r f. inductance	Antenna coupling	GE	ML7463895G1

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
2228		Switch	6-point rotary	do	GE	Cat. 7760475G8
2229		Capacitor	0.002-mf, ± 2%, 5,000-v.	do	CD	P7761443P27

j. Antenna tuning unit BC-306-A.

	2C516A	Antenna tuning unit.	BC-306-A			
1501		Switch	5 - position rotary, 3 - section.	Antenna variometer adjustment.	GE	ML7463975G1
1502		Coil	Tapped variometer	Antenna tuning	GE	ML7761714G1

38. Identical and interchangeable parts.—Parts which are electrically and mechanically identical and interchangeable, but which have different reference numbers are listed below.

Reference No.	Stock No.	Name	Description	Function	Mfr.
503, 504, 505, 308, 2208	3D9100-11	Capacitor	0.0001-mf, ± 2%, 3,000-v	M. O. tank tuning	CD
309, 2209	3D200-1	Capacitor	0.0002-mf, ± 5%, 3,000-v	M. O. tank tuning	CD
329, 2229		Capacitor	0.002-mf, ± 2%, 5,000-v, type 9L.	Antenna coupling	CD
909, 1009	3D9400-3	Capacitor	0.0004-mf, ± 5%, 5,000-v	Plate bypass	CD
1108, 1111	3D9100-12	Capacitor	0.0001-mf, ± 10%, 1,000-v	Grid bypass	CD

1134	3DA10-17	Capacitor	0.01-mf, 10%, 1,000-v	Voltmeter bypass	CD
304, 318, 2204, 2218		Capacitor	0.002-mf, $\pm 10\%$, 5,000-v		CD
310, 311, 2210, 2211	3DA3	Capacitor	0.003-mf, $\pm 5\%$, 5,000-v	M. O. to P. A. coupling	CD
2212, 2215		Capacitor	0.0035-mf, $\pm 5\%$, 5,000-v	M. O. to P. A. coupling	CD
2213, 2214		Capacitor	0.0024-mf, $\pm 5\%$, 5,000-v	M. O. to P. A. coupling	CD
509, 510, 609, 610, 703, 705, 803, 805, 903, 905, 1003, 1005.	3D9400-6	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v		CD
312, 315	3DA5	Capacitor	0.005-mf, $\pm 5\%$, 5,000-v	M. O. to P. A. coupling	CD
313, 314	3DA2-8	Capacitor	0.002-mf, $\pm 5\%$, 5,000-v	M. O. to P. A. coupling	CD
325, 326	3DA1-3	Capacitor	0.001-mf, $\pm 5\%$, 3,000-v	P. A. tank tuning	CD
324, 2224		Capacitor	0.0002-mf, $\pm 5\%$, 3,000-v type 15L.	P. A. tank	CD
323, 2223	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v	P. A. tank	CD
523, 524, 525	3D9090	Capacitor	0.00009-mf, $\pm 15\%$, 3,000-v	P. A. tank tuning	CD
1120, 1155, 1163	2C6191A/C5	Capacitor	1-mf, 1,200-v d-c	H. V. filter	GE
1144, 1160, 1185	3DB1.1A	Capacitor	1-mf, $\pm 10\%$, 300-v d-c		CD
316, 512, 612, 707, 807, 907, 1007, 2216.		Capacitor, variable.	8-26-mm	Neutralize P. A.	Hamm
1106, 1118	2C6191A/D1	Coil	R. f. choke	Plate filter	GE
306, 2206	NYGD#2494	Coil	R. f. choke	Grid impedance	GE
302, 2202		Coil	R. f. choke	Plate filter	GE
2205, 2219		Capacitor, variable.	Thermal compensator	M. O. tuning	GE
1130, 1178	2Z5534A	Jack JK-34-A	2-contact jack	Connect key	GE
1129, 1177	2Z5533A	Jack JK-33-A	3-contact jack	Connect microphone	GE
1123, 1124	3Z6003-3	Resistor	30-ohm, $\pm 10\%$, 5-w	Limit pilot lamp current	IRC
1145, 1182	3Z6005-2	Resistor	50-ohm, $\pm 10\%$, 5-w	Voltage divider	IRC
1152, 1153	3Z5991-2	Resistor	1-ohm, $\pm 5\%$, 5-w	Limit fil. current S. A.	IRC
317, 517, 614, 2217	3Z6001E5	Resistor	15-ohm, 4.5-w	Parasitic suppressor	GE

1113, 1114	2C6191A/R31	Resistor, variable.	3,000-ohm potentiometer	Grid bias control	YAX
1127, 1175	2Z8739	Socket SO-39	Cording receptacle	For plug PL-59	GE
1126, 1174	2Z8741	Socket SO-41	do	For plug PL-61	GE
1128, 1176	2Z8744	Socket SO-44	do	For plug PL-64	GE
1125, 1173	2Z8754	Socket SO-54	do	For plug PL-74	GE
1101, 1110, 1161, 1162	2C6191/S2	Socket	For VT-4-C tube		GE
1190, 1194	NYGD#2678	Switch	DPST toggle	Filament control	H&H
1102, 1131	3Z9622	Switch	Push button nonlocking		GE
529, 629, 724, 824, 924, 1024	3Z9605A	Switch	6-position, single pole, rotary.	Antenna coupling	GE
328, 2228		Switch	6-position, single pole, rotary.	Antenna coupling	GE

39. Manufacturers and their addresses.

<i>Abbreviation</i>	<i>Name</i>	<i>Address</i>
GE	General Electric Co.	1 River Road, Schenectady, N. Y.
IRC	International Resistance Co.	401 North Broad Street, Phil- adelphia, Pa.
CD	Cornell-Dubilier Electric Co.	South Plainfield, N. J.
YAX	P. R. Mallory & Co.	Indianapolis, Ind.
H&H	Hart & Hegeman Div., Arrow- Hart and Hegeman Electric Co.	Hartford, Conn.
Hamm	Hammarlund Manufacturing Co.	424 W. 33d St., New York, N. Y.

CHAPTER 3

RADIO TRANSMITTER BC-AA-191

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SECTION I

GENERAL CHARACTERISTICS

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Antenna switching relay BC-AA-196 or BC-CC-196.....	49
Radio control box BC-AA-192.....	50

40. Frequency range.—The frequency range of radio transmitter BC-AA-191 is continuous from 400 to 12,500 kilocycles, divided into eight bands covered by plug-in transmitter tuning units. The number of tuning units supplied with each radio set depends on the authorized frequency range of the set.

41. Types of transmission.—In this respect the BC-AA-191 is the same as the BC-191-(*). (See par. 3.)

42. Power.—*a. Input.*—The types of power equipment used with this transmitter are similar to those for the BC-191-(*), listed in paragraph 4*a*, except that there is no authorized rectifier power supply for use with 110-volt a-c power sources.

b. Output.—Nominal power output on C. W. position is slightly less than that of the BC-191-(*), or about 35 to 70 watts, depending on operating frequency.

43. Distance range.—See paragraph 5.

44. **Major components.**—Radio transmitter BC-AA-191 comprises the transmitter, two small setscrew wrenches, junction box TM-AA-160 and mounting FT-115 (see figs. 26 and 28). Auxiliary transmitter tuning units TU-AA-3 to TU-AA-10, antenna tuning units BC-AA-193 or BC-BB-193, BC-AA-194 and BC-AA-204, antenna switching relay BC-AA-196 or BC-CC-196, and radio control box BC-AA-192 are supplied only as component parts of each radio set in which the transmitter is used.

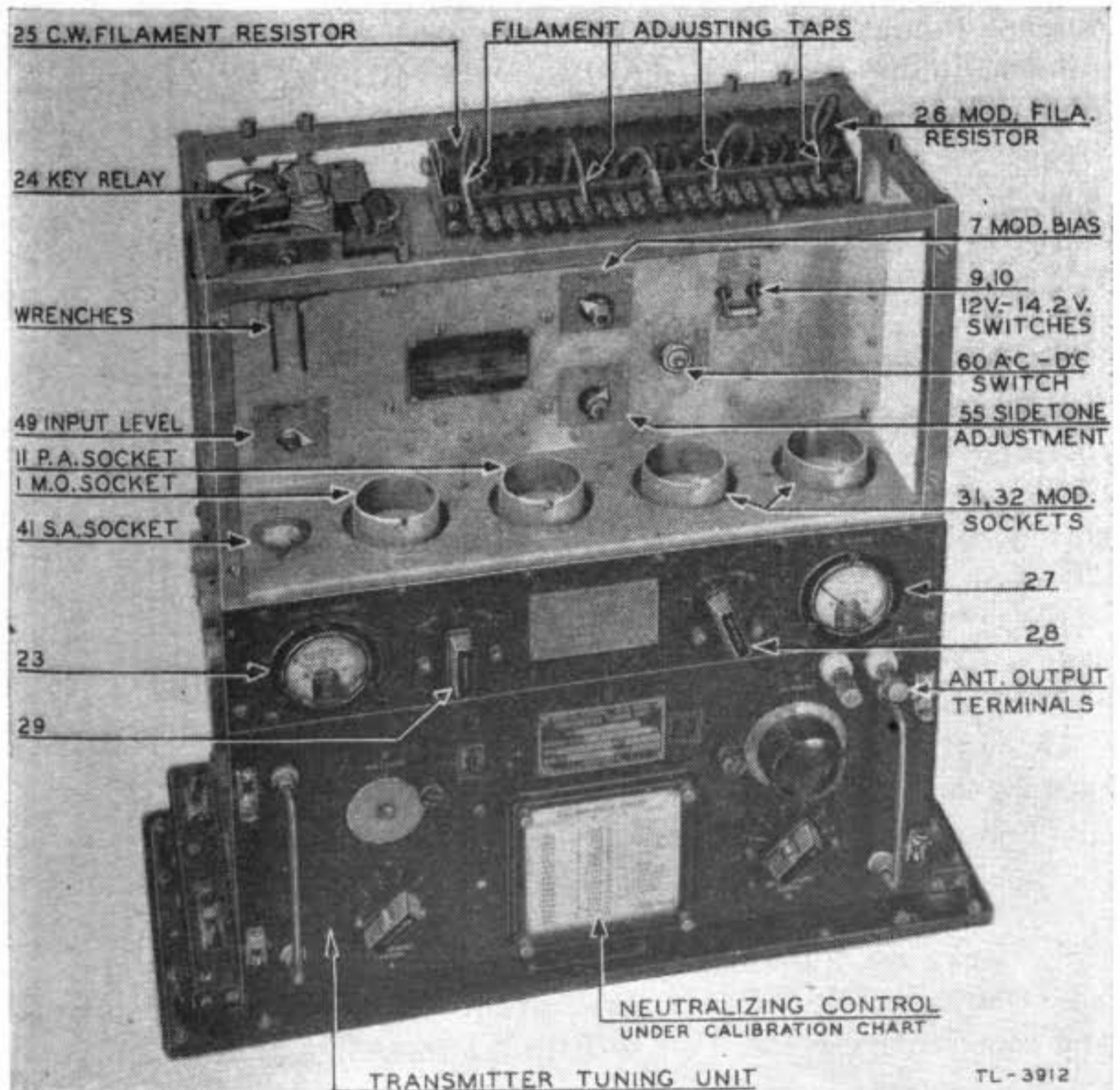


FIGURE 26.—Radio transmitter BC-AA-191 with panels removed showing location of main controls—front view.

45. **Transmitter.**—This transmitter is similar to transmitter BC-191-(*) in basic design, but the controls and circuits for antenna tuning, switching and power control are incorporated in separate auxiliary equipment which is connected to the BC-AA-191 by cording. In addition, the BC-AA-191 lacks many of the electrical and mechanical circuit refinements incorporated in the BC-191-(*). Location

of controls is somewhat different, as may be seen by comparison of figures 4 and 26. The function and purpose of the controls are like those of the BC-191-(*), but the BC-AA-191 does not have the power OFF ON switch, TEST KEY, or antenna tuning controls M, N, O, and P which are found on the BC-191-(*). The power OFF ON switch is located on the auxiliary radio control box BC-AA-192, which is corded to the transmitter. In the absence of a TEST KEY the operating key is plugged into the KEY jack on the radio control box and used as a test key as well as for radiotelegraph transmission. All antenna tuning apparatus and controls are contained in the auxiliary antenna tuning units BC-AA-193 or BC-BB-193, BC-AA-194 and BC-AA-204. Each of these units also contains a 0- to 5-ampere radio frequency ANT. CURRENT meter. Antenna switching relay BC-AA-196 or BC-CC-196 is built in a case which can be mounted on top of any one of the antenna tuning units as shown in figure 30. This arrangement insures short leads connecting the relay and the tuning unit. The two units are connected to the transmitter by cordage.

46. Transmitter tuning units TU-AA-3 to TU-AA-10.—The frequency range covered by each of these tuning units is the same as that of transmitter tuning units TU-3-A or -B, and TU-5-A or -B to TU-10-A or -B (par. 2). Tuning unit TU-AA-4 covers a frequency of 800 to 1,500 kilocycles. Mechanically and electrically the TU-AA-3 to TU-AA-10 type units are very similar to those described in paragraph 8. However, they do not contain thermal compensating devices so their frequency stability and calibration accuracy is not as good as those used with radio transmitter BC-191-(*).

47. Vacuum tubes.—The radio transmitter BC-AA-191 uses five vacuum tubes:

One tube VT-4-B or VT-4-C as master oscillator.

One tube VT-4-B or VT-4-C as power amplifier.

Two tubes VT-4-B or VT-4-C as class B modulators.

One tube VT-25 as speech amplifier.

Note that tube VT-4-C will give improved results in this transmitter as a replacement for the VT-4-B in the master oscillator and power amplifier sockets. There is no advantage to be gained, however, from the use of tubes VT-4-C in the modulator sockets. (See par. 36 for data on tube characteristics.)

48. Antenna tuning units BC-AA-193 or BC-BB-193, BC-AA-194, and BC-AA-204.—*a.* Antenna tuning unit BC-AA-193 or BC-BB-193 consists of a tapped variometer 80 and a radio frequency ammeter 82 housed in a dural case. Two controls are provided on the front panel for varying inductance sufficient to res-

onate an average 200-foot trailing wire antenna over the 400- to 800-kilocycle range. One of the controls, marked ANT. IND. SWITCH E, controls switch 81 for securing relatively large changes in inductance by steps. The other control, marked ANT. IND. TUNING F, adjusts the variometer giving continuous inductance variation for fine control. The ANT. CURRENT meter 82 indicates antenna current. Two models of this unit have been issued: BC-AA-193 and BC-BB-193. They are alike except for minor mechanical differences and are completely interchangeable.



FIGURE 27.—Antenna tuning unit BC-AA-194—front view.

b. Antenna tuning unit BC-AA-194 is contained in a similar dural housing. (See fig. 27.) It consists of a tapped variometer 97, a variable capacitor 93, and two fixed capacitors 91, 92. There are four controls on the front: variometer tap switch 96, labeled ANT. IND. SWITCH G, variometer control ANT. IND. TUNING H, tap switch 94, labeled ANT. CAP. SWITCH J, and variable capacitor 94 control ANT. CAP. TUNING K. This unit is for use with aircraft and fixed station antennas at frequencies above 800 kilocycles.

c. Antenna tuning unit BC-AA-204 is similar to BC-AA-193 or BC-BB-193 in component parts. The variometer, however, has less

inductance than that of BC-AA-193 or BC-BB-193. The front panel controls are identical to those on BC-AA-193 or BC-BB-193. The BC-AA-204 is designed for resonating three- and five-section fishpole antennas for vehicles at frequencies between 1,500 and 4,500 kilocycles.

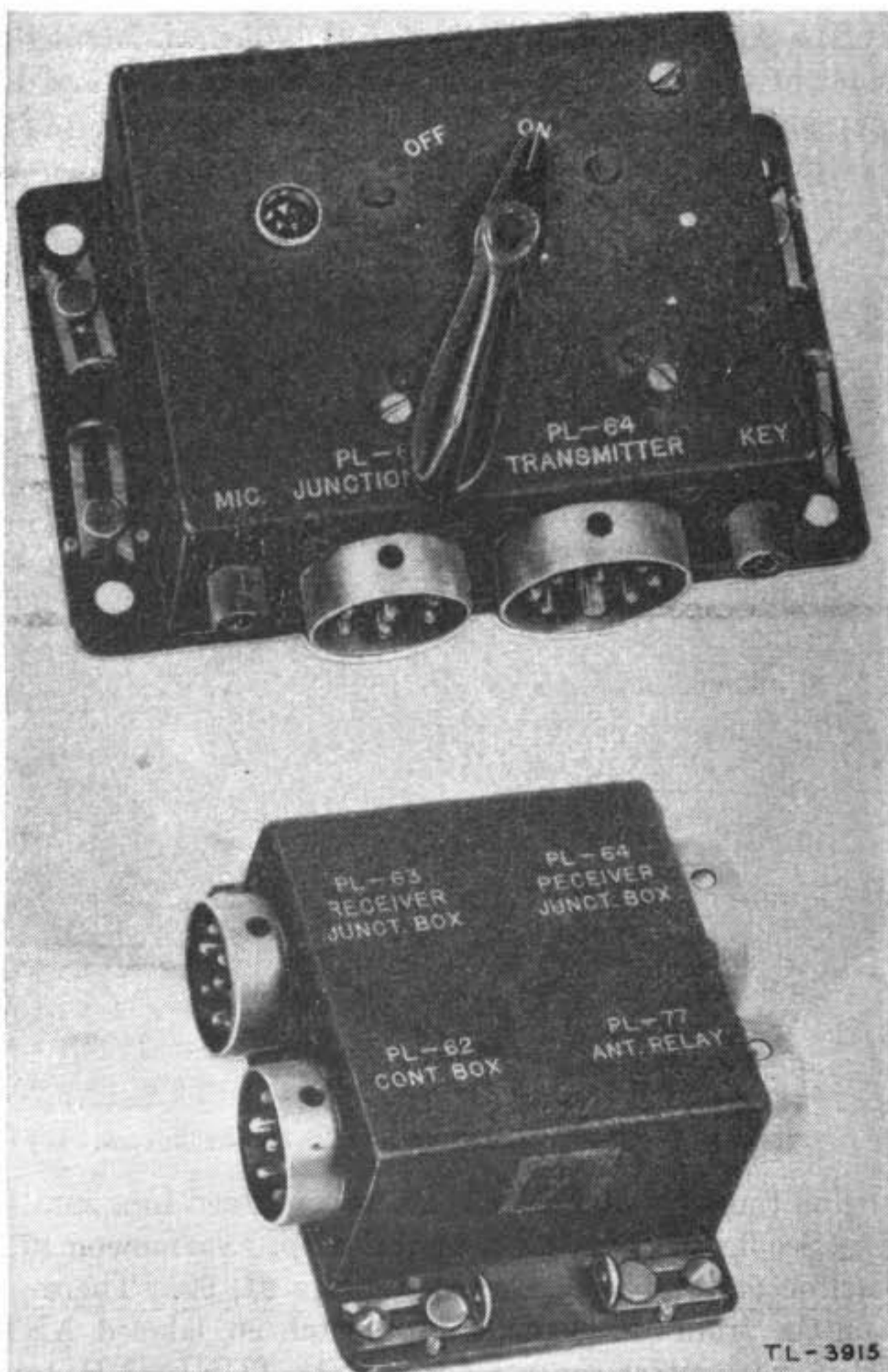


FIGURE 28.—Radio control box BC-AA-192 and junction box TM-AA-160.

d. The cases of the three tuning units are so designed that the front panel is always in a vertical position, whether wall or table mounting is employed.

49. **Antenna switching relay BC-AA-196 or BC-CC-196.**—This unit comprises a relay-operated switch 552 which, at keying speed transfers the antenna from receiver to transmitter and grounds the receiver antenna circuit whenever the transmitter key is closed. Three antenna circuit terminals protrude from the top of the dural case which houses the relay and switch. A socket for insertion of a cording plug is located in one side. This socket makes connection to the relay coil. The housing is designed to mount on top of any of the antenna tuning units. Two types, the BC-AA-196 and BC-CC-196, have been issued. They differ only in slight details and are interchangeable. (See fig. 30.)

50. **Radio control box BC-AA-192.**—The control box (fig. 28) contains an OFF ON switch 73, a key jack 74, a microphone jack 75, and sockets 71 and 72 for plugs PL-62 and PL-64 for cording. Some models also include a pilot light and an a-c d-c switch. The box is attached to a type FT-112 mounting by four snap slide catches.

SECTION II

EMPLOYMENT

	Paragraph
Installation.....	51
Controls.....	52
Adjustments prior to operation.....	53
Tuning.....	54
Operating procedure.....	55
Operation in extreme climatic conditions and in an emergency.....	56
Daily care, removal from service, and storage.....	57

51. **Installation.**—*Caution:* Complete all preliminary installations before connecting the cords to the power supply unit.

a. *Minor installations.*—The only minor installation necessary is insertion of tubes. Remove the tube compartment cover by releasing the two slide catch fasteners, as shown in figure 1, and insert the five tubes in the sockets marked with corresponding VT numbers.

b. *Actual installation.*—Make all interconnection cording with power supply equipment turned off and the OFF ON switch on the radio control box in the OFF position. *Do not connect* the cord and plug from the power supply equipment to the PL-59 socket on the left end of the transmitter frame at this time. Connect the cording to the other components of the radio set in accordance with diagrams supplied on the set chests. When installing the transmitter, leave at least 2 inches clearance all around from the nearest wall for proper ventilation. Be sure to provide sufficient clear space in front of the transmitter for tube changing, removal of transmitter tuning units,

and tuning adjustments. Do not fasten cording down closer than 18 inches to the transmitter. This will prevent vibration from being transmitted to the unit through the cords.

52. Controls.—a. On transmitter.—(1) On the front panel, just below the tube compartment, are the **TOTAL PL. CURRENT** meter, the **TONE C. W. VOICE** switch, the **C. W. FIL. MOD. FIL.** switch, and the **FIL. VOLTAGE** meter. Use and adjustment of these are indicated in paragraphs 12a, 53, and 55.

(2) Located on the back wall of the tube compartment are the **INPUT LEVEL** control (back of the VT-25 at the left end), the **MOD. BIAS** control (at right center), the **SIDE TONE** switch (just beneath the **MOD. BIAS** control), the **12V. 14.2V.** switch (at the right, behind tubes four and five), and the **A-C D-C** switch (just beneath and to the left of the **12V. 14.2V.** switch). At the upper left of the tube compartment is the receiver control circuit toggle switch 56, marked **POSITION NO. 1** and **POSITION NO. 2**. (See fig. 26.) This switch, through cording connections with associated receiving equipment in a radio set, determines the circuit control exercised on the receiver by the transmitter keying relay.

(a) In **POSITION NO. 1** a closed circuit path between two terminals on the receiver cording sockets is provided, when the transmitter is not keyed. This type of connection can be used for break-in operation with a receiver which has no antenna shorting relay. The two terminals on the cording sockets at the receiver are connected in series with the high voltage or screen supply for the receiver tubes. This arrangement breaks the receiver power supply line whenever the transmitter is keyed, thus silencing the receiver during transmission.

(b) When the switch is on **POSITION NO. 2** the circuit is such that one wire from the receiver cording socket is grounded when the transmitter is keyed. When the transmitter is not on the air, the circuit from the receiver is open. This arrangement can be used to close the circuit of an antenna-shortening or high voltage supply-opening relay built into some types of receiving equipment. In some sets the cording is such that the switch is inoperative.

(3) On the top of the transmitter, accessible by removal of the top plate, is the **S. A. BIAS** adjustment. This is a potentiometer shaft located between the filament resistor and the filament resistor terminal board, at the left end of the board. The shaft is slotted for a screw driver. (See figs. 29 and 34.)

(4) These controls have the same purpose as those on the **BC-191-(*)** transmitter (par. 12a).

b. On transmitter tuning units.—The controls on the transmitter tuning units TU-AA-3 to TU-AA-10 are identical with those on the TU-3-A or -B to TU-10-A or -B transmitter tuning units used with the BC-191-(*) transmitter (par. 12*b*).

53. Adjustments prior to operation.—Determine the type of power supply equipment which will be used. Refer to paragraph 12*a* and figure 26 for location of A-C D-C and 12V. 14.2V. switches. Adjustment of these switches is as follows:

a. Filament voltage adjustment.—At the top right rear of the transmitter tube compartment is the filament resistor connection board. There are five tap wires, each with a small plug at one end. The plugs can be inserted vertically in the terminals of the connection board. Spring action holds them in place when inserted. (See figs. 26 and 29.) Adjustment of filament voltage is made by inserting the taps in the terminals, proceeding from one terminal to the next until proper voltage adjustment is secured.

b. Adjustment for storage battery-dynamotor type of supply.—
(1) Connect all power cording between transmitter and power equipment *except the high-voltage cord to socket PL-59.*

(2) Place A-C D-C switch in tube compartment at D-C.

(3) Place 12V. 14.2V. switch on 14.2V. (Have the battery on charge by running the vehicle engine.)

(4) Set TONE C. W. VOICE switch on VOICE and C. W. FIL. MOD. FIL. switch to MOD. FIL.

(5) Insert tap plug marked AC in center terminal of connection board.

(6) Place OFF ON switch on radio control box at ON. The voltmeter should indicate the modulator filament voltage.

(7) Starting at the right end and working to the left, adjust right end tap (marked 14) of the modulator filament resistor terminal board until the voltmeter indicates approximately 10.5 volts.

(8) Place voltmeter switch to C. W. FIL.

(9) Starting at the left end and working to the right, adjust the left end resistor tap, stamped 14, until the meter reads approximately 10.5 volts. (10.5 volts will drop to 10 volts when plate load is applied. Operating filament voltage is 10 volts.)

(10) Turn off battery charging equipment (by stopping the vehicle engine or by other suitable means) and place the 12V. 14.2V. switch at 12V. Repeat the procedure used for 14.2 volts in (7), (8), and (9) above except that this time the inner two resistor caps marked 12 should be used.

(11) As now adjusted, filament voltage will not require readjustment unless cable lengths are changed. In a normal vehicle or aircraft installation a battery charging generator is used at all times. The 12V. 14.2V. switch should accordingly be set in 14.2V. position.

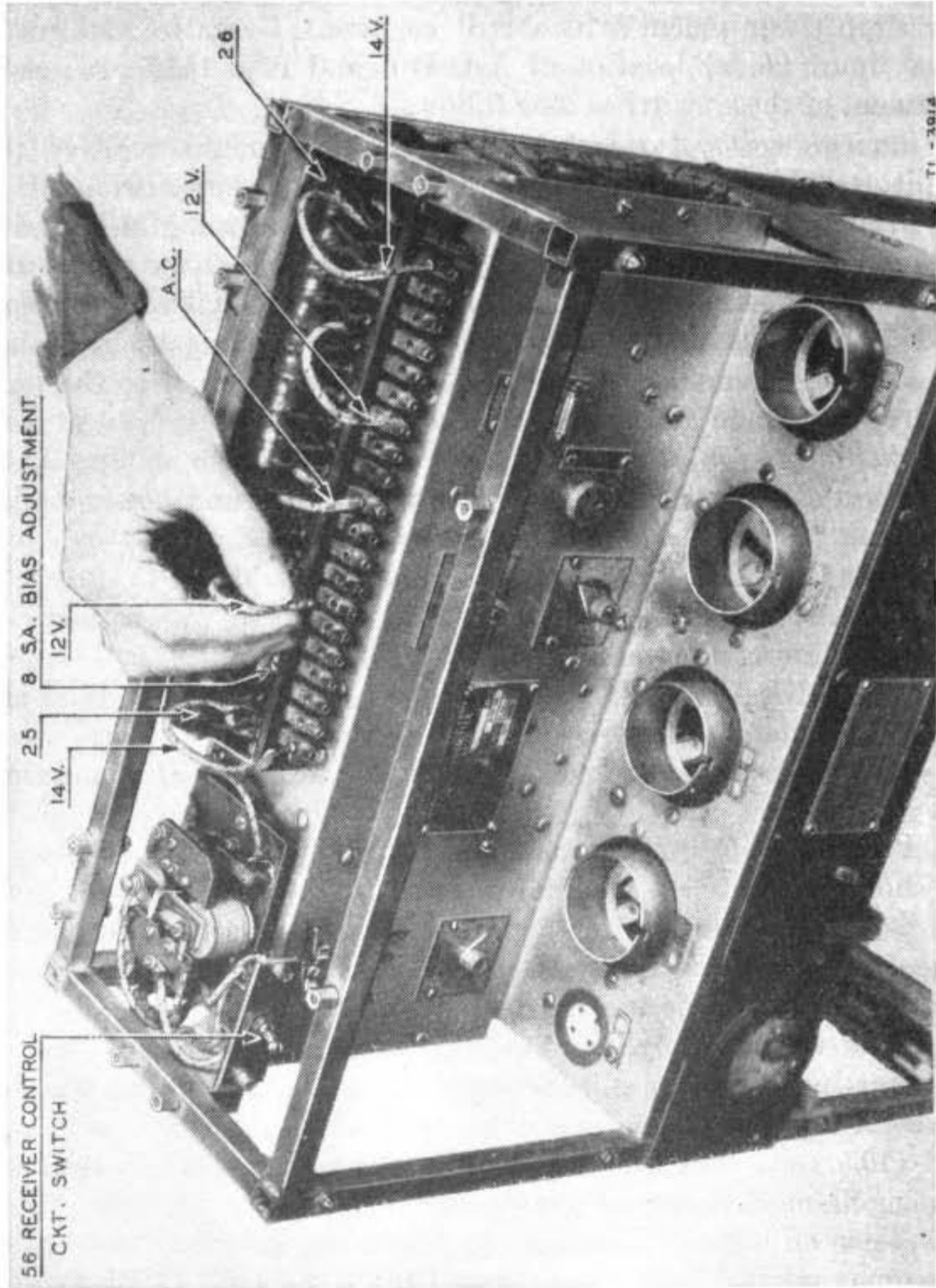


FIGURE 29.—Inserting filament adjusting tap in terminal on filament resistor connection board. (Location of S. A. BIAS adjustment is also shown.)

c. Portable gas engine-driven power equipment.—(1) Connect all power cording between the transmitter and power equipment, *except high voltage cord to socket PL-59.*

(2) Check power equipment to see that it is supplying the rated 14.6 volts to the transmitter.

(3) Move A-C D-C switch in tube compartment to the D-C position.
 (4) Place TONE C. W. VOICE switch to C. W., voltmeter switch to C. W. FIL., and 12V. 14.2V. switch to 14.2V.

(5) Insert tap plug marked AC in the center terminal of connection board.

(6) Place transmitter ON OFF switch to the ON position. The filaments of the speech amplifier, master oscillator, and power amplifier tubes should light.

(7) Starting at the left and working to the right, adjust the left end tap (stamped 14), selecting a resistor connection where the voltage reading will be 10.5 volts. (This should not be less than 10 volts as indicated by the red mark on the voltmeter when plate power is applied.) Turn off transmitter.

(8) Change TONE C. W. VOICE switch to VOICE. Change 12V. 14.2V. switch to 12V., and voltmeter switch to MOD. FIL.

(9) Move transmitter switch to the ON position and all tubes should light.

(10) Starting at the center and working to the right, adjust right tap (stamped 12) and select a resistor tap where the modulator filament will indicate 10.5 volts.

(11) Without further change, turn voltmeter switch to C. W. FIL. Starting at the center and working to the left, adjust tap (stamped 12) on the left side, selecting a connection where the C. W. FIL. voltage is 10.5 volts.

(12) Correct filament voltage can now be had on either C. W. or VOICE and TONE by changing the 12V. 14.2V. switch to 12V. for operation on VOICE or TONE and to 14.2V. for C. W. operation.

54. Tuning.—*a. Preliminary.*—Tuning procedure is the same as that indicated in paragraph 17*a* and *b*. The only difference to be observed is that the antenna circuit connections must be made by a two-wire pair from terminals 1 and 2 on the upper right corner of the transmitter tuning unit front panel to the antenna tuning unit being employed. Be careful not to touch the terminal board in the tuning-unit receptacle when there is no tuning unit installed. There is no safety interlock switch on the BC-AA-191 transmitter so it is possible to come in contact with a dangerous voltage by touching this board.

b. Antenna.—The general operating considerations of the antenna system are the same as for the BC-191-(*) transmitter discussed in paragraph 17*c*. The tuning procedure for the various antenna tuning

units is described below. After the M. O. and P. A. circuits are tuned up with control D, ANT. COUPLING SWITCH set at 1, proceed with the antenna tuning indicated, advancing control D, ANT. COUPLING SWITCH, to a higher setting if required to secure proper loading (180 to 200 milliamperes on C. W.).

(1) The BC-AA-193 or BC-BB-193 antenna tuning unit is designed to load an antenna inductively. There is sufficient inductance variation to operate a 200-foot trailing wire aircraft or equivalent fixed antenna from 400 to 800 kilocycles. To reduce radio frequency losses, operate with an antenna system which will require a minimum of loading inductance at a given frequency. The controls in the unit are arranged so that the amount of inductance increases with dial and scale reading. Best operation is obtained with the lowest possible dial and scale readings.

(2) The BC-AA-194 unit is designed for use with antennas operating above or below their fundamental frequency. For operation at frequencies below the fundamental, follow the instructions given for BC-AA-193 or BC-BB-193. Short out the series capacity by placing ANT. CAP. SWITCH J in position 4. Adjust ANT. IND. SWITCH G and ANT. IND. TUNING H controls for resonance. This will be indicated either by maximum radio frequency current on the ANT. CURRENT meter or maximum current on the TOTAL PL. CURRENT meter. For operation at frequencies above the fundamental, the antenna represents an inductive reactance in series with a resistance. For this condition, short the antenna loading inductance out of the circuit by placing ANT. IND. SWITCH G in position 1. Then adjust ANT. CAP. SWITCH J and ANT. CAP. TUNING K to tune the antenna, watching for resonance on the ANT. CURRENT meter or TOTAL PL. CURRENT meter. If the antenna is operated at a frequency very close to its fundamental it may be found that both capacitance and inductance are required to resonate properly. If this condition exists, use a maximum of series capacitance (switch J advanced to a high number and dial K set at a high numerical setting) and a minimum of loading inductance (switch G at a low number and dial H set at a low setting).

(3) Type BC-AA-204 antenna tuning unit is intended for operation with 9- to 15-foot steel fishpole type vehicle antennas operating from 1500 to 4500 kilocycles. For these antennas, tuning procedure is similar to that for BC-AA-193 or BC-BB-193 in (1) above. The antenna switching relay BC-AA-196 or BC-CC-196 is mounted on top of the antenna tuning unit, fitting on the two studs provided. Connect antenna tuning unit to the switching relay, and from there

to the antenna and receiver, following the diagram in figure 31. When the antenna tuning is completed, readjust control C for minimum total plate current.

55. Operating procedure.—Operating procedure is virtually the same as for BC-191-(*) described in paragraph 18. Connect key and microphone by plugging them into proper jacks provided in radio



FIGURE 30.—Antenna tuning unit BC-(*)-193 or BC-AA-204 with antenna switching relay BC-(*)-196 mounted on top.

control box BC-AA-192. Adjustment for voice and tone operation is also explained in paragraph 18. However, the S. A. BIAS control does not have a numbered dial so adjustment must be made by measuring the voltage across capacitor 53 (fig. 34) with TONE C. W. VOICE switch set at VOICE and key held down. This adjustment can only be made with the top and back plate of the transmitter removed. *Since dangerous voltages are exposed by this procedure, be very careful not to come in contact with any of the wiring.* Use a high resist-

ance voltmeter such as the one supplied with test set I-56 or I-56-A and connect the positive voltmeter lead to the chassis frame. Touch negative lead test prod to the proper terminal of capacitor 53 (only one of the terminals will give a voltage reading). Insert an insulated screw driver in the slotted S. A. BIAS control shaft (see fig. 29) and adjust for a voltmeter reading of 35 to 40 volts. If two persons are present, have one depress the key and make the adjustment while the other handles the voltmeter. *Be careful!*

56. Operation in extreme climatic conditions and in an emergency.—See paragraphs 21 and 22.

57. Daily care, removal from service, and storage.—See paragraphs 23, 24, and 25.

SECTION III

FUNCTIONING OF PARTS

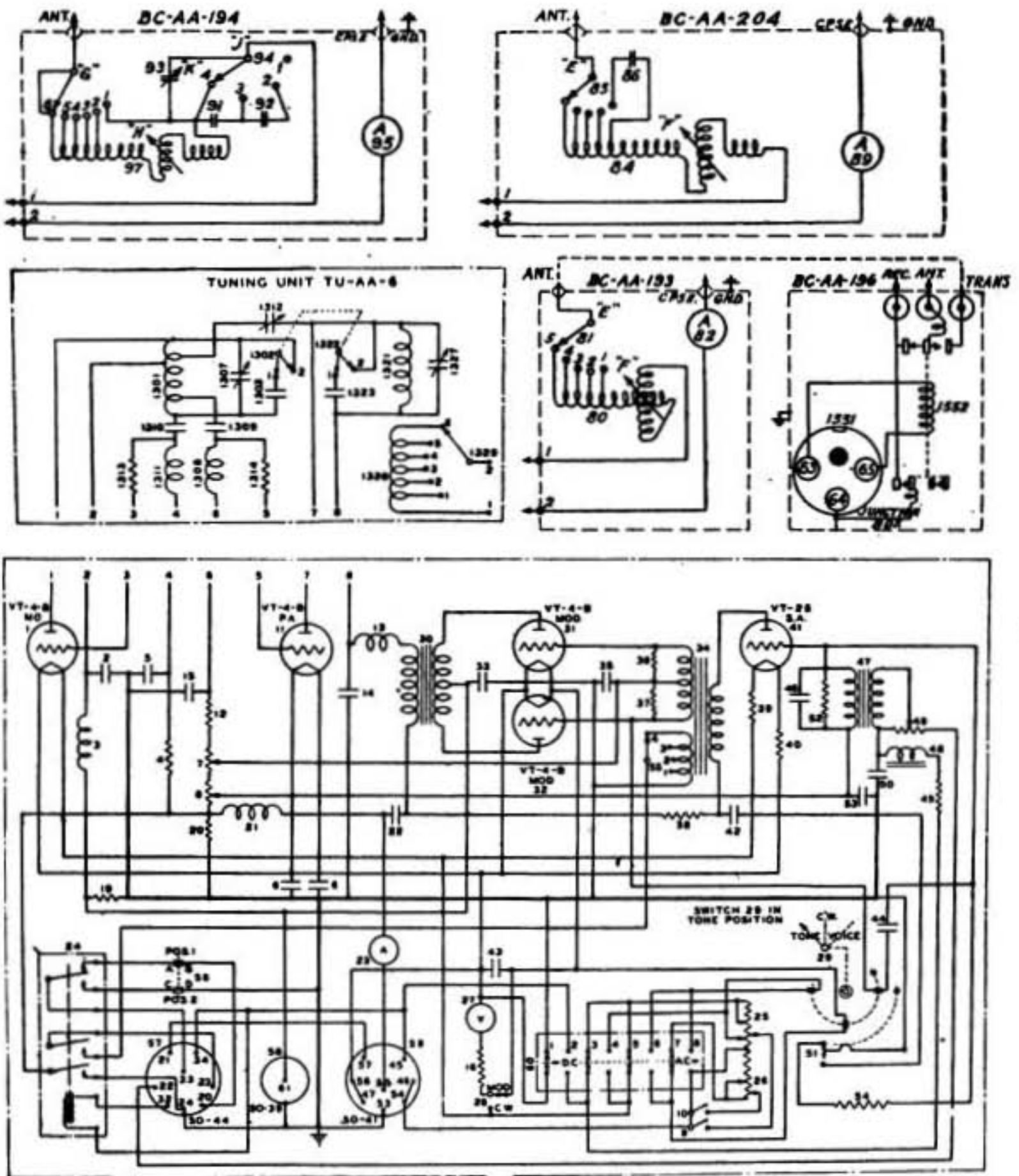
	Paragraph
General	58
Antenna tuning units BC-AA-193 or BC-BB-193, BC-AA-194 and BC-AA-204.....	59
Antenna switching relay BC-AA-196 or BC-CC-196.....	60

58. General.—The general circuit functioning of radio transmitter BC-AA-191 is the same as that of the BC-191-(*) in all major respects, except for the fact that all antenna tuning and switching is done by external auxiliary equipment and the use of an external radio control box BC-AA-192 containing the power OFF ON switch and outlets for plugging in microphone and telegraph key. (See pars. 26 and 27.)

59. Antenna tuning units BC-AA-193 or BC-BB-193, BC-AA-194 and BC-AA-204.—These separate units perform the same function and in general have circuits similar to the various antenna circuits of BC-191-(*) which result when ANT. CIRCUIT SWITCH N is moved through its several positions. (See par. 17c.) Comparison of figure 7 with circuits of antenna tuning units BC-AA-193 or BC-BB-193, BC-AA-194, and BC-AA-204 in figure 31 will show that BC-AA-193 or BC-BB-193 and BC-AA-204 have circuits almost the same as positions 3 and 4 of control N on the BC-191-(*). The circuit of BC-AA-194 is approximately the same as that of position 2 of control N.

60. Antenna switching relay BC-AA-196 or BC-CC-196.—*a.* This relay accomplishes the following functions at keying speed:

(1) Transfers the antenna from the receiver to the transmitter when the transmitter key is closed.



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FIGURE 31.—Radio transmitter BC-AA-191 with transmitter tuning unit TU-AA-6, antenna tuning units BC-AA-193 or BC-BB-193, BC-AA-194, BC-AA-204, and antenna switching relay BC-AA-196 or BC-CC-196—schematic diagram.

(2) Grounds the receiver antenna circuit when the key is closed.
 b. The relay coil 1552 is connected in parallel with the transmitter switching relay coil 24 by the cording through socket 1551.

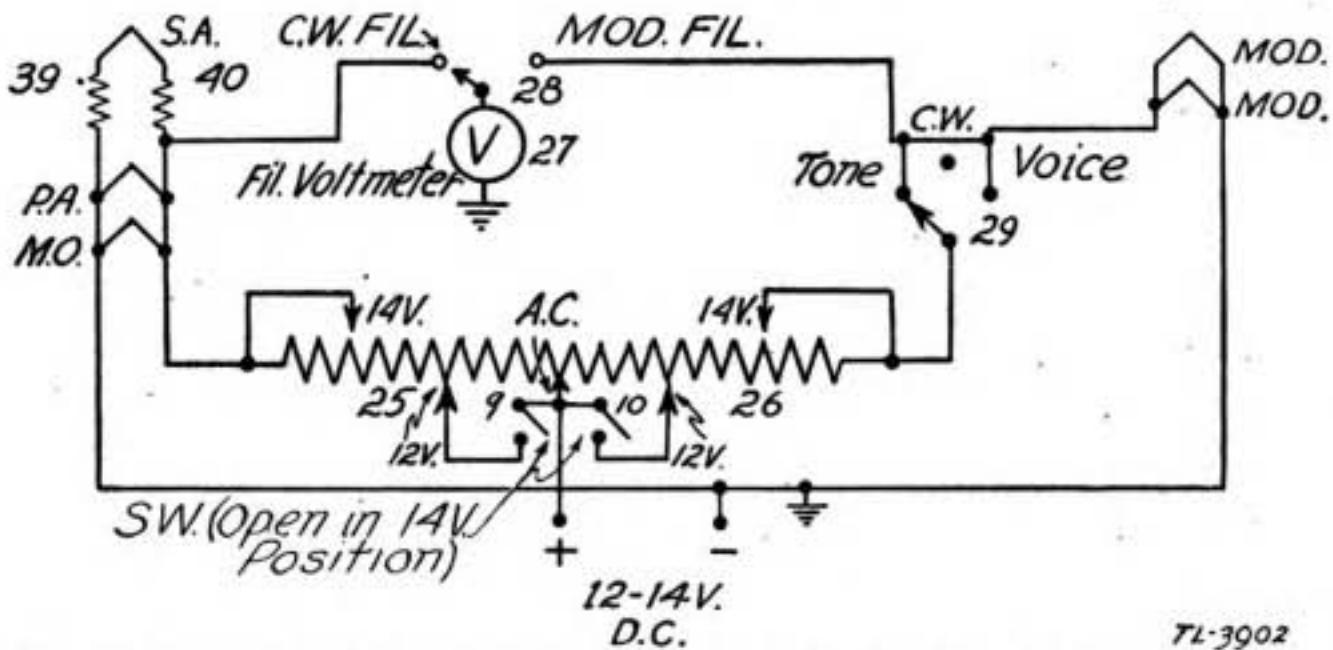


FIGURE 32.—Radio transmitter BC-AA-191, filament circuit, d-c operation—functional diagram. 7L-3902

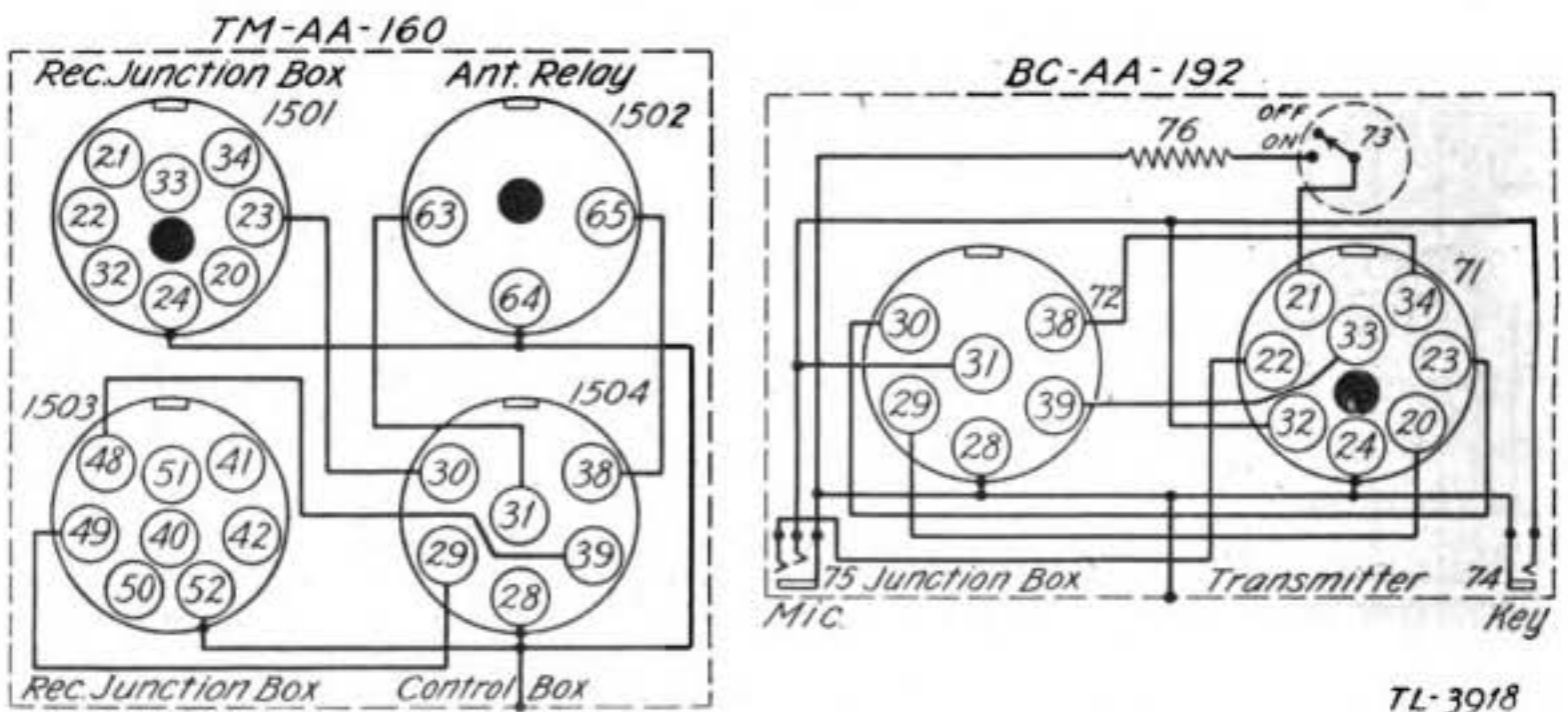


FIGURE 33.—Radio control box BC-AA-192 and junction box TM-AA-160—schematic diagram. TL-3918

SECTION IV

SERVICING AND REPAIR

	Paragraph
General.....	61
Normal voltage, current, and resistance readings.....	62
Trouble chart.....	63

61. General.—*a.* The servicing and repair of the transmitter are covered in paragraphs 29 to 34, inclusive. The external tuning and switching components may fail to operate due to breakage in the connecting wires and connecting cords. Always check these carefully when trouble develops. The antenna switching relay may fail to

function due to cording defects or due to poor socket and plug contacts. Power failure may be traced to cording defects between the transmitter, the radio control box BC-AA-192, and junction box TM-AA-160 (if used). Check condition of fuses and connections in fuse box BX-10 if the installation includes this component.

b. Trouble with the MOD. BIAS control and S. A. BIAS control due to wearing of the resistance element may cause incorrect bias

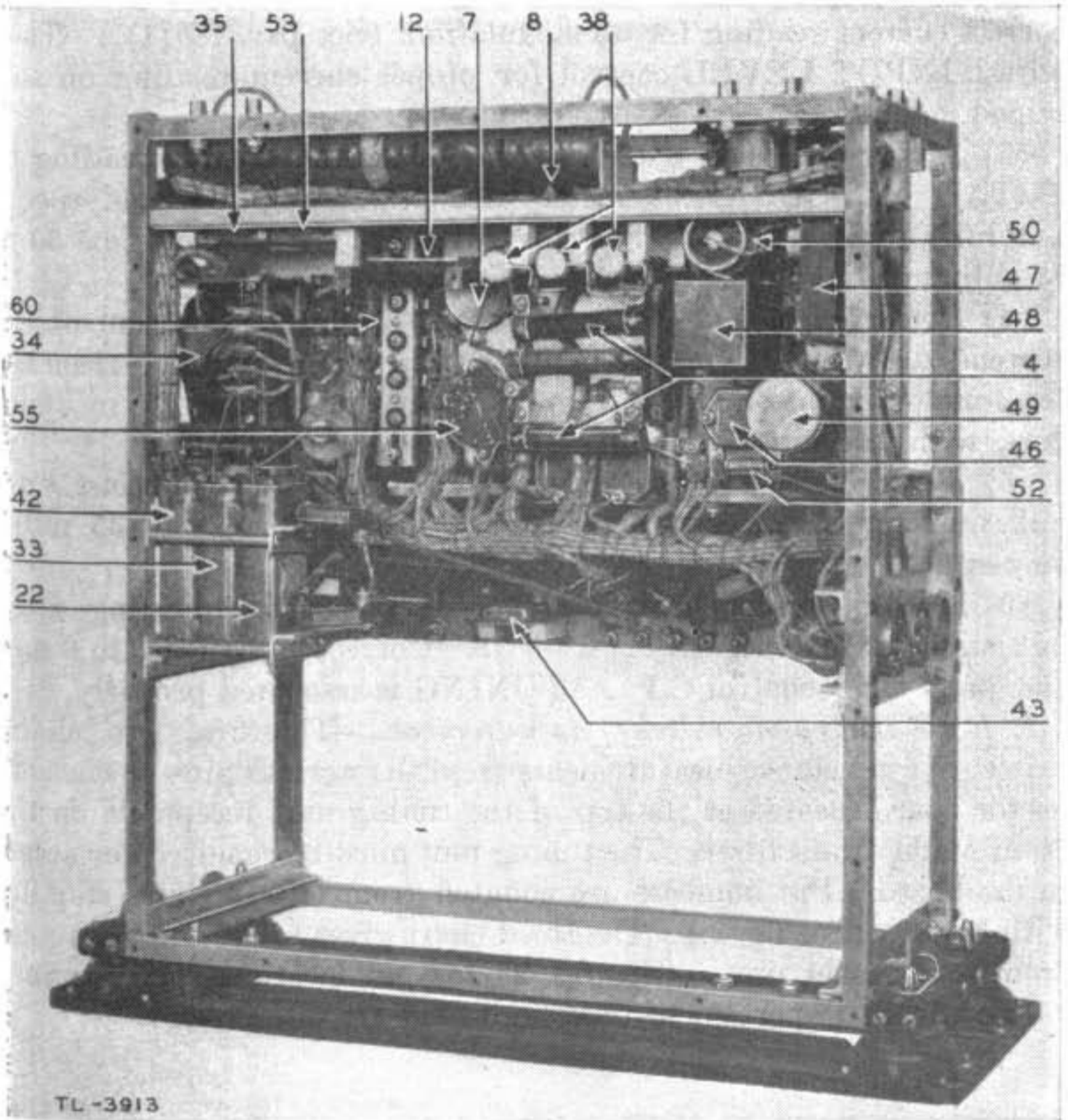


FIGURE 34.—Radio transmitter BC-AA-191, with transmitter tuning unit and top rear and side panels removed to show location of parts—rear view.

voltages for the modulator and speech amplifier tubes. If this occurs, the controls should be replaced by repair personnel. For neutralization adjustment, see paragraph 35a and b.

62. Normal voltage, current, and resistance readings.—a. Normal plate and grid currents.—(1) S. A. plate current.—Read by

using tube socket adapter in VT-25 socket. Should be 19 to 21 milliamperes. Adjust S. A. BIAS control 8 to secure this value of current.

(2) *Modulator plate current.*—Can be determined by observing increase in TOTAL PL. CURRENT reading when changing from C. W. to VOICE and impressing normal speech modulation. Should average 100 to 125 milliamperes for sustained speech tones. With no modulation it should average 20 milliamperes higher than for continuous wave operation. First adjust MOD. BIAS control 7 to secure correct current reading for no modulation. (See par. 18b(1).) Then adjust INPUT LEVEL control for proper current reading on sustained modulation.

(3) *Master oscillator plate current.*—Determined from reading of TOTAL PL. CURRENT meter with power amplifier and speech amplifier tubes removed. Selector switch on C. W. should be 30 to 75 milliamperes, depending on frequency of operation.

(4) *Power amplifier.*—Determined by subtracting the sum of the currents drawn by the master oscillator and speech amplifier from the total plate current on C. W. Should be between 100 and 150 milliamperes with full antenna loading.

(5) *Master oscillator grid current.*—Measured by connecting a d-c milliammeter in series with resistor 4. Should be 20 to 35 milliamperes.

(6) *Power amplifier grid current.*—Measured by inserting a d-c milliammeter in series with resistor 12. Correct value is 6.5 to 9 milliamperes when control C P. A. TUNING is resonated properly.

b. Resistance and voltage measurements.—The first two charts below give resistance measurements from the various pins on the connector board located at the top of the tuning unit receptacle on the front of the transmitter. The tuning unit must be removed for access to the board. Pin numbers are counted from left to right, starting with No. 1. (See fig. 3.) The third chart gives resistance to ground from tube socket pins. (See fig. 23 for pin locations.) Resistance values within 15 percent of those indicated are satisfactory.

RESISTANCE TO GROUND

Pin No.	1	2	3	4	5	6	7	8
Ohms	open	1 meg	open	0.1 or 0.03 meg	open	0.13 or .055 meg	open	1 meg.

NOTE.—Some sets issued give readings of 0.1 meg from pin No. 4 to ground, others give 0.03 meg due to use of a different size resistor 20. Likewise, resistance to ground from pin No. 6 is 0.13 meg on some sets and 0.055 meg on others.

PIN TO PIN RESISTANCE (Ohms unless otherwise indicated)

Pin to pin	1	2	3	4	5	6	7	8
1	0	open	open	open	open	open	open	open.
2	open	0	open	1 meg	open	1 meg	open	190.
3	open	open	0	open	open	open	open	open.
4	open	1 meg	open	0	open	35,000	open	1 meg.
5	open	open	open	open	0	open	open	open.
6	open	1 meg	open	35,000	open	0	open	1 meg.
7	open	open	open	open	open	open	0	open.

RESISTANCE FROM TUBE SOCKET PINS TO GROUND

Stage	Tube	Socket pin marking			
		P	F1	G*	F
M.O.	VT-4-B	1 meg	160 ohms	0.11 or 0.04 meg	0 ohms.
P.A.	VT-4-B	1 meg	160 ohms	0.13 or 0.055 meg	0.
Mods	VT-4-B	1 meg	160 ohms	108,000 ohms	0.
S.A.	VT-25	1 meg	2 ohms	0.1 or 0.03 meg	155 ohms.

VOLTAGE CHART

(Using 1,000 ohms per volt, or better, voltmeter)

	Volts approx.	Where measured	Ground polarity	Selector switch position	Notes
S. A. plate.....	425	At VT-25 plate; socket 41.....	Minus.....	VOICE	Measure with tube in circuit. Use tube socket adapter.
S. A. grid bias.....	35-40	Across capacitor 53.....	Plus.....	VOICE	
Mod. grid bias.....	72-75	Across capacitor 35.....	Plus.....	VOICE	
Plate supply.....	1, 000-1, 100	Terminal 61 of socket SO-39 and ground.	Minus.....	TONE or VOICE	
Keying.....	150	Across resistor 20.....	Plus.....	Any.....	Keying relay 24 open.
Side tone: Position 1..... Position 4.....	3-9 17. 5-30	Arm of sw. 55 to ground, across an 8,000 ohm resistor.	TONE or C. W.	Voltage is a-c; frequency should be 600-1,200 cycles. Voltage is higher on C. W. than on TONE. Use I-56-A output meter.
Microphone supply.....	10	From terminal 22 of PL-64 to ground.	Minus.....	VOICE	Measured with microphone disconnected from circuit. PL-59 disconnected. OFF ON switch at ON.

63. Trouble chart.—The trouble chart below lists a number of typical conditions which may occur when using this equipment. Note that some of these troubles are caused by failure to adjust the equipment properly when setting it up. Always recheck installation and tune-up procedure before operating the equipment.

Symptoms	Probable causes
No filament voltage. Cording properly connected.	Open fuse or breaker in power supply. Short-circuited power cord. Open power cord. TONE C. W. VOICE switch defective. Filament resistor 25, 26 defective.
Filament voltage normal on C. W., high on TONE and VOICE.	Modulator tubes burned out. Filament resistor connection board connected improperly.
No plate current. Filament voltage normal. Cords connected properly.	Defective high voltage cord. Burned out high voltage fuse in power supply or in transmitter. Fuse failure is caused by failure to follow tuning procedure exactly (par. 17) or by defective high voltage filter condensers 33 and 22. Open resistor 20, defective plate current meter 23 will cause lack of plate current, too. Check action of keying relay 24.
Very high plate current on continuous-wave operation. No radio frequency output on any position of control D. Control C will not resonate.	M. O. tube not functioning. Replace if defective. Check high voltage and filament circuits of master oscillator circuit for continuity.
No pronounced plate current dip when control C is tuned. TOTAL PL. CURRENT meter reading is high. Tuning of control C shifts somewhat as antenna controls are tuned. ANT. CURRENT meter reading normal.	Antenna loading on power amplifier too great. Reduce by placing control D at a lower setting. Also see paragraph 17c(8). Check P. A. tube. Check grid bias voltage on this tube. If low, check resistance from pin G of socket 11 to frame. See resistance chart paragraph 62.
Power amplifier will not load on continuous-wave operation. (Total plate current does not increase with tuning of antenna.) Tuning of control C is normal.	Check antenna for poor joints, leaky insulators. Check connections between transmitter, antenna tuning units, and antenna switching relay. Check antenna switching relay to see that it is operating.

Symptoms	Probable causes
<p>Total plate current 150 ma on continuous wave operation at resonance of control C. Control D set at 1. Antenna circuit detuned. TOTAL PL. CURRENT meter dips sharply at resonance of control C. Resonance setting of C is off calibration chart figures. Filament voltage and other checks are normal.</p>	<p>Power amplifier probably requires neutralization. To check, replace transmitter tuning unit with one for another frequency band and tune up M. O. and P. A. controls at a point near middle of frequency band covered by tuning unit. If operation is normal with the second tuning unit, replace first unit and neutralize, following instructions in paragraph 35a, and b.</p>
<p>Total plate current high on continuous-wave operation at all settings of control D. Low radio frequency output on ANT. CURRENT meter. Plate current dip at resonance of control C is very small. P. A. tube checks perfect. Condition exists with all transmitter tuning units supplied with set.</p>	<p>M. O. tube is oscillating weakly, indicates worn out tube or trouble in master oscillator circuit. Check tube by replacement. If trouble continues make resistance check of tube socket 1 with power turned off. See resistance charts in paragraph 62.</p>

MODULATOR TROUBLES

(In all cases below continuous-wave operation has been tried and found to be normal.)

Symptoms	Probable causes
<p>Badly distorted signals on VOICE. Interference on adjacent channels reported when transmitting on TONE. Total plate current low on TONE.</p>	<p>Improper modulator or speech amplifier grid bias adjustment, or defective modulator tubes. Bad P. A. tube will cause modulator and speech amplifier bias to be improper value. Check resistance of resistors 7, 8, and 12.</p>
<p>No modulation on VOICE. Modulation satisfactory on TONE. Plate current normal on TONE.</p>	<p>Check INPUT LEVEL adjustment. If correct, check microphone, cord and plug by replacement. Remove high voltage by disconnecting cord and plug PL-59. Place high resistance a-c voltmeter of test set across terminals 3 and 4 of transformer 47 with tube filaments on. Speak into microphone, with microphone push button switch closed. On loud speech a reading of 1 or 2 volts is normal. Check microphone d-c voltage with d-c voltmeter between pin 22 of socket PL-64 and chassis frame. Microphone not plugged in. 10 volts are normal.</p>

Symptoms	Probable causes
<p>No modulation on TONE or VOICE. Plate current on TONE and VOICE is same as on C. W.</p>	<p>Modulator tubes are not functioning as shown by lack of plate current increase on tone or voice. Check modulator tubes and value of modulator grid bias (see chart, par. 62) and continuity of high voltage circuits to plates of modulator tubes. Check TONE C. W. VOICE switch for open circuit. Make certain that modulator filaments light. If not, check connections on MOD. and of filament resistor connection board and check filament resistor 26 for open circuit.</p>
<p>High plate current. Normal reading on ANT. CURRENT meter. Control C properly adjusted. Plate current <i>decreases</i> when voice or tone modulation is applied.</p>	<p>Check amount of antenna coupling. Operation with control D advanced too far will cause drop in plate current with modulation. Check filament voltages. Low voltage may sometimes cause the condition also. Check MOD. BIAS adjustment. If condition still continues, modulation transformer 30 may be defective.</p>
<p>Distortion on VOICE. TONE transmission normal. PL. CURRENT normal.</p>	<p>Check microphone. Check INPUT LEVEL adjustment for overmodulation. Normal setting of 7 to 8 should swing plate current to peaks of 300 milliamperes on voice. If distortion continues with this adjustment, adjust INPUT LEVEL to limit peak plate current swings to 280 milliamperes on voice. If trouble remains, check grid bias and plate voltages of S. A. tube using tube socket adapter from I-56 or I-56-A test set analyzer. Insert adapter in S. A. socket and VT-25 in adapter socket. Also check resistors 36, 37 across terminals 3-4 and 4-5 of transformer 34 to see that they are making good contact and have correct resistance value.</p>
<p>High hum level on VOICE modulation reported by other stations.</p>	<p>Check for poor ground connections, if the set is grounded. Check capacitors 33, 22, 42, 50, 35 and 53 for open circuit.</p>

SECTION V

LIST OF PARTS

Table of replaceable parts-----	Paragraph 64
Identical and interchangeable parts-----	65
Manufacturers and their addresses-----	66

64. Table of replaceable parts.—a. Radio transmitter BC-AA-191 (stock No. 2C6191).

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
1	2C6191/S2	Tube socket	For VT-4-B	Hold M. O. tube	GE	Cat. 7461594G1
2	3DA6	Capacitor	0.006-mf, $\pm 5\%$, 2,000-v	M. O. plate bypass	CD	ML7867303Pt1
3	2C6191A/D1	Coil	R. f. choke	M. O. plate filter, r. f.	GE	
4	3Z6500	Resistor	5,000-ohm, $\pm 10\%$, 5-w, wire.	M. O. grid leak	CCC	ML7867303Pt2
5	3D9100-5	Capacitor	0.0001-mf, $\pm 10\%$, 2,500-v.	M. O. grid bypass	CD	ML7867303Pt3
6	3DA20-3	do	0.02-mf, $\pm 10\%$, 2,500-v	Filament r. f. bypass	CD	ML7867303Pt4
7	2C6191/R31	Resistor, variable.	7,500-ohm, $\pm 10\%$, no taper.	Mod. bias adjustment	CHI	ML7461569G1
8	2C6191/R32	do	do	S. A. bias adjustment	CHI	ML7461569G2
9	3Z9855	Switch	Special SPST	12V. 14.2V. fil. switch	GE	ML7867303Pt13
10	3Z9855	do	Special SPST ganged to 9.	do	GE	ML7867303Pt13
11	2C6191/S2	Tube socket	For VT-4-B	Hold P. A. tube	GE	Cat. 7461594G1
12	3Z6615	Resistor	15,000-ohm, $\pm 5\%$, 5-w	P. A. grid leak	CCC	ML7867303Pt5
13	2C6191A/D1	Coil	R. f. choke	P. A. plate filter, r. f.	GE	
14	3DA1-3	Capacitor	0.001-mf, $\pm 5\%$, 3,000-v	P. A. plate bypass	CD	ML7867303Pt7
15	3D9100-5	do	0.0001-mf, $\pm 10\%$, 2,500-v.	P. A. grid bypass	CD	ML7867303Pt3
16	3Z6015	Resistor	150-ohm, $\pm 1\%$, 1-w	Part of voltmeter 27	IRC	
19	3Z6750	do	500,000-ohm, $\pm 10\%$, 1-w, carbon.	High voltage bridge	CCC	ML7867303Pt33
20	3Z6700	do	100,000-ohm, $\pm 10\%$, 5-w.	Keying bias	CCC	ML7867303Pt8

*20	3Z6625-1	do	25,000-ohm, $\pm 10\%$, 5-w.	do	CCC	
21	2C6191/D2	Coil	R. f. choke	H. V. filter, r. f.	GE	M7460961G2
22	2C6191/C5	Capacitor	1-mf, 1,200-v, pyranol.	H. V. filter	GE	ML7867303Pt9
23	3F222.1	Milliammeter	500-ma, d-c. Red line at 210 ma.	Plate current	GE	ML7867303Pt10
24	2C6191/L2	Relay	3 pole	Keying switching	GE	Cat. 7761041G1
25	2C6191/R5A	Resistor	1 unit, 1.2-ohm wire- wound.	C. W. filament circuit	GE	ML7867303Pt12
26	2C6191/R5A	do	do	Mod. filament circuit	GE	ML7867303Pt12
27	3F7322	Voltmeter	15-v, a-c and d-c	Filament voltmeter	GE	
	2C6191/V4/2	Washer	Felt	Hold item 27		
28	3Z9608	Switch	SPDT rotary	Connect voltmeter	GE	Cat. 7760916G1
29	3Z9601	Switch	TONE C. W. VOICE selector.	Select operating condition	GE	Cat. 7760427G5
30	2C6191/T1	Transformer	Modulation output	Modulation circuit	GE	
31	2C6191/S2	Tube socket	For VT-4-B	Hold mod. tube	GE	Cat. 761594G1
32	2C6191/S2	do	do	do	GE	Cat. 761594G1
33	2C6191/C5	Capacitor	1-mf, 1,200-v, pyranol.	Mod. plate bypass	GE	ML7867303Pt9
34	2C6191/T2	Transformer	Modulator interstage	Modulator circuit	GE	ML7867303Pt16
35	2DB1.1	Capacitor	1-mf, 300-v	Mod. grid bypass	CD	ML7867303Pt17
36	3Z6650	Resistor	50,000-ohm, $\pm 10\%$, 1-w, carbon.	Mod. grid stabilizer	CCC	ML7867303Pt18
37	3Z6650	do	do	do	CCC	ML7867303Pt18
38	3Z6595	do	9,500-ohm, $\pm 10\%$, 5-w.	S. A. plate dropping	CCC	ML7867303Pt19
39	2C6191/R8	do	1-ohm, 4.5-w	S. A. fil. limiting	GE	ML7867303Pt20
40	2C6191/R8	do	do	do	GE	ML7867303Pt20
41	2Z8759	Tube socket	For VT-25	Hold S. A. tube	GE	ML7867303Pt22
	2C6191/I1	Washer	Fibre	For item 41		
42	2C6191/C5	Capacitor	1-mf, 1,200-v, pyranol.	S. A. plate bypass	GE	ML7867303Pt9

*Some sets were issued with reference number 20, value 100,000 ohms, while in others the value of this part was 25,000 ohms.

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
43	3DA10-8	do	0.01-mf, $\pm 10\%$, 2,500-v	Voltmeter bypass	CD	ML7867303Pt21
44	3DA10-8	do	do	S. A. feedback circuit	CD	ML7867303Pt21
45	3Z6003	Resistor	30-ohm, 0.2-w	Microphone current limiter.	AX	ML7867303Pt23
46	3DA1-4	Capacitor	0.001-mf, $\pm 10\%$, 2,500-v.	S. A. grid circuit	CD	ML7867303Pt24
47	2C6191/T3	Transformer	Audio, microphone to grid.	Couple mic. to S. A.	GE	
48	2C6191/K1	Coil	Audio choke	Microphone filter	GE	ML7867303Pt26
49	2C6191/R33	Resistor variable.	200-ohm potentiometer	Input level control	CHI	M7461569G3
50	3D310	Capacitor	25-mf, 25-v, d-c, electrolytic.	Microphone filter	AX	ML7867303Pt28
51	3Z9601	Switch	SPDT ganged to part 29.	Controls tone circuit	GE	Cat. 7760427G5
52	3Z6730	Resistor	300,000-ohm, $\pm 10\%$, 3/4-w, carbon.	S. A. grid stabilizer	CCC	ML7867303Pt29
53	3DB1.1	Capacitor	1-mf, 300-v	S. A. grid return bypass	CD	ML7867303Pt17
54	3Z6630-1	Resistor	30,000-ohm, $\pm 5\%$, 2-w	S. A. tone circuit	CCC	ML7867303Pt32
55	3Z9610	Switch	Single pole, 4-position	Sidetone control	YAX	M7461586G1
56	3Z8106	do	DPST toggle	Receiver control ckt	GE	K7868751Pt1
57	2Z8744	Socket SO-44	Cording plug receptacle	For PL-64	GE	W7350499Pts 46 & 47
58	2Z8739	Socket SO-39	do	For PL-59	GE	W7350499Pts 48 & 49

59	2Z8741	Socket SO-41	do	For PL-61	GE	W7350499Pt50
60	3Z9611	Switch	Special 2-position	A-c d-c fil. control	GE	Cat. 7760921G1

b. Transmitter tuning unit TU-AA-3 (stock No. 2C8003).

101		Coil	Variometer	M. O. tank	GE	T7659234Pt16
102	2C8003/D4	do	R. f. choke	M. O. plate filter	GE	M7460961G3
103	2C8003/D9	do	R. f. choke part 117	M. O. grid impedance	GE	M7461192G1
104	3DA2-8	Capacitor	0.002-mf, $\pm 5\%$, 5,000-v	M. O. grid blocking	CD	T7659234Pt62
106	2C8003/D8	Coil	R. f. choke	P. A. grid impedance	GE	M7460961G6
107	3Z9615	Switch	Rotary	M. O. band change	GE	T7659203G3
108	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	M. O. tank	CD	T7659234Pt21
109	3D9200-1	do	0.0002-mf, $\pm 5\%$, 3,000-v.	do	CD	T7659234Pt22
110	3DA3	do	0.003-mf, $\pm 5\%$, 5,000-v	M. O. to P. A. coupling	CD	T7659234Pt23
111	3DA3	do	do	do	CD	T7659234Pt23
112	3DA5	do	0.005-mf, $\pm 5\%$, 5,000-v	do	CD	T7659234Pt61
113	3DA2-8	do	0.002-mf, $\pm 5\%$, 5,000-v	do	CD	T7659234Pt62
114	3DA2-8	do	do	do	CD	Do.
115	3DA5	do	0.005-mf, $\pm 5\%$, 5,000-v	do	CD	T7659234Pt61
116	3D9026V	Capacitor, var	26-mmf, with mycalex insulation.	Neutralizing P. A	CAR	T7659234Pt9
117	3Z6001E5	Resistor	15-ohm, 4.5-w	Parasitic suppressor	GE	QLK2155993
121	2C8003/D1	Coil	Variometer	P. A. tank	GE	P7760511G1 less Pt8
122	3Z9615	Switch	Rotary part of item 107	P. A. band change	GE	T7659203G3
123	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	P. A. tank	CD	T7659234Pt21

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
124	3D9200-1	Capacitor	0.0002-mf, $\pm 5\%$, 3,000-v.	P. A. tank	CD	T7659234Pt22
125	3DA1-3	do	0.001-mf, $\pm 5\%$, 3,000-v.	do	CD	T7659234Pt32
126	3DA1-3	do	do	do	CD	Do.
127	2C8003/D1	Coil	Secondary of variometer 121.	Couple P. A. to ant.	GE	P7760511Pt8
128	3Z9605	Switch	6-position single pole	Ant. coupling	GE	Cat. 7760475G1

c. Transmitter tuning unit TU-AA-4 (stock No. 2C8004).

901		Coil	R. f. inductance	M. O. tank	GE	T7659210Pt97
902	3Z9614	Switch	Rotary	M. O. band change	GE	T7659203G2
903	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	M. O. tank	CD	T7659210Pt20
904	3D9100-7	do	do	do	CD	Do.
905	3D9100-7	do	do	do	CD	Do.
906	3D9050-1	do	0.00005-mf, $\pm 5\%$, 3,000-v.	do	CD	T7659210Pt80
907	3D9150V	Capacitor, variable.	150-mmf, mycalex insulation.	M. O. tank tuning	CAR	T7659210Pt23
908	2C8005/D10	Coil	R. f. choke	P. A. grid impedance	GE	M7461192G2
909	3DA2-8	Capacitor	0.002-mf, $\pm 10\%$, 5,000-v.	Coupling M. O. to P. A.	CD	T7659210Pt75
910	3DA2-8	do	do	M. O. grid feedback	CD	Do.
911	2C8005/D10	Coil	R. f. choke	M. O. grid impedance	GE	M7461192G2

912	3D9026V	Capacitor, variable.	26-mmf, mycalex insulation.	Neutralizing P. A.	CAR	T7659210Pt9
913	3Z6001E5	Resistor	15-ohm, 4.5-w	M. O. parasitic suppression.	GE	QLK2155993
914	3Z6001E5	do	do	P. A. parasitic suppression.	GE	QLK2155993
915	2C8010/D16	Coil	R. f. choke	M. O. plate filter	GE	M7461194G1
916	3Z6001E5	Resistor	15-ohm, 4.5-w	Neutralizing balance	GE	QLK2155993
921		Coil	R. f. inductance	P. A. tank	GE	P7760797G1 less Pts 3, 4, 9, 10.
922	3Z9614	Switch	Rotary	P. A. band change	GE	T7659203G2
923	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	P. A. tank	CD	T7659210Pt20
924	3D9100-7	do	do	do	CD	T7659210Pt20
925	3D9100-7	do	do	do	CD	T7659210Pt20
926	3D9030	do	0.00003 - mf, $\pm 5\%$, 2,000-v.	do	CD	T7659210Pt21
927	3D9150V	Capacitor, variable.	150-mmf, mycalex insulation.	P. A. tank tuning	CAR	T7659210Pt23
928		Coil	Tapped r. f. inductance, secondary of 921.	Couple P. A. to ant.	GE	P7760797Pt3, 4, 9, 10.
929	3Z9605	Switch	6-position, single pole	Ant. coupling	GE	Cat. 7760475G1

d. Transmitter tuning unit TU-AA-5 (stock No. 2C8005).

201	2C8005/D1	Coil	R. f. inductance	M. O. tank	GE	T7659210Pt100
202	3Z9614	Switch	Rotary	M. O. band change	GE	T7659203G2
203	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	M. O. tank	CD	T7659210Pt20
204	3D9100-7	do	do	do	CD	T7659210Pt20

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
205	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	M. O. tank	CD	T7659210Pt20
206	3D9030	do	0.00003-mf, $\pm 5\%$, 2,000-v.	do	CD	T7659210Pt21
207	3D9150V-1	Capacitor, variable.	150-mmf, mycalex insulation.	M. O. tank tuning	CAR	T7659210Pt101
208	2C8005/D10	Coil	R. f. choke	P. A. grid impedance	GE	M7461192G2
209	3D9400-3	Capacitor	0.0004-mf, $\pm 5\%$, 5,000-v.	Coupling M. O. to P. A.	CD	T7659210Pt22
210	3D9400-3	do	do	M. O. grid feedback	CD	Do.
211	2C8005/D10	Coil	R. f. choke	M. O. grid impedance	GE	M7461192G2
212	3D9026V	Capacitor, variable.	26-mmf, mycalex insulation.	Neutralizing P. A.	CAR	T7659210Pt9
213	3Z6001E5	Resistor	15-ohm, 4.5-w, part of 211.	M. O. parasitic suppression.	GE	QLK2155993
214	3Z6001E5	do	15-ohm, 4.5-w, part of 208.	P. A. parasitic suppression.	GE	QLK2155993
221	2C8005/D2	Coil	R. f. inductance	P. A. tank	GE	T7659210Pt15
222	3Z9614	Switch	Rotary, ganged to 202	P. A. band change	GE	T7659203G2
223	3D9100-7	Capacitor	0.0001-mf, $\pm 5\%$, 3,000-v.	P. A. tank	CD	T7659210Pt20
224	3D9100-7	do	do	do	CD	T7659210Pt20
225	3D9100-7	do	do	do	CD	T7659210Pt20
227	3D9150V	Capacitor, variable.	150-mmf, mycalex insulation.	P. A. tank tuning	CAR	T7659210Pt33

228	2C8005/D3	Coil	R. f. inductance, secondary of 221.	Couple P. A. to ant.	GE	T7659210Pt16
229	3Z9605	Switch	6-position, single pole	Ant. coupling	GE	Cat. 7760475G1

e. Transmitter tuning unit TU-AA-6 (stock No. 2C8006).

1301	2C8006/D1	Coil	R. f. inductance	M. O. tank	GE	T7659210Pt113
1302	3Z9612	Switch	Rotary	M. O. band change	GE	T7659555G1
1303	3D9050-1	Capacitor	0.00005-mf, $\pm 5\%$, 3,000-v.	M. O. tank	CD	T7659210Pt80
1307	3D9074V	Capacitor, variable.	74-mmf, mycalex insulation.	M. O. tank tuning	CAR	T7659210Pt89
1308	2C8006/D14	Coil	R. f. choke	P. A. grid impedance	GE	M7461192G6
1309	3D9400-3	Capacitor	0.0004-mf, $\pm 5\%$, 5,000-v.	Coupling M. O. to P. A.	CD	T7659210Pt22
1310	3D9400-3	do	do	M. O. grid feedback	CD	Do.
1311	2C8006/D14	Coil	R. f. choke	M. O. grid	GE	M7461192G6
1312	3D9026V	Capacitor, variable.	26-mmf, mycalex insulation.	Neutralize P. A.	CAR	T7659210Pt9
1313	3Z6001E5	Resistor	15-ohm, 4.5-w, part of 1311.	Parasitic suppression	GE	QLK2155993
1314	3Z6001E5	do	15-ohm, 4.5-w, part of 1308.	do	GE	Do.
1321	2C8006/D2	Coil	R. f. inductance	P. A. tank	GE	T7659210Pt116
1322	3Z9612	Switch	Rotary ganged with 1302.	P. A. band change	GE	T7659555G1
1323	3D9050-1	Capacitor	0.00005-mf, $\pm 5\%$, 3,000-v.	P. A. tank	CD	T7659210Pt80
1327	3D9110V	Capacitor, variable.	110-mmf, mycalex insulation.	P. A. tank tuning	CAR	T7659210Pt90

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
1328	2C8005/D3	Coil	Tapped r. f. inductance, secondary of 1321.	Couple P. A. to ant.	GE	T7659210Pt16
1329	3Z9605	Switch	6-position single pole	Ant. coupling	GE	Cat. 7760475G1

f. Transmitter tuning unit TU-AA-7 (stock No. 2C8007).

1001		Coil	R. f. inductance	M. O. tank	GE	T7659242Pt82
1002	3D9110V-2	Capacitor, variable.	110-mmf, mycalex insulation, 2 dielectrics out of phase.	M. O. tank tuning	CAR	T7659242Pt66
1003	3D9400-3	Capacitor	0.004-mf, $\pm 10\%$, 5,000-v.	M. O. grid feedback	CD	T7659242Pt62
1004	2C8006/D14	Coil	R. f. choke	M. O. grid impedance	GE	M7461192G6
1005	3DA2-8	Capacitor	0.002-mf, $\pm 10\%$, 5,000-v.	P. A. to M. O. coupling	CD	T7659242Pt21
1006	2C8007/D3	Coil	R. f. choke	P. A. grid impedance	GE	M7460961G1
1007	3D9026V	Capacitor, variable.	26-mmf, mycalex	P. A. neutralizing	CAR	T7659242Pt10
1014	3Z6001E5	Resistor	15-ohm, 4.5-w, part of 1004.	Parasitic suppressor	GE	QLK2155993
1021	2C8007/D4	Coil	R. f. inductance	P. A. tank	GE	P7760506G5 less Pt21
1022	3D9110V	Capacitor, variable.	110-mmf, mycalex insulation.	P. A. tank tuning	CAR	T7659242Pt15

1023	2C8008/D2	Coil	R. f. inductance, secondary of 1021.	Couple P. A. to ant.	GE	P7760506Pt21
1024	3Z9605	Switch	6-position, single pole.	Ant. coupling	GE	Cat. 7760475G1

g. Transmitter tuning unit TU-AA-8 (stock No. 2C8008).

501	2C8008/D1	Coil	R. f. inductance	M. O. tank	GE	T7659242Pt4
502	3D9074V-1	Capacitor, variable.	74-mmf, mycalex insulation.	M. O. tank tuning	CAR	T7659242Pt68
503	3D9400-3	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. grid feedback	CD	T7659242Pt62
504	2C8008/D5	Coil	R. f. choke	M. O. grid impedance	GE	M7460961G4
505	3D9400-3	Capacitor	0.0004-mf, $\pm 10\%$, 5,000-v.	M. O. to P. A. coupling	CD	T7659242Pt62
506	2C8008/D12	Coil	R. f. choke	P. A. grid impedance	GE	M7461192G3
507	3D9026V	Capacitor, variable.	26-mmf, mycalex insulation.	P. A. neutralizing	CAR	T7659242Pt10
508	3Z6001E5	Resistor	15-ohm, 4.5-w, part of 506.	Parasitic suppressor	GE	QLK2155993
521	2C8008/D2	Coil	R. f. inductance	P. A. tank	GE	P7760506G3 less Pt21
522	3D9074V	Capacitor, variable.	74-mmf, mycalex insulation.	P. A. tank tuning	CAR	T7659242Pt16
523	2C8008/D2	Coil	R. f. inductance, secondary of part 521.	Couple P. A. to ant.	GE	P7760506Pt21
524	3Z9605	Switch	6-position, single pole.	Ant. coupling	GE	Cat. 7760475G1

h. Transmitter tuning unit TU-AA-9 (stock No. 2C8009).

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
1101		Coil	R. f. inductance	M. O. tank	GE	T7659242Pt84
1102	3D9074V	Capacitor, variable.	74-mmf, mycalex insulation, end plate removed.	M. O. tank tuning	CAR	T7659242Pt86
1103	3D9400-3	Capacitor	0.0004-mf, \pm 10%, 5,000-v.	M. O. grid feedback	CD	T7659242Pt62
1104	2C8009/D6	Coil	R. f. choke	M. O. grid impedance	GE	M7460961G9
1105	3D9400-3	Capacitor	0.0004-mf, \pm 10%, 5,000-v.	M. O. to P. A. coupling	CD	T7659242Pt62
1106	2C8009/D6	Coil	R. f. choke	P. A. grid impedance	GE	M7460961G9
1107	3D9026V	Capacitor, variable.	26-mmf, mycalex insulation.	P. A. neutralization	CAR	T7659242Pt10
1121		Coil	R. f. inductance	P. A. tank	GE	P7760506G6 less Pts 24, 27, 34 & 37
1122	3D9110V	Capacitor	110-mmf, mycalex insulation.	P. A. tank tuning	CAR	T7659242Pt15
1123		Coil	R. f. inductance	Couple P. A. to ant.	GE	P7760506Pts 24, 27, 34, & 37
1124	3Z9605	Switch	6-position, single pole	Ant. coupling	GE	Cat. 7760475G1

i. Transmitter tuning unit TU-AA-10 (stock No. 2C8010).

601		Coil	R. f. inductance	M. O. tank	GE	T7659242Pt5
602	3D9110V-1	Capacitor, variable.	110-mmf, mycalex insulation.	M. O. tank tuning	CAR	T7659242Pt69

603	3D9400-3	Capacitor	0.0004-mf, \pm 10%, 5,000-v.	M. O. grid feedback	CD	T7659242Pt62
604	2C8010/D7	Coil	R. f. choke	M. O. grid impedance	GE	M7460961G5
605	3D9400-3	Capacitor	0.0004-mf, \pm 10%, 5,000-v.	M. O. to P. A. coupling	CD	T7659242Pt62
606	2C8010/D7	Coil	R. f. choke	P. A. grid impedance	GE	M7460961G5
607	3D9026V	Capacitor, variable.	26-mmf, mycalex insulation.	P. A. neutralization	CAR	T7659242Pt10
609	3D9400-3	Capacitor	0.0004-mf, \pm 10%, 5,000-v.	M. O. plate filter	CD	T7659242Pt62
610	2C8010/D16	Coil	R. f. choke	do	GE	M7461194G1
621		do	R. f. inductance	P. A. tank	GE	P7760506G4 less Pts 24, 25, 26 & 27
622	3D9110V	Capacitor, variable.	110-mmf, mycalex	P. A. tank tuning	CAR	T7659242Pt15
623		Coil	R. f. inductance, secondary of 621.	Couple P. A. to ant.	GE	P7760506G4 Pts 24, 25, 26, & 27
624	3Z9605	Switch	6-position, single pole	Ant. coupling	GE	Cat. 7760475G1

j. Antenna tuning unit BC-AA-193 (stock No. 2C503).

80		Coil	Variometer	Ant. tuning	GE	P7760467G1
81	3Z9613	Switch	5-position, single pole	do	GE	T7659203G1
82	3F288	Ammeter	5-amp., r. f.	Ant. current indicator	GE	T7659201Pt9

k. Antenna tuning unit BC-AA-194 (stock No. 2C504).

Reference No.	Stock No.	Name	Description	Function	Mfr.	Drawing No. GE
91	3D9200-1	Capacitor	0.0002-mf, $\pm 5\%$, 3,000-v.	Ant. series tuning	CD	T7659230Pt4
92	3D9200-1	do	do	do	CD	T7659230Pt4
93	3D9150V	Capacitor, variable.	150-mmf, mycalex insulation.	do	CAR	T7761042Pt4
94	3Z9601	Switch	4-position, single pole	Ant. tuning	GE	Cat. 7760475G2
95	3F288	Ammeter	5-amp., r. f.	Ant. current indicator	GE	T7659230Pt7
96	3Z9605	Switch	6-position, single pole	Ant. tuning	GE	Cat. 7760475G1
97	2C504/10	Coil	Variometer	do	GE	P7760495G1

l. Antenna turning unit BC-AA-204 (stock No. 2C514).

84		Coil	Variometer	Ant. tuning	GE	P7760467G2
85	3Z9613	Switch	5-position, single pole	do	GE	T7659203G1
86	3D9100-4	Capacitor	0.0001-mf, $\pm 5\%$, 5,000-v.	do	CD	T7659201Pt35
89	3F288	Ammeter	5-amp. r. f.	Ant. current indicator	GE	T7659201Pt9

m. Antenna switching relay BC-AA-196 (stock No. 2C496).

1551	2Z8757	Socket SO-57	Receptacle for cording table.	Holds plug PL-77	GE	P7760687Pts 32, 33
1552	2C496/4	Relay	Ant. switching, special	Ant. switching	GE	P7760628G5

n. Radio control box BC-AA-192 (stock No. 2C3192).

71	2Z8744	Socket	SO-44 cording receptacle.	Holds plug PL-64	GE	T7659606Pts 13, 14
72	2Z8742	do	SO-42 cording receptacle.	Holds plug PL-62	GE	T7659606Pts 11, 12
73	3Z9607	Switch	Toggle, SPST	Power OFF ON	GE	Cat. 7760916G2
74	2Z5524.1	Jack	2-contact	Connect key	GE	T7659606Pt10
75	2Z5523.2	do	3-contact	Connect microphone	GE	T7659606Pt9
76	2C3192/6	Resistor	2-ohm, 15-w	Current limiting	GE	QLK1924025

o. Junction box TM-AA-160 (stock No. 2Z5660).

1501	2Z8744	Socket	SO-44 cording receptacle.	For plug PL-64	GE	T7659583Pts 9, 10
1502	2Z8757	do	SO-57 cording receptacle.	For plug PL-77	GE	T7659583Pts 11, 12
1503	2Z8743	do	SO-43 cording receptacle.	For plug PL-63	GE	T7659583Pts 13, 14
1504	2Z8742	Socket	SO-42 cording receptacle.	For plug PL-62	GE	T7659583Pts 15, 16

65. Identical and interchangeable parts.—Parts which are electrically and mechanically identical and interchangeable but which have different reference numbers are listed below.

Reference No.	Stock No	Name	Description	Function	Mfr.	Drawing No. GE
1, 11, 31, 32	2C6191/S2	Tube socket	For VT-4-B	Hold tube	GE	none
3, 13	2C6191A/D1	Coil	R. f. choke	R. f. filter	GE	M7460961G8
1104, 1106	2C8009/D6	do	do	Grid impedance	GE	M7460961G9
604, 606	2C8010/D7	do	do	do	GE	M7460961G5
208, 211, 908, 911.	2C8005/D10	do	do	do	GE	M7461192G2
1308, 1311, 1004.	2C8006/D14	do	do	do	GE	M7461192G6
610, 915	2C8010/D16	do	do	Plate filter	GE	M7461194G1
5, 15	3D9100-5	Capacitor	0.0001-mf, $\pm 10\%$, 2,500-v.	Bypass	CD	ML7867303Pt3
14, 125, 126	3DA1-3	do	0.001-mf, $\pm 5\%$, 3,000-v.	Plate bypass	CD	ML7867303Pt7
22, 33, 42	2C6191/C5	do	1-mf, 1,200-v, py- ranol.	H. V. filter	GE	ML7867303Pt9
35, 53	3DB1.1	do	1-mf, 300-v	Audio bypass	CD	ML7867303Pt17
43, 44	3DA10-8	do	0.01 - mf, $\pm 10\%$ 2,500-v.		CD	ML7867303Pt21
112, 115	3DA5	do	0.005 - mf, $\pm 5\%$ 5,000-v.	M. O. to P. A. coupling.	CD	T7659234Pt61
91, 92	3D9200-1	do	0.0002 - mf, $\pm 5\%$, 3,000-v.		CD	T7659234Pt22

108, 123, 903, 904, 923 - 925, 203 - 205, 223 - 225.	3D9100-7	Capacitor	0.0001 - mf, $\pm 5\%$, 3,000-v.		CD	T7659234Pt21
110, 111	3DA3	Capacitor	0.003 - mf, $\pm 5\%$, 5,000-v.	M. O. to P. A. coupling.	CD	T7659234Pt23
104, 113, 114, 909, 910, 1005.	3DA2-8	Capacitor	0.002 - mf, $\pm 5\%$, 5,000-v.		CD	T7659234Pt62
906, 1303, 1323.	3D9050-1	Capacitor	0.00005 - mf, $\pm 5\%$, 3,000-v.		CD	T7659210Pt80
206, 926	3D9030	Capacitor	0.00003 - mf, $\pm 5\%$, 2,000-v.		CD	T7659210Pt21
209, 210, 503, 505, 603, 605, 609, 1003, 1103, 1105, 1309, 1310.	3D9400-3	Capacitor	0.0004 - mf, $\pm 5\%$, 5,000-v.		CD	T7659210Pt22
36, 37	3Z6650	Resistor	50,000-ohm, $\pm 10\%$, 1-w.	Mod. grid stabilizer	CCC	ML7867303Pt18
39, 40	2C6191/R8	Resistor	1-ohm, 4.5-w	S. A. fil. limiting	GE	ML7867303Pt20
117, 213, 214, 508, 913, 914, 916, 1313, 1314, 1014.	3Z6001E5	Resistor	15-ohm, 4.5-w	Parasitic suppressor	GE	QLK2155993
82, 89, 95	3F288	Ammeter	5-amp., r. f.	Ant. current indicator	GE	
57, 71, 1501	2Z8744	Socket SO-44	Cording receptacle	Holds plug PL-64	GE	W7350499Pts46, 47
2, 1504	2Z8742	Socket SO-42	Cording receptacle	Holds plug PL-62	GE	T7659606Pts11, 12
102, 1551	2Z8757	Socket SO-57	Cording receptacle	Holds plug PL-77	GE	

Reference No.	Stock No.	Name	Description	Function	M fr.	Drawing No. GE
9, 10	3Z9855	Switch	SPST	12V 14.2V fil. switch	GE	ML7867303Pt13
128, 929, 229, 1329, 1024, 524, 1124, 624, 96.	3Z9605	Switch	6-position, single pole.	Ant. coupling	GE	
902, 202	3Z9614	Switch	Rotary	M. O. band change	GE	T7659203G2
81, 85	3Z9613	Switch	5-position, single pole.	Ant. tuning	GE	T7659203G1
228, 1328	2C8005/D3	Coil	R. f. inductance	Ant. coupling	GE	T7659210Pt16
1023, 523	2C8008/D2	Coil	R. f. inductance	Ant. coupling	GE	P7760506Pt21

66. Manufacturers and their addresses.

<i>Abbreviation</i>	<i>Name</i>	<i>Address</i>
GE	General Electric Co.	1 River Road, Schenectady, N. Y.
IRC	International Resistance Co.	401 North Broad St., Philadelphia, Pa.
CD	Cornell-Dubilier Electric Co.	South Plainfield, N. J.
YAX	P. R. Mallory & Co.	Indianapolis, Ind.
CAR	The Allen D. Cardwell Mfg. Corp.	81 Prospect St., Brooklyn, N. Y.
AX	Aerovox Corp.	740 Belleville Ave., New Bedford, Mass.
CCC	Continental Carbon Co.	13900 Lorain Ave., Cleveland, Ohio.
CHI	Chicago Telephone Supply Co.	New Richmond, Ind.

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[A. G. 062.11 (9-8-42).]

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G. C. MARSHALL,
Chief of Staff.

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J. A. ULIO,
Major General,
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(For explanation of symbols see FM 21-6.)