Superseded File

INSTRUCTION BOOK

FOR

RADIO TRANSMITTER BC-191-C
RADIO TRANSMITTER BC-191-D
RADIO TRANSMITTER BC-191-E

AND

ASSOCIATED EQUIPMENT

MANUFACTURED BY

GENERAL ELECTRIC COMPANY
U. S. A.

PRO PATRIA VIGILANS

RESTRICTED

PUBLISHED BY AUTHORITY
OF
THE CHIEF SIGNAL OFFICER

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FOR

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THE CHIEF SIGNAL OFFICER

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SAFETY TO HUMAN LIFE

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH-VOLTAGE SUPPLY ON. DO NOT COMPLETE OR MAINTAIN ANY CONNECTION BETWEEN RADIO TRANSMITTER AND DYNAMOTOR UNIT UNLESS ALL DUPLICATE UNUSED SOCKETS ON THE RADIO TRANSMITTER ARE COVERED BY SOCKET CAPS WITH CATCHES PROPERLY SNAPPED IN PLACE.

KEEP AWAY FROM LIVE CIRCUITS

1. Under no circumstances should any person be permitted to operate the dynamotor unit with relay fuse box covers or end bells removed; or to replace fuses with power on; or to remove, place, or handle removed plugs with the dynamotor unit running.

2. Under no circumstances adjust circuits or service the equipment when only the carrier is keyed off. The radio transmitter uses a grid-bias keying circuit, which does not remove high voltage when the key is open.

DO NOT OPERATE THE EQUIPMENT WITH SHIELDS REMOVED

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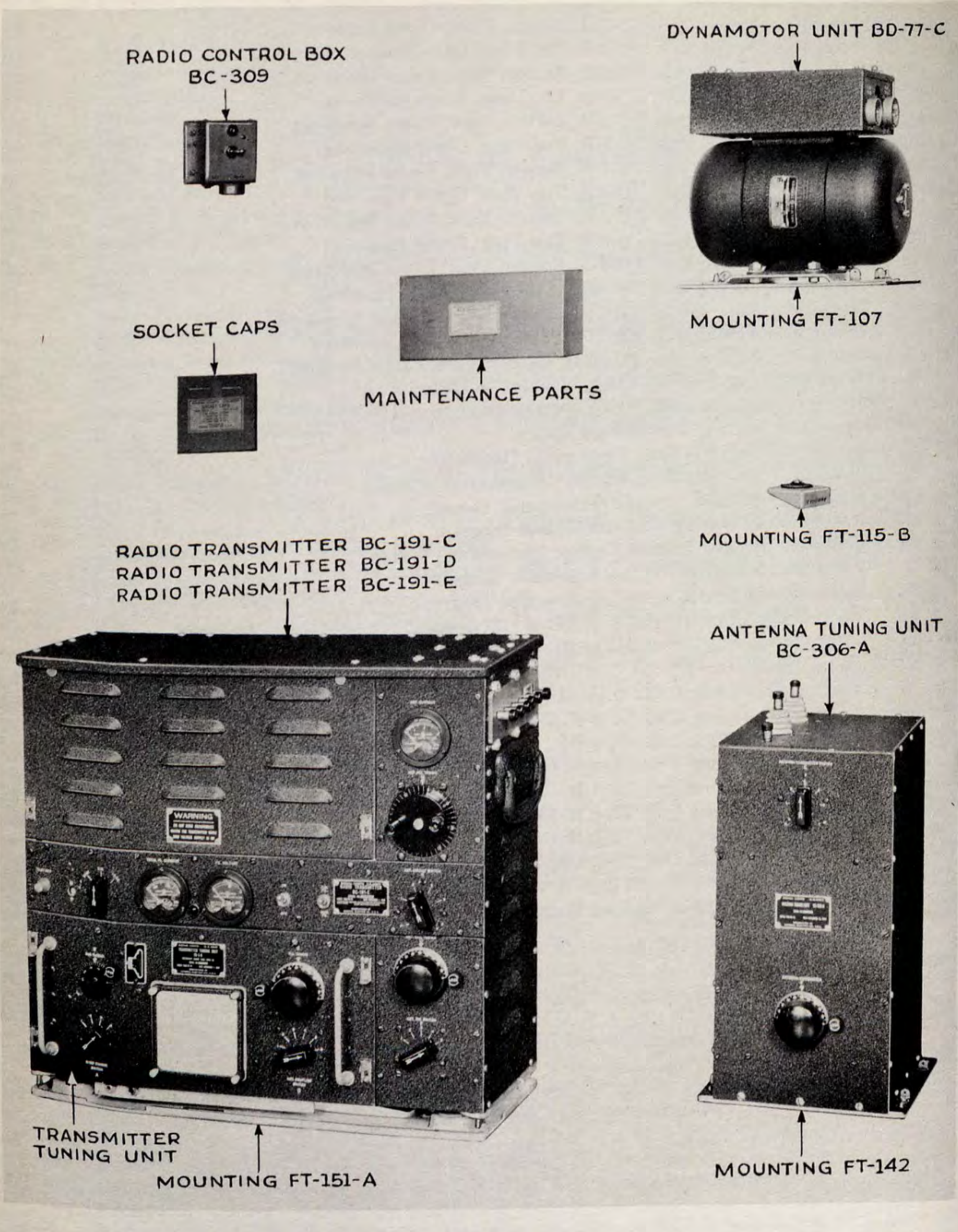


FIG. 1. RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E, AND ASSOCIATED EQUIPMENT

I. DESCRIPTION OF COMPLETE EQUIPMENT

GENERAL

1. Radio Transmitters BC-191-C, BC-191-D, and BC-191-E with their associated equipment are designed for aircraft, armored cars and other vehicles, portable ground stations and various applications requiring a medium power equipment with the characteristics of strength, light weight, flexibility, and portability. The equipment is designed to provide communication by voice, tone, or CW telegraph over the frequency range of 150 to 12,500 kilocycles. However, only the frequencies covered by the particular transmitting tuning units, which are included in the parts list of a specific radio set, are available for use with that radio set. Suitable tuning equipment is provided in the radio transmitter to permit operation into a wide range of antennas over most of the frequency range. Antenna Tuning Unit BC-306-A may be used to extend the range of antenna tuning for frequencies between 150 and 800 kilocycles.

Fig. 2. Antenna Tuning Unit BC-306-A

2. Radio Transmitters BC-191-C, BC-191-D, and BC-191-E are essentially identical except for minor mechanical constructional details which do not affect electrical performance and operation. Radio Transmitter BC-191-D is identical with Radio Transmitter BC-191-C except that the former uses a re-designed filament resistor connection board and a re-designed antenna loading switch. These two items are electrically and mechanically interchangeable with the corresponding parts in Radio Transmitter BC-191-C. Radio Transmitter BC-191-E includes the above new features and in addition has a new single unit filter capacitor pack (reference no. 1197 a, b, c) replacing three individual capacitors (reference numbers 1120, 1155 and 1163). This new part is electrically but not mechanically interchangeable with the three individual capacitors used in Radio Transmitters BC-191-C and BC-191-D.

3. Two types of equipment are available for furnishing the power required by the radio transmitter. Dynamotor Unit BD-77-C provides operation from a 12/14-volt storage battery or other d-c source for use in aircraft and vehicles. Suitable rectifiers or engine-driven power units are used in ground radio sets. The dynamotor unit is described in this Instruction Book. Separate books are required for the power units. The input power when operating on continuous wave telegraph will be approximately 560 watts. The fully modulated voice transmission will require 840 watts power input.

4. Because of the flexibility with which they can be adapted to fit different requirements and conditions of operation, Radio Transmitters BC-191-C, BC-191-D, and BC-191-E are component parts of a number of different radio sets intended for dissimilar applications. The other components, such as tuning units, power supply, cords, etc., are listed in the "Parts List" of each set.

ANTENNA TUNING UNIT BC-306-A (INCLUDES MOUNTING FT-142)

5. This unit consists of a painted duralumin case which houses a variometer 1502, control F; and a switch 1501, control E. Sufficient inductive reactance is provided in this unit, in addition to the reactance provided in the radio transmitter and transmitter tuning units, to resonate antennas whose effective capacitance varies as indicated on the following page.

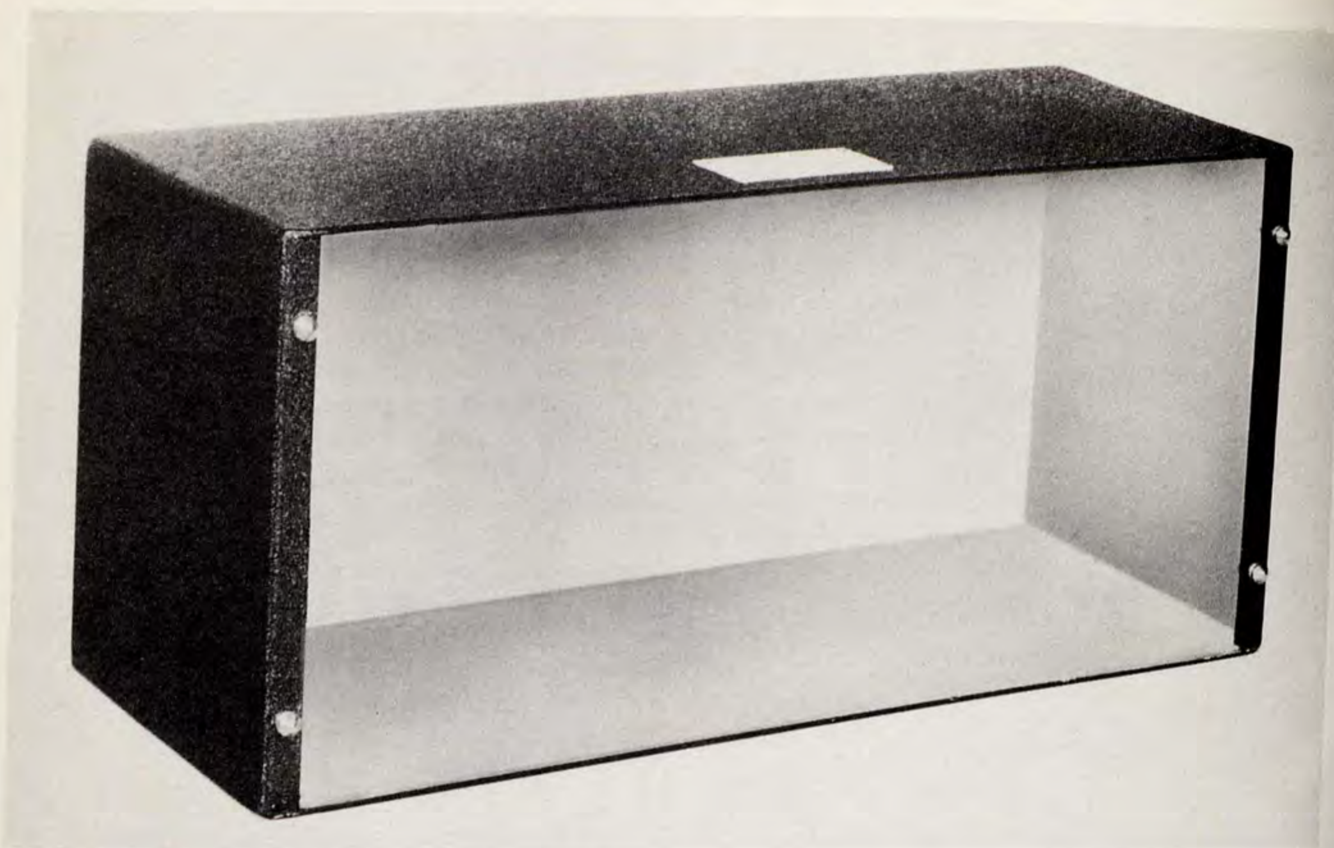


Fig. 3. Case CS-48

Frequency Range	Effective Capacitance Range
150–350 kc	1000–1500 mmfds
350–800 kc	350–800 mmfds

6. The controls permit a continuous variation of the inductive reactance. Suitably insulated binding posts are located on the top shield. Four snap-slide catches are used to attach the unit to Mounting FT-142.

7. The terminals at the top of the antenna tuning unit are for interconnection between the "loading" terminals of the radio transmitter when operating on frequencies above 400 kilocycles. For operation on frequencies below 400 kilocycles, the antenna tuning unit is connected in the antenna circuit and the two "loading" terminals are connected together as described in paragraph 36, section II, EMPLOYMENT.

CASE CS-48

8. This case consists of an individual metal container into which any one of the transmitter tuning units may be inserted and mounted or carried. The tuning unit is secured in the case by the same four snap-slide catches that are used to secure the unit in the radio transmitter.

DYNAMOTOR UNIT BD-77-C (INCLUDES MOUNTING FT-107)

9. Dynamotor Unit BD-77-C consists of a dynamotor upon which is mounted a box containing the relay, fuses, sockets, capacitors, etc. The dynamotor proper is a two-pole, totally enclosed, ball-bearing, d-c to d-c rotating machine. It is rated at 14 volts—40 amperes input, 1000 volts—0.35 ampere output at 5000 rpm, with 55 deg. Centigrade rise for ½ hour intermittent duty. It has been designed to give efficient, reliable service over long periods of time with a minimum of attention. Skeleton type bearing brackets on each end afford maximum accessibility of the commutators and brushes. The portion of the armature winding between each commutator and armature core is securely bound with cord and thoroughly impregnated, thus affording a mechanical protection for the armature winding against injury from moisture, dirt, and abrasion. The external leads of the dynamotor go directly into the relay-fuse box through two bushings in the top of the magnet frame.

FIG. 4. DYNAMOTOR UNIT BD-77-C

10. A totally enclosed, solenoid type starting relay, particularly designed to withstand vibration, sudden shock and acceleration as encountered in aircraft installation is used. The double-break contacts are sufficiently large to carry the heavy starting current of the dynamotor.

11. The input binding posts and fuse clips are mounted on and securely pinned to a molded terminal board. In addition, all fuse clips and terminals are soldered to their mounting screws so as to insure a tight, low-resistance, electrical contact.

12. Four snap-slide catches are employed to fasten the cover to the relay-fuse box. A spare H-V fuse, spare fuse links, and a socket wrench are carried in clips inside of this cover. In one end of the relay fuse-box are mounted the Sockets SO-39 and SO-41. A $\frac{15}{16}$ in. diameter hole for entrance of a conduit containing the two power-input leads is provided between these sockets.

13. A radio-frequency interference filter is included. This is designed to eliminate objectionable noise in associated receiving equipment due to the operation of the dynamotor alone. The filter consists of capacitors connected so as to by-pass various dynamotor circuit points and give maximum noise suppression.

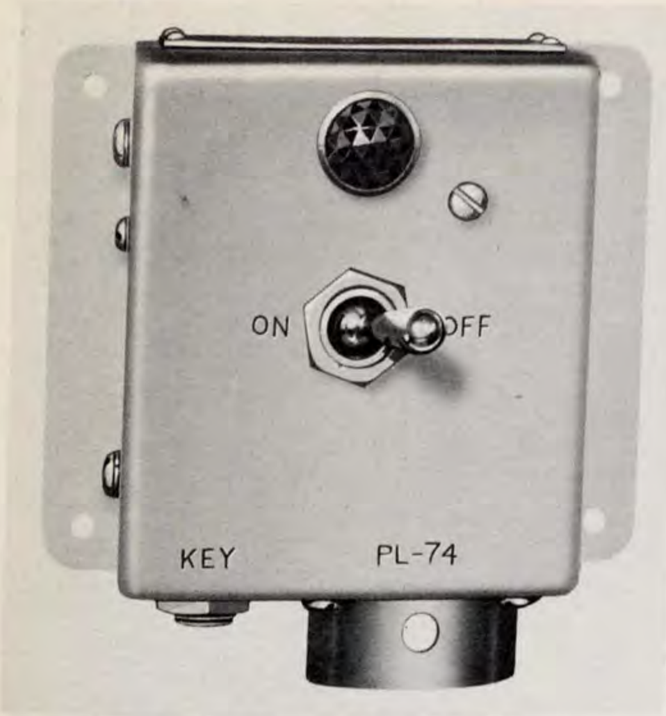


Fig. 5. Radio Control Box BC-309

RADIO CONTROL BOX BC-309

14. Radio Control Box BC-309 permits remote control of Radio Transmitters BC-191-C, BC-191-D, and BC-191-E. It contains an ON-OFF switch, 1302; a pilot light, 1304; a key jack, 1303 (for Plug PL-47 or PL-55), and a socket, 1301 (for Plug PL-74). The circuit diagram is shown in Fig. 61. The inside of the control box is accessible by removing the four screws in the sides of the box near the base.

RADIO TRANSMITTERS BC-191-C, BC-191-D, AND BC-191-E (INCLUDES MOUNTING FT-151-A)

15. Radio Transmitters BC-191-C, BC-191-D, and BC-191-E consist of a shielded metal cabinet containing the necessary vacuum tubes, sockets, antenna tuning equipment, audio-frequency circuits, input and output terminals, and plug connectors for connection to the radio-frequency circuits contained in the transmitter tuning units. The circuits of these units are shown in Figs. 63 and 65, and their external dimensions are shown in Fig. 67.

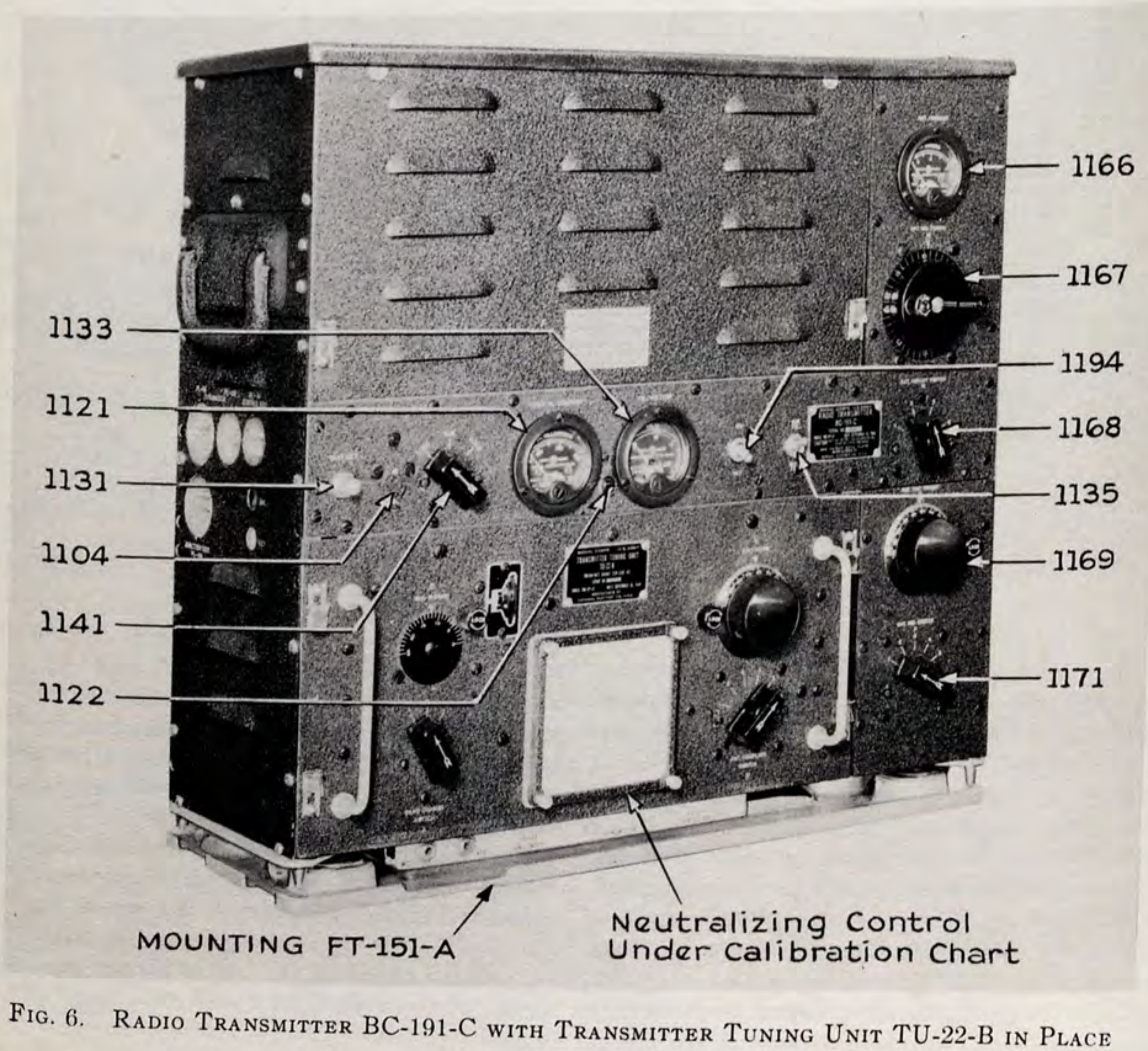


Fig. 6. Radio Transmitter BC-191-C with Transmitter Tuning Unit TU-22-B in Place

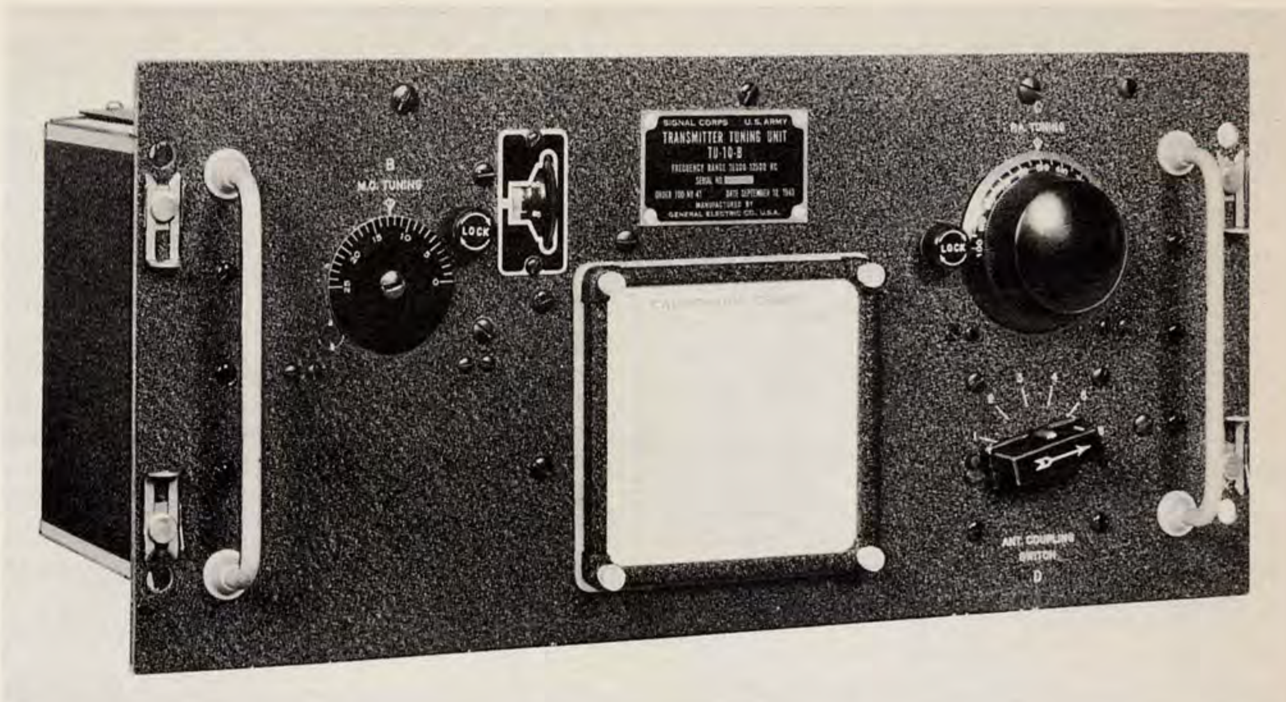


FIG. 7. TYPICAL FRONT VIEW OF A TRANSMITTER TUNING UNIT WITHOUT A BAND CHANGE SWITCH

16. The transmitter frame is constructed of seamless chrome-molybdenum steel tubing. Shields are attached to this frame by means of button-head machine screws in all cases except the front tube compartment shield, which is fastened by means of snap catches. Vacuum tubes are mounted in the upper front portion of the frame and are readily accessible by removal of the aforementioned tube compartment shield. The right-hand side of the frame includes the antenna tuning equipment. The test key, signal switch, filament voltage and plate current meters, indicator lamp, on-off switch, and voltmeter switch are mounted on a narrow panel below the tube compartment. Access to the calibration reset capacitor is gained through a small port in this panel. The bottom front portion of the radio transmitter is provided with accurately fitted guides to receive the transmitter tuning units which are slid into place so that the tuning unit panel forms the bottom front portion of the transmitter panel. Sockets and jacks for external power and control circuit connections are provided in duplicate; one set on the bottom, the other on the left-hand side of the transmitter.

17. The radio transmitter uses five vacuum tubes as follows:

- 1 Tube VT-4-C as master oscillator
- 1 Tube VT-4-C as power amplifier
- 2 Tubes VT-4-C as class B modulators
- 1 Tube VT-25 as speech amplifier or audio-frequency oscillator.

TRANSMITTER TUNING UNITS TU-3-B, ETC.

18. There are eight transmitter tuning units covering the frequency range of 350 to 800 and 1500 to 12,500 kilocycles, as listed below:

1.	TU-3-B	400–800 kc
2.	TU-5-B	1500–3000 kc
3.	TU-6-B	3000–4500 kc
4.	TU-7-B	4500–6200 kc
5.	TU-8-B	6200–7700 kc
6.	TU-9-B	7700–10,000 kc
7.	TU-10-B	10,000–12,500 kc
8.	TU-22-B	350–650 kc.

19. Each of these units consists of a duralumin case in which are housed the radio-frequency circuits for the master oscillator and power amplifier. The unit is plugged into the radio transmitter, its front panel forming a part of the transmitter front panel. The circuits of all transmitter tuning units are shown in Fig. 68. The tuning unit panel contains the following controls: band-change switch, control A (used only when tuning controls do not cover the complete frequency range), master-oscillator tuning, control B, power-amplifier tuning, control C, antenna coupling switch, control D, and neutralizing capacitor control. Since the neutralizing capacitor does not require adjustment in service, it is made accessible only by removal of the tuning chart which is mounted to the front panel.

CO-ORDINATION OF UNITS

20. The various units previously described, when connected together by their respective cords, comprise the transmitting equipment of a radio set. The following additional items are necessary to make a complete operative installation:

(a) Radio receiving equipment including headsets
(b) Suitable antenna system
(c) Microphone T-17, or equivalent
(d) Hand telegraph key
(e) Primary power source
(f) Plugs and cordage

AIRCRAFT RADIO SETS

21. In the aircraft radio sets, the receiving equipment is interconnected with the transmitting equipment so that they are co-ordinated for break-in operation. The receiver can be operated when the radio transmitter is either "OFF" or "ON," provided that neither the telegraph key nor the microphone switch is depressed. It is impossible for the radio transmitter and receiver to be operative at the same time; that is, the keying relay in the radio transmitter, when it causes the radio transmitter to function, at the same time open-circuits the receiver plate, or screen-grid supply, and only transmitter side tone is heard in the headset. When the keying relay opens, transmitter output ceases and the receiver plate, or screen-grid supply, is restored. The radio transmitter is made ready for operation by its OFF-ON switch, or that on the Radio Control Box BC-309, and transmission is controlled by the telegraph key or the microphone switch.

LIST OF MAIN UNITS

22. The tabulation on page 7 gives the sizes and weights of the main units.

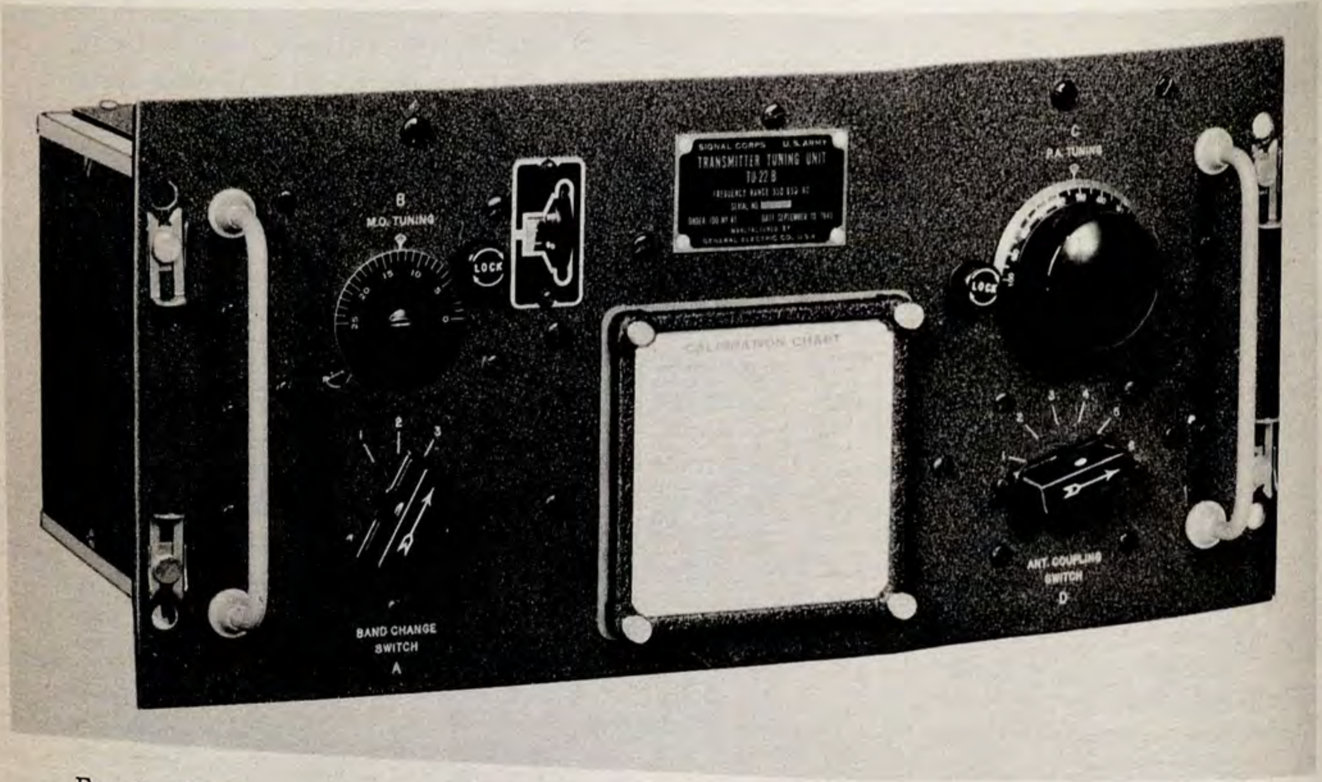


FIG. 8. TYPICAL FRONT VIEW OF A TRANSMITTING TUNING UNIT WITH A BAND CHANGE SWITCH

Description	Dimensions in Inches H x W x D	Wt. in Pounds
Antenna Tuning Unit BC-306-A	17¾x9½x9⅛	9.75
Weight less Mounting FT-142		9.062
Case CS-48	7⅞x16¾x7$\frac{29}{32}$	4.375
Dynamotor Unit BD-77-C	10$\frac{29}{32}$x11$\frac{1}{16}$x7½	38.7
Weight less Mounting FT-107		37.25
Mounting FT-107	$\frac{13}{16}$x10⅝x7½	1.45
Mounting FT-115-B	1$\frac{7}{32}$x2⅛x2$\frac{5}{16}$	0.195
Mounting FT-142	$\frac{13}{32}$x9½x8	0.69
Mounting FT-151-A	1.352x22x8	3.75
Mounting FT-151-B	1.352x22x8	3.66
Radio Control Box BC-309	3$\frac{9}{16}$x3½x2$\frac{7}{32}$	0.418
Radio Transmitter BC-191-C (without tubes or tuning units)	21$\frac{21}{32}$x23⅛x9$\frac{5}{16}$	55.00
Radio Transmitter BC-191-D (without tubes or tuning units)	21$\frac{21}{32}$x23⅛x9$\frac{5}{16}$	55.00
Radio Transmitter BC-191-E (without tubes or tuning units)	21$\frac{21}{32}$x23⅛x9$\frac{5}{16}$	55.00
Weight less Mounting FT-151-A		51.25
Transmitter Tuning Unit TU-3-B	7⅝x16¾x8¾	13.00
Transmitter Tuning Unit TU-5-B	7⅝x16¾x8¾	14.437
Transmitter Tuning Unit TU-6-B	7⅝x16¾x8¾	12.437
Transmitter Tuning Unit TU-7-B	7⅝x16¾x8¾	11.687
Transmitter Tuning Unit TU-8-B	7⅝x16¾x8¾	11.437
Transmitter Tuning Unit TU-9-B	7⅝x16¾x8¾	11.437
Transmitter Tuning Unit TU-10-B	7⅝x16¾x8¾	11.437
Transmitter Tuning Unit TU-22-B	7⅝x16¾x8¾	12.250
Tube VT-4-C	2$\frac{5}{16}$ dia.x7⅞ long	0.46
Tube VT-25	2$\frac{3}{16}$ dia.x5⅝ long	0.125
1 Carton of Maintenance Parts. This carton contains:	2¾x3⅞x7⅞	1.75
4—Brushes BR-5 (Dynamotor H.V.)		
4—Brushes BR-6 (Dynamotor L.V.)		
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—Set Screw Wrenches		
¼—Pt. of Glyptal Varnish No. 1153		
1—Carton of Socket Caps. This carton contains:	1½x3½x3½	0.375
1—Socket Cap M-163-A		
1—Socket Cap M-164-A		
2—Socket Caps M-165-A		

II. EMPLOYMENT

INSTALLATION

23. Radio Transmitters BC-191-C, BC-191-D, BC-191-E and associated equipment are part of aircraft, vehicular and portable ground radio sets. Accordingly, conditions vary widely and no detailed single set of installation instructions can be given in this book. However, separate instructions are furnished for each radio set and only such general instructions as should be followed in all installations are given in the following paragraphs.

24. The requirements for shielding and bonding of cords in aircraft installations are very rigid, in order that difficulties with the receiver side-tone pick-up and radio-frequency from the power supply will be minimized.

Radio Transmitters BC-191-C, BC-191-D, and BC-191-E

25. The radio transmitter outline dimensions and weights are shown in Fig. 67.

26. The radio transmitter should be located in relation to its associated equipment so that dynamotor unit and antenna leads will be of minimum length.

FIG. 9. MOUNTING FT-115-B

Two types of shock-absorber mountings are available for use with the radio transmitter: Mounting FT-151-A or FT-151-B, tray-type; and Mounting FT-115-B, disposable-type. The selection of one or the other, or a combination of the mountings, is governed by installation conditions. The tray-type mounting, to which the radio transmitter is attached by four snap-slide catches, is most convenient and is generally used, usually with the disposable mounting added near the top of the radio transmitter to prevent swaying. Mounting FT-115-B consists of a rubber button in a steel shell which may be attached to the top, bottom, or sides of the radio transmitter. Certain transmitter-cover fastening screws have been placed so as to allow attachment of this mounting.

27. The radio transmitter should not be mounted closer than two inches from a wall, and in aircraft and vehicular installations, Mounting FT-115-B must be added at the top of the radio transmitter to prevent excessive swaying. The power cords or flexible conduit should not be fastened nearer than 12 inches from the radio transmitter. This precaution prevents vibration from being transmitted to the unit through the cords. It is important that sufficient space be allowed in the front of the radio transmitter to facilitate replacement of tubes, removal of transmitter tuning unit, and the making of tuning adjustments. After installation has been completed and tested, the snap-slide catches should be securely safety-wired at the places provided.

28. *Be sure that the AC–DC switch in the tube compartment is safety-wired in the proper operating position.*

Radio Control Box BC-309

29. The control box should be mounted in the position most convenient for the operator. In case several locations are possible for this unit, the one giving the shortest length of cords should be chosen. Outline dimensions and weight are shown in Fig. 62.

Dynamotor Unit BD-77-C (Includes Mounting FT-107)

30. Outline dimensions and weight are shown in Fig. 59. The dynamotor unit should be mounted in an accessible position to allow access to the relay-fuse box, keeping in mind that the length of the leads from the battery to the dynamotor unit must be as short as practicable. This unit when operated in conjunction with Radio Transmitter BC-191-C, BC-191-D, or BC-191-E draws from 40 to 50 amperes. No. 6 AWG or larger conductor should therefore be used for these leads in order to keep the voltage drop at a minimum. In any case the total resistance of the primary power circuit should not exceed 0.04 ohms. Mounting FT-107 should be securely attached so that the dynamotor unit cannot be torn loose by acceleration, vibration, or shock.

31. After the dynamotor unit is clamped securely to Mounting FT-107 by means of the four snap-slide catches, Plugs PL-59 and PL-61 of the applicable cords should be plugged into Sockets SO-39 and SO-41, respectively, on the dynamotor unit. The primary leads from the battery or junction box should then be clamped securely to the proper binding posts on the dynamotor unit terminal board. Safety-wire all four snap slides used to attach the dynamotor unit to its mounting.

Junction Boxes TM-178 and TM-178-A

32. These units, when used, should be located for the best routing of cords in the particular installation. Since these units contain no controls which are required to function during the operation of the equipment, they can be mounted in a relatively inaccessible location. In most installations, these junction boxes are replaced by a suitable "built-in" junction box.

Cords

33. The cords to be used with the various radio sets are listed in the parts lists for same. Separate instruction books for the vehicular and ground radio sets show the method of installation of the cords. The transmitter schematic diagrams show the necessary cording for Radio Transmitters BC-191-C, BC-191-D, and BC-191-E. A typical cording arrangement of an aircraft radio set is shown in Fig. 77.

Antennas

34. Because of the wide variety of antennas in the radio sets of which Radio Transmitter BC-191-C, BC-191-D, or BC-191-E is a part, no specific details will be given for antenna installations. However, the following general precautions should be observed:

a. The antenna and ground or counterpoise leads should be made as short as possible, except in ground sets where the length of lead-in is definitely determined.

b. Antenna leads should be insulated to withstand radio-frequency potentials as high as 5000 volts.

c. Antenna leads should be so placed that operating personnel will not come in contact with them during normal operation of the equipment. Points accessible to personnel should be covered with isolantite beads.

d. Ground connections should have as low resistance as possible. In aircraft installations the ground path should be well bonded. In ground radio sets a counterpoise system is normally required and should be used unless a low resistance ground connection can be obtained.

e. In installations where a ground system is used instead of a counterpoise, a suitable copper link should be placed between the "CPSE" and "GND" posts on the output terminal board. The "GND" post should always be connected to the ground system by a short lead, allowing, of course, for flexure due to vibration and shock. An additional link will be required between posts "LOAD A" and "LOAD B" when Antenna Tuning Unit BC-306-A is not used. This antenna tuning unit is not recommended when frequencies above 800 kilocycles are used.

Antenna Tuning Unit BC-306-A

35. This tuning unit is provided with Mounting FT-142. It should be mounted so that the tuning controls will be accessible during operation. It is desirable that the length of leads between the radio transmitter and the antenna tuning unit be kept to a minimum and that the leads be well insulated. Outline dimensions and weight are shown in Fig. 56.

36. For operation on frequencies above 400 kilocycles, terminals "A—TRANS." and "B—ANT." on the antenna tuning unit are connected to LOADING TERMINALS "A" and "B" respectively, on the radio transmitter. For operation on frequencies below 400 kilocycles, a jumper is placed across LOADING TERMINALS "A" and "B" on the radio transmitter. Terminal "A—TRANS." on the antenna tuning unit is then connected to the antenna post on the radio transmitter while the antenna connection is made to terminal "B—ANT." The post marked "GND" on the antenna tuning unit should always be connected to the transmitter ground.

Reel RL-30-B and Connector Clamp MC-163

37. The reel should be mounted in such a position that the crank is readily accessible and the counter is visible. In order to prevent excessive "piling" when the wire is being reeled in, the reel should be mounted at least six inches above the fairlead and so placed that the point at which the antenna wire leaves the spool is in line with the axis of the fairlead; that is, for best operation there should be no bends in the antenna wire between the point where it leaves the reel and the far end of the fairlead. The four mounting bolts can be inserted in the reel base through the hole provided in the web of the spool. Unless the mounting screws themselves are grounded, a heavy grounding wire or strap should be clamped under the nut of one of the mounting screws for the purpose of thoroughly grounding all metal parts of the reel.

38. To fasten the antenna wire to the bottom of the spool channel it is first necessary to remove the spool cover by withdrawing it forward over the spool. This can best be done by placing the fingers of both hands on opposite sides of the cover and pressing on the spool with the thumbs. The end of the wire should be looped under the anchor pin in the spool hub and then twisted around the wire proper a few times. The twisted loop should then be placed in the groove and all of the wire wound on the spool by turning the crank in a clockwise direction. At this point, the cover should be replaced by passing the wire through the slot opposite the wire opening and pushing the cover over the spool until it rests against the flange on the back plate. The cover should now be rotated so that the wire from the fairlead to the spool will not rub the edges of the wire opening in

the cover either when the spool is full or nearly empty. The counter should now be set to zero. This should be done each time the reel is used in order to reduce the error in the reading caused by irregularities in winding.

39. Electrical connection is made by means of Connector Clamp MC-163, the installation of which is as follows:

a. Remove the brass bushing from Connector Clamp MC-163 by loosening screw in top of cover and fasten the antenna lead from the radio transmitter to this bushing by means of the screw provided.

b. Replace the bushing in cover and place the connector over the top of the fairlead, clamping it into place by means of the screw in the side of the cover.

c. Wind approximately 250 feet of Wire W-106 on the spool and feed the free end through the connector clamp and fairlead until it touches the ground below the airplane.

d. Connect the free end of the wire to the cable loop on the Weight WT-9. Considerable care should be taken in making the connection between the antenna wire and the weight cable in order that the joint will run smoothly through the connector clamp while the antenna is being let out or reeled in. The loop formed in the antenna wire should be as small as practicable and the section where the antenna wire is twisted back upon itself should be tapered and made as short as a safe joint will permit.

e. Wind up the antenna wire in the reel until the Weight WT-9 rests securely in the fairlead socket. Let out and reel in approximately ten feet of the antenna several times (have someone pull lightly on the weight to keep the antenna wire tight) to insure that the connector clamp is working properly and that the joint between the antenna wire and weight cable runs smoothly through the clamp.

40. Fairlead Extension F-9 is used when the standard Fairlead F-8 is not long enough. It consists of Coupling MC-161 and a 36-inch length of standard phenolic tubing of the same cross section as the tube of Fairlead F-8. The extension is installed by slipping

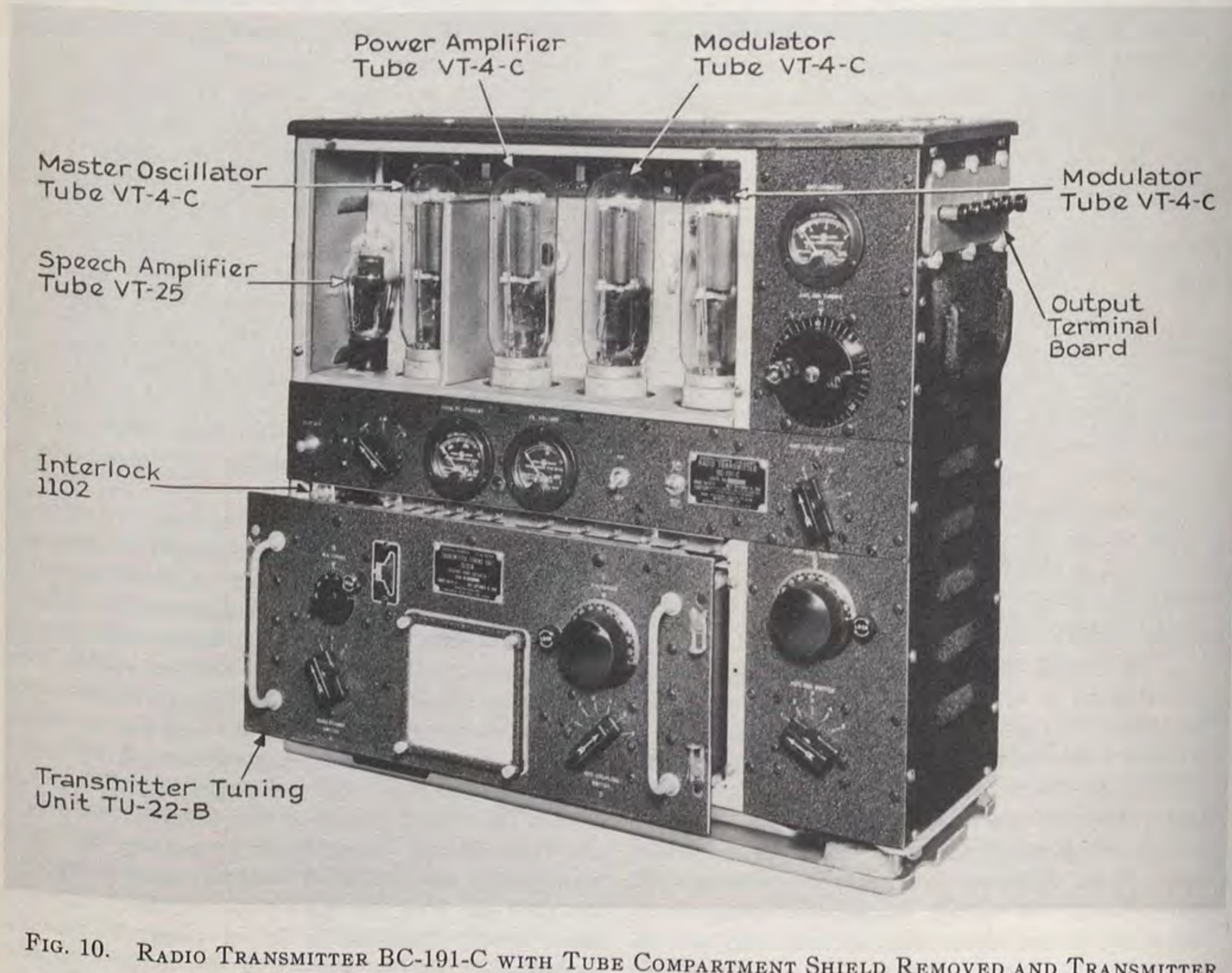


FIG. 10. RADIO TRANSMITTER BC-191-C WITH TUBE COMPARTMENT SHIELD REMOVED AND TRANSMITTER TUNING UNIT TU-22-B BEING INSERTED

Coupling MC-161 over the top of the fairlead tube so that it covers approximately 3 inches of the tube and then securing it in place by means of one of the clamps provided. The tubing may then be clamped into the coupling by means of the remaining clamp. This tubing may be cut to fit a particular installation, or more than one extension may be used if required.

Interconnection with the Radio Receiver in Aircraft

41. It is necessary, in order to minimize receiver noise, that the cord shields be well grounded and so supported that they cannot rub on other cords or metal surfaces. In order that receiver and transmitter operation will be co-ordinated, the toggle switch located in Junction Box TM-178 should be in position No. 1 should this junction box be used in the installation.

PREPARATION FOR USE

42. After installation and before the equipment is put into operation, the circuits of all cords and external wiring should be checked to insure compliance with the circuit diagram and the applicable interconnection diagram. This circuit check should be made with all plugs removed from the sockets in the radio transmitter and power unit to determine that all cord and junction box connections are made as indicated on the diagrams. A voltmeter and battery may be used for this purpose. The plugs should be replaced in their respective sockets after this check.

Radio Transmitters BC-191-C, BC-191-D, and BC-191-E

43. The following procedure is recommended for preparing the radio transmitter for use after installation:

a. Remove Plug PL-59 from the power unit, or dynamotor unit, and cover its socket with a Socket Cap M-164-A.

b. Remove the tube compartment shield and insert the tubes. From the front of the radio transmitter, progressing from left to right, the tubes are as follows: (See Fig. 10):

Tube VT-25; Speech amplifier
Tube VT-4-C; Master oscillator
Tube VT-4-C; Power amplifier
Tube VT-4-C; Modulator
Tube VT-4-C; Modulator

c. *D-c Filament Supply.* (Note: This subparagraph refers to direct-current filament operation only. Instructions for adjusting the filament voltage when operating from an a-c power source will be furnished as a part of the operating instructions for the a-c power unit.)

(1) Place the AC–DC switch in the tube compartment in the DC position.

(2) Remove all links from the filament resistor connection board. See Figs. 11 and 12.

(3) Assuming that the primary source voltage is 14.25 (the terminal voltage of a 12-volt storage battery under charge), place the 12 V./14.2-V. switch in the tube compartment in the 14.2-volt position.

(4) Set the transmitter signal switch on CW and the filament voltmeter switch on CW FIL.

(5) Place the OFF–ON switch in the ON position. This should start the dynamotor and apply filament supply potential to the radio transmitter, but not to the tubes. With a screwdriver or a short piece of copper wire, No. 12 B & S or larger, connect between adjacent studs on the 14 V. and CW FILAMENT rows. The CW filaments will light and the filament voltmeter read. Repeat this until the two studs are found that, when connected, will cause the filament voltmeter to read slightly over 10 volts. Then place the OFF–ON switch in the OFF position and connect a link between the two studs just selected.

(6) Set the transmitter signal switch on VOICE and the filament voltmeter switch on MOD. FIL. Repeat the operation of (5) for the 14 V. and MOD. FILAMENT rows of studs.

(7) Again place the OFF–ON switch in the ON position. Set the filament voltmeter switch on CW FIL. (signal switch on VOICE). The CW filament voltage will now be less than 10 volts. In the same manner, connect between the adjacent studs of the COMP. and CW FILAMENT rows until the filament voltmeter again reads slightly over 10 volts. The OFF–ON switch may then be placed in the OFF position and the link fastened in the proper place.

(8) Cut off the charging generator, place the 12 V./14.2-V. switch in the 12-volt position and, in a similar manner to the preceding, select the proper studs on the 12 V. and CW FILAMENT rows and the 12 V. and MOD. FILAMENT rows so that the filament voltmeter will indicate slightly over 10 volts in either position. As now adjusted the filament voltages will not require further adjustment unless the cable lengths or charging rates are changed. Ordinarily, in aircraft installations and vehicles, a battery-charging generator is used at all times. The 12 V./14.2 V.-switch should accordingly be placed in the 14.2-volt position. If it is desired to check the operation of the radio equipment when the charging generator is below operating speed, this switch should be changed to the 12-volt position since operation at low voltage will reduce the life of the tubes.

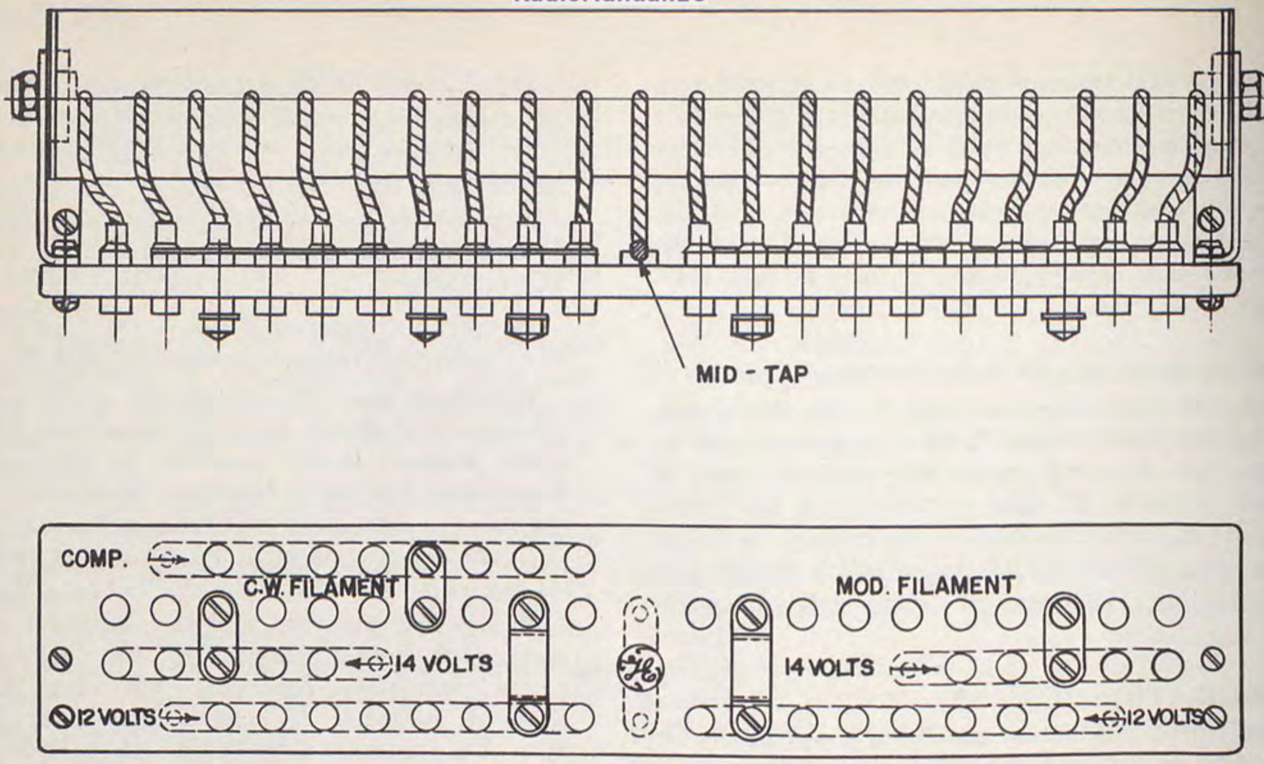


FIG. 11. RADIO TRANSMITTER BC-191-C, FILAMENT RESISTOR AND TERMINAL BOARD

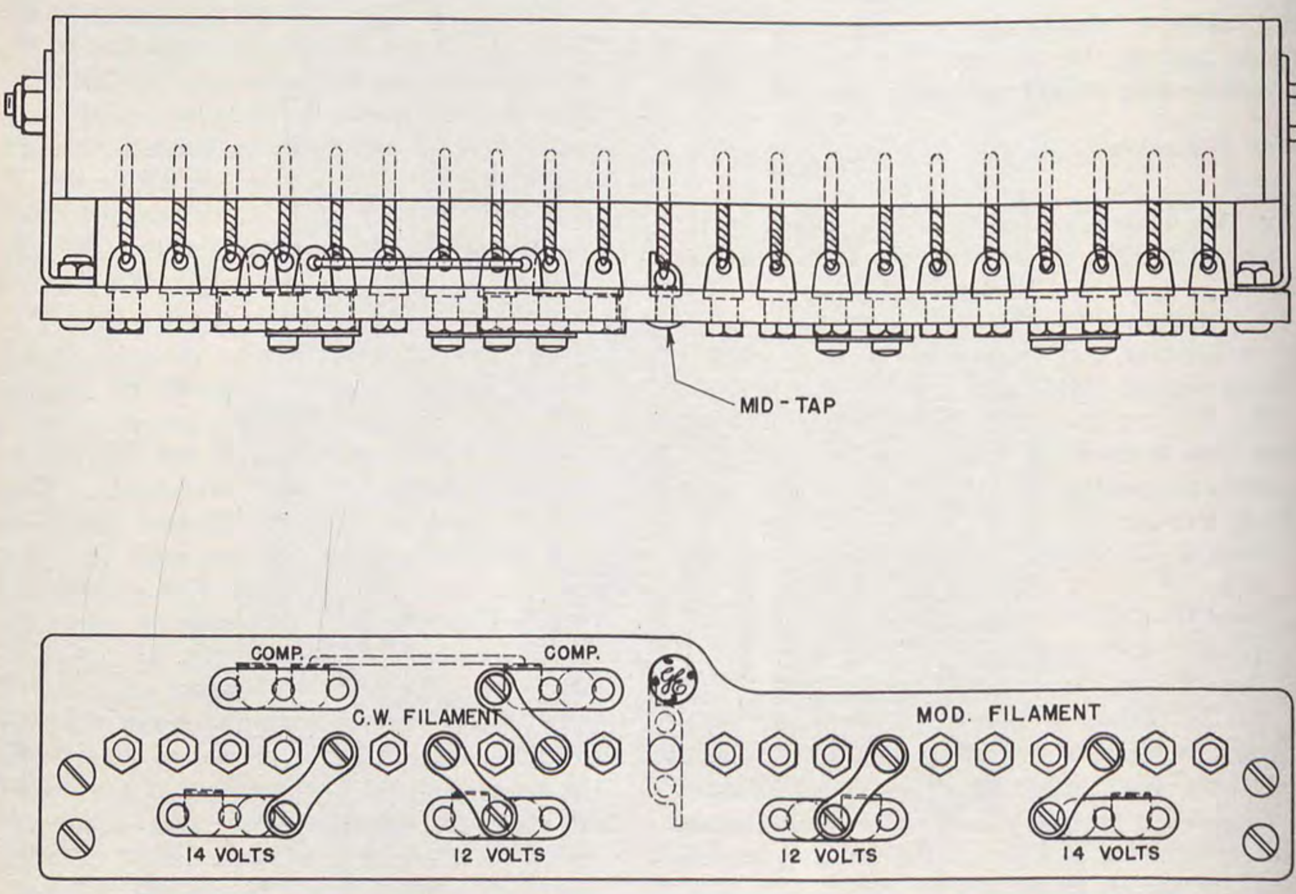


FIG. 12. RADIO TRANSMITTER BC-191-D OR BC-191-E, FILAMENT RESISTOR AND TERMINAL BOARD

d. Replace Plug PL-59 in the dynamotor unit or power unit.

Dynamotor Unit BD-77-C

44. Before being used for the first time, it is recommended that the end bells of the dynamotor be removed to make certain that the armature rotates freely in its bearings, and a check should be made to determine how much time has elapsed since the dynamotor unit was last serviced. If this time exceeds five months, follow the lubrication instructions appearing in paragraph 122 of this book. Do not lubricate more often or add more lubricant than is specified in those instructions.

45. The voltage at the input terminals of the dynamotor unit must be 14 volts in order to obtain rated power output from the transmitting equipment.

OPERATION

At High Altitudes

46. Radio Transmitter BC-191-C, BC-191-D, or BC-191-E and associated equipment may be expected to give satisfactory service on CW at all altitudes up to 27,000 feet. On TONE and VOICE, however, insulation breakdown may be experienced with Transmitter Tuning Unit TU-8-B (6200–7700 KC) above 25,000 feet and with Transmitter Tuning Unit TU-9-B (7700–10,000 KC) above 19,000 feet. These altitude limitations may be exceeded slightly by care in tuning and by carefully guarding against accumulation of dust and other foreign matter in the equipment. Complete assurance of effective operation between 6200 and 10,000 kilocycles at altitudes between 19,000 and 27,000 feet may be had on CW alone. Transmitter Tuning Units TU-3-B and TU-22-B may be expected to give satisfactory service at all altitudes up to 15,000 feet.

Transmitter Adjustment

47. WARNING: OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON. DO NOT COMPLETE OR MAINTAIN ANY CONNECTION BETWEEN TRANSMITTER AND DYNAMOTOR UNIT UNLESS ALL DUPLICATE UNUSED SOCKETS ON THE TRANSMITTER ARE COVERED BY SOCKET CAPS WITH CATCHES PROPERLY SNAPPED IN PLACE.

48. Assuming that the installation and preliminary adjustments have been made in accordance with the foregoing instructions the following operating procedure is recommended. Some of these adjustments need be made only at the time of installation.

49. Under no conditions should any of the switches on the radio transmitter or tuning unit be changed with the key or microphone button depressed. Insure that all switches position correctly; do not attempt to leave switches between points. Failure to observe this procedure causes undue arcing of the switch and severe strain on the vacuum tubes.

a. *CW Operation:* Select the transmitter tuning unit for the desired frequency. CW operation may then be obtained as follows:

(1) Place the signal switch on CW.

(2) From the calibration chart on the front of the transmitter tuning unit, set the band change switch A, the M-O tuning control, and the P-A tuning control for the desired frequency, and set the ANT. COUPLING SWITCH D on Point 1. (It should be remembered that the band change switch does not appear on Transmitter Tuning Units TU-7-B to TU-10-B inclusive.)

(3) Place the OFF–ON switch in the ON position. The dynamotor should now start and the m-o and p-a filaments will light. In case repeated failures of Fuse FU-22 are encountered and if such failures persist after compliance with instructions pertaining to Dynamotor Unit BD-77-C, it is recommended that Fuse FU-22 be removed from the relay-fuse box and one extra Fuse Link M-168 inserted in the fuse cartridge. Fuse FU-22 will then have two fuse links in it and should be replaced in the relay-fuse box of the dynamotor unit. In no case should the use of more than two fuse links be attempted.

(4) Press the test key or the transmitting key. The vacuum tubes will now draw plate current as indicated by the TOTAL PLATE CURRENT meter. The p-a tuning should be checked immediately for resonance by varying the control slightly until a minimum total plate current is indicated. When the p-a circuit is properly resonated, the total plate current will be from 80 to 110 milliamperes.

(5) The antenna should next be tuned to resonance. Because a wide variety of antennas is possible, no specific instructions for antenna tuning are given other than instructions to effect antenna resonance by means of the controls provided on the radio transmitter, and on the antenna tuning unit whenever the latter is in use. The subject of ANTENNA CIRCUITS is considered more in detail elsewhere in this Instruction Book, and should be referred to in preparation for operation of the equipment. See paragraphs 51 to 70 inclusive.

(6) Antenna resonance is indicated by a reading of current on the ANT. CURRENT meter and by an increase in total plate current. The increase in plate current is the more sensitive indication of approaching antenna resonance. When the antenna is tuned to resonance, the total plate current reading will be somewhat higher than the off-resonance value. If the plate-current is below 200 to 220 milliamperes, the coupling to the antenna should be increased by placing control D on a higher point and the antenna circuit retuned. When finally adjusted, the total plate current should read from 200 to 220 milliamperes. If necessary, detune the antenna circuit keeping the p-a dial, Control C, in resonance to keep within the plate current limits.

(7) The equipment is now delivering rated power output, and the transmission may be carried on by operating the transmitting key. In order to shut down the equipment, it is necessary only to place the OFF–ON switch in the OFF position.

b. *Voice Operation:* Assuming that the equipment has been placed in operation on CW, the following procedure is recommended for obtaining voice operation. Note the value of total plate current for CW operation. Then place the signal switch in the VOICE position, and, by means of the MOD. BIAS adjustment in the tube compartment, adjust until the total plate current with the microphone switch depressed is approximately 20 to 30 milliamperes higher than for CW. The modulator tubes are now biased nearly to cutoff for proper Class B operation, and radiophone communication may be carried on by speaking into the microphone. It will be noted that the total plate current increases when the microphone is spoken into. This increase is due to current drawn by the modulator tubes. With sustained normal level of speech impressed on the microphone, the plate current should rise to an average of 300 milliamperes. If this value is not obtained, the INPUT LEVEL control in the tube compartment can be adjusted until the proper amount of modulation, as indicated by the correct plate current, is obtained.

c. *Tone Operation:* After the equipment has been adjusted for VOICE operation, it is necessary only to place the signal switch on TONE for proper tone telegraph operation. The total plate current on TONE will be between 300 and 350 milliamperes.

d. *Speech-amplifier Bias:* The correct speech-amplifier bias will usually be found between 6.0 and 7.5 on the bias adjustment dial. Settings in this range will normally give the proper speech-amplifier plate current and optimum side-tone frequency on all tuning units. The speech-amplifier adjustment has been properly made at the factory and should not require readjustment. Refer to paragraphs 128 and 131.

e. *Side Tone in Aircraft Set:* If the receiver circuits have been properly co-ordinated with the radio transmitter, the receiver control circuit will operate each time the transmitting key or microphone switch is closed, and the transmitter side tone will be supplied to the headset. When the key or the switch is opened, the receiver again becomes operative, thus allowing break-in operation. The SIDE TONE level control, located in the tube compartment, is used to adjust side tone to a suitable value for any particular installation. It will normally be found that a higher level is desirable for voice operation than for CW or Tone operation.

f. *Calibration Reset:* Due to necessary manufacturing tolerances, the interelectrode capacity of a vacuum tube varies between limits fixed for each particular type of tube. Since the tube capacitance is an appreciable part of any master-oscillator circuit, it is impossible to make up a calibration chart which will be accurate within 0.05 per cent for all tubes whose capacitances are within the allowable limits. For this reason Radio Transmitters BC-191-C, BC-191-D, BC-191-E are provided with calibration reset capacitors which enable the operator to reset the transmitter frequencies to correspond with the calibration charts when the sets are first placed in operation and thereafter whenever the master-oscillator tubes are changed. A heterodyne frequency meter or other standard of frequency is required. The procedure is as follows:

(1) Allow radio transmitter to warm. The operator will obtain the most accurate results by allowing the radio transmitter to "warm up" on key locked "CW" for a period of at least 25 to 30 minutes before setting the calibration reset capacitor, or checking the calibrated transmitter frequency.

(2) With the transmitter tuning unit for the highest available working frequency placed in the radio transmitter, tune the radio transmitter for CW operation on one of the calibrated frequencies at the high frequency end of the band. (Approach the calibrated point by proceeding from a lower dial reading to a higher one.)

(3) Place the frequency meter in operation and adjust it to the frequency indicated on the transmitter calibration in accordance with the operating instructions and calibration chart furnished with the frequency meter. The cali-

bration accuracy of this frequency meter should be 0.01 per cent, or better.

(4) Open the calibration reset port, located on the front panel between the TEST KEY and TONE-CW-VOICE switch, insert a screwdriver and rotate the calibration reset capacitor until the transmitter frequency coincides with that of the frequency meter or standard.

(5) Close the calibration reset port.

50. The transmitter calibration is now reset for any tuning unit of the same order number and serial number as the radio transmitter and the accuracy of calibration will be within 0.05 per cent plus the accuracy of the standard. The calibration must be checked in this manner each time the m-o tube is changed.

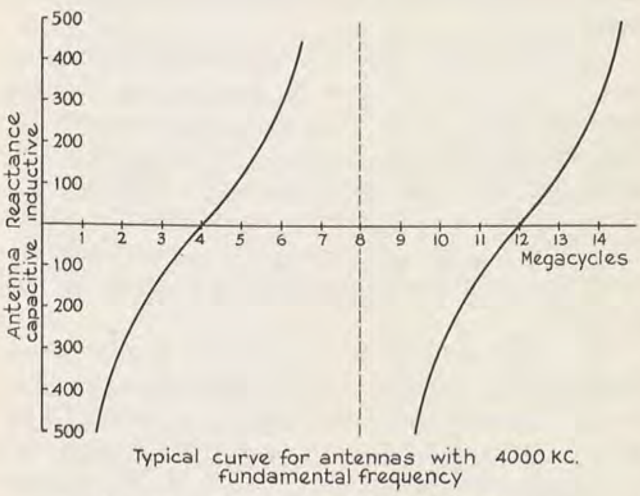


FIG. 13. ANTENNA REACTANCE CURVE

Antenna Circuits

51. The antenna is, in general, a system of conductors which, when excited by a radio-frequency voltage, sets up an electromagnetic and electrostatic field causing a component of this field to travel away from the antenna with the velocity of light.

52. The radiation characteristics of antennas, directivity and radiation efficiencies, are determined by their physical shape and location with respect to other bodies. In aircraft, since there is no wide latitude in physical design of fixed antennas, the problem becomes mainly one of determining the best methods of operating available designs.

53. It is necessary first to determine how the antenna impedances vary at the operating frequencies in order that the loading facilities may be properly used. The reactance of an antenna may be approximated from the theory of transmission lines in which uniformly distributed inductance and capacitance are assumed, resistance and insulator leakage being neglected.

54. Selecting a certain length of antenna and plotting its reactance variation with frequency, we obtain repeating cotangent curves. It may be seen that at certain frequencies the reactance becomes zero. Under these conditions, the antenna is "resonant," analogous to a simple-series circuit tuned to resonance.

55. It may be noted that the "series" resonant points occur at all odd multiples of the first resonant frequency, which is called the fundamental frequency. The fundamental frequency, the third harmonic, and the fifth harmonic, all points of zero reactance, correspond to a voltage distribution along simple vertical wire of "quarter-wave," "three-quarters wave," and "five-quarters wave." Antennas of this type, operated at zero or low reactances, are commonly called "current fed"; that is, they require low driving voltages for their operation.

56. At even multiples of the fundamental frequency, it may be seen that the antenna reactance is very high. Operation at the second and fourth harmonics corresponds to "half-wave" and "full-wave" operation. Under these conditions, antennas are "voltage fed"; that is, they require high driving voltages.

57. The resistance component of the antenna impedance is made of two parts; radiation resistance which represents the radiation of power or waves away from the antenna and which is productive of a useful result; and loss resistance which is a combination of losses due to conductor and ground resistance, and to dielectric hysteresis. Loss resistance performs no useful function and every effort should be made to maintain it very small in comparison with the radiation resistance. The efficiency of an antenna with respect to radiation of power may be expressed as the ratio of radiation resistance to total antenna resistance.

58. Antenna resistance varies over wide limits with frequency. The resistance values approach very high values at the even harmonics, and minimum values at the odd harmonics. It is thus seen that the operation of a radio transmitter over a wide frequency band requires that the radio transmitter be capable of providing a considerable range of output voltages. This is accomplished in each transmitter tuning unit by a six-point ANT. COUPLING SWITCH, control D. In order that the voltage range required be kept at a minimum, antennas are usually "resonated"; that is, they are series tuned by either inductance, or capacitance, as may be necessary, so that the required output voltage range depends only on the antenna resistance variation over the desired frequency range. Transmitter Tuning Units TU-3-B and TU-22-B have a series capacitor in use when control D is on position 6 for resonating when operating into a pure resistance approximating 40 ohms. Do not operate position 6 into low resistances as the large amount of resonant current will overload this series capacitor.

59. When operating antennas at frequencies lower than their fundamental, or odd harmonics, they appear to the antenna tuning equipment as a capacitance in series with a resistance. In order to balance out this capacitive reactance, it is necessary to load the antenna by means of an inductance, the reactance of which is made equal to that of the apparent antenna capacitance. For operation of antennas at frequencies higher than their fundamental and odd harmonics, the converse is true, a capacitance in series with the antenna being necessary in order to balance the apparent antenna inductive reactance.

60. In most cases, except where 3/4 and 5/4 wave trailing wires are used for high frequencies, antenna operation will be around the fundamental frequency.

61. In general, it may be said that if antennas are operated so that their effective length is an appreciable percentage of the operating wavelength, they will have marked directive properties. This corresponds to operation near to and higher than the fundamental frequency. When antennas are operated at frequencies much lower than the fundamental, the ratio of radiation to total resistance is less favorable, but the directive properties are not nearly so evident. The fundamental frequency of an antenna depends mainly on its effective length including the ground lead. Fundamental frequencies in the range 2500-7000 kilocycles will be the most common with the usual types of fixed antennas, while fundamentals as low as 1500 kilocycles will be obtained with 200-foot trailing-wire antennas.

62. The antenna tuning equipment in the radio transmitter is designed to feed antennas at any frequency from 800 to 12,500 kilocycles. Over this band of frequencies it is necessary to feed antennas at, above, and below their fundamental frequencies. Therefore, the circuit and circuit constants are so selected as to permit of both current and voltage feed. A rotating inductor and a tapped inductance provide the inductive reactance variation. A variable capacitor provides the variation in capacitive reactance and also serves as coupling impedance for voltage feed. Controls governing the variation in inductive or capacitive reactance are so arranged that inductance or capacitance are increased with increase in dial reading.

63. With the ANT. CIRCUIT SWITCH, N, on position 1, the radio transmitter works into a simple series 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 fixed antennas. The antenna feed circuit is maintained at resonance by means of ANT. IND. TUNING, M, while the voltage fed to the antenna is varied by means of ANT. CAP. TUNING, O, and ANT. COUPLING SWITCH, D. Feed circuit resonance is indicated by the ANT. CURRENT meter. The current in the feed circuit is adjusted by control D and should not exceed 6 amperes. The step by step tuning procedure is as follows:

a. Set control O at some arbitrary scale reading.

b. Resonate circuit by means of control M for a maximum reading on ANT. CURRENT meter.

c. Adjust control D so that antenna ammeter reads below 6 amperes.

d. Re-resonate circuit as in step b.

64. Repeat the above procedure until the proper loading (200-220 ma on CW) is indicated on the plate ammeter. The lower the dial reading on control M and the lower the reading on the ANT. CURRENT meter that it is possible to obtain at a given frequency, the less the tuning circuit losses and thus more useful power is delivered to the antenna for radiation purposes.

65. With ANT. CIRCUIT SWITCH, N, on position 2, the radio transmitter works into a series resonant circuit where the antenna is "current fed." The antenna circuit is resonated by means of ANT. IND. TUNING, M. and ANT. CAP. TUNING, O, as indicated by a maximum reading of the ANT. CURRENT meter. This circuit is used generally for operation near the fundamental frequency of the antenna.

66. With control N on position 3, the radio transmitter works into a series resonant circuit providing "current feed" and inductive loading. The antenna circuit is resonated by means of a continuously variable rotating inductor, control M. This circuit is used for operation below the fundamental frequency of the antenna and for operation into trailing wire antennas. When using a trailing wire antenna, control M should be set to zero and the antenna circuit then adjusted for resonance at the ¼ or ¾ wave point by varying the length of the trailing wire. For the approximate length of wire required, refer to paragraph 76.

67. With control N on position 4, the antenna circuit is identical with that obtained on position 3 except that an additional tapped inductance, controlled by ANT. IND. SWITCH, P, is added in series with the rotating inductor. This circuit is used when the operating frequency is relatively far below the fundamental frequency of the antenna.

68. It is recommended that the operator check the possible resonance of coil, item 1170, at operating frequencies above 4500 kilocycles. Although this coil is not connected in the antenna circuit, the inherent capacitive coupling may cause absorption of useful radio-frequency power. Absorption may be easily determined by placing control switch "P" at several points while watching the antenna current. Control "P" must not be allowed to remain at a point which indicates a decrease in antenna current. In general, it

will be found that no difficulty will occur if the following points are used.

Transmitter Tuning Unit	"P" Switch Position
TU-7-B	2
TU-8-B	5
TU-9-B	5
TU-10-B	5

The antenna resonance is then made in the usual manner using controls M, N, and possibly O.

69. For operation in the frequency range of 150 to 800 kilocycles, the externally connected Antenna Tuning Unit BC-306-A is used. This unit contains the necessary inductive reactance to resonate specified antennas at frequencies well below their fundamental. The variation in inductive reactance is provided by the ANTENNA VARIOMETER SWITCH, control E, and the ANTENNA VARIOMETER, control F. In general, it will be necessary to use Antenna Tuning Unit BC-306-A with Transmitter Tuning Units TU-3-B and TU-22-B, i.e., 350 kc to 800 kc. The antenna loading equipment contained in the radio transmitter will resonate a 400-micromicrofarad antenna to approximately 650 kilocycles. Therefore, when the minimum inductance is reached on the BC-306-A, (E=2, F=0), place control E in position 1 which disconnects this unit. Proceed to resonate the antenna circuit with control N on position 4. Control M is the continuously variable inductance between inductance steps on control P.

70. On Transmitter Tuning Units TU-3-B and TU-22-B, it may be found that one coupling tap will not give sufficient loading while the next higher tap will give overloading to the radio transmitter. In this case, use the higher coupling tap by slightly detuning the antenna circuit and keeping the pa-dial, control C, tuned to a minimum plate current until the normal transmitter loading of 210 to 220 milliamperes total plate current is obtained.

Dynamotor Unit BD-77-C

71. Starting and stopping of the dynamotor unit is controlled remotely by the "OFF-ON" switch either at Radio Transmitter BC-191-C, BC-191-D, BC-191-E or at Radio Control Box BC-309. No adjustments are required or provided on the dynamotor unit.

72. When operated at full-rated load continuously for ½ hour, the temperature rise of the dynamotor will not exceed 55 degrees Centigrade. However, if the dynamotor is operated for a greater length of time, even at lighter loads, without being allowed to cool off, its temperature will continue to increase and will ultimately reach values which are injurious to the insulation and may even burn out the windings. This also applies to the starting relay. If it is desired to operate the dynamotor unit continuously for a period greater than ½ hour (such as for testing purposes in the laboratory) the end bells of the dynamotor and the cover of the relay-fuse box should first be removed. The dynamotor unit can then be operated at rated load continuously for any period of time without injurious heating. Care should be exercised to place guards around the dynamotor unit when operated in this manner so that operators cannot come in contact with exposed high voltages.

Reel RL-30-B

73. Braking, locking and winding operations are controlled from the crank on the reel. Normally the reel is in the locked position such that the wire will not unwind from the spool. Reeling-in is accomplished by rotating the crank in a clockwise direction, as indicated by the direction arrow "Wind" on the nameplate at the center of the reel spool. A ratchet mechanism on the spool prevents the wire from unreeling when the crank is released. By rotating the crank in a counter-clockwise direction the braking mechanism is released, thereby permitting the wire to be reeled out. Braking force decreases gradually as the handle is rotated through approximately the first 40 degrees of its motion. Beyond this point and up to the extreme limit of its motion the brake is completely released and the spool is free to spin. The speed of unwinding can be readily controlled by regulating the braking effect with the crank. A spring return on the crank automatically resets the brake to the normal or locked position when it is released.

74. Tuning the antenna should be accomplished by allowing slightly more wire than is necessary to run from the reel and then reeling in slowly to obtain the proper length by observing the resonant condition. During the reeling out operation, care should be taken that all of the wire is not unreeled. The speed with which the reeling takes place would be sufficient to snap the wire if it reached its ultimate length, causing a loss of both the weight and wire.

75. WHEN UNREELING WIRE, NEVER ALLOW THE CRANK TO SNAP INTO THE LOCKING POSITION WHEN THE SPOOL IS ROTATING RAPIDLY. THE SUDDEN STOP WHICH WOULD RESULT MAY BREAK THE ANTENNA WIRE AND PLACE UNDUE STRESS ON THE REEL MECHANISM.

76. The following table gives the approximate antenna length for various frequencies as well as the approximate counter reading when 250 feet of Wire W-106 is wound on the spool.

KC	¼ Wave		¾ Wave	
	Length (Ft)	Counter Reading	Length (Ft)	Counter Reading
2000	123	108		
3000	82	72		
4000	62	54		
5000	49	44	147	130
6000	41	36	123	108
7000	35	30	105	92
8000	31	28	93	82
9000	27	24	81	72
10000	24	22	73	64

Operating Routine

77. The operating routine and type of transmission to be used will be governed by tactical requirements. The following recommendations are given, however, to assist in routine operation of equipments:

a. Complete equipment operation should be checked before the start of any mission.

b. Make certain that spare fuseholders are filled with good fuses, and that spare tubes (if carried) are in good condition.

c. The transmission range of the equipment on CW is considerably greater than on VOICE. If distance, atmospheric noise, etc., make voice communication difficult, changing to TONE or CW will probably improve communication.

d. In case of failure of one or two vacuum tubes with no spares on hand, CW communication can be carried on by inserting the good tubes in the m-o and p-a sockets. CW operation can also be maintained when the Tube VT-25 is removed, although no side tone will be supplied in this event.

SUMMARY COVERING NORMAL OPERATION

78. Although the normal operation of this equipment is simple after the correct installation has been made, it is well to study the proper sequence of various equipment procedure as summarized in the following paragraphs. It is assumed that the installation has been tested and all circuits are normal.

DO NOT CHANGE ANY SWITCHES WITH THE KEY OR MICROPHONE BUTTON DEPRESSED.

a. *To start the equipment:* place the "OFF-ON" switch to "ON." The dynamotor will start and the filaments will light. Unless the "TONE" and "VOICE" emissions have been adjusted, start up initially as given below. To control carrier, depress the key.

b. *To stop the equipment:* open the key; then place the "OFF-ON" switch in "OFF."

c. *To change frequencies:* select the required tuning unit and place in the radio transmitter. Place the M-O dial, band switch (if any), and the P-A dial on the desired calibrated frequency as given on the calibration chart. Place the emission switch on CW, start up the radio transmitter and immediately check the P-A dial for minimum plate current as indicated on the total plate current meter. Resonate the antenna circuit and load to a total plate current of 210 to 220 milliamperes with the P-A dial resonated, i.e., always tuned to a minimum plate current. Proceed to key the carrier on CW or select the other types of emission as given below.

d. *To select any available type of emission:* start up the radio transmitter and tune for CW transmission first as given under c., then, open the key and place the TONE-CW-VOICE switch on VOICE. Remove the tube shield and adjust the "MOD. BIAS" after key is depressed until the total plate current reads 20 to 30 milliamperes above the CW value. Proceed to control carrier by microphone button and modulate by voice. Adjust the voice level by the "Input Level" control so the total plate current reaches 300 to 350 milliamperes on peaks of sustained voice. Adjust the side tone control for the desired side tone level.

e. *For tone transmission:* the operator must always adjust radio transmitter for VOICE, FIRST. Then open the key, place the selector switch on TONE and proceed to key carrier as in CW.

f. *To increase power output:* go to a higher number on the antenna coupling switch, control D, at the same time keeping the PA dial control C, and the antenna circuit in resonance. Power may be increased until a CW plate current of 220 m.a. at 14 volts input is reached.

g. *To decrease power:* go to a lower number on antenna coupling switch, control D, at the same time keeping the PA dial control C, and the antenna circuit in resonance.

It should be noted that the CW power output may be increased or decreased in the above manner from the value of plate current with the antenna circuit open to the full load rating of 220 milliamperes. However, the TONE and VOICE carrier powers SHOULD NOT BE INCREASED OR DECREASED. Unless the TONE and VOICE carriers are adjusted as given under steps d., and e., above, distortion will result. Also, the misadjustment may cause arc-overs which would damage the equipment.

h. *To reset to the calibration chart:* after changing the m-o tube, etc., start the radio transmitter on the highest frequency of the highest frequency tuning unit available. Warm up the radio transmitter on CW key locked for 25 to 30 minutes. The tube shield must be in place. Listen to the calibrated frequency on a suitable accurate heterodyne frequency meter and adjust the radio transmitter to zero beat by means of a screw driver inserted into the reset port on the left front transmitter panel. This should bring the radio transmitter back to calibration and all other frequencies should be within 0.05 per cent. For greater accuracies reset as above to the exact frequency desired.

III. DETAILED FUNCTIONING OF PARTS

RADIO TRANSMITTER BC-191-C, BC-191-D, BC-191-E

79. In order that the theory of the principal component units may be better understood, the complete circuit has been broken down into several simplified circuits as shown on the functional diagrams which follow. Each basic circuit will be described in detail.

80. The radio-frequency circuit of the radio transmitter (see Fig. 14) is of the conventional master-oscillator and power-amplifier type. The audio-frequency circuit consists of a speech amplifier and a Class B audio-frequency modulator which applies plate modulation to the Class C radio-frequency power amplifier. When operating on TONE, the speech amplifier is converted into an audio-frequency oscillator which supplies grid excitation at a frequency of approximately 1000 cycles to the modulator tubes.

81. Side tone for monitoring purposes is supplied during VOICE, TONE, and CW operation. CW side tone is obtained by the use of the speech-amplifier tube as an audio oscillator.

82. The master-oscillator and power-amplifier radio-frequency circuits are built into the transmitter tuning units, of which 10 are required to cover the complete frequency range of the equipment.

83. The master-oscillator circuit is of the series fed type, either capacitively or inductively coupled to the power amplifier, depending on the tuning unit in use. Assuming that a Transmitter Tuning Unit TU-8-B (6200-7700 kc) is in place in the radio transmitter, the transmitter circuits will be discussed in detail. (See Fig. 14.)

84. The tapped coil 801 and the capacitor 802

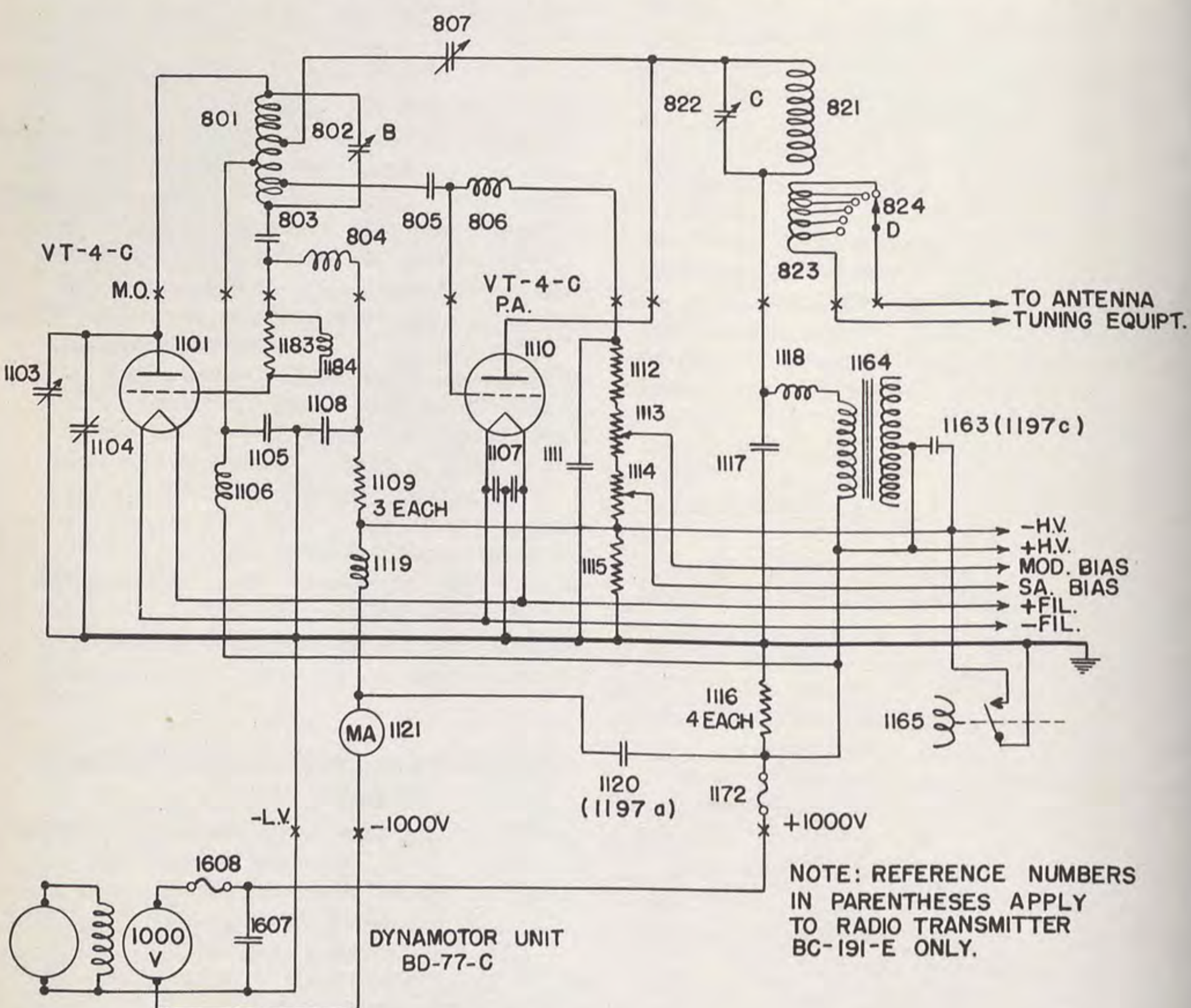


Fig.14. Radio Transmitter BC-191-C, BC-191-D, or BC-191-E, Functional Diagram of Radio-Frequency and High-voltage Circuits

comprise the radio-frequency oscillating circuit. Both the coil and the capacitor are thermally compensated to reduce frequency variation due to changes in ambient temperature. Capacitor 802 is provided with a front panel control (B) by means of which the oscillator may be adjusted to the desired frequency. The center tap on the coil determines the master oscillator grid excitation. The coil is also tapped an equal number of turns on either side of this center tap, the lead connecting to capacitor 805 furnishing the power-amplifier (p-a) grid excitation. Master-oscillator (m-o) grid excitation is taken through capacitor 803, which blocks the plate voltage off the grid circuit. Resistor 1183 and choke 1184 in parallel are connected in series with the grid to prevent the generation of parasitic oscillations. Plate power for the m.o. is fed to the tuning unit through r-f choke 1106, which, with capacitor 1105 prevents r.f. from flowing into the power supply.

85. Resistor 1109 is the m-o grid leak which provides the required operating bias for the m-o tube from the rectified grid current. Capacitor 1108 is an r-f by-pass. Grid choke 804, in conjunction with resistor 1109 serves as the necessary direct-current path from the grid to filament maintaining a high impedance to the r-f grid excitation.

86. Capacitor 1104 is the calibration reset, by which the master-oscillator frequency can be adjusted to correspond to the calibration whenever the oscillator tube is changed. Capacitor 1103 provides thermal compensation for frequency drift normally caused by warm-up and variation of ambient temperature of the oscillator tube.

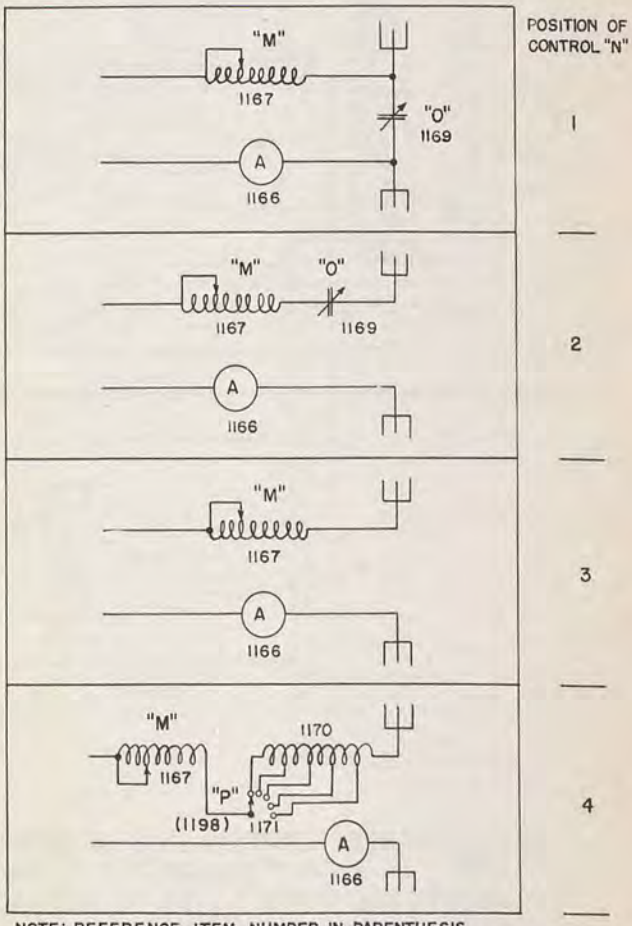
87. The p-a tank circuit consists of coil 821 and variable capacitor 822. This capacitor has a panel control (C) for tuning the tank circuit to resonance. The p-a grid receives excitation through capacitor 805 from the m-o tank coil. Capacitor 805 also isolates the m-o plate voltage from the p-a grid. The p-a grid bias is obtained from the flow of rectified grid current through resistors 1112, 1113, and 1114. Choke 806 provides a low impedance path for the d-c grid current but a high impedance path at radio frequencies. Plate power for the p.a. is fed to the tuning unit through choke 1118, which, with capacitor 1117, prevents r-f current from flowing into the power supply.

88. The neutralizing capacitor 807 forms a part of a bridge circuit including the power-amplifier grid-to-plate capacitance. Balancing of this circuit by means of capacitor 807 prevents any reaction 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 neutralized at the factory, and should never require adjustment in service unless the setting is accidentally disturbed. Instructions for making the neutralization adjustment are given in the "Service Notes" included in paragraph 136 of this Instruction Book.

89. The p.a. is inductively coupled to the antenna circuit by means of the tapped inductance 823, the taps on which are selected by a panel-control tap switch 824 labeled ANT. COUPLING SWITCH, D. Sufficient variation in coupling is provided to allow operation into a wide range of antenna resistances.

90. The operation of the other types of transmitter tuning units is very similar to that described above, the only difference being in the methods by which the m-o and p-a circuits are tuned over their respective frequency bands. A detailed discussion of the circuits involved is included in the description of the transmitter tuning units later in these instructions. (Paragraphs 110 to 114 inclusive).

91. The antenna tuning equipment and circuits provided in the radio transmitter are designed for operation with aircraft and fixed station antennas at frequencies above 800 kilocycles. Rotating inductance 1167, control M; inductance 1170; switch 1171 (or 1198), control P; variable capacitor 1169, control O; switch 1168, control N; and r-f ammeter 1166 com-

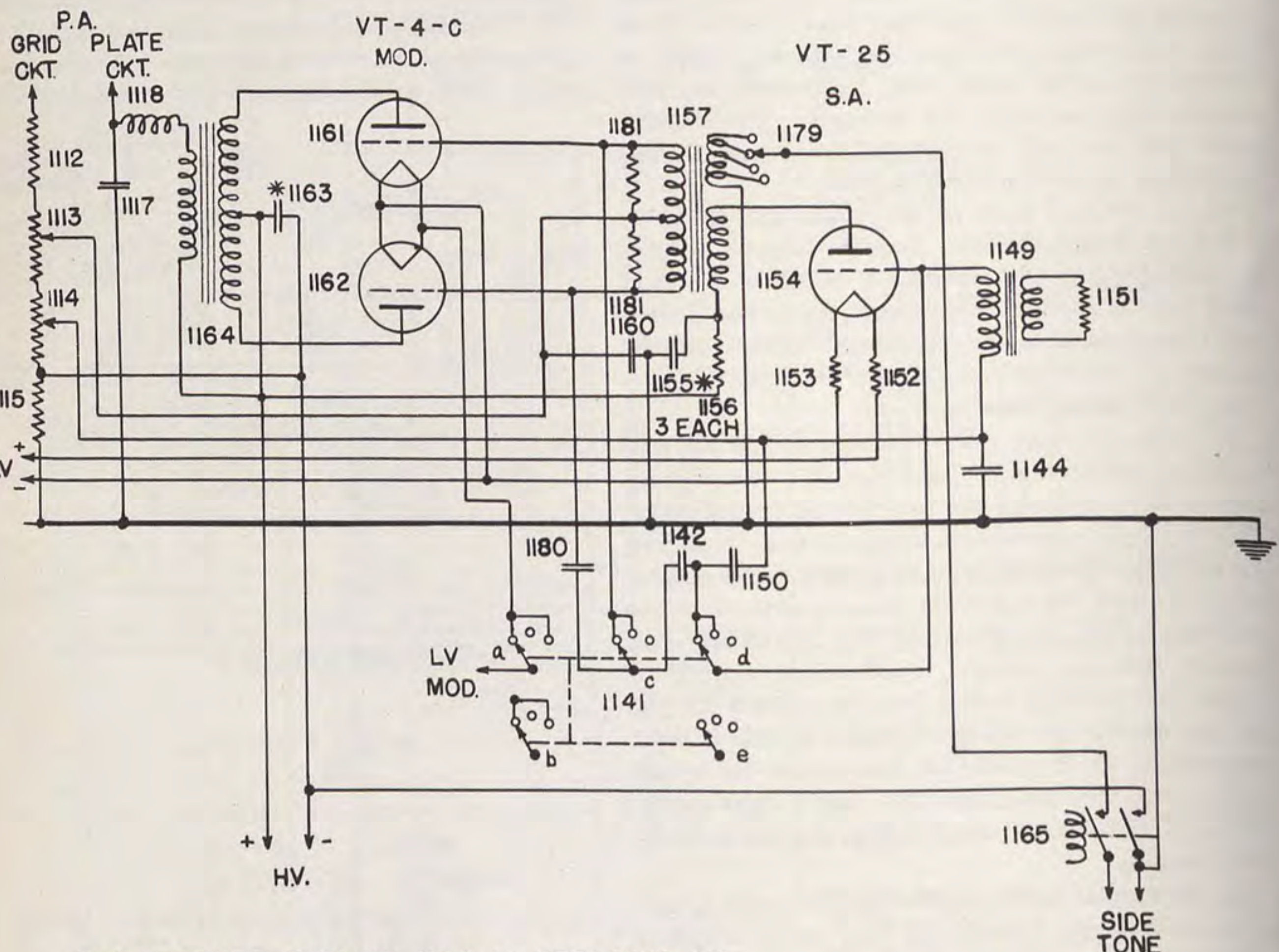


NOTE: REFERENCE ITEM NUMBER IN PARENTHESIS APPLIES TO RADIO TRANSMITTERS BC-191-D AND BC-191-E.

FIG. 15. RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E FUNCTIONAL DIAGRAM OF ANTENNA TUNING CIRCUITS

prise the antenna tuning equipment which is included in the radio transmitter unit. (See Fig. 15). These parts may be connected to form four different antenna feed circuits corresponding to the four positions of the ANT. CIRCUIT SWITCH, control N, symbol 1168. Fig. 15 shows four simple line diagrams, marked (1) to (4) respectively, which indicate the type of antenna tuning circuit provided for the correspondingly numbered positions of control N. With this switch in position (1), the radio transmitter works into a simple series resonant circuit consisting of the tuning inductance 1176, control M, and the tuning capacitor 1169, control O; with the antenna ammeter indicating the current in the resonant circuit. The high voltage built up across the tuning capacitor is used to voltage feed the antenna. With control N in position (2), the tuning inductance and tuning capacitor are connected in series with the antenna permitting operation near the fundamental frequency of the antenna, i.e., where only small amounts of inductive or capacitive loading are required. Positions (3) and (4) provide inductive loading of the antenna with either tuning inductance 1167 alone or the tuning inductance and the tapped inductance 1170, controlled by switch 1171 (or 1198) control P, in the circuit. The antenna ammeter 1166 indicates actual resonance of the antenna circuit for positions (2), (3) and (4) of control N.

92. As illustrated in Fig. 16 modulation is applied to the plate supply of the power amplifier by means of the modulation transformer 1164. The modulator tubes 1161 and 1162 are operated in a push-pull Class B circuit, in which they are biased nearly to cut off. This type of operation is characterized by high efficiency and output. The modulator power drain is negligible unless the tubes are being driven by the



✱ REFERENCE NUMBER 1163 IS REPLACED BY 1197c IN RADIO TRANSMITTER BC-191-E ONLY.
REFERENCE NUMBER 1155 IS REPLACED BY 1197b IN RADIO TRANSMITTER BC-191-E ONLY.

Fig. 16. Radio Transmitter BC-191-C, BC-191-D, or BC-191-E, Functional Diagram of Audio-Frequency Circuits—Tone Operation

speech amplifier or tone oscillator. 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 the modulator grid current. Plate power for the speech amplifier is obtained from the positive high voltage through resistor 1156 which limits it to the proper value. Capacitor 1155 (1197b) serves as an audio-frequency by-pass for this power source. Receiver side tone for monitoring the transmitted signal is provided by a tapped winding on the interstage transformer. Switch 1179 selects the proper tap on this transformer winding to give the desired side-tone level.

93. The TONE-CW-VOICE switch 1141 serves to select the desired type of transmission. It performs the following functions:

a. It controls the modulator filaments.

b. It controls the line compensating section of the filament resistor 1138.

c. It controls the tone oscillator feed-back circuit.

d. It connects the microphone circuit to the input transformer 1149 for VOICE operation.

94. With switch 1141 in the TONE position, (Fig. 16), capacitor 1142 feeds energy from the speech-amplifier plate to its grid in the proper phase relation to cause oscillation at an audio rate. The secondaries of input transformer 1149 and interstage transformer 1157 are resonated by capacitors 1150 and 1180 respectively to provide the desired frequency of oscillation. Resistor 1151 on the primary of the input transformer serves to stabilize the grid excitation of the speech-amplifier tube. The modulator tubes receive their excitation from transformer 1157.

95. For CW operation (Fig. 17), switch 1141 shuts off the modulator tubes by removing filament power. The speech amplifier functions the same as for TONE operation although it furnishes only the audio-frequency signal (receiver side tone) for monitoring the CW transmission.

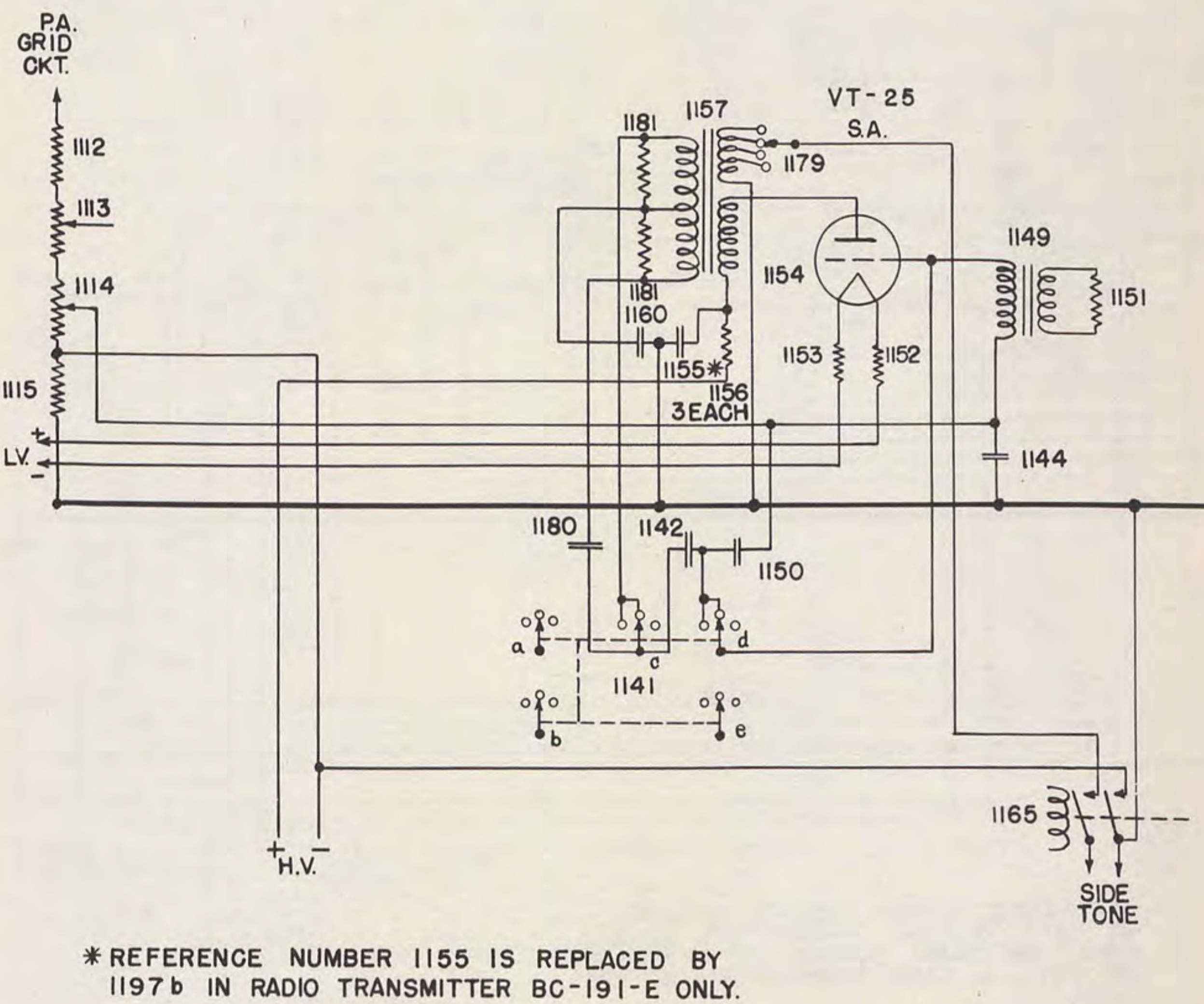


Fig. 17. Radio Transmitter BC-191-C, BC-191-D, or BC-191-E, Functional Diagram of Audio-Frequency Circuits—CW Operation (Side Tone)

96. In the VOICE position (Fig. 18), 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 supply. Potentiometer 1148 is the 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.

97. Bias for the modulator tubes is obtained from resistor 1113, and bias for the speech amplifier from resistor 1114. These resistors form a part of the p-a grid leak, the voltage across them resulting from the rectified grid current of the p.a. Capacitors 1144 and 1160 serve to by-pass the speech-amplifier and modulator bias respectively at audio frequencies. Both the modulators bias control, labeled MOD. BIAS, and the speech-amplifier bias control, S.A. BIAS, are accessible in the tube compartment. Instructions for adjustment of modulator bias are given under II. EMPLOYMENT in this Instruction Book. The speech-amplifier grid bias is adjusted to the correct value at the factory and its value is not relatively critical. Instructions for it adjustment, should this be necessary, are given under IV. MAINTENANCE —Service Notes. Capacitor 1163 (1197c) serves as the modulator plate by-pass for the audio frequencies.

98. Keying of the radio transmitter is accomplished by means of resistor 1115, one end of which is connected to negative high voltage and the grid circuit returns, and the other end to filament or ground potential. The keying contacts of relay 1165 are connected across this resistor. When the contacts are opened, the resistor network consisting of resistors 1115 and 1116, connected from positive to negative high voltage so divide the voltage that the grids of the tubes are biased beyond cut-off, and oscillations are stopped.

99. The keying and antenna switching relay performs the following functions, see Fig. 19.

a. It keys the radio transmitter by short-circuiting resistor 1115 (refer to Fig. 14).

b. It disconnects the radio receiver from the

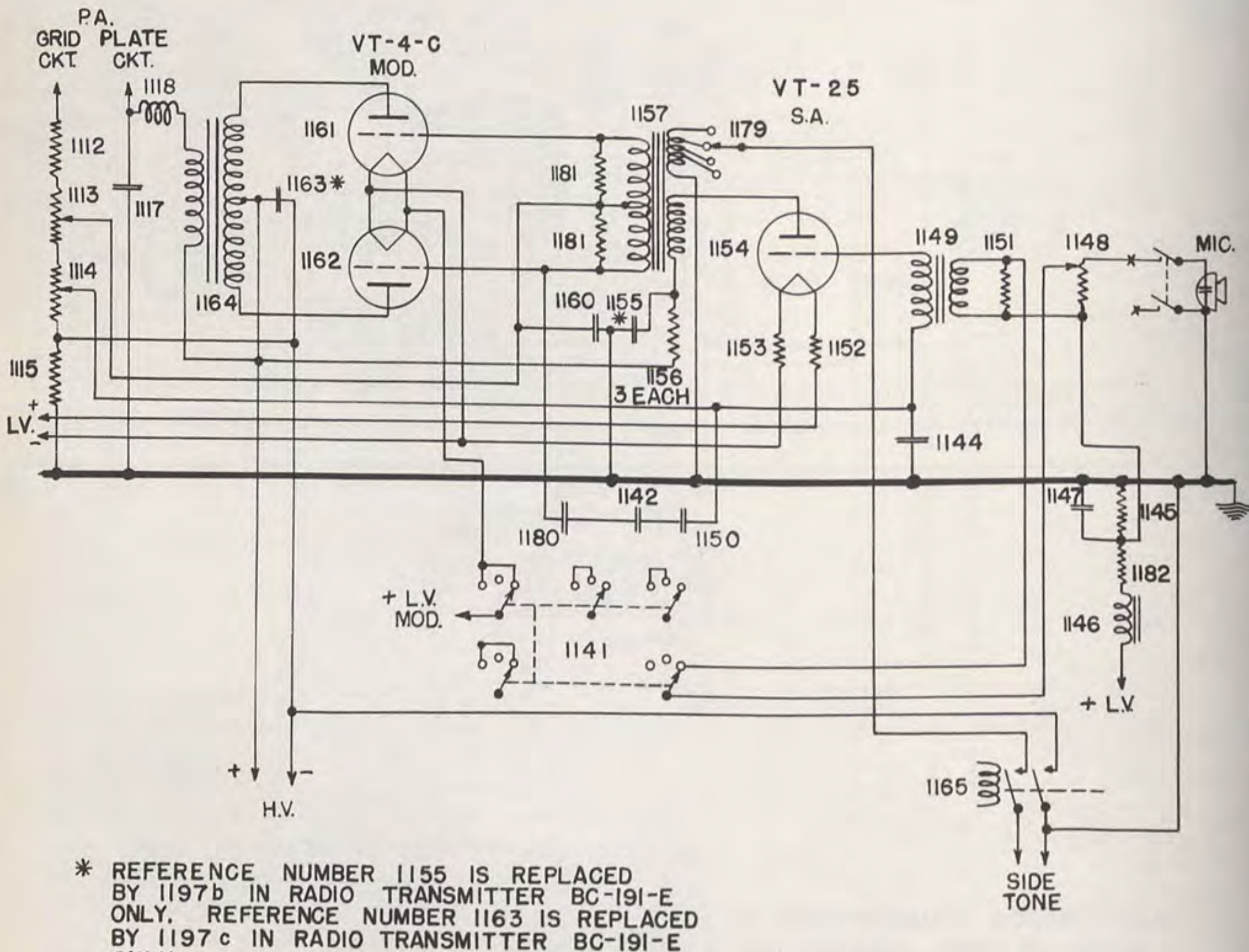


FIG. 18. RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E, FUNCTIONAL DIAGRAM OF AUDIO-FREQUENCY CIRCUITS—VOICE OPERATION

antenna and grounds the receiver input circuit when the transmitting key is closed.

c. It connects the radio transmitter to the antenna circuit when the key is closed.

d. It opens the receiver screen grid or plate supply or operates a receiver control relay when the key is closed.

e. It keys the side-tone circuit.

100. A test key 1131, which may be used to close the keying relay while checking operation or making tuning adjustments, is located on the transmitter panel.

101. Control and power circuit connections are made through the sockets and jacks provided in duplicate on the left side and bottom of the transmitter unit. Low-voltage and power-control circuits enter the radio transmitter through Plug PL-61 inserted in either of the sockets 1126 or 1174. The positive high-voltage connection enters this unit, through Plug PL-59 in either of the sockets 1127 or 1175. Interphone, side tone, and receiver keying connections to the junction box, if used, are made by means of Plug PL-64 in sockets 1128 or 1176. Connections to Radio Control Box BC-309 for remote controlled operation are made through Plug PL-74 in sockets 1125 or 1173. Jacks 1129 or 1177 and 1130 or 1178 are for microphone and key connections respectively for locally controlled operation of the radio transmitter.

102. The OFF-ON switch 1194 serves to close the dynamotor unit relay and thereby apply power to the radio transmitter. Interlock 1102 serves to remove power from the radio transmitter when the transmitter tuning unit is not in place. Indicator

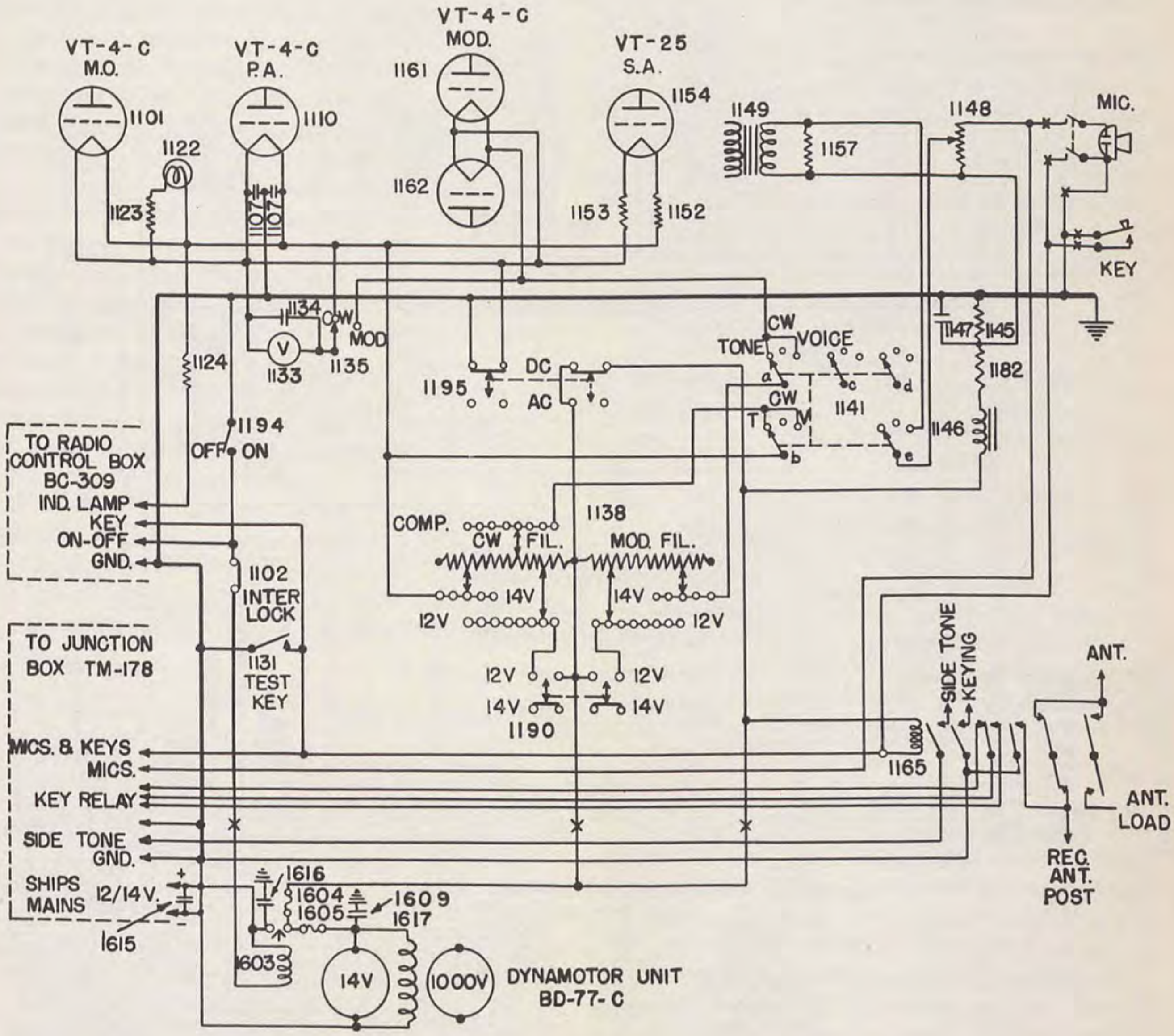


Fig 19. Radio Transmitter BC-191-C, BC-191-D, or BC-191-E, Functional Diagram of Low-Voltage and Control Circuits—D-C Operation

lamp 1122 shows when power is applied to the radio transmitter. It is connected in series with resistor 1123 across the filament supply. Resistor 1124 is the series resistor for the indicator lamp in Radio Control Box BC-309.

103. Overload protection is provided by Fuse FU-12-A, symbol 1172, which is located in the positive high-voltage lead. Radio-frequency choke 1119 is used for filtering in the negative high-voltage lead. Milliammeter 1121, in the same lead, measures total plate current. Capacitor 1120 (1197a) serves as plate supply filter.

104. Radio Transmitters BC-191-C, BC-191-D, and BC-191-E are designed so that they could be operated from 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.

105. An a-c/d-c switch 1195 performs the circuit changes to adapt the radio transmitter for operation from such an a-c supply (Fig. 20). In the a-c position, the filament circuit is separated from the control circuits 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. Switch 1195 would be placed in the a-c position only when the rectifier is used, since regardless of the type of drive used with the Power Unit PE-AA-49 or PE-49-A, d-c is supplied for both plate and filament circuits. THE RADIO TRANSMITTER SHOULD NEVER BE OPERATED WITH A-C ON THE FILAMENTS WHEN THE A-C/D-C SWITCH IS ON D-C OR VICE VERSA.

106. Under the condition of d-c filament supply (Fig. 19), resistor 1138 is used to adjust the filament

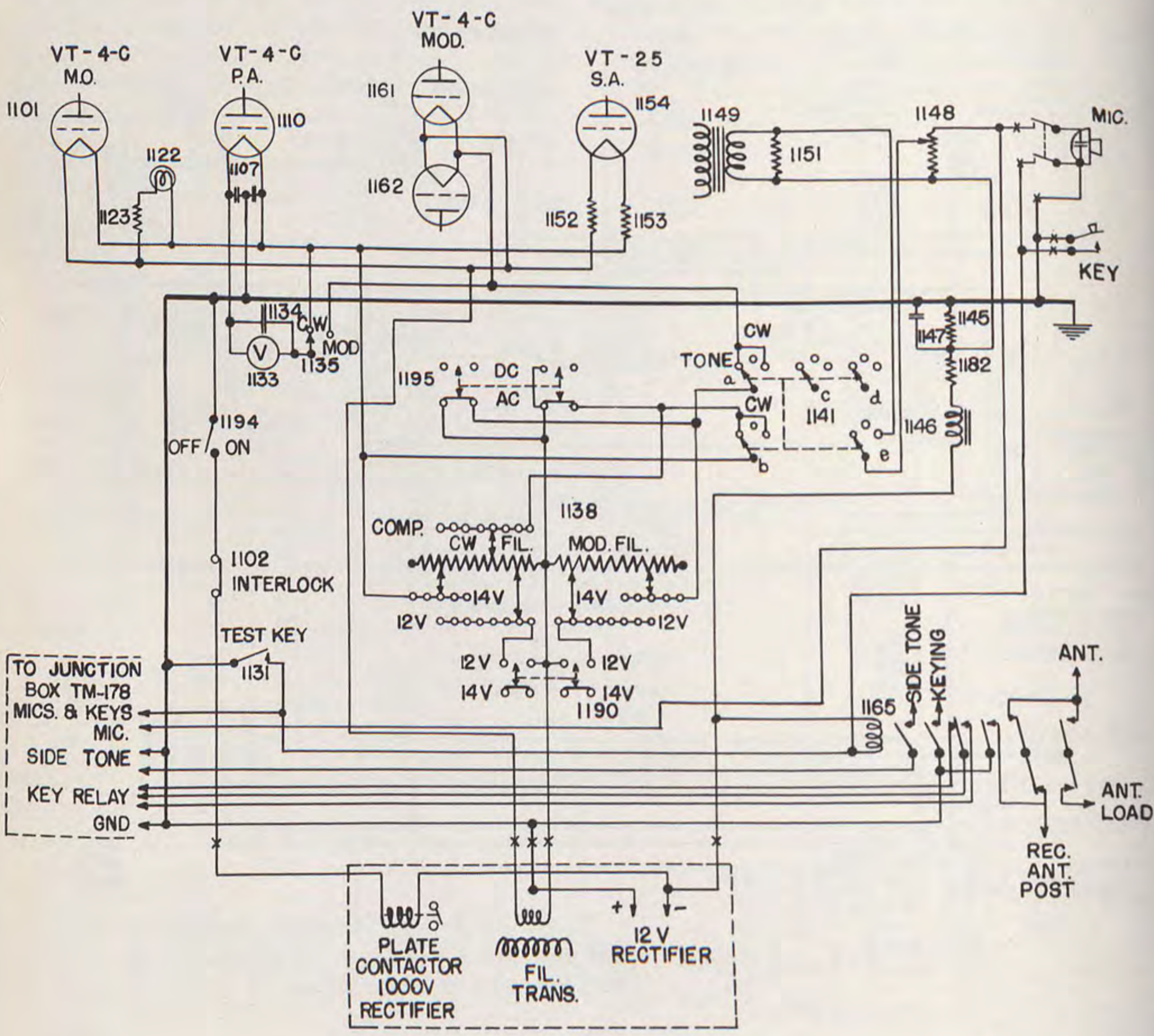


Fig. 20. Radio Transmitter BC-191-C, BC-191-D, or BC-191-E, Functional Diagram of Low-Voltage and Control Circuits—A-C Operation

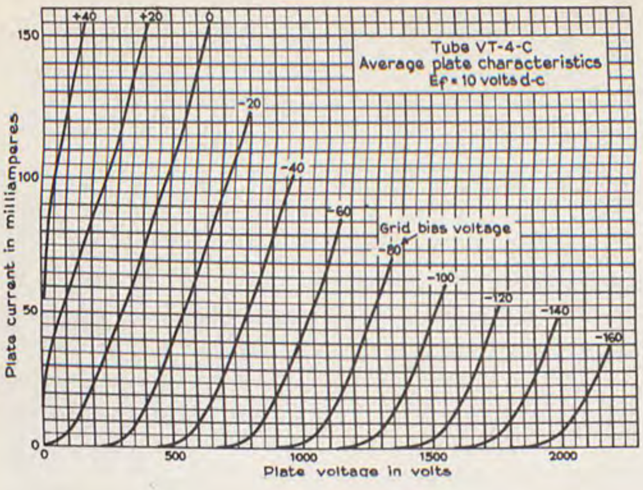


FIG. 21. TUBE VT-4-C, CHARACTERISTIC CURVES

potentials to 10 volts as indicated on voltmeter 1133. The mid-tap 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 CW operation, and the other side for the modulator tubes. Provision is made to short out a section of the CW filament resistor by means of switch 1141 (b) 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 CW to TONE or VOICE. A portion of the resistor may be short-circuited by the 12/14-V. switch 1190 so that correct filament voltage may be applied both when the power-supply storage battery is being charged (terminal voltage approximately 14.2 volts) and when not being charged (terminal voltage 12 volts). Switch 1135 connects filament voltmeter 1133 to either the CW or MOD. filaments. When the filaments are operated from an a-c source (Fig. 20), resistor 1138 serves simply as a compensating resistor to eliminate the need for readjusting the filament rheostat when changing from CW to modulated transmission, or vice versa.

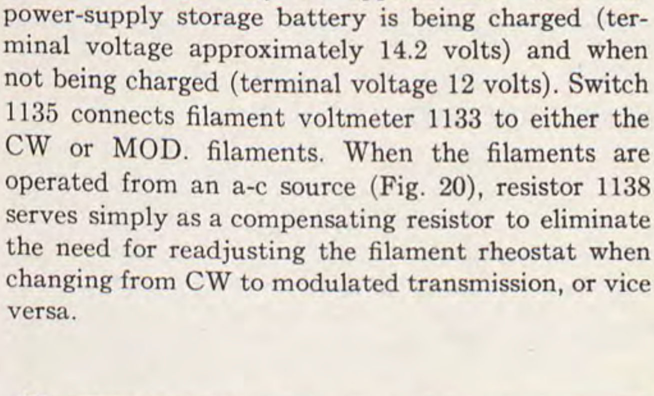


FIG. 22. TUBE VT-25, CHARACTERISTIC CURVES

VACUUM TUBES

107. Tube VT-4-C is a triode with a directly heated thoriated filament, which provides large emission with low expenditure of filament energy. Connections for the grid, plate, and filament are brought through the tube base. This tube has a manufacturer's rating of 100 watts maximum plate dissipation. Characteristic curves of Tube VT-4-C are shown in Fig. 21. The following table gives the constants of typical tubes as used in this radio transmitter:

Filament voltage	10 volts
Filament current	3.25 amperes
Plate current (max.)	0.175 ampere
Amplification factor	12
Plate resistance	3400 ohms
Plate voltage	1000 volts

Note: Tube VT-4-C has a definitely specified limit to secondary emission and is therefore a better oscillator and amplifier than Tube VT-4-B.

108. Tube VT-25 is a triode with a directly heated filament. The grid, plate, and filament leads are brought out through the tube base. This tube functions in this radio transmitter as a speech amplifier or audio oscillator. The following table gives the constants of typical tubes as used in this transmitter:

Filament voltage	7.5 volts
Filament current	1.25 amperes
Grid voltage	−35 volts
Plate current	0.019 ampere
Amplification factor	8
Plate resistance	5000 ohms
Plate voltage	425 volts

Characteristic curves of Tube VT-25 are shown in Fig. 22.

109. For normal continuous-wave operation, the speech-amplifier, master-oscillator, and power-amplifier tubes are used. For VOICE and also TONE modulated continuous-wave operation, all five tubes are used. Separate filament resistors are employed for the master-oscillator, power-amplifier, and modulator tubes. This obviates the necessity of readjusting the filament voltage each time a change is made from CW to TONE, or VOICE, and vice versa.

TRANSMITTER TUNING UNITS

110. The circuit description of Transmitter Tuning Unit TU-8-B, which was given in connection with the description of the radio transmitter, is applicable to Transmitter Tuning Units TU-7-B and TU-9-B. The circuit of the TU-10-B is practically the same as that of the TU-8-B, the m-o plate by-pass capacitor 1009 and plate choke 1010 being added. Refer to Fig. 68 for a schematic diagram of all transmitter tuning units.

111. Transmitter Tuning Unit TU-6-B is very similar to the TU-8-B. The same type of m-o circuit

is used. However, the frequency range of this tuning unit is covered in two bands. Band change switches 602 and 622, control A, connect fixed capacitors 603 and 623 in the m-o and p-a circuits respectively to cover the low-frequency end of the band. Capacitor 603 in the m-o circuit is provided with a thermo-metal compensator (613) to provide the required frequency stability. Resistor 614 is the p-a grid parasitic resistor.

112. The frequency range of Transmitter Tuning Unit TU-5-B is covered by four frequency bands controlled by switches 502 and 522, control A. The type of circuit and thermal frequency compensation is the same as that in the units previously described. Resistor 517 is the p-a grid parasitic resistor.

113. Transmitter Tuning Units TU-3-B and TU-22-B include the same circuits, type of control and thermal frequency compensation. They differ only in frequency range and circuit parts. A description of Transmitter Tuning Unit TU-3-B will therefore be applicable to both tuning units. The tapped variometer 301, with the voltage dividing network capacitors 310, 311, 312, 313, 314, and 315 comprise the basic m-o tank. The band change switch 307, control A, selects the proper taps on the variometer and connects the additional tank capacitors 308 and 309 into the circuit so as to properly cover the frequency range. The thermal compensators 305, 319 and 320, consist of small capacitors with a special ceramic dielectric designed to provide the required thermal frequency stability. 302 and 303 are the m-o plate and grid chokes respectively. 304 is the m-o grid blocking capacitor. Resistor 317 is located in the m-o grid circuit to suppress parasitic oscillations. Excitation for the p.a. is obtained across capacitor 314 through blocking capacitor 318. 306 is the p-a grid choke. The p-a tank is tuned by means of the tapped variometer 321 and fixed capacitors 323, 324, 325, and 326. Switch 322, ganged with 307 to control A, selects the proper variometer tap and capacitor arrangement for the desired frequency. The voltage required to neutralize the power amplifier is obtained across capacitor 313 through neutralizing capacitor 316. Coil 327 and switch 328, control D, provide the necessary coupling to the antenna circuit.

114. To obtain the high degree of frequency stability required in this equipment, the blocking and coupling capacitors used in all tuning units are of an improved high stability type. Relative to Transmitter Tuning Units TU-5-B to TU-10-B inclusive, the master-oscillator tank coils are tension wound and the variable tank capacitors are specially constructed of invar to provide a lower and more uniform temperature coefficient.

ANTENNA TUNING UNIT BC-306-A

115. This antenna tuning unit, Fig. 23, consists of tapped variometer 1502 which furnishes inductive loading reactance for series resonating the highly capacitive antennas used with Transmitter Tuning Units TU-3-B and TU-22-B, i.e. 350 kc to 800 kc.

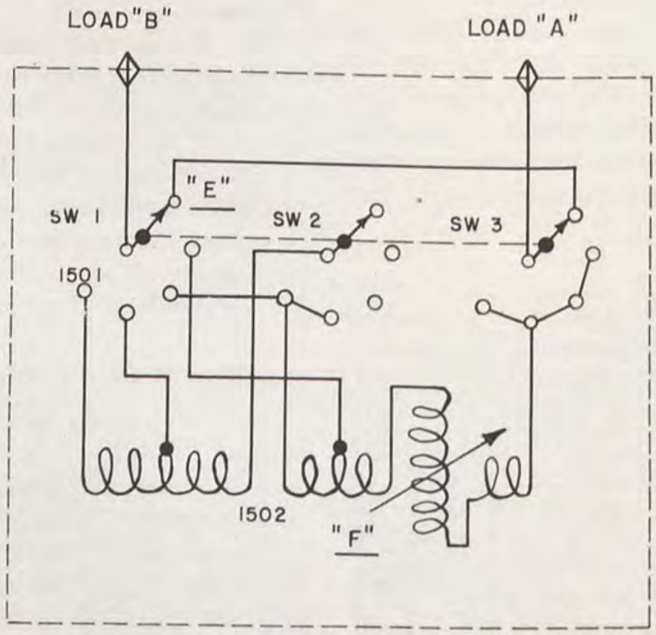


FIG. 23. ANTENNA TUNING UNIT BC-306-A, SCHEMATIC DIAGRAM

The varying amounts of reactance used are adjusted by the variable rotor, control F, and the tap switch 1501, control E. It will be noted that the tap switch is made up of three parts. This construction permits a total disconnection of the tuning unit when control E is on tap 1. It also permits the efficient use of a small portion of the inductance on taps 2 and 3 without excessive loss from a large unused section being connected to the circuit.

DYNAMOTOR UNIT BD-77-C

116. The function of Dynamotor Unit BD-77-C (Fig. 24) is to provide high voltage for the vacuum tube plates. The dynamotor derives its power from a 12/14-volt d-c source, such as a storage battery. The complete dynamotor unit consists of the dynamotor proper together with its fuses, starting relay, terminal board, by-pass capacitors, and sockets for connection to the transmitter unit. Spare fuse links, a spare high-voltage fuse, and a small hexagon servicing wrench are attached to the cover of the fuse box.

117. The dynamotor is started by ON-OFF switch 1194 on the front panel of the radio transmitter. This switch energizes the starting relay 1603 which closes and applies the input voltage to the motor end of dynamotor 1617 through the protecting fuse 1605. This also permits current to flow through fuse 1604 to the transmitter filament and control circuits. Capacitors 1607, 1609, 1613, 1614, 1615, and 1616 by-pass to ground any radio-frequency interference which may be generated by the dynamotor brushes. Sockets 1602 (SO-39) and 1601 (SO-41) contain all high- and low-voltage leads which are to be connected to the radio transmitter. Fuse 1605 (Fuse FU-22) which protects the low-voltage circuits from overloads is of a type known as "Superlag," and is designed to permit heavy starting surges of low duration, though prolonged overload current will cause the fuse to open.

118. Protection of the high-voltage circuit and of the dynamotor winding is obtained by fuse 1608 (Fuse FU-18-A) which is of the flame-proof type.

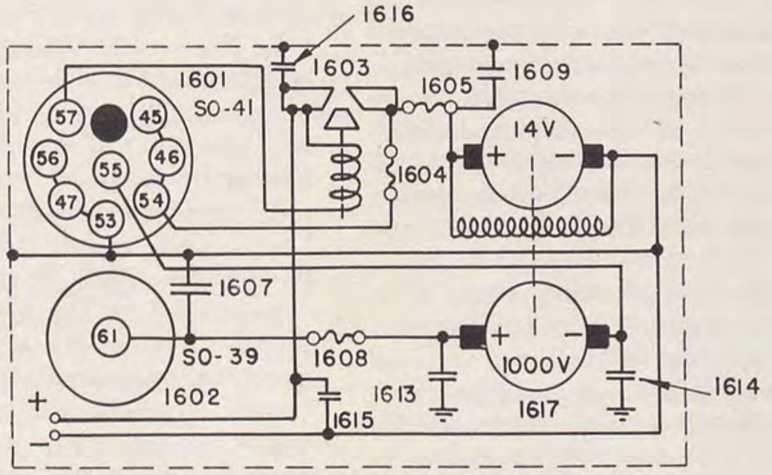


FIG. 24. DYNAMOTOR UNIT BD-77-C, SCHEMATIC DIAGRAM

IV. MAINTENANCE

INSPECTION

119. The inspection operations applying to aircraft installations of this equipment are covered by various Air Corps Circulars and Technical Orders. These documents contain, in detail, a list of the various inspection operations and the time intervals at which they are to be performed. Those instructions shall govern over any general instructions contained herein. The inspection and maintenance of other radio sets (vehicular and ground sets) of which this equipment forms a part is covered by the instruction books for those sets.

120. In general a thorough periodic inspection of the complete installation at least once every 50 hours of operation will materially aid in the maintenance of uninterrupted performance. The following inspection is recommended.

a. Determine that the storage battery is at the proper gravity and that the charging generator and regulator are adjusted so as to keep the battery fully charged.

b. Clean accumulated dust and dirt from all units. Use an air hose or bellows, paying particular attention to the loading coil, item 1170, in the antenna compartment of the radio transmitter. At this time inspect the rotating coil, in this compartment. The winding should be thoroughly cleaned with carbon tetrachloride (Carbona) and a clean cloth.

c. Make certain that all safety wiring is in place, that all mounting brackets and supports are rigidly fastened and that all nuts and machine screws are supplied with lockwashers and are tight.

d. Determine that no cords have broken shielding, and that all grounding and bonding is in place.

e. Inspect plugs for proper fit and plug sockets for compressed pin springs. Compressed pin springs, which have taken a permanent set, can be restored by a light hammer blow on the end of the pin.

f. Make certain that all fuses are held tightly in their clips. A loosely held fuse should be removed and the clips bent with the fingers until they grip the fuse tightly. The clips and fuse ends should be kept clean and the contact surfaces bright.

g. Antennas should be inspected for broken or frayed leads, and insulators should be wiped clean. Be sure that antenna leads have not been bent close to metal frameworks where high antenna voltages might cause spark-overs.

h. Inspect keys and microphones for broken cords and deformed plugs.

i. Inspect dynamotor brushes for length. Detailed instructions on care of brushes are given in paragraph 137a.

j. Inspect both dynamotor commutators for cleanliness and excessive wear. Information on care of commutators is given in paragraph 137b.

k. Rotate the dynamotor armature by hand to make certain it turns freely and is not rubbing against the field poles or leads. When all four brushes are removed, the armature should spin freely on its bearings. Refer to paragraph 137c. for detailed information on dynamotor bearings.

l. Inspect the wire horn gap on the back of the output terminal board. The correct setting of this gap is 0.171 inch. Adjustment should be made with the fingers in order that the wire remain smooth and free from nicks.

LUBRICATION

121. The lubrication of the equipment involves the use of five lubricants and one cleaning solvent. These are:

a. Light Oil: A high-grade, low pour test, mineral oil with viscosity rating SAE10.

b. Light Oil: A high-grade, low pour test mineral oil with viscosity rating SAE20.

c. Light Oil: A high-grade instrument oil such as Type D6B5 as manufactured by the General Electric Company.

d. Grease: Use only high-temperature ball bearing grease such as Grade 295 Air Corps Specification No. 3560. "Refined Calol Grease" as manufactured by the New Departure Mfg. Co., Bristol, Conn., or NY & NJ Lubricant No. 1572 meets the requirements of the above specification. "Calol" is a stiff, pale yellow, high-flow point, sodium base grease which has been developed particularly for ball bearing applications of this nature. Do not use unauthorized grease as these may melt out at high temperatures or may oxidize rapidly and become gummy when packed in the bearings.

e. Acheson "Oil Dag" or equivalent—finely divided graphite in oil. Acheson Colloids Corp., Port Huron, Mich.

f. Cleaning Solvent: Carbon tetrachloride (Carbona) is strongly recommended.

122. *Dynamotor Unit BD-77-C.* Under normal operating conditions, the dynamotor bearings should be lubricated in accordance with the following schedule:

a. After every 1000 hours of operation or at intervals of six months, add three drops of SAE20 oil into the small oil hole which is provided in the top of each bearing housing and is closed by a screw plug.

b. After every 5000 hours of operation or at intervals of one year, add approximately 0.05

cu. in. (3/8 in. cube) of ball bearing grease to each bearing through the oil hole mentioned above.

Note: Do not add more oil or grease than specified above, since the excess lubricant will tend to work out of the bearing housing onto the commutators and brushes where it will cause trouble if not wiped off. Too much grease in the bearing will have a tendency to churn and may cause the bearing to overheat. Always make certain that the lubricants used are clean and that no dirt, moisture or foreign matter enters the oil hole when adding the lubricant. Tighten screw plugs securely into the oil holes as soon as lubricant is added.

c. After every 10,000 hours of operation or at least every two years, remove the armature from the dynamotor, throroughly clean the bearings and bearing housings with carbon tetrachloride and repack each ball bearing level full of approved ball bearing grease. See procedure for disassembly and cleaning of bearings.

123. *Reel RL-30-B:* The construction of this unit is such that it will require very little attention. The following lubrication routine is recommended to obtain the best operating results:

a. After every 40 hours of flying time apply six drops of SAE10 oil at the oil hole indicated on the hub nameplate.

b. After every 1000 hours of flying time or every six months, whichever comes first, do as follows:

(1) Remove the three fillister head screws which hold the crank handle lever to the hub and remove the crank.

(2) Remove the small cotter pin and castle nut on the end of the reel shaft.

(3) Remove reel spool and hub from the shaft.

(4) Clean the accumulated dirt from reel shaft and the parts in the mounting base. Examine the exterior parts of the reel hub and clean off all dirt.

(5) Lubricate these points using SAE10 oil:

Counter gear shaft bearing—1 drop.

Main shaft—several drops along the bearing surfaces.

Rear ball bearing on hub adjacent to ratchet teeth—5 drops.

Front thrust bearing around the edge of the retaining nut at the front end of the hub—5 drops.

Front ball bearing around the gap between the outside of the hub and the edge of the piece into which the three screws from the crank handle lever are threaded—5 drops.

(6) Reassemble the reel as follows:

Place the reel spool and hub on the shaft. Give the spool a slight spin clockwise until the ratchet engages the pawls.

Replace the castle nut with the fingers, run it down until snug and then back if off until the hub runs free (at least 1/6 of a turn). Replace the cotter pin.

Assemble the crank handle and tighten the three fillister head screws.

This completes the operation of servicing the reel.

124. The following miscellaneous lubrication instructions should be followed in connection with the maintenance of other units of the radio transmitting equipment. Places to oil and grease are listed. Do this after every 500 hours of service or at least after every 1000 hours. Do it more often if dirt accumulation is excessive. Clean parts as required:

a. Oil General Electric Type D6B5—Switch shafts in radio transmitter, transmitter tuning units and antenna tuning unit. Vernier mechanisms in radio transmitter, transmitter tuning unit and antenna tuning unit. Pivot bearings of antenna switching relay and main bearings of rotating antenna inductor. Variable capacitor shafts in radio transmitter and transmitter tuning units.

b. Grease—Contacts of switches, and switch positioning devices in radio transmitter, transmitter tuning unit, and antenna tuning unit.

c. NEVER lubricate the contact roller or the contact roller shaft of the rotating antenna inductor. These parts should run DRY and should always be kept spotlessly clean. Carbon tetrachloride (Carbona) should be used to clean these parts.

d. Graphite in Oil—In the transmitter tuning units, apply "Oil Dag" to the bearings and surfaces of the worm and worm gear of the master-oscillator tuning units.

SERVICE NOTES

125. In the servicing and locating of faults in the radio transmitter and associated equipment, it is necessary to remove various shields and covers to make the circuits accessible. Great care must be taken in testing with shields removed, because a great many points of high voltage are thus exposed. Whenever such testing is necessary, the proper procedure is to remove all power from the equipment, make the necessary circuit changes or meter connections and then apply power, keeping clear of all meters which are connected in the "high" sides of circuits where there may exist an appreciable voltage to ground.

126. ALWAYS REMEMBER THAT WHEN THE DYNAMOTOR IS RUNNING AND THE TRANSMITTING KEY IS OPEN, HIGH VOLTAGE IS PRESENT IN THE RADIO TRANSMITTER EVEN THOUGH THERE IS NO PLATE AMMETER READING.

127. In checking low voltage and filament circuits, the single conductor cord with Plug PL-59 should be disconnected from the radio transmitter, thus removing the high-voltage supply.

128. The following information is supplied to aid in servicing the equipment and locating faults:

a. *Voltage Readings:* (Use the high resistance Voltohmmeter of Test Set I-56-A.)

(1) Low-voltage input of 12 to 14.25 volts, depending on the power-supply voltage, should be obtained at terminal 45 of Sockets SO-41 and ground.

(2) Speech-amplifier plate voltage of approximately 425 volts should be obtained at the plate connection of the speech-amplifier tube when the radio transmitter is on VOICE. It is recommended that a tube socket adapter be used which will allow not only readings of voltage but also all currents for the Tube VT-25.

(3) Modulator bias voltage of 72 to 75 should be obtained across capacitor 1160, the positive side being at ground potential. Selector switch should be on VOICE.

(4) Speech-amplifier bias voltage of 35 to 40 should be obtained across capacitor 1144, the positive side being at ground potential. Transmitter switch should be on VOICE.

(5) Plate voltage of 1000 to 1100 volts should be obtained between terminal 61 of Sockets SO-39 and ground.

(6) Keying voltage of approximately 200 volts will be obtained across resistor 1115 when keying relay 1165 is open.

(7) Using the Weston output meter of Test Set I-56-A, the side-tone voltage may be measured across an 8000-ohm load resistor. With the SIDE TONE switch on position 4, 17.5 to 30 volts a-c should be present at an audio frequency of 600 to 1200 cycles, depending on the transmitter tuning unit in use.

The SIDE TONE switch on position 1 will give 3- to 9-volt a.c. It will be generally found that the CW position will give a higher voltage than the VOICE or TONE positions.

(8) Microphone-supply voltage of 4.5- to 5.3-volt d.c. should be obtained across resistor 1145. For this test, the microphone should be in the circuit.

b. *Current Readings*

(1) Speech-amplifier plate current should be from 17 to 22 milliamperes. Adjustment of its bias voltage to obtain this value is accomplished by potentiometer 1114 which is accessible in the tube compartment.

(2) Modulator plate current may be determined by observing the increase in total plate current reading when changing from CW to VOICE and impressing normal modulation. The modulator plate current should average 100 to 160 milliamperes for sustained tones. A greater or smaller value than this indicates that a readjustment of the input level should be made.

(3) Master-oscillator plate current can be determined on the TOTAL PLATE CURRENT meter, by removing the power-amplifier and speech-amplifier tubes and placing the radio transmitter on CW. The current indicated should be from 30 to 75 milliamperes, depending on the transmitter tuning unit in use.

(4) Power-amplifier plate current may be determined by subtracting from the total plate current on CW the currents drawn by the master oscillator and speech amplifier. Its value should be from 100 to 150 milliamperes at full load.

(5) Master-oscillator grid current can be determined by connecting a d-c milliammeter in series with resistor 1109. Correct value should be from 30 to 50 milliamperes.

(6) Power-amplifier grid current can be determined by inserting a d-c milliammeter in series with resistor 1112. Correct value is from 15 to 25 milliamperes.

129. Various other circuits may be checked by referring to the schematic diagrams Figs. 63 and 65. Then by referring to the various unit connection diagrams, the location of the various circuit elements may be ascertained.

130. *Dynamotor Performance.* The dynamotor should operate approximately as follows on a load test:

Input		Output	
Volts	*Amperes	Volts	Milli-amperes
14.0	14-15	1140-1160	0
14.0	30-32.5	1070-1090	220
14.0	40.5-43.5	1025-1050	350

* The input current above includes that taken by the starting relay.

131. *Location of Faults.* If the operation of the equipment falls below normal, several simple checks listed below may be readily investigated.

Symptoms	Probable Causes
No filament voltage	Relay 1603 not operating when OFF-ON switch is placed in ON position. Fuse 1604 open. Normal fuse resistance is not over one ohm. Switch 1135 must be in proper position corresponding to "CW" or "MOD."
Low filament voltage	Resistor 1138 not adjusted properly. High resistance leads between dynamotor and radio transmitter. There should be at least 10 volts at socket terminals 47 and 54 of Socket SO-41 item 1174. Low input voltage to dynamotor.
Key relay inactive	Key jack not making good contact. Cord open. Energizing coil open.
No plate current	Fuse 1608 in dynamotor unit or fuse 1172 in radio transmitter open. Normal fuse resistance not over 3 ohms. Filaments not lighted. Key relay inactive.
Excessive plate current (No antenna load—CW)	P-A dial "C" not in tune. M-O tube inoperative.
Excessive plate current (antenna-loaded-CW)	Coupling tap "D" on too high a number. On some tuning units, or with low resistances, it may be necessary to detune the antenna to secure 220 ma on CW. *Always maintain the P-A dial "C" in tune.*
No antenna current	Antenna circuit open. Antenna not properly tuned. Link not in terminal board A to B. CPSE not connected to ground when using ground.
No side tone (Tone—CW)	Tube VT-25 defective. Speech-amplifier bias control not set properly. The correct setting will usually be found between 6.0 and 7.5 on the dial.
No or low side tone (Voice)	Same as above. Adjustment may be too low. Operator may need to adjust side-tone level to a higher number than for Tone or CW, especially if a low-level voice is used.

132. Troubles of a more complex nature will require analysis with Test Set I-56-A or equivalent. Methods of procedure for some of the more probable troubles are listed as follows:

OPERATING PERSONNEL ARE WARNED TO USE EXTREME CAUTION IN AVOIDING ACCIDENTAL CONTACT WITH HIGH VOLTAGE PARTS WHILE MAKING THE FOLLOWING TESTS. ALWAYS REMEMBER THAT WHEN THE DYNAMOTOR IS RUNNING AND THE TRANSMITTING KEY IS OPEN, HIGH VOLTAGE IS PRESENT IN THE RADIO TRANSMITTER EVEN THOUGH THERE IS NO PLATE AMMETER READING.

Fault	Test Procedure
Dynamotor won't run	Test fuse 1605 (Fuse FU-22) and check voltage (12 or 14) at line input terminals. Remove end bells and disconnect input voltage. Then rotate armature. If armature does not rotate freely, follow instructions given in paragraphs 122 and 137.

Fault (Continued)	Test Procedure (Continued)
	If the dynamotor armature turns freely connect input voltage again and short pin No. 57 of Socket SO-41 to ground. If machine now runs, look for open lead in cord to radio transmitter. Check to see if tuning unit is firmly in place and interlock 1102 is closed.
	If dynamotor does not run when pin No. 57 of Socket SO-41 is grounded, listen for click of starting relay 1603 and check voltage across its terminals. 12 to 14 volts should exist with pin No. 57 grounded.
	If the dynamotor starts to rotate then stops as Fuse FU-22 blows, replace the single link in Fuse FU-22 with two links (Fuse Link M-168) in parallel. The instantaneous line current sometimes overheats the fuse on input lines of good regulation while normal running currents would be satisfactory.
	With the power disconnected, one may short the large relay terminals and check the dynamotor circuits for continuity to the brushes. CAUTION: Replace all dynamotor brushes in the same holder with the marking up, exactly as removed. The brushes have been accurately fitted and run-in exactly as shipped. A very slight difference between brush holders would cut the effective brush contact area considerably. This would lower dynamotor efficiency.
	If after these tests the dynamotor will not operate, first try a substitute dynamotor, if available, then ship the defective unit to the Signal Corps Radio Section of an Air Depot for servicing.
P-A tuning control "C" has no effect on total plate current	First, reduce the ANT. COUPLING control "D" to a minimum; switch position 1. If this has no effect, examine and replace the m-o tube. Be sure radio transmitter is on the "CW" position as this entire fault may be caused by an improperly tuned power-amplifier tube and mis-adjusted modulator tubes when operating in the "VOICE" position. Measure the voltage from the junction of 1111 and 1112 to ground. If the master oscillator is functioning properly, this voltage should be approximately 200 v. d.c., key down. Should this voltage be near zero, check the voltages on the master-oscillator tube and continuity of the p-a grid circuits.
	The master-oscillator tube may be checked for operation by holding a neon bulb in the hand in contact with the glass of the master-oscillator tube. If the m-o tube is oscillating, the neon tube will glow. By substitution of tuning units, one may determine if the trouble is peculiar to the tuning unit or to the radio transmitter.
	If the trouble is in the tuning unit, remove the cover and check continuity of all circuits. Look for chips and shorted turns on the tank coils, dirty capacitors, and open choke coils. Capacitor plates may be effectively cleaned with pipe cleaners. If the unit is to be blown out, be sure to use clean dry air.

Fault (Continued)	Test Procedure (Continued)
Transmitter sparks over at high altitudes	Read instructions on high altitude operation given in paragraph 46 of section II, EMPLOYMENT. If the radio transmitter does not meet the altitude operation stated in the above section, the radio transmitter must be thoroughly checked over. Tuning units must be blown clean and capacitors wiped plate by plate with a pipe cleaner. The master-oscillator and power-amplifier tubes should be changed. The air gap on the back of the output terminal board must be set for 0.171 inch. Wipe the key relay posts and output terminal board with a dry lintless cloth. Inspect antenna compartment for clearances of the wiring. All wires should be spaced clear from ground. Compare the faulty transmitter antenna compartment with a normal unit.
No modulation on VOICE	Check the Tone-CW-Voice selector switch for position. Substitute another Tube VT-25. Check that the CW carrier is properly adjusted. Check voice increase of 20 to 35 ma in total plate current over the CW value of 220 ma. If total plate current cannot be adjusted for this increase, change modulator tubes. Check continuity of circuits with all power off. Remove high voltage Plug PL-59 from the radio transmitter and place the high resistance voltmeter of Test Set I-56-A across terminals 3 and 4 of transformer 1149. Speak into the microphone with the filaments lighted. The a-c voltage on a loud signal should be approximately 1 to 2 volts. This is a check of the input circuits. If no voltage is read check continuity of circuits as given in the resistance chart (paragraph 134).
No modulation on TONE	If the CW and Voice operation is normal, one can assume that the tubes are satisfactory and the trouble lies in the fact that the speech amplifier tube fails to oscillate. If this is the case, no side tone will be heard on pin No. 33 of socket 1176 either on the CW or Tone positions. Check the S-A bias control. This will usually be between 6 and 7.5 on the dial. If still no tone modulation exists, remove the dynamotor cables and check continuity of circuits, especially switch 1141.
Distortion on VOICE	Check Input Level Control. The setting of this control depends on the microphone and the voice level of the operator. It will usually be found that a setting of 7 to 8 on the dial allows the total plate current to swing to 350 milliamperes on peaks of voice level, using the standard Signal Corps microphones. If the Voice modulator bias has been properly adjusted and distortion is still present, set the Input Level so that peaks of modulation are limited as shown by the total plate current swinging upward to a maximum of 300 milliamperes. If either modulator, Tube VT-4-C, or the speech amplifier, Tube VT-25, are defective, distortion will exist. Recheck CW first, then Voice adjustments to see if properly adjusted.

133. *Typical Readings.* The following values of voltages, currents, and settings represent average data and may vary as much as 10 per cent for individual equipments. CW output is measured into a phantom antenna whose constants are similar to those in actual practice. The antenna current was measured by an external ammeter directly in series with the phantom resistor. The transmitter ammeter at the time gave current readings slightly higher because of the inherent stray capacitance in the radio transmitter.

RADIO-FREQUENCY POWER OUTPUT

Transmitter Tuning Unit	F_{kc}	C_a (1)	A	B	C	D	E (2)	F (2)	M	N	O	P	Total I_p MA	Watts Out. (3)	Ant. Current
TU-3-B	400	400	1	863	33	1	3	32	0	3	–	–	220	45.0	3.0
TU-3-B	800	400	3	2088	73	3	1	0	18	4	–	3	215	40.0	2.83
TU-5-B	1500	200	1	1335	43	3	–	–	12.5	4	–	2	205	45.0	3.0
TU-5-B	3000	200	4	2098	80	2	–	–	21.5	3	–	–	220	65.0	3.6
TU-6-B	3000	150	1	976	41	3	–	–	21.8	3	–	–	220	60.0	3.46
TU-6-B	4500	150	2	2162	86	2	–	–	12.5	3	–	–	220	55.0	3.32
TU-7-B	4500	100	–	419	22	2	–	–	14.5	3	–	2	220	60.0	3.46
TU-7-B	6200	100	–	2180	95	3	–	–	5.4	3	–	2	220	75.0	3.87
TU-8-B	6200	100	–	698	20	2	–	–	7.8	3	–	5	220	70.0	3.74
TU-8-B	7700	100	–	2163	84	2	–	–	4.5	3	–	5	220	75.0	3.87
TU-9-B	7700	100	–	580	23	3	–	–	4.8	3	–	5	220	70.0	–
TU-9-B	10000	100	–	2169	82	2	–	–	1.0	3	–	5	220	75.0	3.87
TU-10-B	10000	100	–	468	18	2	–	–	4.8	2	100	5	220	65.0	3.60
TU-10-B	12500	100	–	2095	76	2	–	–	1.0	2	100	5	220	75.0	3.67
TU-22-B	350	400	1	770	24	1	3	54	0	3	–	–	220	45.0	3.00
TU-22-B	650	400	3	1776	67	4	1	16	0	3	–	–	220	40.0	2.83

(1) Apparent capacitance (C_a) in micromicrofarads.
(2) Where readings are not listed in columns "E" and "F," Antenna Tuning Unit BC-306-A is not used. The antenna circuit tuning given is considered the most efficient method of loading for the particular frequency used.
(3) Nominal 5-ohm phantom resistor.

134. *Resistance Charts.* In order that the location of faults be expedited, the following point-to-point checks are suggested. Circuits which may be tested with a simple continuity meter, (i.e., a voltmeter in series with a flashlight cell) are listed as having zero resistance. Average resistance values are tabulated and are to be tested with the Weston Voltohmmeter, Model 564, Type 3B of Test Set I-56-A. Individual radio transmitters will vary somewhat from the average values given, the maximum tolerance being approximately ten per cent.

RADIO TRANSMITTERS BC-191-C, BC-191-D AND BC-191-E

Refer to Schematic Diagrams, Figs. 63 and 65. All voltages, tuning unit, and back shield removed.

Master-oscillator and Power-amplifier Circuits

	OHMS
Point 61 of Sockets SO-39 (1127, 1175) to socket shell, ground	1 meg.
Point 61 of Sockets SO-39 (1127, 1175) to point 2 of tuning unit plugboard	10
Point 61 of Sockets SO-39 (1127, 1175) to point 2 of transformer 1164	4
Point 2 of transformer 1164 to point 8 of tuning unit plugboard	115
Point 3 of tuning unit plugboard to grid terminal of M-O socket	0
Point 4 of tuning unit plugboard to terminal 55 of Socket SO-41 (1126, 1174)	7500
Point 6 of tuning unit plugboard to terminal 55 of Socket SO-41 (1126, 1174)	10,000

Modulator Circuits

	OHMS
Point 61 of Socket SO-39 (1127, 1175) to plate of socket 1161	70
Point 61 of Socket SO-39 (1127, 1175) to plate of socket 1162	70
Terminal 4 of transformer 1157 to grid of socket 1161	500
Terminal 4 of transformer 1157 to grid of socket 1162	500
Terminal 4 of transformer 1157 to terminal 55 of Sockets SO-41 (1126, 1174)	3000 to 7000

Speech-amplifier and Side-tone Circuits

	OHMS
Side-tone switch on tap 4, orange and green wire on 1179 to ground	150
Point 61 of Sockets SO-39 (1127, 1175) to terminal 2 of transformer 1157	33,000

Speech-amplifier and Side-tone Circuits (Continued)

	OHMS
Terminal 2 of transformer 1157 to plate of socket 1154	700
Grid of socket 1154 to terminal 3 of transformer 1149	6000
Terminal 3 of transformer 1149 to terminal 55 of Socket SO-41 (1126, 1174) (S-A Bias Control on position "10")	3100
Terminal 2 of transformer 1149 to ground (a-c—d-c switch on d-c)	35
Terminal 2 of transformer 1149 to ground (a-c—d-c switch on a-c)	50
Terminal 1 of transformer 1149 to terminal 23 of Socket SO-44 (1128, 1176)	
Voice Position	0 to 200
CW or Tone Position	220

DYNAMOTOR UNIT BD-77-C

	OHMS
−L.V. input terminal to negative brush	0
−L.V. input terminal to ground	0
+L.V. brushholder to ground (brush removed)	6
+L.V. input terminal to terminal 57 of Socket SO-41 (1601)	14
+L.V. brush to terminal 54 of Socket SO-41 (1601) fuses in	2

135. The transmitter tuning unit circuits are shown in Fig. 68. All circuits, not broken by a capacitor, are of low enough resistance to be checked by a continuity meter. The parasitic resistors are approximately 15 ohms and the radio-frequency chokes will have resistances between 1 and 40 ohms depending upon the tuning unit tested. Various other circuits may be easily checked by reference to the values of resistances and tolerances given in section V SUPPLEMENTARY DATA AND LIST OF REPLACEABLE PARTS.

136. *Neutralization of Power Amplifier*

Neutralization of the power amplifier is not ordinarily necessary, since this is done when the units are tested at the manufacturer's plant. However, if the setting is disturbed for any reason, the following procedure may be used to restore the adjustment.

a. A very accurate method of neutralizing is by use of a cathode-ray oscillograph. Filament voltage is removed from the p.a. by placing a piece of paper over one filament pin. When the radio transmitter is now turned on, the P-A filament should not light. Remove connections to the antenna. Connect the vertical plates of a cathode-ray oscillograph to terminals "LOAD A" and "CPSE" on the radio transmitter.

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 2000 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 p.a. to resonance as shown by a maximum amplitude of r-f carrier on the oscillograph. Proceed by tuning the neutralizing control, behind the tuning chart, for a minimum amplitude on the oscillograph at the same time maintaining the p.a. in tune. When the best minimum is reached with the p.a. in tune, the tuning unit is neutralized. In the lower frequency tuning units, the oscillograph pick-up will be practically zero at neutralization, while on the higher frequency units, considerable amplitude will still be noticed from stray ground currents. A check on neutralizing may be made on reaction of the plate-current meter as described below. It may be noted that nearly all tuning units are neutralized when the neutralizing capacitor is approximately one-half engaged.

b. A simpler method, although not quite so accurate, eliminates the use of the cathode-ray oscillograph. Filament voltage is removed from the p-a as before and the p-a tuning control is varied back and forth through resonance. Each time the circuit passes through resonance, there will be a slight kick on the plate current meter indicating that power is being fed through the p.a. by the m.o. By varying the p-a control through resonance and observing the plate current meter as the neutralizing control is varied, a setting may be found where a violet plate-current kick no longer appears, indicating that the p.a. is neutralized.

137. *Dynamotor Unit BD-77-C*

a. BRUSHES: The brushes can be removed by unscrewing the slotted brush cap on each side of the bearing bracket. It is recommended that each brush be suitably marked to indicate which brush holder it came from and its relative position in that brush holder in order that the brushes may later be replaced in their original positions. THIS IS IMPORTANT. Blow out dust and clean all foreign matter from each brush holder and brush and make certain that the brushes slide freely in their brush holders, dressing the brushes with fine sandpaper or a file, if necessary. Any brushes which have worn down to a length of less than ⅜ in. (measured from contact surface to near end of spring) should be replaced with new ones. In installing new brushes it may be necessary to "sand-in" the brush in order to make its contact surface fit the contour of the commutator. The brush must slide freely in its holder. "Sanding-in" may be accomplished by using a strip of No. 00 sandpaper about 5 in. by 1 in. for l-v brushes and 8 in. by ⅝ in. for h-v brushes. Wrap the strip of sandpaper around the commutator with the sand surface out. Insert the brushes in the brush holders and replace the brush caps so that the brushes are pressed tightly against the sandpaper. Holding the ends of the sandpaper so as to stretch it tightly against the commutator, rotate the armature back and forth until the full width of the brush face is making contact against the sandpaper as indicated by the sanding marks or scratches on the contact surface of the brush when it is withdrawn. Sand the sides of the brush, if necessary, for a free fit in the holder. No sanding should be necessary to secure a good brush fit with the original brushes if they are replaced correctly. Never apply oil, grease or any other lubricant to the brush, commutator or brush holder. Under normal conditions of operation, it is estimated that the useful life of brushes is 2000 hours for low-voltage and 10,000 hours for high-voltage brushes.

b. COMMUTATORS: Both commutators should be wiped with a clean, lintless cloth. Any scum appearing on the low-voltage commutator should be removed by moistening the cloth in carbon tetrachloride (Carbona). The normal black or dark brown polished surface on the high-voltage commutator should not be removed. The type of brush material used in the low-voltage brushes of the dynamotor may, under certain conditions of installation, cause a discoloration of the low-voltage commutator. Under these circumstances the commutator will have a mottled appearance which is caused by the formation of a very thin oxide film on the surface of the commutator bars. This film is normal and is not injurious to the commutator or brushes. Do not try to remove the oxide film described above. A rough or pitted commutator should be smoothed with No. 00 or finer sandpaper. NEVER USE EMERY CLOTH OR A FILE. Under normal conditions of operation the low-voltage and high-voltage commutators should not require turning down before 2000 hours and 10,000 hours of service, respectively. However, if the commutator bars have worn down flush with the mica, the armature should be removed from the dynamotor to turn down the commutator face and undercut the mica between bars.

c. BEARINGS: If the armature does not spin freely when rotated by hand with the brushes removed, the following may be the cause:

Dirt or other foreign matter in a bearing.

Defective ball bearing (cracked race, chipped or flattened ball).

Grease in bearing has become hard and gummy due to oxidation during long periods without actual use.

In any case, the armature should be removed from the frame as described under Disassembly (paragraph 137d) and the bearings thoroughly cleaned. If, after cleaning, the outer race will not spin smoothly, it is probably due to a cracked race or chipped or flattened ball, and the defective bearing should be removed and replaced with a new one. Always use a bearing puller to remove a defective bearing and never hammer or pry the bearing off since this may bend the shaft and injure the commutator. A new bearing should be pressed on the shaft until the inner race of the bearing rests against the shoulder on the shaft. For this operation always use an arbor press and a metal cylinder or collar which bears only against the inner race of the bearing. Care must be taken that no force or stress is placed on the outer race of either bearing at any time since this will usually result in a damaged bearing.

d. DISASSEMBLY: The following procedure is recommended for disassembling the dynamotor for cleaning and repacking the bearings:

(1) Remove the three "safety-wired" screws on each end of the dynamotor and take off the two end bells.

(2) Unscrew the slotted brush cap in each brush holder and remove all four brushes. Take special care to mark the position of the brushes in their brush holders such that they may later be replaced in their exact original positions.

(3) Unscrew the four slotted screws located around the rim of the low-voltage bearing bracket and pry the bracket loose from the frame. The low voltage end of the dynamotor can be identified by the long, small diameter commutator and the large copper-graphite brushes.

(4) Detach the two field leads from the terminal clamps on the low-voltage brush holders by unscrewing the screw in each terminal clamp. It is not necessary nor advisable to remove the terminal clamp from the brush holders.

(5) The bearing bracket can now be taken out of the way and the armature withdrawn from the frame. Take care not to injure the armature windings or commutator by rubbing against the field poles. Do not lose any shim washers which may be in the bearing housings, or which may stick to the bearing. If any shims are present they must be reassembled in the same housing.

(6) End Play Adjustment: A spanner screw is provided on one bearing bracket for adjusting end play in the dynamotor. This is properly adjusted at the factory and ordinarily will not need to be changed unless the armature is replaced. Before making any adjustments with this screw, it is necessary that two setscrews on either side of the bearing be loosened. The proper adjustment is made by operating the dynamotor until it is hot (about 30 min.) then screwing the spanner screw in until the bearings begin to growl then back off about ⅛ turn (45 degrees). The setscrews should then be tightened to hold the spanner nut in position.

(7) In cleaning the ball bearings it is not necessary to remove them from the armature shaft. Simply immerse the bearing in a shallow pan of clean carbon tetrachloride and wash all of the grease from the bearing. The use of a small camel's-hair brush will greatly aid the thorough cleaning of the bearing. Change the cleaning solvent in the pan as soon as it becomes dirty. Always use clean solvent for the final rinsing of the bearings. DO NOT ALLOW THE CLEANING SOLVENT TO COME IN CONTACT WITH THE COMMUTATORS OR WINDINGS. In case the cleaning fluid is accidentally splashed on these parts wipe it off immediately. Make certain the bearing is thoroughly clean and dry before repacking with new grease. If the bearing is not to be repacked with grease within a few minutes after cleaning, flush it with a clean, light mineral oil to protect the polished balls and races from rusting.

e. REASSEMBLING: In reassembling the dynamotor, follow in reverse order the procedure for disassembly. Make certain that the two field leads are securely attached to the proper terminal clamps on the low-voltage brush holders and that the "slack" or "loop" in these leads is "tucked" back of the field coils. Do not loosen or remove the brush holders from the bearing brackets. If a brush holder is loosened or removed for any reason, replace it securely in exactly its original position and check to make certain the contact surface of the brush fits the commutator perfectly. If necessary, sand-in the brush to secure a good fit against the commutator.

V. SUPPLEMENTARY DATA AND LIST OF REPLACEMENT PARTS

TABLE OF REPLACEABLE PARTS

Note: A number in parenthesis after a reference number indicates that the reference covers more than one item and the quantity

Reference numbers followed by * are used only in Radio Transmitter BC-191-C.
Reference numbers followed by † are used only in Radio Transmitter BC-191-D.
Reference numbers followed by ‡ are used only in Radio Transmitter BC-191-E.

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E						
1101	2C6191/S2	TSK-1	Socket	For Tube VT-4-C	M-O tube	Cat. 7461594 G1
1102		CSW-1	Switch	G.E. Cat. GA19A14, modified	Interlock	ML-7876926 G1
1103			Capacitor		Tube thermal compensator	ML-7462641 G1
1104			Capacitor	Part of 1103	Calibration reset	ML-7462641 G1
1105	3DA6-4	C-9	Capacitor	Cornell-Dubilier Type 15L, modified, 0.006 mfd. ±10%, 2500 volts	M-O plate by-pass	P-7761442 P12
1106	2C6191A/D2	RFC-14	Coil		M-O plate R-F choke	ML-7461859 G1
1107 (2)	3DA20-6	C-10	Capacitor	Cornell-Dubilier Type 9-L, modified, 0.02 mfd. ±10%, 1000 volts	Filament by-pass	P-7761443 P22
1108	3D9100-12	C-11	Capacitor	Cornell-Dubilier Type 9L, modified, 0.0001 mfd. ±10%, 1000 volts	M-O grid by-pass	P-7761443 P23
1109 (3)	3Z6250	R-2	Resistor	IRC Type DJ-1 (A) coating, modified, 2500 ohms, ±5%, 12 watts	M-O grid	P-7761526 P7
1110	2C6191/S2	TSK-1	Socket	For Tube VT-4-C	P-A tube	Cat. 7461594 G1
1111	3D9100-12	C-11	Capacitor	Cornell-Dubilier Type 9L, modified, 0.0001 mfd. ±10%, 1000 volts	P-A grid by-pass	P-7761443 P23
1112	3Z6400-1	R-3	Resistor	IRC Type DJ-1 (A) coating, modified, 4000 ohms, 12 watts	P-A grid (fixed)	P-7761481 P10
1113	2C6191A/R31	VR-1	Resistor	Yaxley Mfg. Co., 3000 ohms, +5%−0%, no taper	P-A grid (variable)	K-7870710
1114	2C6191A/R31	VR-1	Resistor	Yaxley Mfg. Co., 3000 ohms, +5%, −0%, no taper	P-A grid (variable)	K-7870710
1115	3Z6720	R-4	Resistor	IRC Type BT-1 waxed, modified, 200,000 ohms, ±10%, 1 watt, red body, black end, yellow dot	Keying	P-7761481 P27

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E (Continued)						
1116 (4)	3Z6725	R-5	Resistor	IRC Type BT-1 waxed, modified, 250,000 ohms, ±10%, 1 watt, red body, green end, yellow dot	H-V filter	P-7761481 P3
1117	3DA1-9	C-12	Capacitor	Cornell-Dubilier Type 15L, modified, 0.001 mfd. ±5%, 4500 volts	P-A plate by-pass	P-7761442 P13
1118	2C6191A/D1	RFC-14	Coil		P-A plate choke	ML-7461859 G1
1119	2C6191A/D2	RFC-15	Coil		Supply R-F choke	ML-7462675 G1
1120*†	2C6191A/C5	C-13	Capacitor	G.E. Model No. 9CE1A153, modified, 1.0 mfd., 1200 volts D.C.	Filter	K-7870691 P1
1121		M-1	Ammeter IS-22	G.E. Type DW-41, 500 milliamperes D.C., white blocking on scale from 210 to 220 M.A.	Plate current	ML-7875379 G2
1122			Lamp LM-27	Mazda No. 44, 6.3 volts, 0.25 amp.	Pilot	
1123	3Z6003-3	R-6	Resistor	IRC Type AB-1 (A) coating, modified, 30 ohms, ±10%, 4 watts	Transmitter pilot lamp	P-7761481 P4
1124	3Z6003-3	R-6	Resistor	IRC Type AB-1 (A) coating, modified, 30 ohms, ±10%, 4 watts	Control box pilot lamp	P-7761481 P4
1125	2Z8754		Socket SO-54	Plug receptacle	For Plug PL-74	ML-7761430 G1
1126	2Z8741		Socket SO-41	Plug receptacle	For Plug PL-61	ML-7761424 G1
1127	2Z8739		Socket SO-39	Plug receptacle	For Plug PL-59	ML-7761427 G1
1128	2Z8744		Socket SO-44	Plug receptacle	For Plug PL-64	ML-7761424 G2
1129		J-1	Jack JK-33-A		Microphone	ML-7461866 G1
1130		J-2	Jack JK-34-A		Key	ML-7461865 G1
1131		CSW-1	Switch	G.E. Cat. GA19A14, modified	Test key	ML-7876926 G1
1133		M-2	Voltmeter IS-122	G.E. Type AW-41, 15 volts AC-DC, white blocking on scale at 10 volts	Filament	ML-7875379 G3
1134	3DA10-17	C-14	Capacitor	Cornell-Dubilier Type 9L, modified, 0.01 mfd. ±10%, 1000 volts	Voltmeter by-pass	P-7761443 P24
1135		CSW-3	Switch	Arrow-Hart & Hegeman Elec. Co. No. 21189, modified, single circuit, two way, 1 amp. 250 volts, 3 amp. 125 volts	Filament voltmeter	ML-7876928 G1

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E (Continued)						
1138	2C6191A/R5	R-7	Resistor	G.E., 1.2 ohms blue stick resistor mounted to tapped connection board	Filament	ML-7761699 G1
1141	3Z9625	CSW-5	Switch		Selector "Tone-CW-Voice"	ML-7463230 G1
1142	3DA1-10	C-15	Capacitor	Cornell-Dubilier Type 9L, modified, 0.001 mfd. ±10%, 2500 volts	Tone feedback	P-7761443 P20
1144	3DB1.1A	C-16	Capacitor	Cornell-Dubilier Type HC-1010A, modified, 1 mfd. ±10%, 300 volts D.C.	S-A grid by-pass	K-7870639 P1
1145	3Z6005-2	R-8	Resistor	IRC Type AB-1 (A) coating, modified, 50 ohms, ±10%, 4 watts	Microphone	P-7761481 P11
1146		AFC-1	Reactor		Microphone filter	P-7762353 G1
1147	2C6191A/C9	C-17	Capacitor	Cornell-Dubilier Type A model MA-12658-PE, modified, 25 mfd. +40%, −10%, 25 volts D.C.	Microphone filter	K-7870437 P1
1148	2C6191A/R32	VR-2	Resistor	Yaxley Mfg. Co., 200 ohms, ±10%, no taper	Input level (variable)	K-7870693 P1
1149		TR-1	Transformer		Microphone	P-7762352 G1
1150	3DA1-7	C-18	Capacitor	Cornell-Dubilier Type 9L, modified, 0.001 mfd. ±5%, 2500 volts	S-A grid	P-7761443 P8
1151	3Z6020-4	R-9	Resistor	IRC Type AA-1 (A) coating, modified, 200 ohms, ±5%, 2 watts	Input load	P-7761526 P10
1152	3Z5991-2	R-10	Resistor	IRC Type AB-1 (A) coating, modified, 1 ohm, ±5%, 4 watts	S-A filament	P-7761481 P8
1153	3Z5991-2	R-10	Resistor	IRC Type AB-1 (A) coating, modified, 1 ohm, ±5%, 4 watts	S-A filament	P-7761481 P8
1154	2Z8759	TSK-2	Socket	Hammarlund Mfg. Co. Type S-4, modified	S-A Tube VT-25	K-7870442 P1
1155*†	2C6191A/C5	C-13	Capacitor	G.E. Model No. 9CE1A153, modified, 1.0 mfd., 1200 volts D.C.	S-A plate by-pass	K-7870691 P1
1156 (3)	3Z6611-1	R-11	Resistor	IRC Type DJ-1 (A) coating, modified, 11,000 ohms, ±5%, 12 watts	S-A plate	P-7761526 P8

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E (Continued)						
1157	2C6191A/C5	TR-2	Transformer		Interstage	P-7761434 G1
1160	3DB1.1A	C-16	Capacitor	Cornell-Dubilier Type HC-1010A, modified 1 mfd. ±10%, 300 volts D.C.	Modulator grid by-pass	K-7870639 P1
1161	2C6191/S2	TSK-1	Socket	For Tube VT-4-C	Modulator tube	Cat. 7461594 G1
1162	2C6191/S2	TSK-1	Socket	For Tube VT-4-C	Modulator tube	Cat. 7461594 G1
1163†*	2C6191A/C5	C-13	Capacitor	G.E. Model No. 9CE1A153, modified, 1.0 mfd., 1200 volts D.C.	Modulator plate by-pass	K-7870691 P1
1164	2C6191A/T1	TR-3	Transformer		Modulation	P-7761432 G1
1165		REL-1	Relay		Antenna switching	ML-7660600 G1
1166		M-3	Ammeter IS-89	G.E. Type DW-44, 8 amp. R-F, with internal thermocouple	Antenna	ML-7875379 G1
1167			Coil		Antenna inductance	ML-7761938 G1
1168	3Z9626	GSW-7	Switch		Antenna circuit	ML-7463231 G1
1169			Capacitor	Hammarlund Mfg. Co., 22 mmf. to 118 mmf.	Antenna tuning (variable)	M-7463006 P1
1170			Coil		Antenna loading inductance	ML-7761429 G1
1171*	3Z9627	CSW-8	Switch		Antenna loading tap	ML-7760475 G7
1172		FU-12	Fuse FU-12-A	0.5 amp, 1000 volts		Cat. 7871111P1
1173	2Z8754		Socket SO-54	Plug receptacle	For Plug PL-74	ML-7761430 G1
1174	2Z8741		Socket SO-41	Plug receptacle	For Plug PL-61	ML-7761424 G1
1175	2Z8739		Socket SO-39	Plug receptacle	For Plug PL-59	ML-7761427 G1
1176			Socket SO-44	Plug receptacle	For Plug PL-64	ML-7761424 G2
1177		J-1	Jack JK-33-A		Microphone	ML-7461866 G1
1178		J-2	Jack JK-34-A		Key	ML-7461865 G1
1179	3Z9610A	CSW-6	Switch	Yaxley Mfg. Co. Type B-12473, modified, single section, one circuit, four point, non-shorting	Side tone	K-7870711 P1
1180	3DA10-13	C-19	Capacitor	Cornell-Dubilier Type 9L, modified, 0.01 mfd. ±5%, 2500 volts	Tone grid	P-7761443 P26
1181 (2)	3Z6630-4	R-12	Resistor	IRC Type BT-1 waxed, Modified, 30,000 ohms, ±5%, 1 watt, orange body, black end, orange dot	Modulator grid	P-7761526 P12

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E (Continued)						
1182	3Z6005-2	R-8	Resistor	IRC Type AB-1 (A) coating modified, 50 ohms, ±10%, 4 watts	Microphone	P-7761481 P11
1183	3Z6010-6	R-13	Resistor	Ganged with 1184	M-O grid parasitic	ML-7871909 G1
1184	3Z6010-6	R-13	Coil	Ganged with 1183	M-O grid parasitic choke	ML-7871909 G1
1185	3DB1.1A	C-16	Capacitor	Cornell-Dubilier Type HC-1010A, modified, 1 mfd. ±10%, 300 volts D.C.	Key filter	K-7870639 P1
1186	3Z5995	R-14	Resistor	IRC Type AA-1 (A) coating, modified, 5 ohms, ±5%, 2 watts	Key filter	P-7761526 P16
1190		CSW-2	Switch	Arrow-Hart & Hegeman Elec. Co. Cat. No. 80600, double pole, single throw, 6 amp. at 250 v., 12 amp. at 125 v.	Filament	ML-7876927 G1
1194		CSW-2	Switch	Arrow-Hart & Hegeman Elec. Co. Cat. No. 80600, double pole, single throw, 6 amp. at 250 v., 12 amp. at 125 v.	Off–On	ML-7876927 G1
1195		CSW-4	Switch	Arrow-Hart & Hegeman Elec. Co., four pole, single throw, 6 amp. at 250 v., 12 amp at 125 v.	AC-DC	M-7463954 P1
1197A‡		C-34	Capacitor	G.E. Type 25F34 modified, 1-1-1 mfd.	Modulator plate by-pass	K-7877630
1197B‡		C-34	Capacitor	3000 volt D.C. included in 1197-A	S.A. plate by-pass	K-7877630
1197C‡		C-34	Capacitor	Included in 1197-A	Filter	K-7877630
1198†‡		CSW-8	Switch		Antenna tap	ML-7762960 G2
TRANSMITTER TUNING UNIT TU-3-B (400-800 KC)						
301			Variometer		M-O tank	ML-7761803 G1
302		RFC-16	Coil		M-O plate choke	ML-7463139 G1
303		RFC-19	Coil	G.E. (with resistor 317)	M-O grid choke	ML-7463144 G1
304		C-21	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.002 mfd. ±10%, 5000 volts	M-O grid	P-7761663 P2

TRANSMITTER TUNING UNIT TU-3-B (Continued)

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
305	2C8003A/C1		Compensator			K-7872702
306		RFC-18	Coil		P-A grid choke	ML-7463142 G1
307	3Z9615	CSW-13	Switch	G.E. (Ganged with 322)	M-O band change	ML-7659203 G3
308		C-22	Capacitor	Cornell-Dubilier Type 15H, modified, 0.0001 mfd. ±2%, 3000 volts	M-O tank	K-7872594 P3
309		C-23	Capacitor	Cornell-Dubilier Type 15H, modified, 0.0002 mfd. ±5% 3000 volts	M-O tank	K-7872594 P4
310		C-24	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.003 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P3
311		C-24	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.003 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P3
312		C-35	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.005 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P4
313		C-36	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.002 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P11
314		C-36	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.002 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P11
315		C-35	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.005 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P4
316			Capacitor	Hammarlund Mfg. Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8
317	3Z6001E5	RFC-19	Resistor	G.E. Type QLK-15 ohms, 4.5 watts	P-A grid parasitic	QLK-2155993 15 ohms
318		C-21	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.002 mfd. ±10%, 5000 volts	P-A grid	P-7761663 P2
319	2C8003A/C2		Compensator			K-7872701
320	2C8003A/C3		Compensator			K-7872700
321			Variometer		P-A tank	ML-7761804 G1
322		CSW-13	Switch	(Ganged with 307)	P-A band change	ML-7659203 G3

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
TRANSMITTER TUNING UNIT TU-3-B (Continued)						
323		C-27	Capacitor	Cornell-Dubilier Type 15L, modified, 0.0001 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P9
324		C-28	Capacitor	Cornell-Dubilier Type 15L, modified, 0.0002 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P8
325		C-37	Capacitor	Cornell-Dubilier Type 15L, modified, 0.001 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P2
326		C-37	Capacitor	Cornell-Dubilier Type 15L, modified, 0.001 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P2
327			Coil		Antenna coupling	ML-7761812 G1
328		CSW-10	Switch		Antenna coupling	ML-7762960 G1
329		C-30	Capacitor	Cornell-Dubilier Type 9L, modified, 0.002 mfd. ±2%, 5000 volts	Antenna coupling	P-7761443 P27
TRANSMITTER TUNING UNIT TU-5-B (1500-3000 KC)						
501			Inductance		M-O tank	ML-7761605 G1
502	3Z9614	CSW-9	Switch	(Ganged with 522)	M-O band change	ML-7659203 G2
503	3D9100-11	C-1	Capacitor	Cornell-Dubilier Type 15H, modified, 0.0001 mfd. ±2%, 3000 volts	M-O tank	P-7761662 P3
504	3D9100-11	C-1	Capacitor	Cornell-Dubilier Type 15H, modified, 0.0001 mfd. ±2%, 3000 volts	M-O tank	P-7761662 P3
505	3D9100-11	C-1	Capacitor	Cornell-Dubilier Type 15H, modified, 0.0001 mfd. ±2%, 3000 volts	M-O tank	P-7761662 P3
506	3D9030-1	C-2	Capacitor	Cornell-Dubilier Type 15H, modified, 0.00003 mfd. ±5%, 2000 volts	M-O tank	P-7761662P1
507			Capacitor	Hammarlund Mfg. Co., max. 135 mmf. ±2%; min. 20 mmf. ±1 mmf.	M-O tank (variable)	P-7761569 P2
508	2C8005A/D10	RFC-1	Coil	(With resistor 517)	P-A grid choke	ML-7462657 G1
509	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	P-A grid blocking	P-7761663 P1

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
				TRANSMITTER TUNING UNIT TU-5-B (Continued)		
510	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	M-O grid blocking	P-7761663 P1
511	2C8005A/D11	RFC-2	Coil		M-O grid choke	ML-7462706 G1
512			Capacitor	Hammarlund Mfg. Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8
513			Compensator			ML-7462769 G1
614			Compensator	(Ganged to 513)		ML-7462769 G1
515			Compensator	(Ganged to 513)		ML-7462769 G1
516			Compensator	(Ganged to 513)		ML-7462769 G1
517	3Z6001E5	RFC-1	Resistor	G.E. Type QLK, 15 ohms, 4.5 watts	P-A grid parasitic	QLK-2155993 15 ohms
521			Inductance		P-A tank	ML-7761615 G1
522	3Z9614	CSW-9	Switch	(Ganged to 502)	P-A band change	P-7659203 G2
523	3D9090	C-4	Capacitor	Cornell-Dubilier Type 15L, modified 0.00009 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P15
524	3D9090	C-4	Capacitor	Cornell-Dubilier Type 15L, modified, 0.00009 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P15
525	3D9090	C-4	Capacitor	Cornell-Dubilier Type 15L, modified, 0.00009 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P15
527			Capacitor	Hammarlund Mfg. Co., max. 156 mmf. ±3%; min. 20 mmf. ±1.5 mmf	P-A tank (variable)	T-7660443 P6
528			Coil		Antenna coupling	ML-7462710 G1
529		CSW-10	Switch		Antenna coupling	ML-7762960 G1
				TRANSMITTER TUNING UNIT TU-6-B (3000-4500 KC)		
601			Inductance		M-O tank	ML-7761606 G1
602	3Z9612	CSW-11	Switch	(Ganged with 622)	M-O band change	ML-7659555 G1
603	3D9050-3	C-7	Capacitor	Cornell-Dubilier Type 15H, modified, 0.00005 mfd. ±5%, 3000 volts	M-O tank	P-7761662 P2
607			Capacitor	Hammarlund Mfg. Co., max. 77 mmf. ±2%; min. 15 mmf. ±1 mmf.	M-O tank (variable)	P-7761569 P3
608	2C8006A/D14	RFC-3	Coil	(With resistor 614)	P-A grid choke	ML-7462659 G2

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
TRANSMITTER TUNING UNIT TU-6-B (Continued)						
609	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	P-A grid blocking	P-7761663 P1
610	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	M-O grid blocking	P-7761663 P1
611	2C8006A/D15	RFC-4	Coil		M-O grid choke	ML-7462659 G1
612			Capacitor	Hammarlund Mfg. Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8
613			Compensator			ML-7462707 G1
614	3Z6001E5	RFC-3	Resistor	G.E. Type QLK, 15 ohms, 4.5 watts	P-A grid parasitic	QLK-2155993 15 ohms
621			Inductance		P-A tank	ML-7761616 G1
622	3Z9612A	CSW-11	Switch	(Ganged with 602)	P-A band change	ML-7659555 G1
623	3D9050-1	C-6	Capacitor	Cornell-Dubilier Type 15L, modified, 0.00005 mfd. ±5%, 3000 volts	P-A fixed tank	P-7761442 P11
627			Capacitor	Hammarlund Mfg. Co., max. 116 mmf. ±3%; min. 19 mmf. ±1.5 mmf.	P-A tank (variable)	T-7660443 P1
628			Coil		Antenna coupling	ML-7461825 G1
629		CSW-10	Switch		Antenna coupling	ML-7762960 G1
TRANSMITTER TUNING UNIT TU-7-B (4500-6200 KC)						
701			Inductance		M-O tank	ML-7761607 G1
702			Capacitor	Hammarlund Mfg. Co., max. 111 mmf. ±2%; min. 23 mmf. ±1 mmf.	M-O tank (variable)	P-7761569 P4
703	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	M-O grid blocking	P-7761663 P1
704	2C8006A/D15	RFC-5	Coil		M-O grid choke	ML-7462659 G3
705	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	P-A grid blocking	P-7761663 P1
706	2C8007A/D3	RFC-6	Coil		P-A grid choke	ML-7462639 G1
707			Capacitor	Hammarlund Mfg. Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8
721			Inductance		P-A tank	ML-7761617 G1

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
				TRANSMITTER TUNING UNIT TU-7-B (Continued)		
722			Capacitor	Hammarlund Mfg. Co., max. 116 mmf. ±2.5%; min. 19 mmf. ±1.5 mmf.	P-A tank (variable)	T-7660443 P2
723			Coil		Antenna coupling	ML-7462759 G1
724		CSW-10	Switch		Antenna coupling	ML-7762960 G1
				TRANSMITTER TUNING UNIT TU-8-B (6200-7700 KC)		
801			Inductance		M-O tank	ML-7761608 G1
802			Capacitor	Hammarlund Mfg. Co., max. 66 mmf. ±2%; min. 14 mmf. ±1 mmf.	M-O tank (variable)	P-7761569 P5
803	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	M-O grid blocking	P-7761663 P1
804	2C8008A/D5	RFC-7	Coil		M-O grid choke	ML-7462638 G1
805	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	P-A grid blocking	P-7761663 P1
806	2C8008A/D12	RFC-8	Coil		P-A grid choke	ML-7462658 G1
807			Capacitor	Hammarlund Mfg. Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8
821			Inductance		P-A tank	ML-7761618 G1
822			Capacitor	Hammarlund Mfg. Co., max. 81 mmf. ±3%; min. 15 mmf. ±1.5 mmf.	P-A tank (variable)	T-7660443 P7
823			Coil		Antenna coupling	ML-7462672 G1
824		CSW-10	Switch		Antenna coupling	ML-7762960 G1
				TRANSMITTER TUNING UNIT TU-9-B (7700-10,000 KC)		
901			Inductance		M-O tank	ML-7761609 G1
902			Capacitor	Hammarlund Mfg. Co., max. 77 mmf. ±2%; min. 15 mmf. ±1 mmf.	M-O tank (variable)	P-7761569 P6
903	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	M-O grid blocking	P-7761663 P1
904	2C8009A/D6	RFC-9	Coil		M-O grid choke	ML-7462662 G1

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
			TRANSMITTER TUNING UNIT TU-9-B (Continued)			
905	3D9400-6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	P-A grid blocking	P-7761663 P1
906	2C8009A/D7	RFC-10	Coil		P-A grid choke	ML-7463044 G1
907			Capacitor	Hammarlund Mfg. Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8
909	3D9400-3	C-8	Capacitor	Cornell-Dubilier Type 9L, modified, 0.0004 mfd. ±5%, 5000 volts	M-O by-pass	P-7761443 P2
921			Inductance		P-A tank	ML-7761619 G1
922			Capacitor	Hammarlund Mfg. Co., max. 116 mmf. ±2.5%; min. 19 mmf. ±1.5 mmf.	P-A tank (variable)	T-7660443 P3
923			Coil		Antenna coupling	ML-7462770 G1
924		CSW-10	Switch		Antenna coupling	ML-7762960 G1
			TRANSMITTER TUNING UNIT TU-10-B (10,000-12,500 KC)			
1001			Inductance		M-O tank	ML-7761610 G1
1002			Capacitor	Hammarlund Mfg. Co., max. 62 mmf. ±2%; min. 14 mmf. ±1 mmf.	M-O tank (variable)	P-7761569 P7
1003	3D9400-6	C3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	M-O grid blocking	P-7761663 P1
1004	2C8010A/D7	RFC-11	Coil		M-O grid choke	ML-7462661 G1
1005	3D9400/6	C-3	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0004 mfd. ±10%, 5000 volts	P-A grid blocking	P-7761663 P1
1006	2C8010A/D7	RFC-12	Coil		P-A grid choke	ML-7463045 G1
1007			Capacitor	Hammarlund Mfg., Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8
1009	3D9400-3	C-8	Capacitor	Cornell-Dubilier Type 9L, modified, 0.0004 mfd. ±5%, 5000 volts	M-O by-pass	P-7761443 P2
1010	2C8010A/D16	RFC-13	Coil		M-O choke	ML-7462679 G1
1021			Inductance		P-A tank	ML-7761620 G1
1022			Capacitor	Hammarlund Mfg. Co., max. 116 mmf. ±2.5%; min. 19 mmf. ±1.5 mmf.	P-A tank (variable)	T-7660443 P4

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
TRANSMITTER TUNING UNIT TU-10-B (Continued)						
1023			Coil		Antenna coupling	ML-7462755 G1
1024		CSW-10	Switch		Antenna coupling	ML-7762960 G1
TRANSMITTER TUNING UNIT TU-22-B (350-650 KC)						
2201			Variometer		M-O tank	ML-7761803 G3
2202		RFC-16	Coil		M-O plate choke	ML-7463139 G1
2203		RFC-17	Coil	(With resistor 2217)	M-O grid choke	ML-7463144 G2
2204		C-21	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.002 mfd. ±10%, 5000 volts	M-O grid	P-7761663 P2
2205			Compensator			K-7872696
2206		RFC-18	Coil		P-A grid choke	ML-7463142 G1
2207		CSW-13	Switch	(Ganged with 2222)	M-O band change	ML-7659203 G3
2208		C-22	Capacitor	Cornell-Dubilier Type 15H, modified, 0.0001 mfd. ±2%, 3000 volts	M-O tank	K-7872594 P3
2209		C-23	Capacitor	Cornell-Dubilier Type 15H, modified, 0.0002 mfd. ±5%, 3000 volts	M-O tank	K-7872594 P4
2210		C24	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.003 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P3
2211		C-24	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.003 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P3
2212		C-25	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0035 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P15
2213		C-26	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0024 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P16
2214		C-26	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0024 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P16
2215		C-25	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.0035 mfd. ±5%, 5000 volts	M-O chain	P-7761663 P15
2216			Capacitor	Hammarlund Mfg. Co., max. 26 mmf. ±4%; min. 8 mmf. ±1.5 mmf.	Neutralizing	T-7660443 P8

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
TRANSMITTER TUNING UNIT TU-22-B (Continued)						
2217		RFC-17	Resistor	G.E. Type, QLK, 15 ohms, 4.5 watts	M-O grid parasitic	QLK-2155993 15 ohms
2218		C-21	Capacitor	Cornell-Dubilier Type 9HL, modified, 0.002 mfd. ±10%, 5000 volts	P-A grid	P-7761663 P2
2219			Compensator			K-7872696
2220			Compensator			K-7875316
2221			Variometer		P-A tank	ML-7761804 G2
2222		CSW-13	Switch	(Ganged with 2207)	P-A band change	ML-7659203 G3
2223		C-27	Capacitor	Cornell-Dubilier Type 15L, modified, 0.0001 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P9
2224		C-28	Capacitor	Cornell-Dubilier Type 15L, modified, 0.0002 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P8
2225		C-29	Capacitor	Cornell-Dubilier Type 15L, modified, 0.0008 mfd. ±5%, 3000 volts	P-A tank	P-7761442 P17
2227			Coil		Antenna coupling	ML-7463895 G1
2228		CSW-10	Switch		Antenna coupling	ML-7762960 G1
2229		C-30	Capacitor	Cornell-Dubilier Type 9L, modified, 0.002 mfd. ±2%, 5000 volts	Antenna coupling	P-7761443 P27
ANTENNA TUNING UNIT BC-306-A						
1501		CSW-12	Switch		Antenna variometer	ML-7463975 G1
1502			Variometer		Antenna	ML-7761714 G1
RADIO CONTROL BOX BC-309						
1301	2Z8754		Socket SO-54	Plug receptacle	For Plug PL-74	ML-7761430 G1
1302	3Z9847	CSW-15	Switch	G.E. Cat. 46X465, modified, single pole, single throw, 3 amps at 250 volts	Off-On	K-7870311 P1
1303		J-2	Jack JK-34-A		Key	ML-7461865 G1
1304	2Z5927		Lamp LM-27	G.E. Mazda No. 44, 6.3 volts, 0.25 amp	Pilot	

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
			DYNAMOTOR UNIT BD-77-C			
1601	2Z8741		Socket SO-41	Plug receptacle	For Plug PL-61	ML-7761424 G1
1602	2Z8739		Socket SO-39	Plug receptacle	For Plug PL-59	ML-7761427 G1
1603		REL-2	Relay	G.E. CR2800-384A2, nominal coil voltage 14 volts D.C.	Starting	M-7464026 P1
1604	3Z1913	FU-13	Fuse FU-13	G.E. Cat. No. GE1027, modified, 30 amps, 250 volts		K-7870616 P1
1605	3Z1922	FU-22	Fuse FU-22	Bussmann Mfg. Co. No. 1021, modified, 60 amps. 250 volts		K-7870604 P1
1607	3DA5	C-20	Capacitor	Cornell-Dubilier Type 9L, modified, 0.005 mfd. ±5%, 5000 volts		P-7761443 P6
1608	3Z1918	FU-18	Fuse FU-18-A	G.E. fuse, 1 amp, 1000 volts		Cat. 7870617
1609	3DA10-17	C-14	Capacitor	Cornell-Dubilier Type 9L, modified, 0.01 mfd. ±10%, 1000 volts	L-V filter	P-7761443 P24
1613		C-31	Capacitor	Cornell-Dubilier Type 9L, modified, 0.015 mfd. ±10%, 5000 volts		P-7762618 P6
1614		C-31	Capacitor	Cornell-Dubilier Type 9L, modified, 0.015 mfd. ±10%, 5000 volts		P-7762618 P6
1615		C-32	Capacitor	Cornell-Dubilier Type 3YL, modified, 0.01 mfd. ±10%, 600 volts		P-7761774 P8
1616		C-33	Capacitor	Cornell-Dubilier Type 3LL, modified, 0.01 mfd. ±10%, 600 volts		ML-7877309 G1
1617			Dynamotor	G.E. Model No. 5D48B8, 14/1000 volts max, 5000 RPM		K-7876652

Reference No.	Stock No.	Renewal Part Designation	Name of Part	Description	Function	Drawing No. (G.E. Co.)
			MOUNTINGS			
		FT-107	Mounting FT-107		Part of Dynamotor Unit BD-77-C	ML-7461031 G1 Sig. C Dwg. SC-D-447
		FT-115	Mounting FT-115-B		Disposable for use with Radio Transmitters BC-191-C, BC-191-D, BC-191-E	ML-7463135 G1 Signal Corps Dwg. SC-C-2286
		FT-142	Mounting FT-142		Part of Antenna Tuning Unit BC-306-A	ML-7462801 G1 Sig. C. Dwg. SC-D-2389
	2Z6691A	FT-151A	Mounting FT-151-A		Part of Radio Transmitters BC-191-C, BC-191-D, BC-191-E	ML-7761671 G1 Signal Corps Dwg. SC-D-2290
		FT-151B	Mounting FT-151-B		For use with Radio Transmitters BC-191-C, BC-191-D, BC-191-E	ML-7761671 G2

THE FOLLOWING ITEMS OF THE SAME TYPE ARE ELECTRICALLY AND MECHANICALLY INTERCHANGEABLE

Description	Reference Numbers
Capacitor, Cornell-Dubilier Type 15H, 3000 volts rated 0.0001 mfd.	503, 504, 505
Capacitor, Cornell-Dubilier Type 15H, 3000 volts rated 0.0001 mfd.	308, 2208
Capacitor, Cornell-Dubilier Type 15H, 3000 volts rated 0.0002 mfd.	309, 2209
Capacitor, Cornell-Dubilier Type 9L, 5000 volts rated 0.002 mfd.	329, 2229
Capacitor, Cornell-Dubilier Type 9L, 5000 volts rated 0.0004 mfd.	909, 1009
Capacitor, Cornell-Dubilier Type 9L, 1000 volts rated 0.0001 mfd.	1108, 1111
Capacitor, Cornell-Dubilier Type 9L, 1000 volts rated 0.01 mfd.	1134, 1609
Capacitor, Cornell-Dubilier Type 9HL, 5000 volts rated 0.002 mfd.	304, 318, 2204, 2218
Capacitor, Cornell-Dubilier Type 9HL, 5000 volts rated 0.003 mfd.	310, 311, 2210, 2211
Capacitor, Cornell-Dubilier Type 9HL, 5000 volts rated 0.0035 mfd.	2212, 2215
Capacitor, Cornell-Dubilier Type 9HL, 5000 volts rated 0.0024 mfd.	2213, 2214
Capacitor, Cornell-Dubilier Type 9HL, 5000 volts rated 0.0004 mfd.	509, 510, 609, 610, 703, 705, 803, 805, 903, 905, 1003, 1005
Capacitor, Cornell-Dubilier Type 9HL, 5000 volts rated 0.005 mfd.	312, 315
Capacitor, Cornell-Dubilier Type 9HL, 5000 volts rated 0.002 mfd.	313, 314
Capacitor, Cornell-Dubilier Type 15L, 3000 volts rated 0.001 mfd.	325, 326
Capacitor, Cornell-Dubilier Type 15L, 3000 volts rated 0.0002 mfd.	324, 2224
Capacitor, Cornell-Dubilier Type 15L, 3000 volts rated 0.0001 mfd.	323, 2223
Capacitor, Cornell-Dubilier Type 15L, 3000 volts rated 0.00009 mfd.	523, 524, 525
Capacitor, G.E., 1200 volts rated 1.0 mfd.	* 1120, 1155, 1163
Capacitor, Cornell-Dubilier Type HC, 3000 volts rated 1.0 mfd.	1144, 1160, 1185
Capacitor, Hammarlund Mfg. Co., 8 to 26 mmfd.	316, 512, 612, 707, 807, 907, 1007, 2216
Choke, R.F., G.E. ML-7461859 G1	1106, 1118
Choke, grid, G.E. ML-7463142 G1	306, 2206
Choke, plate, G.E. ML-7463139 G1	302, 2202
Compensator, G.E. K-7872696	2205, 2219
Jack JK-34-A (Key) G.E. ML-7461865 G1	1130, 1178, 1303
Jack JK-33-A (Microphone) G.E. ML-7461866 G1	1129, 1177
Lamp LM-27 (Pilot) G.E. Mazda No. 44	1122, 1304
Resistor, IRC, wire wound, rated 30 ohms, 4 watts	1123, 1124
Resistor, IRC, wire wound, rated 50 ohms, 4 watts	1145, 1182
Resistor, IRC, wire wound, rated 1 ohm, 4 watts	1152, 1153
Resistor, G.E., wire wound, rated 15 ohms, 4.5 watts	317, 517, 614, 2217
Resistor, Yaxley, variable, rated 3000 ohms	1113, 1114
Socket SO-39 for Plug PL-59	1127, 1175, 1602
Socket SO-41 for Plug PL-61	1126, 1174, 1601
Socket SO-44 for Plug PL-64	1128, 1176
Socket SO-54 for Plug PL-64	1125, 1173, 1301
Socket for Tube VT-4-C	1101, 1110, 1161, 1162
Switch, filament, G.E. ML-7876927 G1	1190, 1194
Switch, filament, G.E. ML-7876926 G1	1102, 1131
Switch, antenna, G.E. ML-7762960 G1	529, 328, 629, 724, 824, 924, 1024, 2228

* 1197 A, B, C, replaces these electrically but not mechanically

Spare Part Desig- nation	Electrical Rating	Manufacturer	Dimensions in Inches				Wt. in Lbs.	Description
			Length	Width	Height	Dia.		
AFC-1	0.5 h., 0.1 amp.	General Electric	2.25	2.50	2.59	—	0.685	Microphone filter reactor
ARM-1		General Electric	9.375			3.25	7.56	Armature for Dynamotor Unit BD-77-[illegible]
BG-1		New Departure			0.5	1.25	0.065	Dynamotor bearing
BP-2		General Electric	6.84	2.25	1.87		0.560	Antenna binding post on transmitter
BP-3		General Electric			2.187	2.06	0.187	Binding post on antenna tuning unit
BP-4		General Electric			0.812	0.50	0.031	Binding post on antenna tuning unit
BR-5	H-V for Dynamotor	General Electric	0.625	0.25	0.25		0.017	Dynamotor brush
BR-6	L-V for Dynamotor	General Electric	0.80	0.75	0.437		0.083	Dynamotor brush
C-1	0.0001 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.270	Mica capacitor
C-2	0.00003 mfd. 2000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.225	Mica capacitor
C-3	0.0004 mfd. 5000 v.	Cornell-Dubilier	1.75	1.32	1.781		0.129	Mica capacitor
C-4	0.00009 mfd. 5000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.270	Mica capacitor
C-6	0.00005 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.229	Mica capacitor
C-7	0.00005 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.229	Mica capacitor
C-8	0.0004 mfd. 5000 v.	Cornell-Dubilier	1.75	1.32	0.468		0.068	Mica capacitor
C-9	0.006 mfd. 2500 v.	Cornell-Dubilier	2.81	0.937	1.937		0.242	Mica capacitor
C-10	0.02 mfd. 1000 v.	Cornell-Dubilier	1.75	1.32	0.468		0.090	Mica capacitor
C-11	0.0001 mfd. 1000 v.	Cornell-Dubilier	1.75	1.32	0.468		0.066	Mica capacitor
C-12	0.001 mfd. 4500 v.	Cornell-Dubilier	2.81	0.937	1.937		0.250	Mica capacitor
C-13	1 mfd. 1200 v.	General Electric	1.75	1.00	4.375		0.513	Pyranol filled capacitor
C-14	0.01 mfd. 1000 v.	Cornell-Dubilier	1.75	1.32	0.468		0.074	Mica capacitor
C-15	0.001 mfd. 2500 v.	Cornell-Dubilier	1.75	1.32	0.468		0.070	Mica capacitor
C-16	1 mfd. 300 v.	Cornell-Dubilier	2.75	2.07	1.00		0.217	Paper capacitor
C-17	25 mfd. 25 v.	Cornell-Dubilier	2.12	1.43	2.75		0.140	Electrolytic capacitor
C-18	0.001 mfd. 2500 v.	Cornell-Dubilier	1.75	1.32	0.468		0.070	Mica capacitor
C-19	0.01 mfd. 2500 v.	Cornell-Dubilier	1.75	1.32	0.468		0.074	Mica capacitor
C-20	0.005 mfd. 5000 v.	Cornell-Dubilier	1.75	1.32	0.468		0.072	Mica capacitor
C-21	0.002 mfd. 5000 v.	Cornell-Dubilier	1.75	1.31	0.78		0.126	Mica capacitor
C-22	0.0001 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	2.125		0.250	Mica capacitor
C-23	0.0002 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	2.125		0.250	Mica capacitor
C-24	0.003 mfd. 5000 v.	Cornell-Dubilier	1.75	1.31	0.78		0.126	Mica capacitor
C-25	0.0035 mfd. 5000 v.	Cornell-Dubilier	1.75	1.31	0.78		0.126	Mica capacitor
C-26	0.0024 mfd. 5000 v.	Cornell-Dubilier	1.75	1.31	0.78		0.124	Mica capacitor
C-27	0.0001 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.250	Mica capacitor
C-28	0.0002 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.250	Mica capacitor
C-29	0.0008 mfd. 3000 v.	Cornell-Dubilier	2.81	0.937	1.937		0.242	Mica capacitor
C-30	0.002 mfd. 5000 v.	Cornell-Dubilier	1.75	1.31	0.468		0.068	Mica capacitor
C-31	0.015 mfd. 5000 v.	Cornell-Dubilier	1.75	1.312	0.781		0.125	Mica capacitor
C-32	0.01 mfd. 600 v.	Cornell-Dubilier	2.625	0.625	0.312		0.0234	Mica capacitor
C-33	0.01 mfd. 600 v.	Cornell-Dubilier	1.937	0.625	0.312		0.0312	Mica capacitor

Spare Part Designation	Electrical Rating	Manufacturer	Dimensions in Inches				Wt. in Lbs.	Description
			Length	Width	Height	Dia.		
C-34	1-1-1 mfd. 3000 v.	General Electric	4.75	2.5	3.0			Pyranol filled capacitor
C-35	0.005 mfd. 5000 v.	Cornell-Dubilier	0.781	1.312	1.75		0.125	Mica capacitor
C-36	0.002 mfd. 5000 v.	Cornell-Dubilier	0.781	1.312	1.75		0.125	Mica capacitor
C-37	0.001 mfd. 3000 v.	Cornell-Dubilier	2.812	0.937	1.937		0.250	Pyranol filled capacitor
CSW-1		General Electric	1.18	0.531	1.56		0.036	Interlock switch and test key
CSW-2		Arrow-Hart Hegeman	1.75	0.75	1.59		0.062	On-Off switch
CSW-3		Arrow-Hart Hegeman	1.56	0.625	1.32		0.032	Voltmeter switch
CSW-4		Arrow-Hart Hegeman	2.718	1.5	1.75		0.187	AC-DC switch
CSW-5		General Electric	2.63	2.63	2.109		0.150	Selector switch
CSW-6		Yaxley Co.	1.5	2.38	2.0		0.106	Side-Tone switch
CSW-7		General Electric	5.38	2.75	2.75		0.565	Antenna circuit
CSW-8		General Electric	2.375	2.375	2.50		0.343	Antenna tap switch
CSW-9		General Electric	10.0	2.56	2.43		0.55	Tandem control switch
CSW-10		General Electric	2.375	2.375	2.50		0.343	Antenna coupling switch
CSW-11		General Electric	10.0	2.56	2.38		0.498	Tandem control switch
CSW-12		General Electric	5.18			2.75	0.594	Antenna variometer switch
CSW-13		General Electric	10.0	2.56	3.0		0.656	Tandem control switch
CSW-14		General Electric	1.187	0.515	1.37		0.625	On-Off switch
FT-107		General Electric	10.62	7.5	0.82		1.45	Mounting FT-107
FT-115		General Electric	2.12	2.31	1.21		0.195	Mounting FT-115-B
FT-142		General Electric	9.5	8.0	0.40		0.69	Mounting FT-142
FT-151A		General Electric	22.0	8.0	1.35		3.797	Mounting FT-151-A
FU-12	0.5 amp. 1000 v.	General Electric	3.0			0.50	0.018	Fuse FU-12-A
FU-13	30 amp. 250 v.	General Electric	2.0			0.56	0.055	Fuse FU-13
FU-18	1 amp. 1000 v.	General Electric	3.0			0.50	0.0187	Fuse FU-18-A
FU-22	60 amp. 250 v.	Bussmann Mfg. Co.	3.0			0.812	0.117	Fuse FU-22
INS-1		General Electric	0.25			2.0	0.045	Ceramic ring
INS-2		General Electric	1.81	0.375	0.375		0.020	Ceramic post
INS-3		General Electric	1.25	0.375	1.25		0.049	Ceramic insulator
INS-4		General Electric	1.75	0.375	0.875		0.048	Ceramic insulator
INS-6		General Electric	2.43	0.375	0.875		0.07	Ceramic insulator
INS-7		General Electric	1.25	0.375	0.375		0.014	Ceramic insulator
INS-8		General Electric	0.875	0.375	0.375		0.01	Ceramic insulator
INS-9		General Electric	1.0	0.375	0.375		0.012	Ceramic post
INS-10		General Electric	1.25	0.375	0.375		0.013	Ceramic post
INS-11		General Electric	1.25	0.375	0.375		0.013	Ceramic post

Spare Part Desig-nation	Electrical Rating	Manufacturer	Dimensions in Inches				Wt. in Lbs.	Description
			Length	Width	Height	Dia.		
INS-12		General Electric	3.25	3.0	0.375		0.021	Ceramic end plate
INS-13		General Electric	0.875	0.375	0.375		0.01	Ceramic post
INS-14		General Electric	1.0	0.375	0.375		0.012	Ceramic post
INS-15		General Electric	1.375			2.125	0.125	Ceramic insulator
INS-16		General Electric	0.281			0.625	0.007	Ceramic insulator
J-1		General Electric	1.245	0.937	0.75		0.030	Jack JK-33-A
J-2		General Electric	1.271	0.937	0.75		0.024	Jack JK-34-A
M-1	500 ma DC	General Electric	2.03			2.56	0.274	Ammeter IS-22 (plate milliammeter)
M-2	15 volts AC-DC	General Electric	2.03			2.56	0.278	Voltmeter IS-122
M-3	8 amp. RF	General Electric	2.03			2.56	0.400	Ammeter IS-89
M-141	30 amp., 250 volts	General Electric	2.25	0.25	0.010		0.001	Fuse Link M-141 for Fuse FU-13
M-168	60 amp., 250 volts	Bussmann Mfg. Co.	3.43	0.375	0.060		0.008	Fuse Link M-168 for Fuse FU-22
R-2	2500 ohms, 12 watts	IRC	3.0			0.750	0.059	Fixed resistor
R-3	4000 ohms, 12 watts	IRC	3.0			0.750	0.059	Fixed resistor
R-4	200,000 ohms, 1 watt	IRC	1.25			0.25	0.006	Fixed resistor
R-5	250,000 ohms, 1 watt	IRC	1.25			0.25	0.006	Fixed resistor
R-6	30 ohms, 4 watts	IRC	1.75			0.43	0.0185	Fixed resistor
R-7	1.2 ohms, 8 amps	General Electric	10.75	2.75	1.93		1.84	Fixed resistor with terminal board
R-8	50 ohms, 4 watts	IRC	1.75			0.43	0.020	Fixed resistor
R-9	200 ohms 2 watts	IRC	0.875			0.43	0.013	Fixed resistor
R-10	1 ohm, 4 watts	IRC	1.75			0.43	0.185	Fixed resistor
R-11	11,000 ohms 12 watts	IRC	3.0			0.75	0.059	Fixed resistor
R-12	30,000 ohms, 1 watt	IRC	1.25			0.25	0.006	Fixed resistor
R-13	100 ohms, 1 watt	General Electric	5.687	1.375	1.375		0.094	Parasitic resistor and choke
R-14	5 ohms, 2 watts	IRC	0.875			0.43	0.0143	Fixed resistor
REL-1		General Electric	5.625	2.75	2.562		1.36	Antenna switch relay
REL-2		General Electric	4.0	2.562	2.75		2.0	Starting relay for dynamotor
RFC-1		General Electric			2.84	1.50	0.086	Radio freq. choke and fixed resistor
RFC-2		General Electric			1.45	1.50	0.066	Radio freq. choke
RFC-3		General Electric			1.45	1.187	0.066	Radio freq. choke and fixed resistor
RFC-4		General Electric			1.45	1.187	0.066	Radio freq. choke
RFC-5		General Electric			1.45	1.187	0.066	Radio freq. choke
RFC-6		General Electric			1.45	1.187	0.046	Radio freq. choke
RFC-7		General Electric			1.45	1.06	0.043	Radio freq. choke
RFC-8		General Electric			1.45	1.06	0.063	Radio freq. choke
RFC-9		General Electric			1.45	0.937	0.039	Radio freq. choke
RFC-10		General Electric			1.45	0.937	0.039	Radio freq. choke
RFC-11		General Electric			1.45	0.937	0.038	Radio freq. choke

Spare Part Designation	Electrical Rating	Manufacturer	Dimensions in Inches				Wt. in Lbs.	Description
			Length	Width	Height	Dia.		
RFC-12		General Electric			1.45	0.937	0.038	Radio freq. choke
RFC-13		General Electric			2.81	0.625	0.052	Radio freq. choke
RFC-14		General Electric			1.93	1.187	0.054	Radio freq. choke
RFC-15		General Electric			1.45	1.06	0.053	Radio freq. choke
RFC-16		General Electric			1.50	1.453	0.066	Radio freq. choke
RFC-17		General Electric			1.484	1.687	0.124	Radio freq. choke and fixed resistor
RFC-18		General Electric			1.844	1.687	0.092	Radio freq. choke
RFC-19		General Electric			1.484	1.687	0.125	Radio freq. choke and fixed resistor
TR-1		General Electric	4.0	2.625	2.953		2.5	Microphone transformer
TR-2		General Electric	4.09	2.75	3.375		2.31	Interstage transformer
TR-3		General Electric	3.75	3.25	4.75		4.81	Modulation transformer
TSK-1		General Electric			1.25	4.0	0.224	Socket for Tube VT-4-C
TSK-2		Hammarlund Mfg. Co.	2.25	1.62	0.68		0.0635	Socket for Tube VT-25
VR-1	3000 ohms	Yaxley Mfg. Co.	1.375	1.625	2.0		0.104	Variable resistor
VR-2	200 ohms	Yaxley Mfg. Co.	1.625	1.625	2.0		0.108	Variable resistor

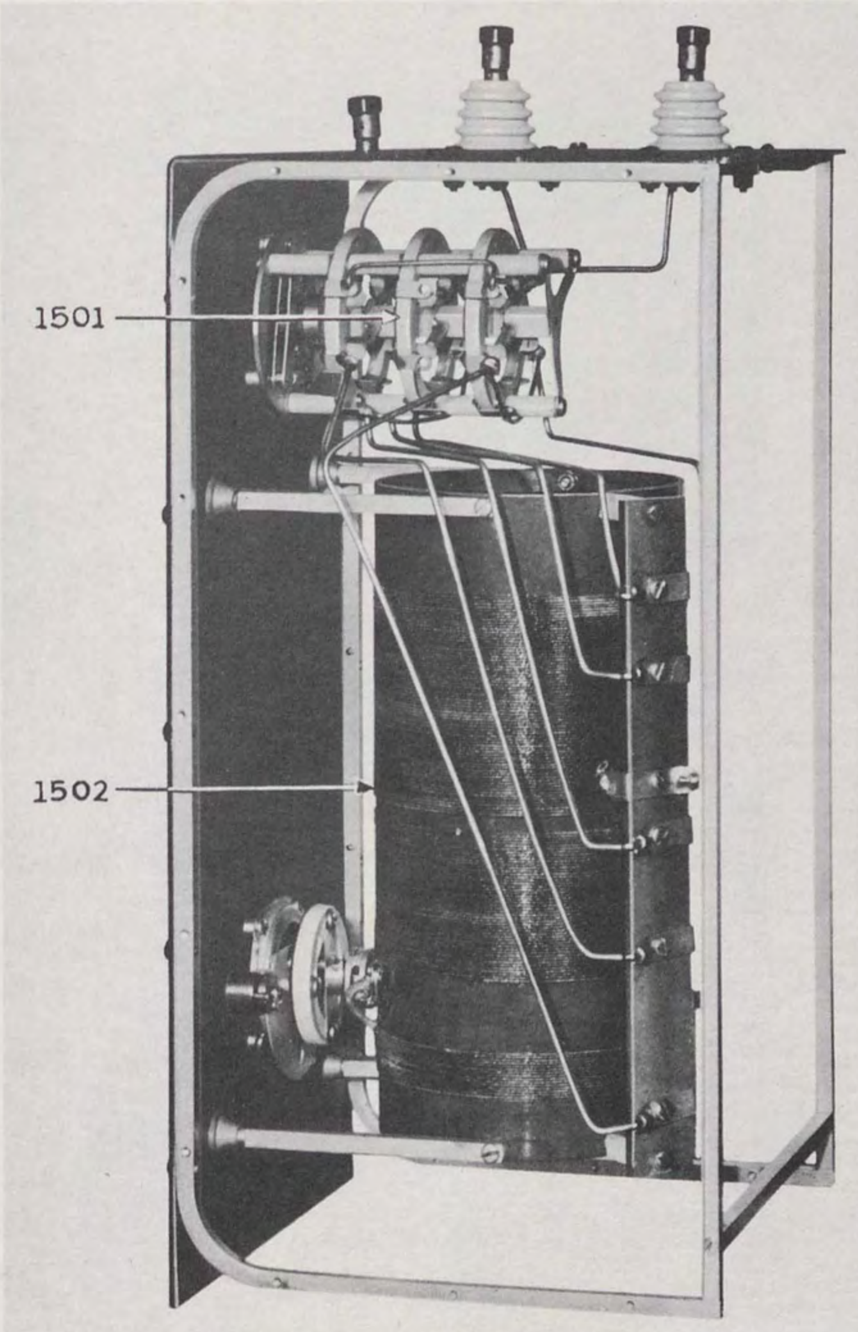


FIG. 25. ANTENNA TUNING UNIT BC-306-A, INTERIOR VIEW

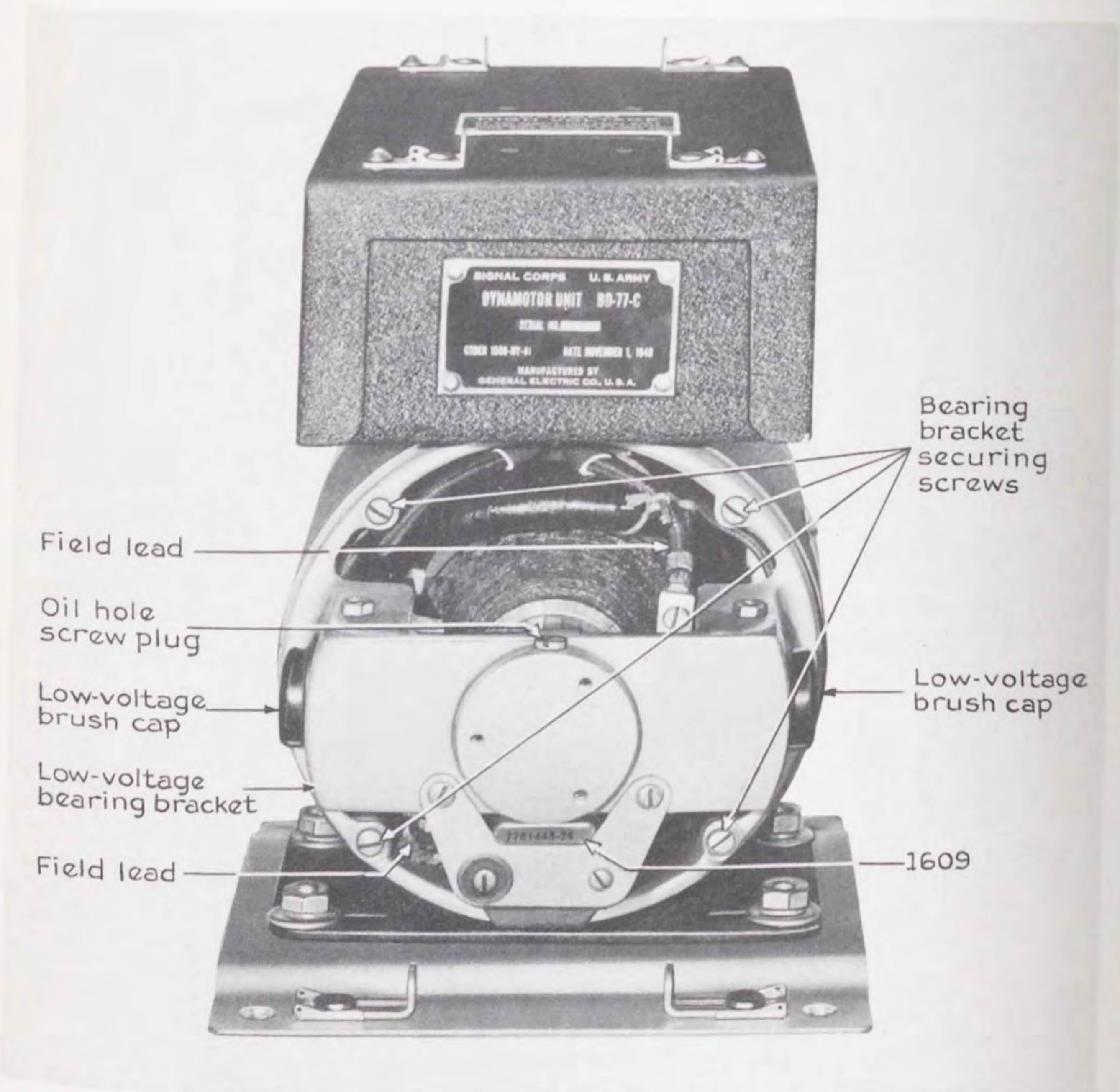


FIG. 26. DYNAMOTOR UNIT BD-77-C, MOUNTING FT-107 AND LOW-VOLTAGE END BELL REMOVED

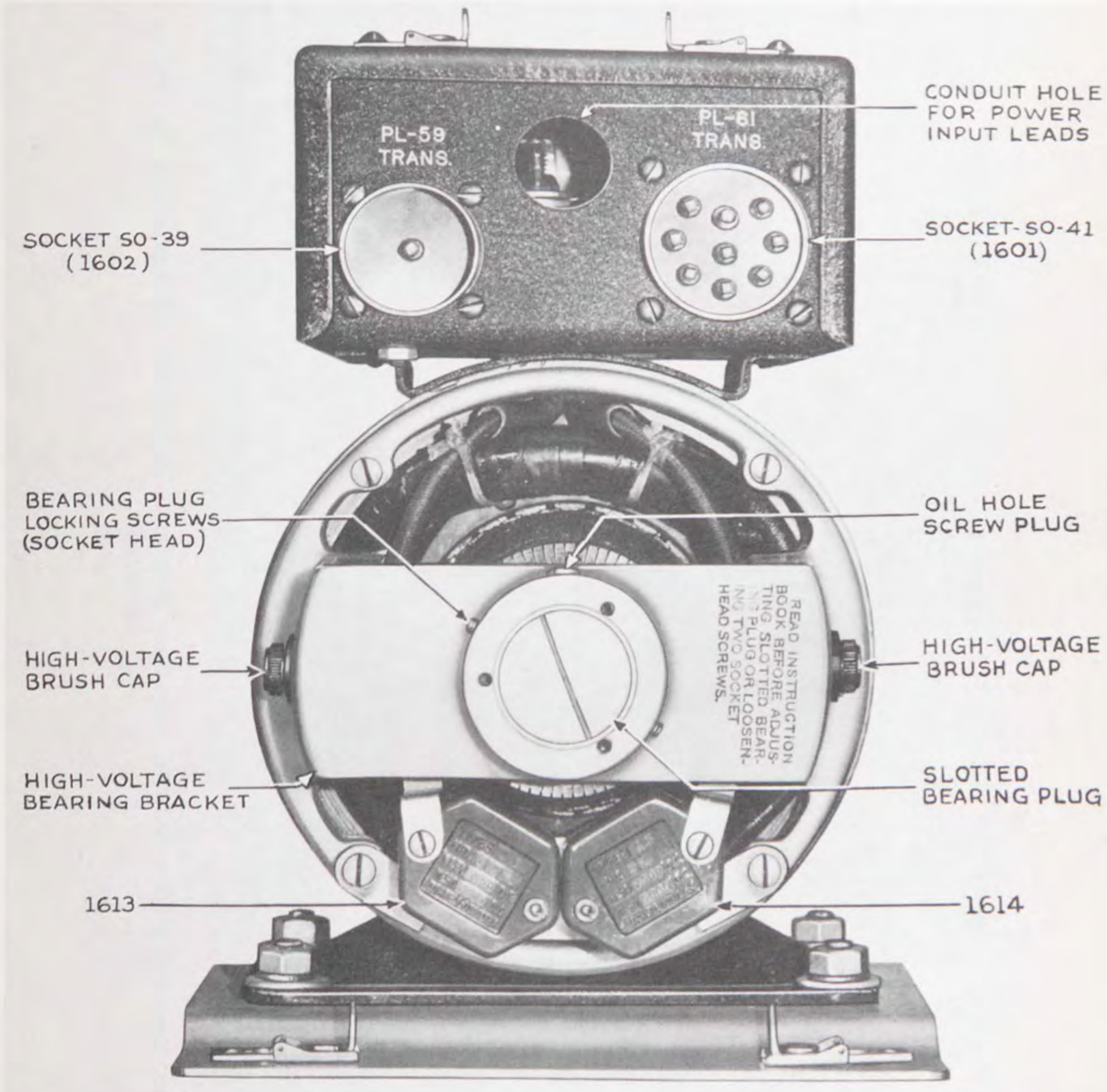


FIG. 27. DYNAMOTOR UNIT BD-77-C, MOUNTING FT-107 AND HIGH-VOLTAGE END BELL REMOVED

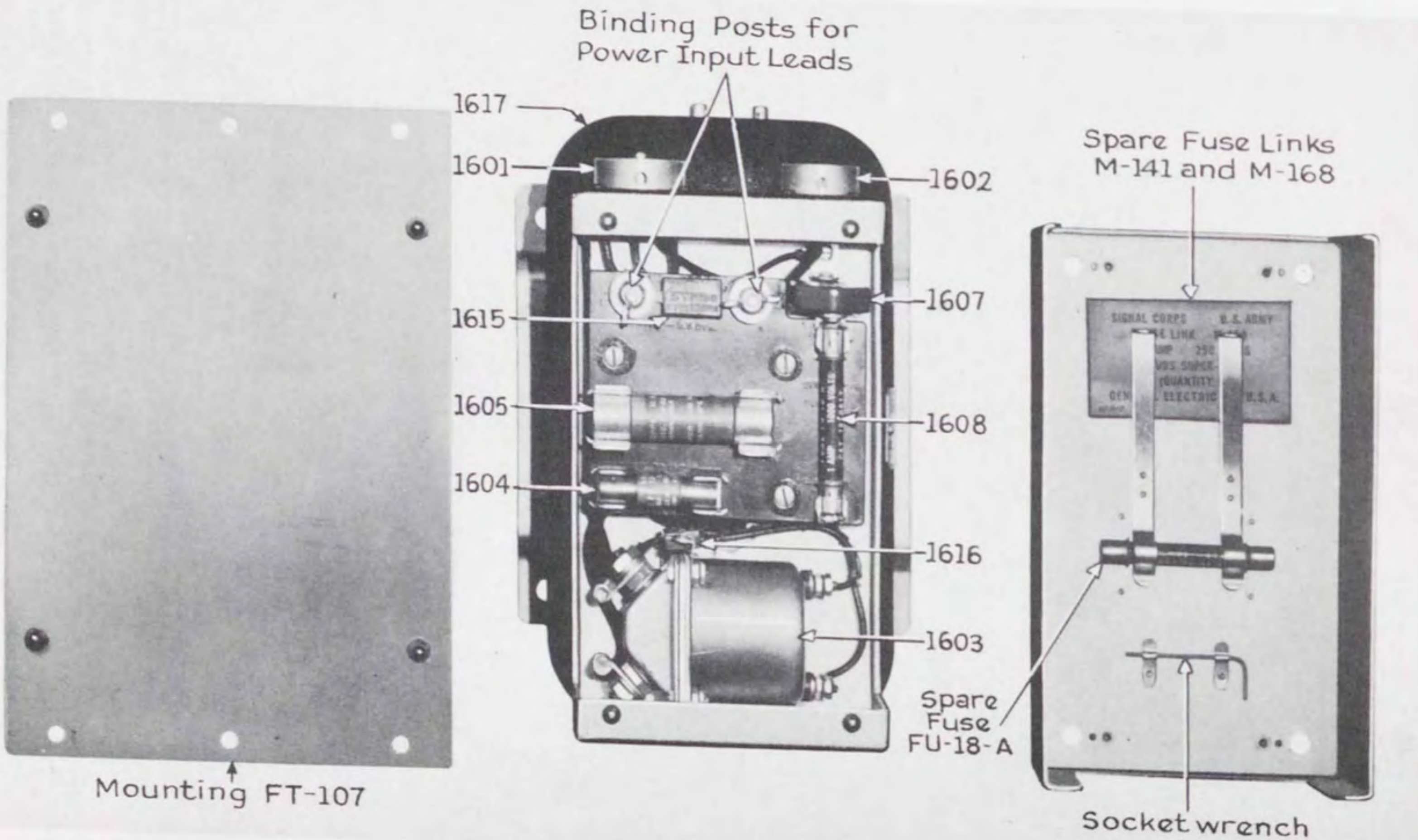


Fig. 28. Dynamotor Unit BD-77-C, Top View with Mounting FT-107 and Relay-fuse Box Cover Removed

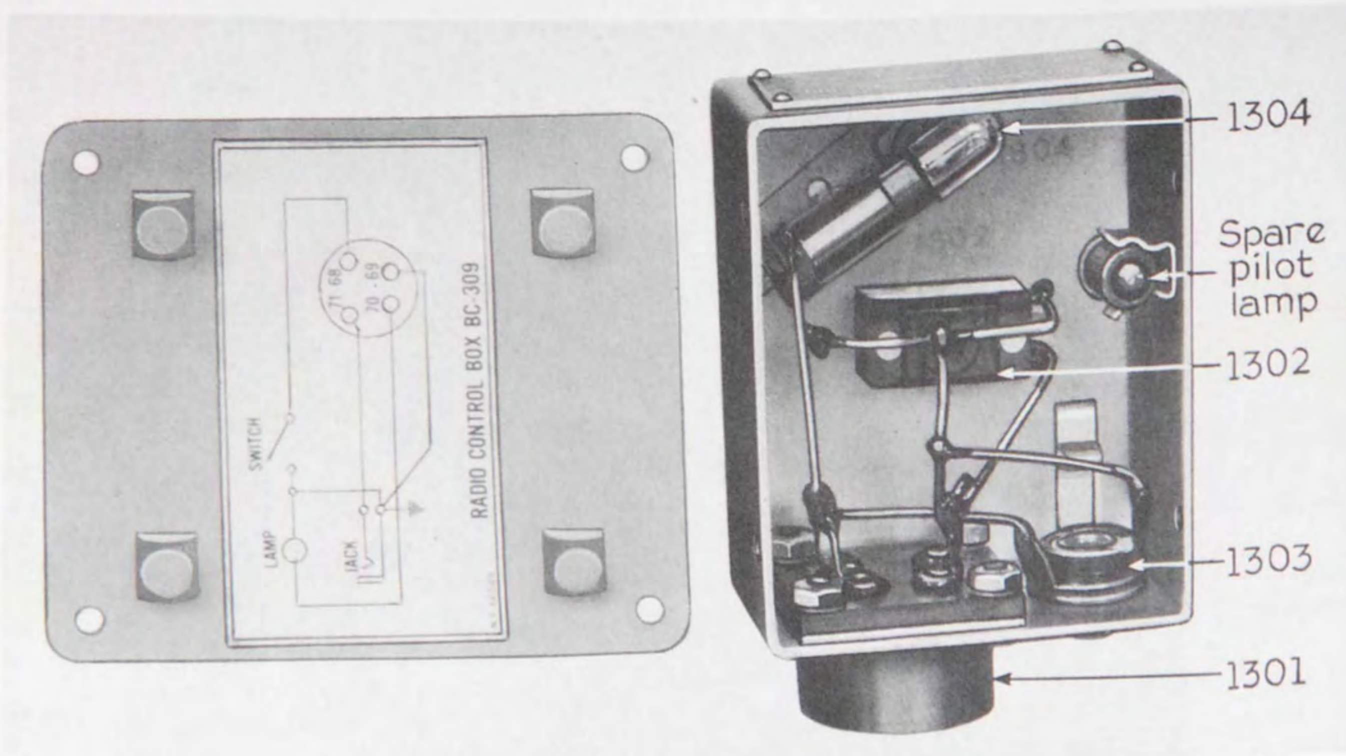


FIG. 29. RADIO CONTROL BOX BC-309, INTERIOR VIEW

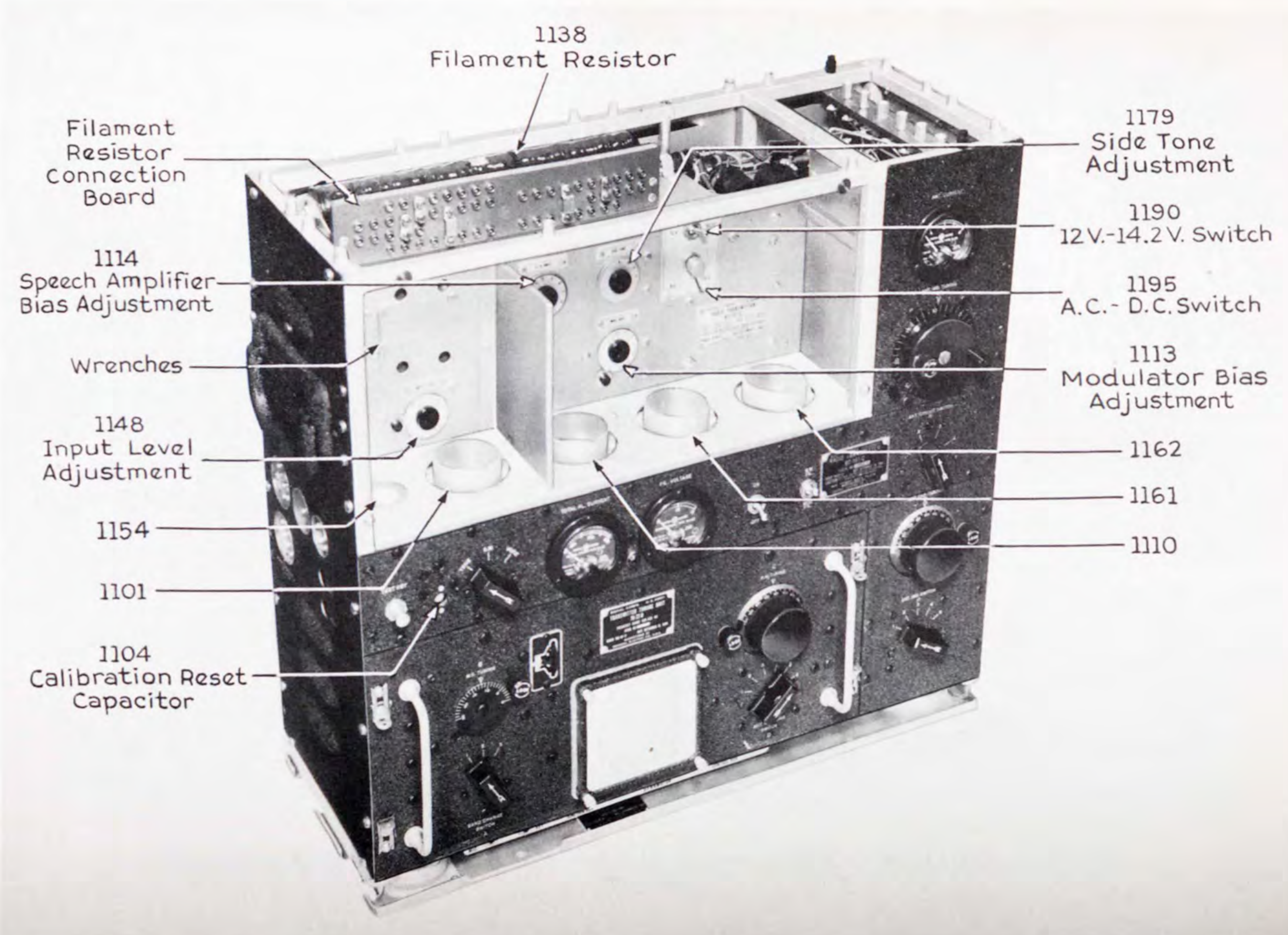


FIG. 30. RADIO TRANSMITTER BC-191-C, TUBE COMPARTMENT SHIELD AND TOP COVER OFF, AND TRANSMITTER TUNING UNIT IN PLACE

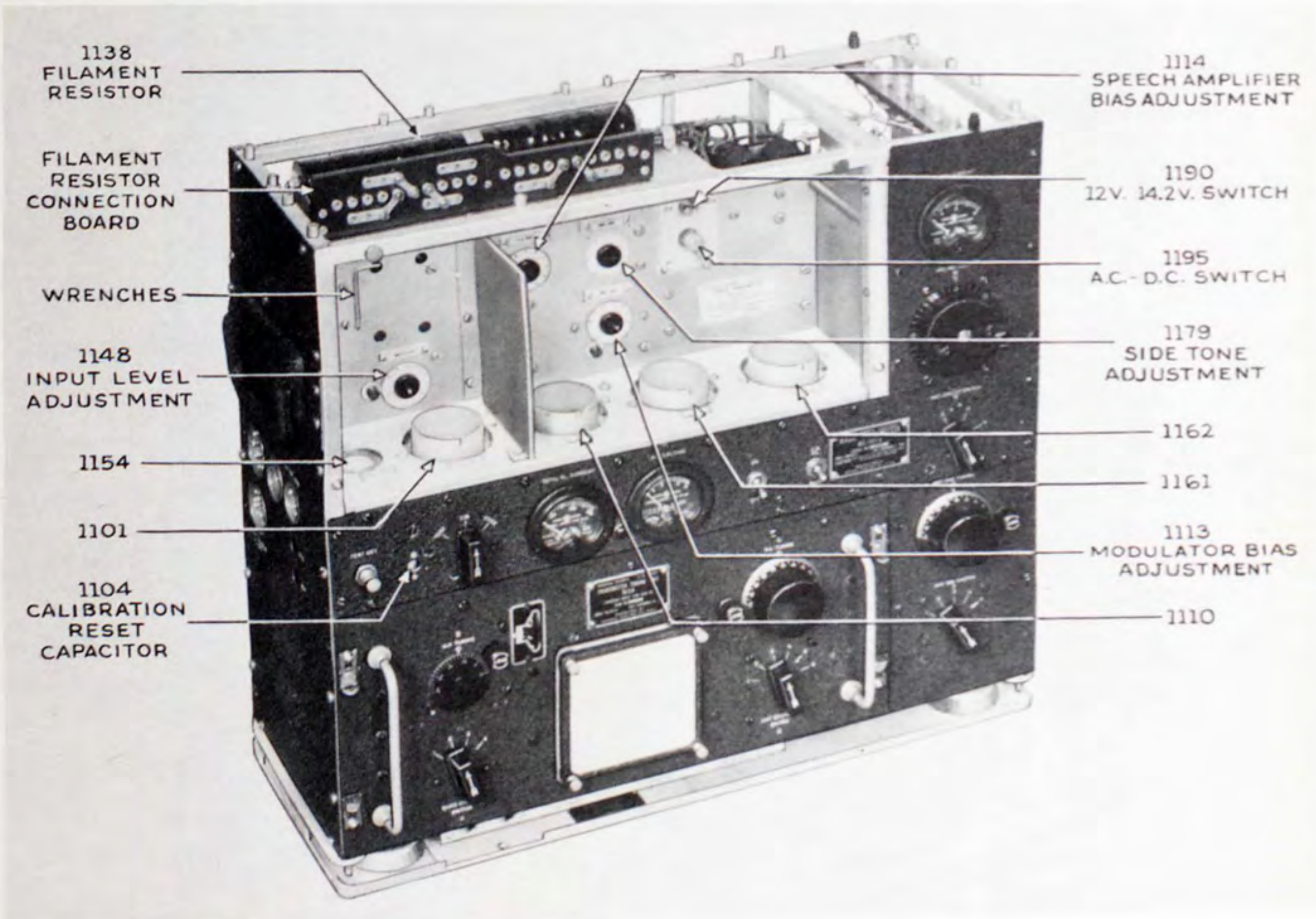


FIG. 31. RADIO TRANSMITTER BC-191-D OR BC-191-E, TUBE COMPARTMENT SHIELD AND TOP COVER OFF, AND TRANSMITTER TUNING UNIT IN PLACE

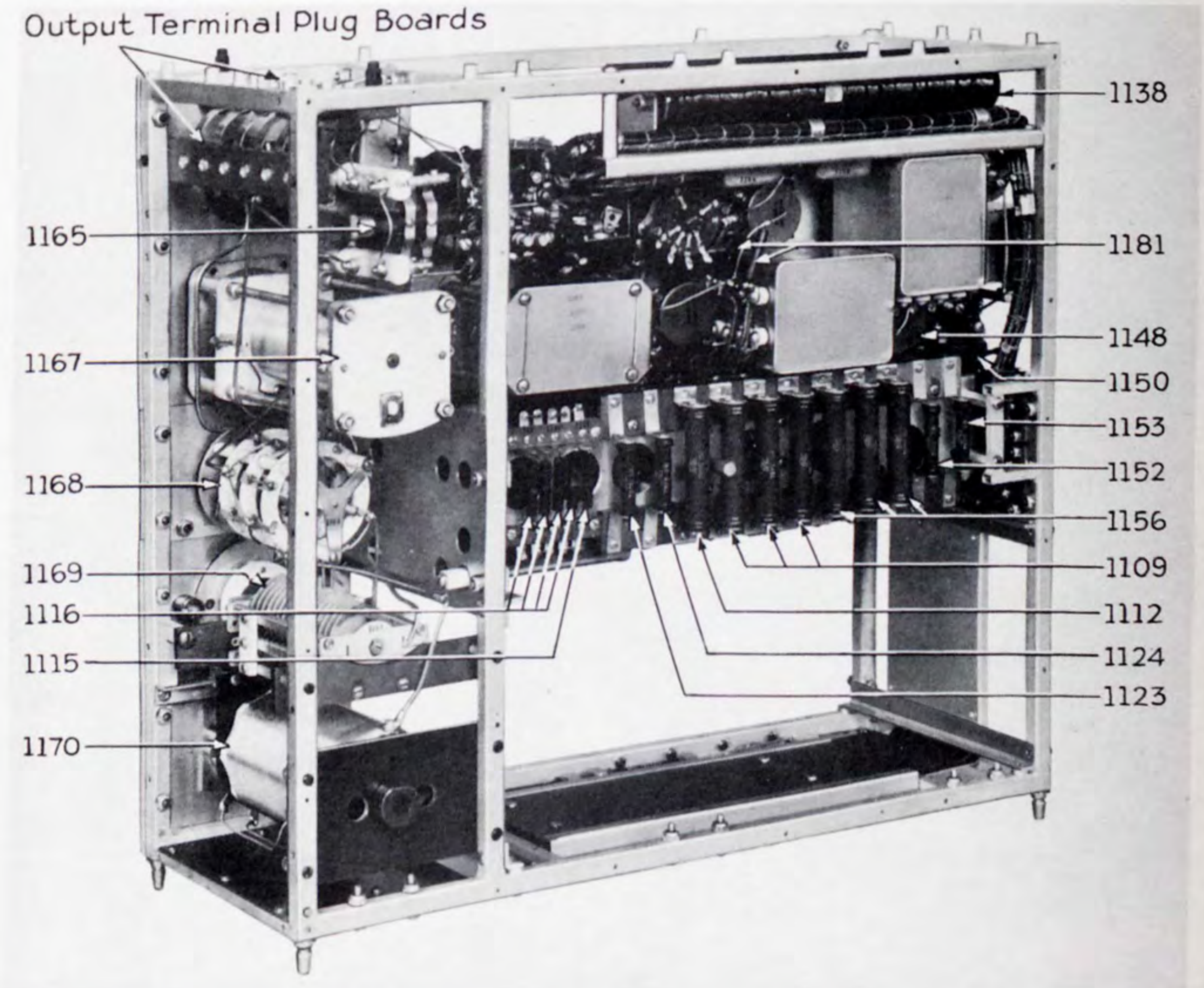


Fig. 32. Radio Transmitter BC-191-C or BC-191-D Rear View; Mounting FT-151-A and Shields Removed

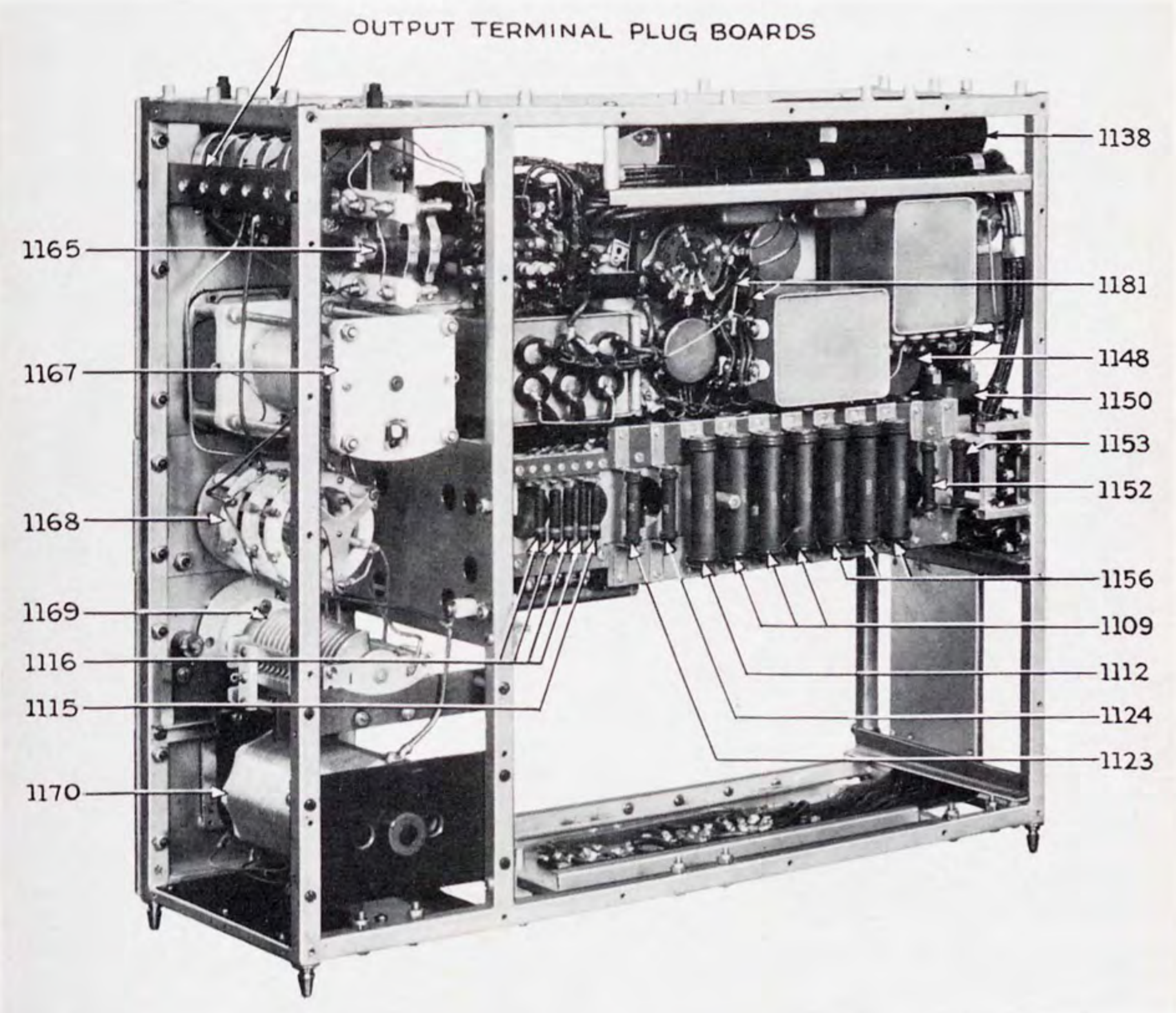


FIG. 33. RADIO TRANSMITTER BC-191-E, REAR VIEW; MOUNTING FT-151-A AND SHIELDS REMOVED

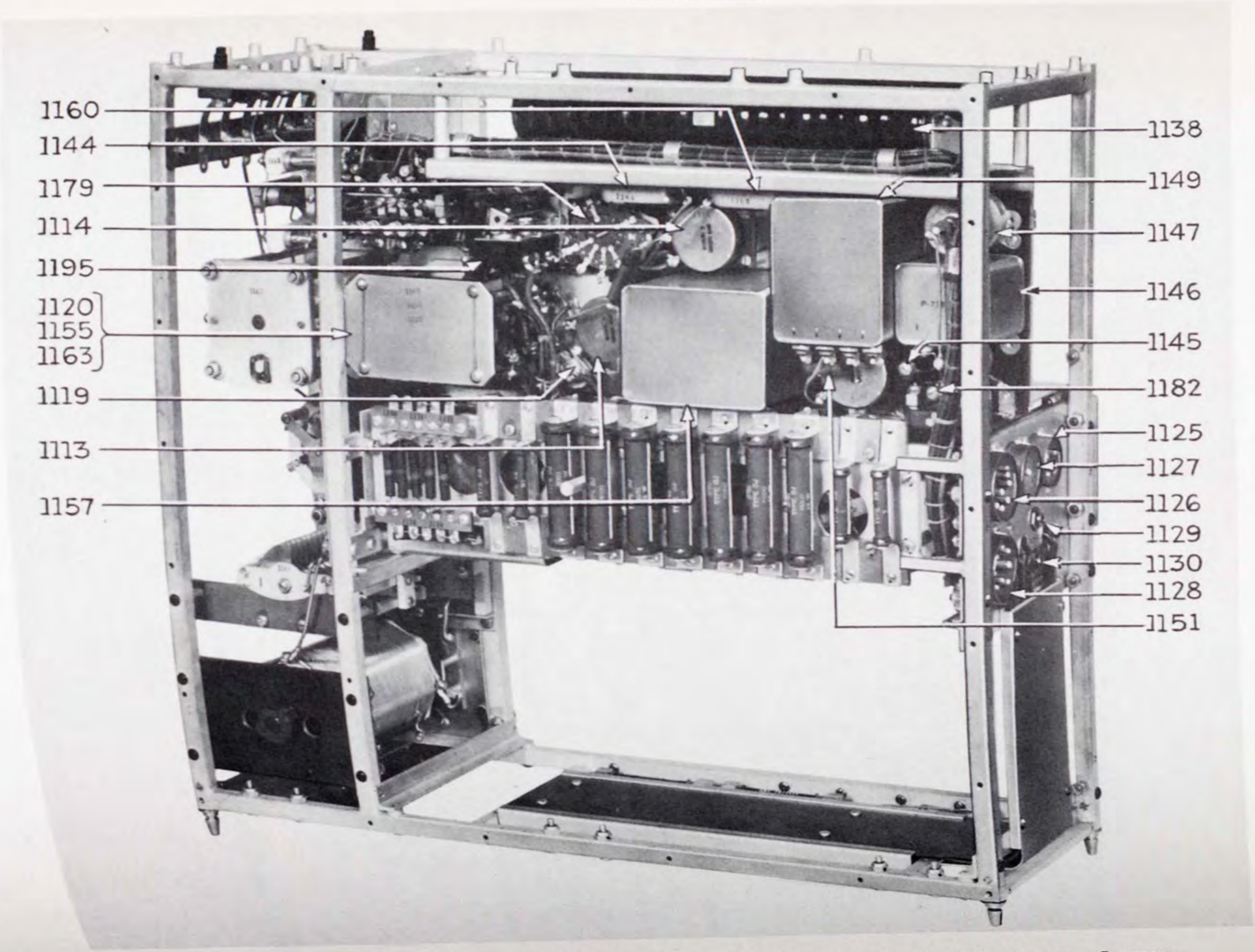


Fig. 34. Radio Transmitter BC-191-C or BC-191-D Rear View; Mounting FT-151-A and Shields Removed

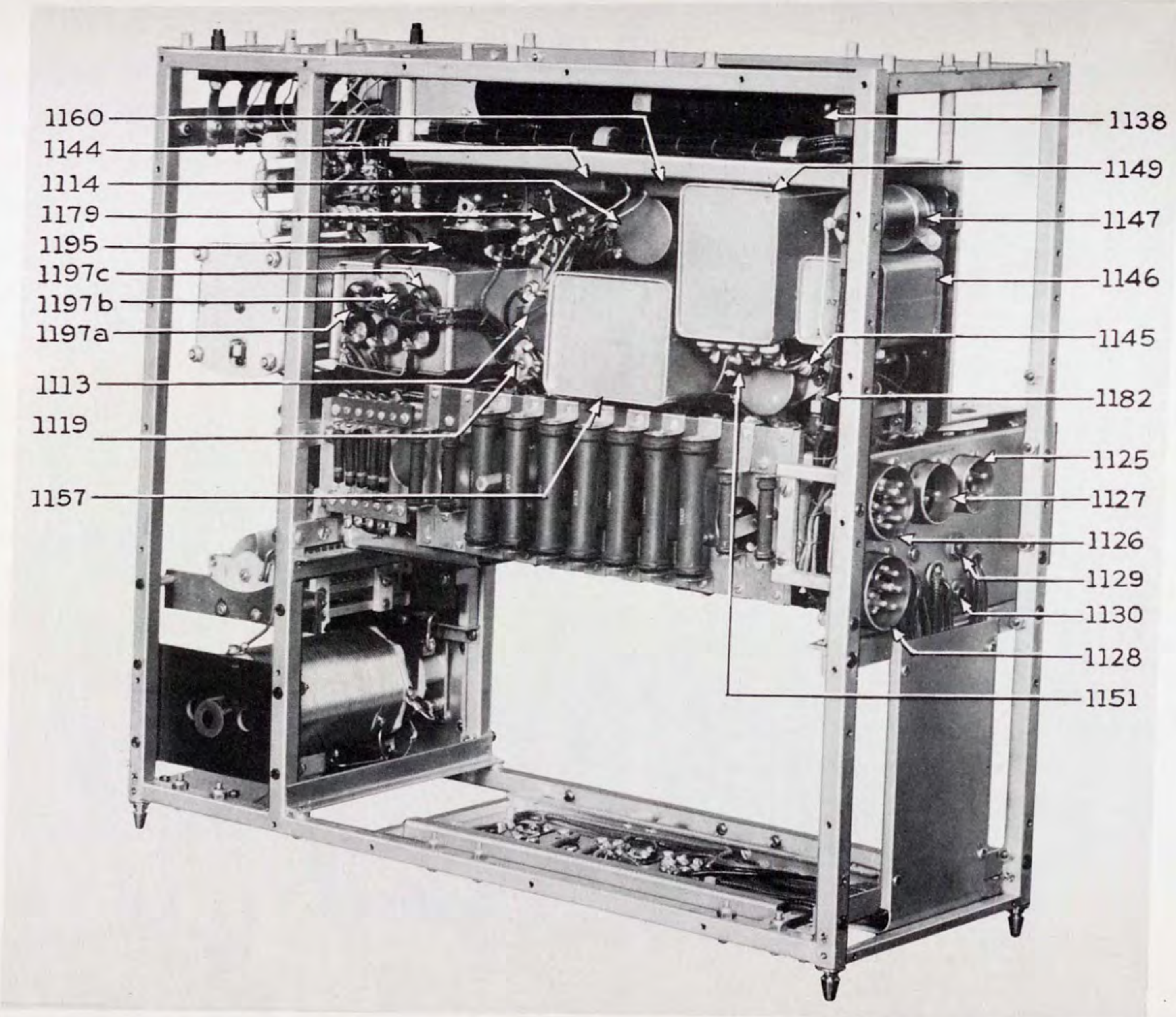


FIG. 35. RADIO TRANSMITTER BC-191-E, REAR VIEW; MOUNTING FT-151-A AND SHIELDS REMOVED

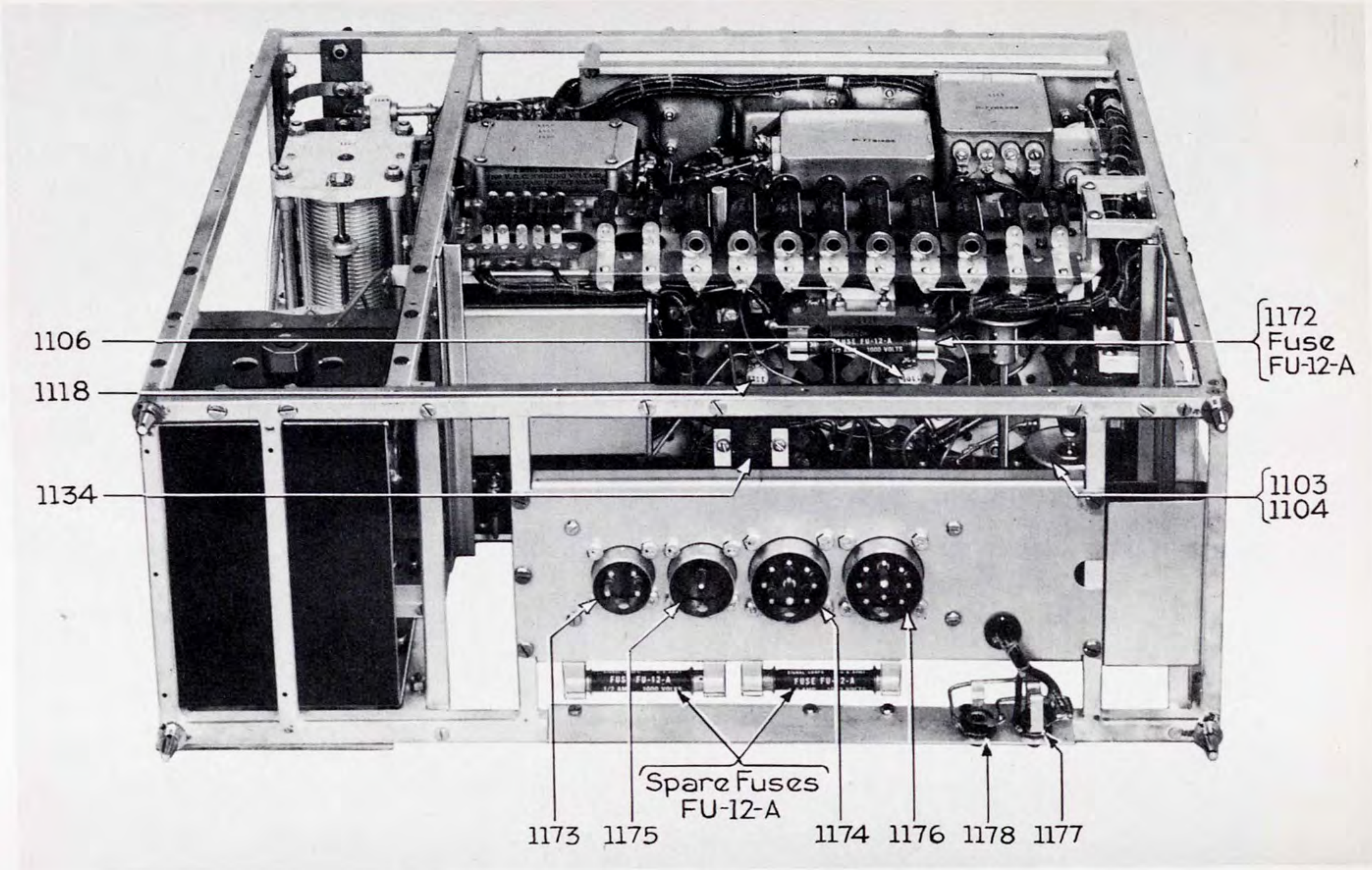


Fig. 36. Radio Transmitter BC-191-C or BC-191-D, Bottom Rear View; Mounting FT-151-A and Shields Removed

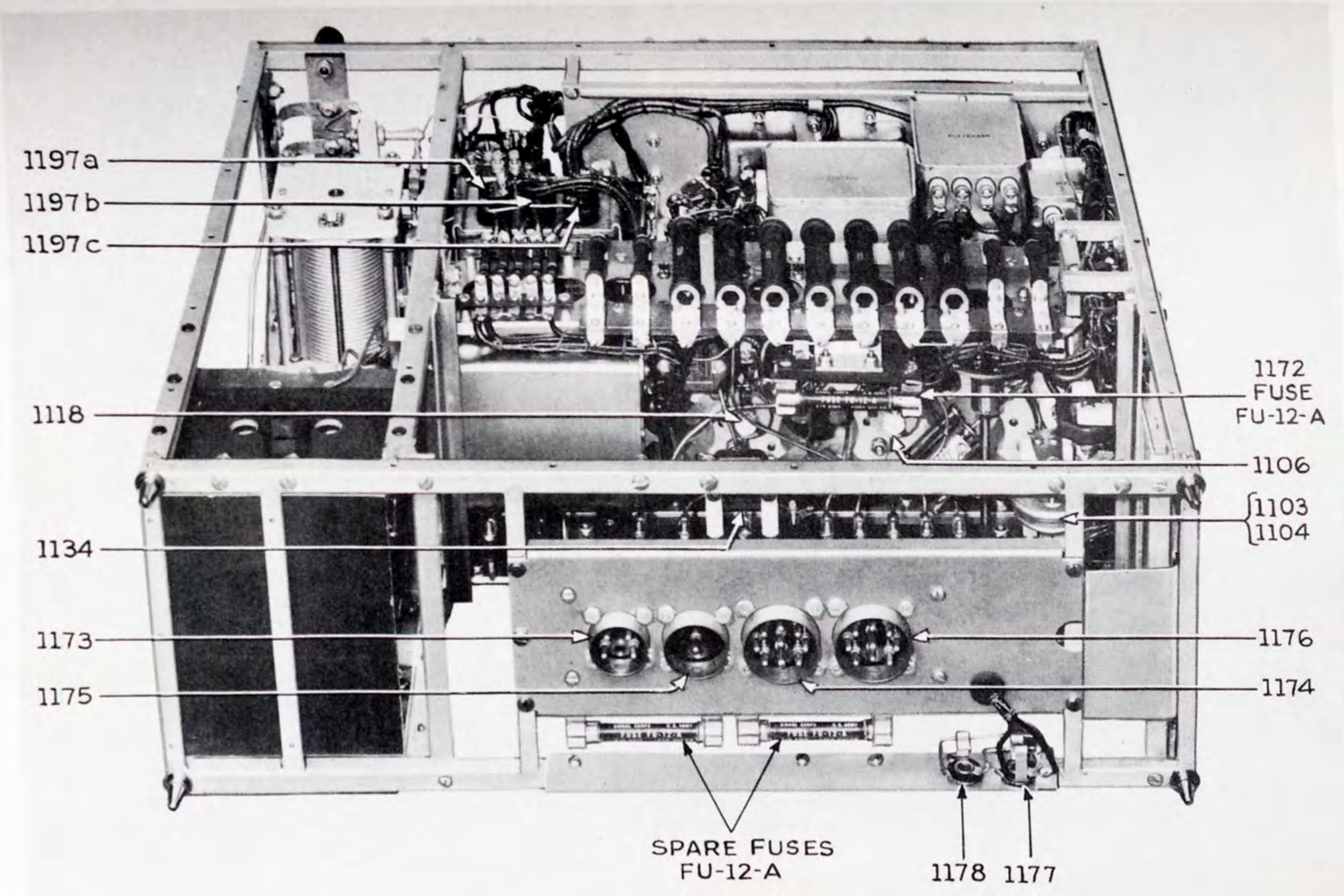


FIG. 37. RADIO TRANSMITTER BC-191-E, BOTTOM REAR VIEW; MOUNTING FT-151-A AND SHIELDS REMOVED

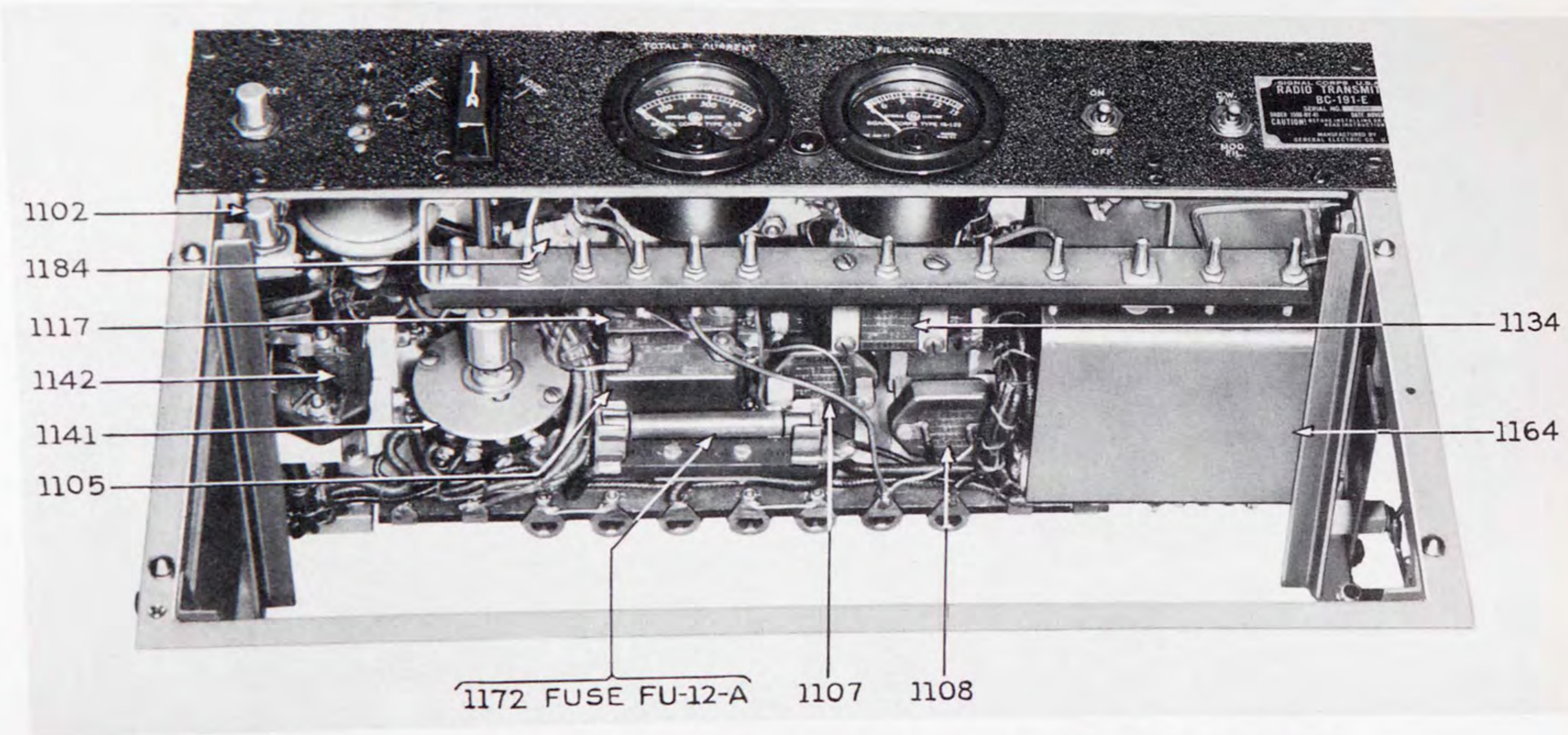


FIG. 38. RADIO TRANSMITTER BC-191-C, BC-191-D, OR BC-191-E, DETAIL VIEW OF INTERIOR

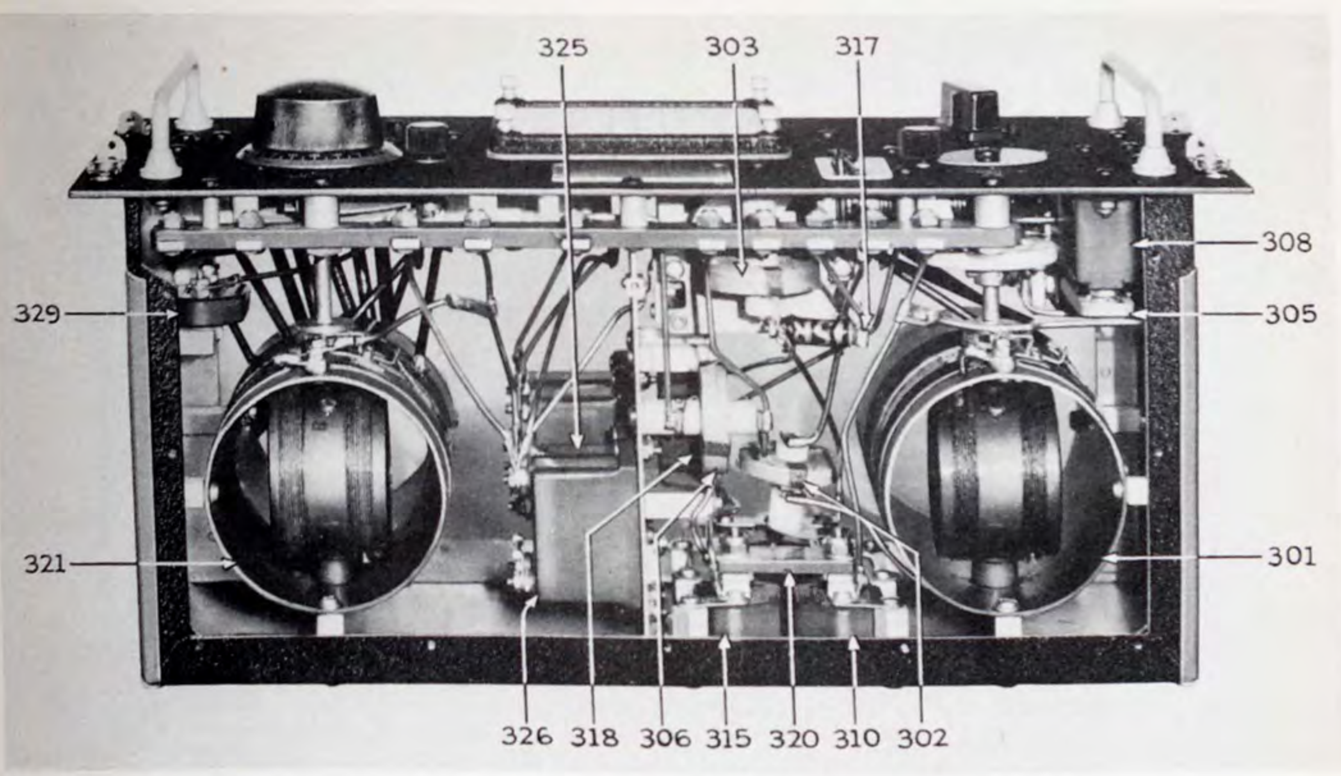


FIG. 39. TRANSMITTER TUNING UNIT TU-3-B, TOP VIEW, COVER REMOVED

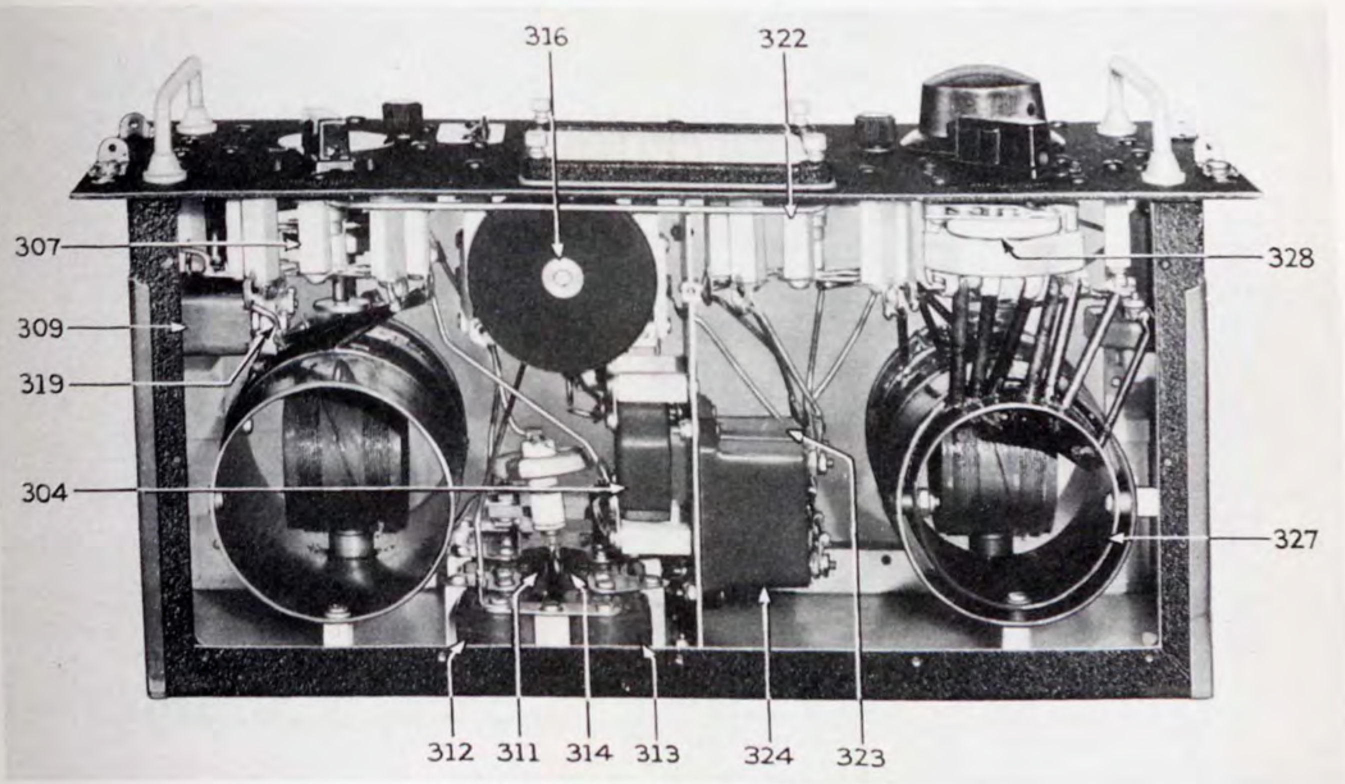


FIG. 40. TRANSMITTER TUNING UNIT TU-3-B, BOTTOM VIEW, COVER REMOVED

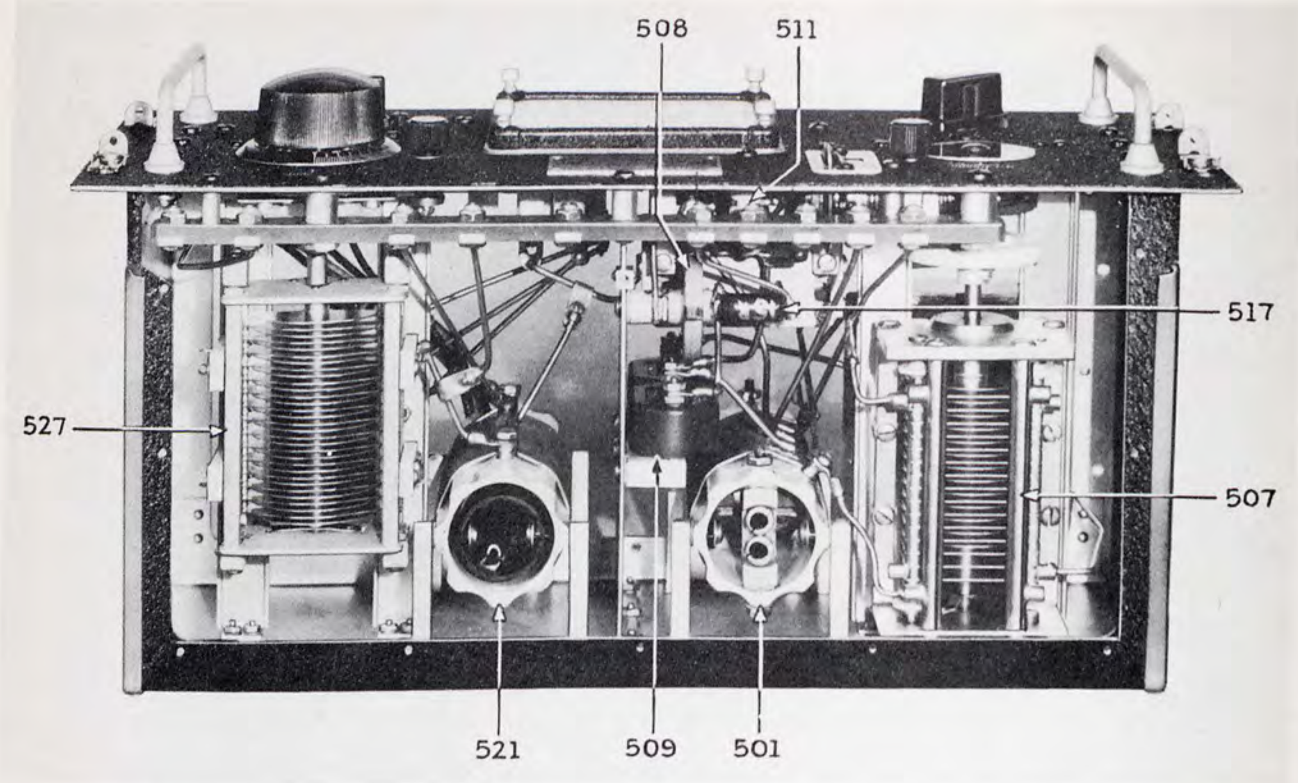


FIG. 41. TRANSMITTER TUNING UNIT TU-5-B, TOP VIEW, COVER REMOVED

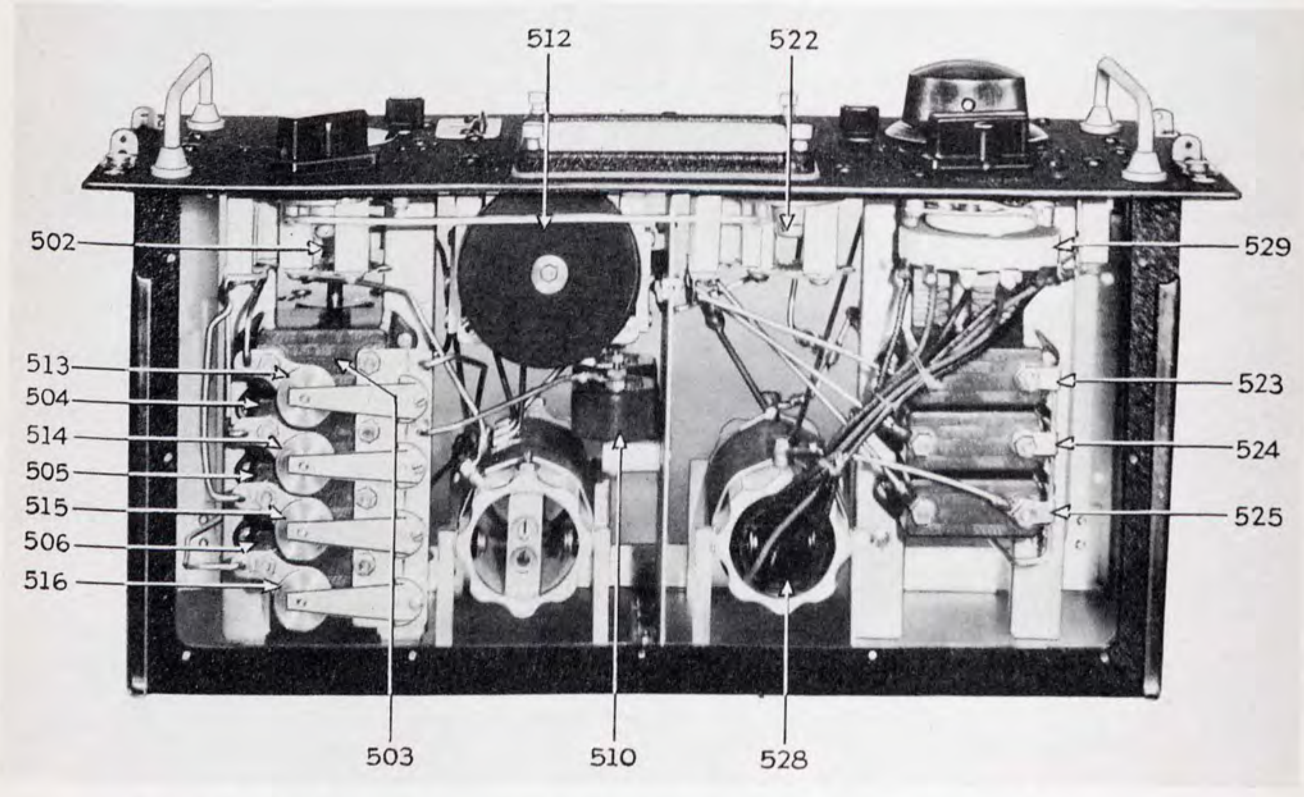


FIG. 42. TRANSMITTER TUNING UNIT TU-5-B, BOTTOM VIEW, COVER REMOVED

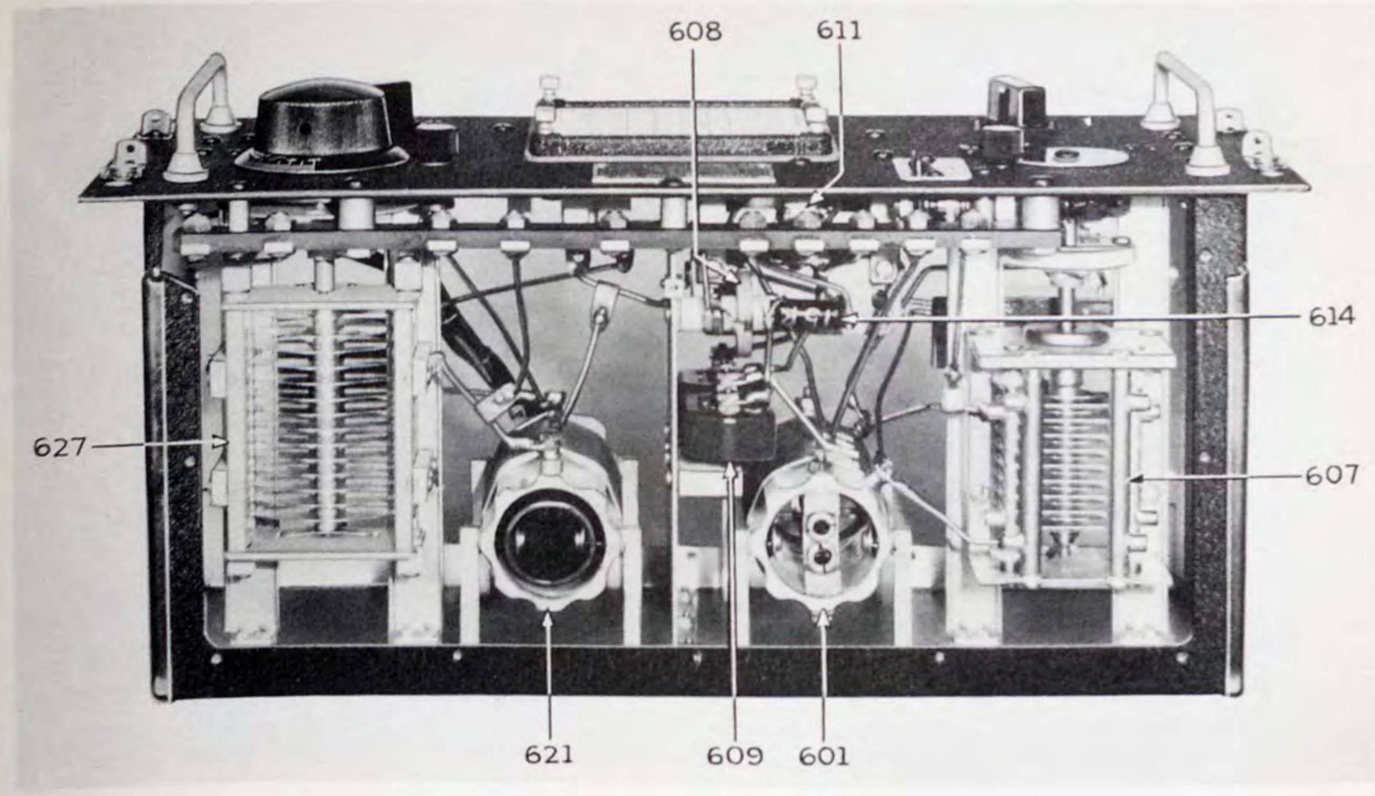


FIG. 43. TRANSMITTER TUNING UNIT TU-6-B, TOP VIEW, COVER REMOVED

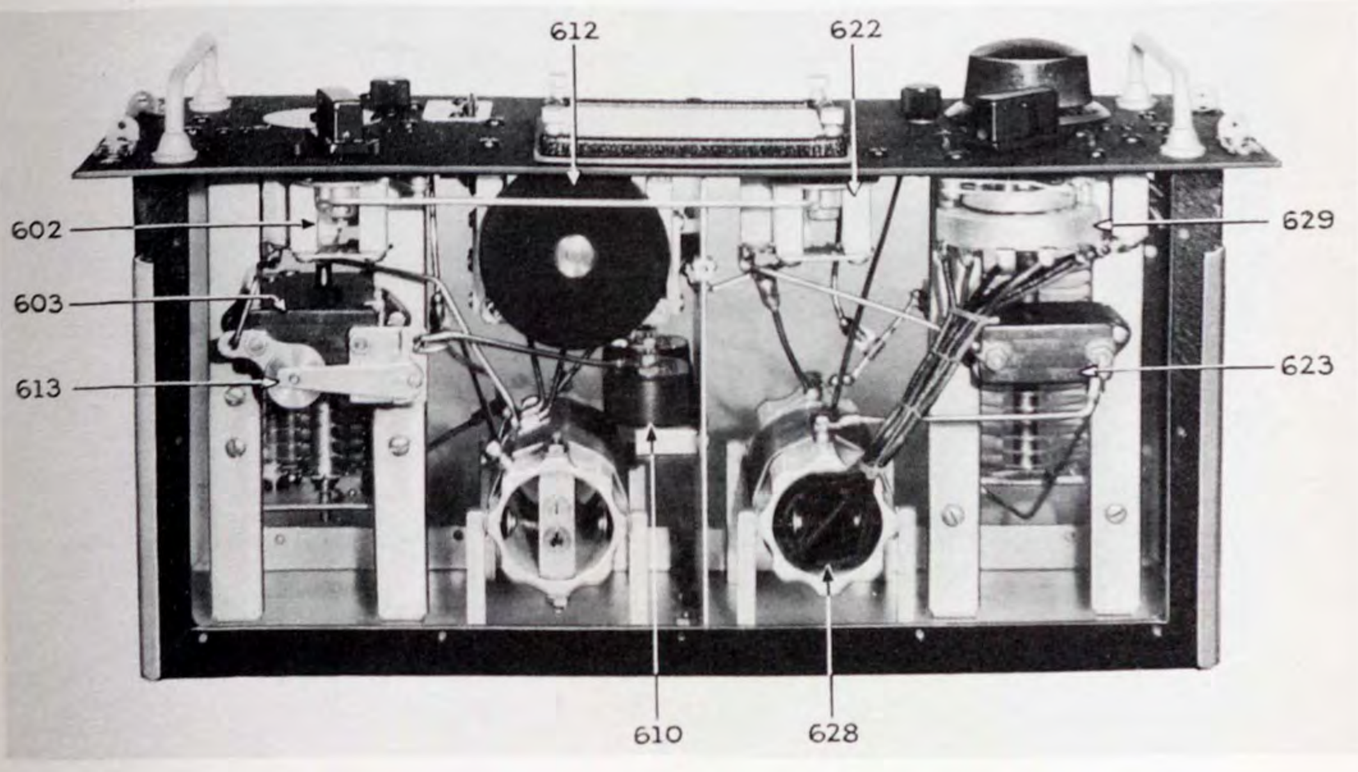


FIG. 44. TRANSMITTER TUNING UNIT TU-6-B, BOTTOM VIEW, COVER REMOVED

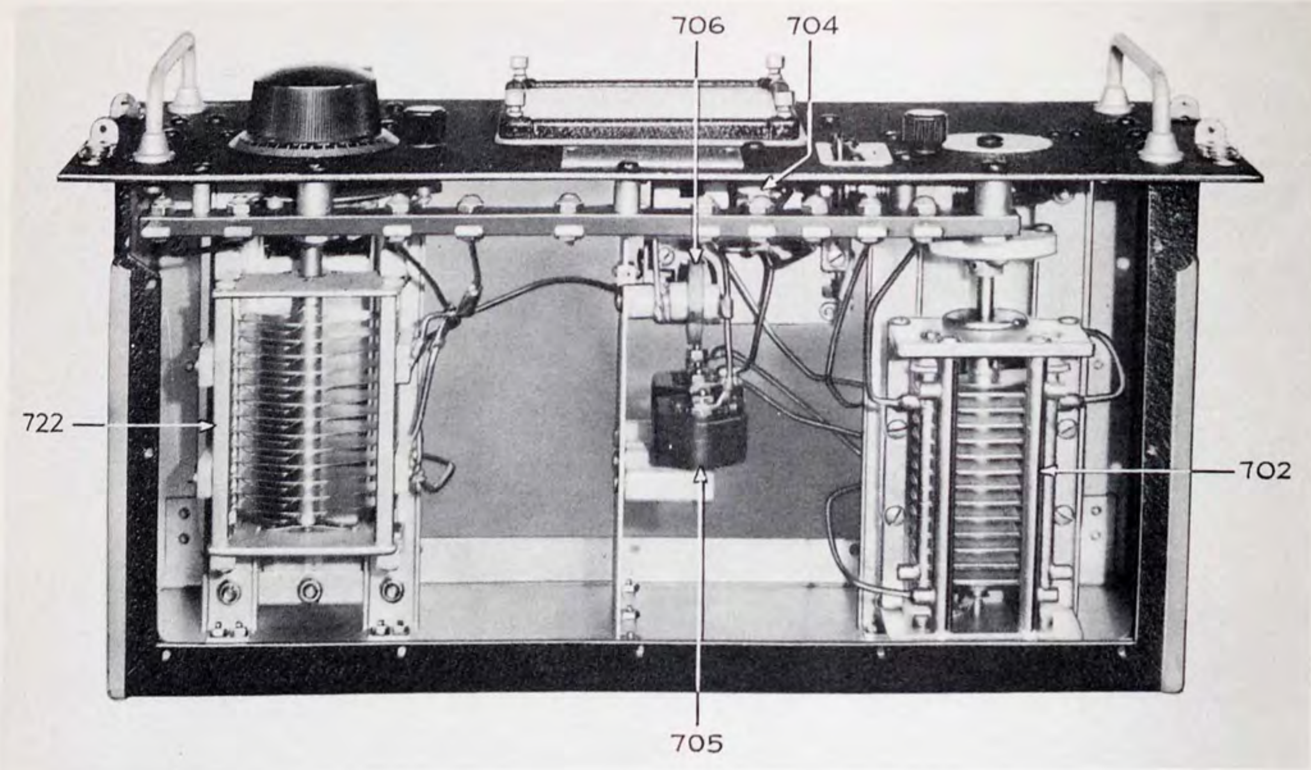


FIG. 45. TRANSMITTER TUNING UNIT TU-7-B, TOP VIEW, COVER REMOVED

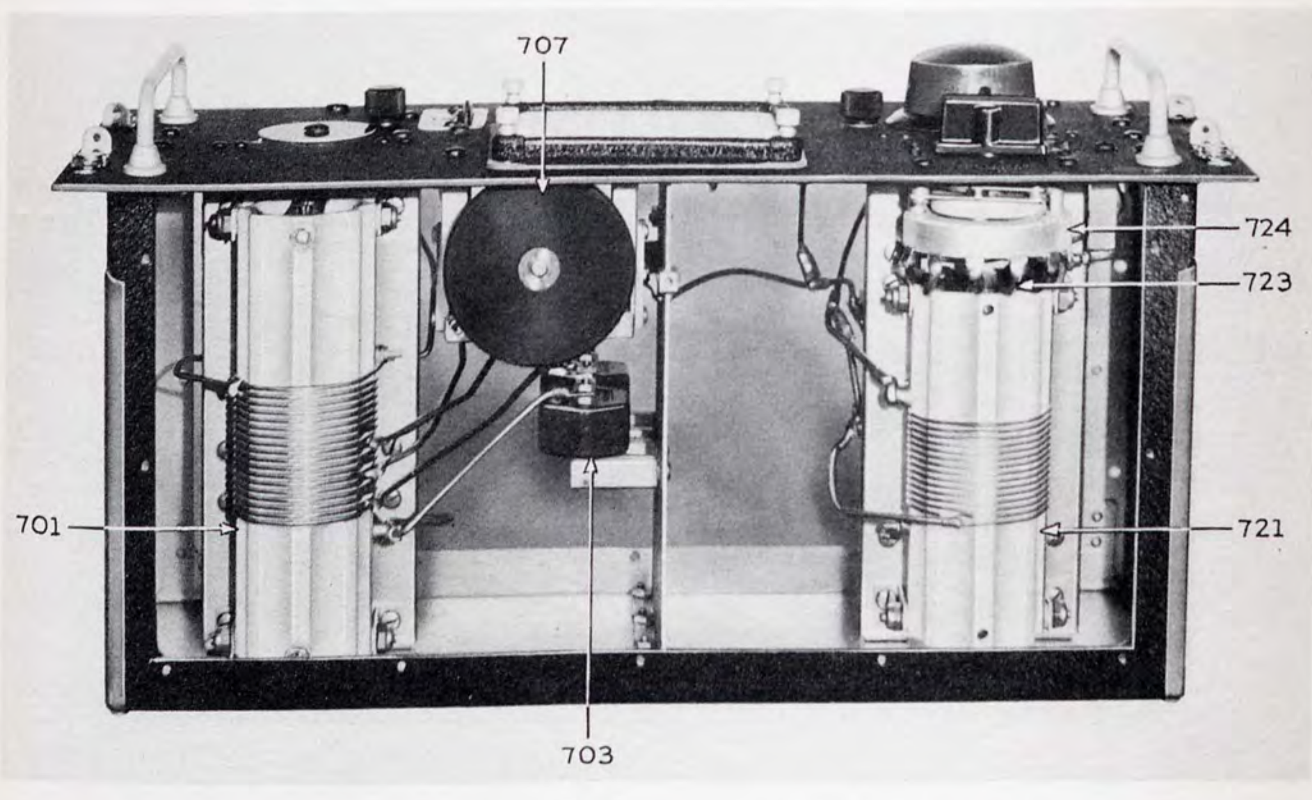


FIG. 46. TRANSMITTER TUNING UNIT TU-7-B, BOTTOM VIEW, COVER REMOVED

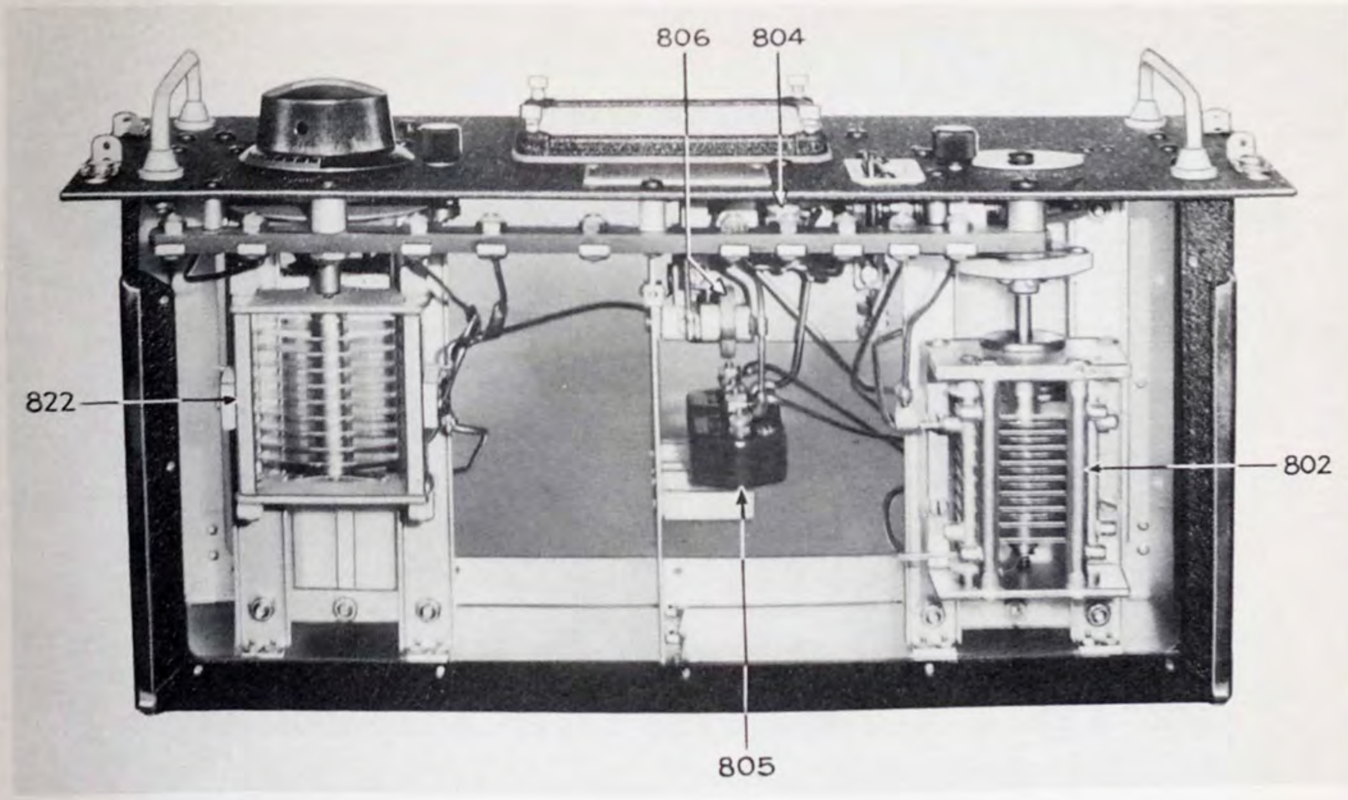


FIG. 47. TRANSMITTER TUNING UNIT TU-8-B, TOP VIEW, COVER REMOVED

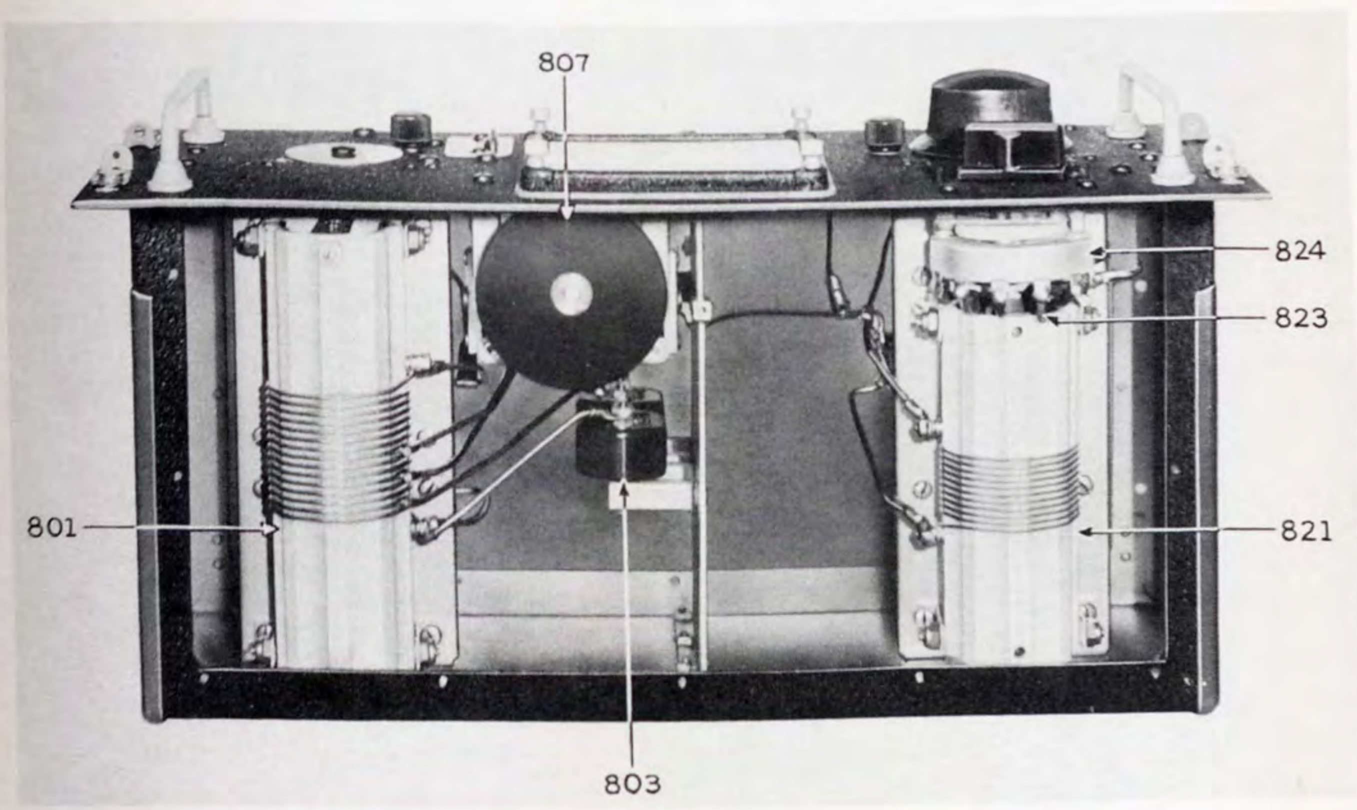


FIG. 48. TRANSMITTER TUNING UNIT TU-8-B, BOTTOM VIEW, COVER REMOVED

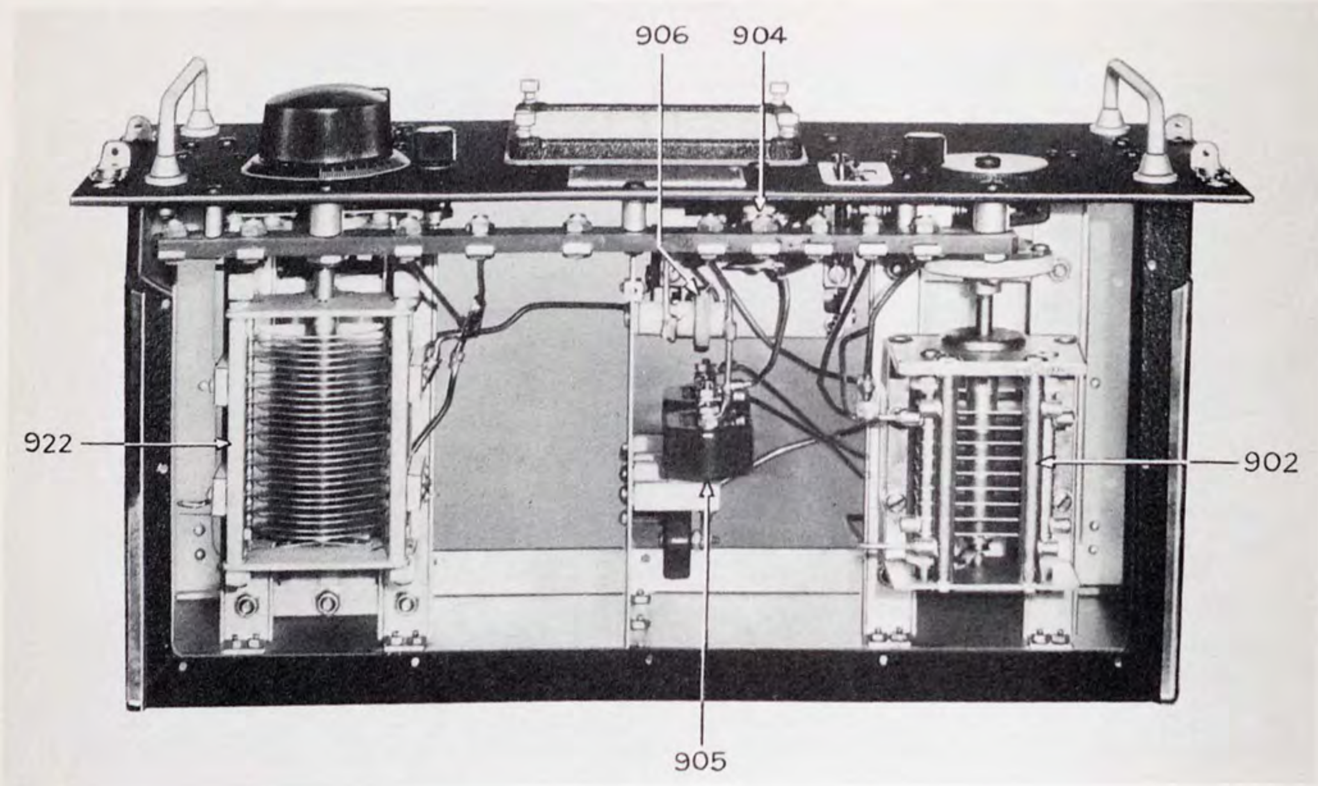


FIG. 49. TRANSMITTER TUNING UNIT TU-9-B, TOP VIEW, COVER REMOVED

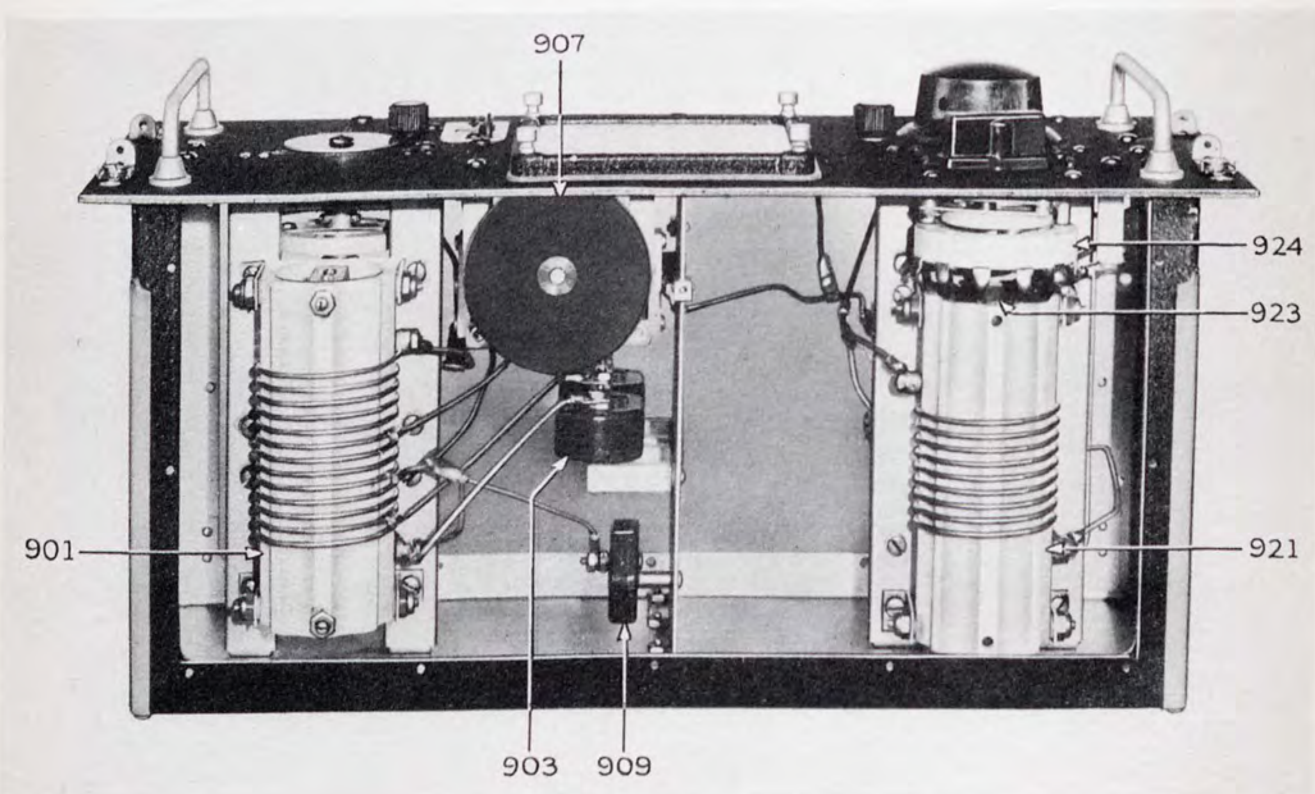


FIG. 50. TRANSMITTER TUNING UNIT TU-9-B, BOTTOM VIEW, COVER REMOVED

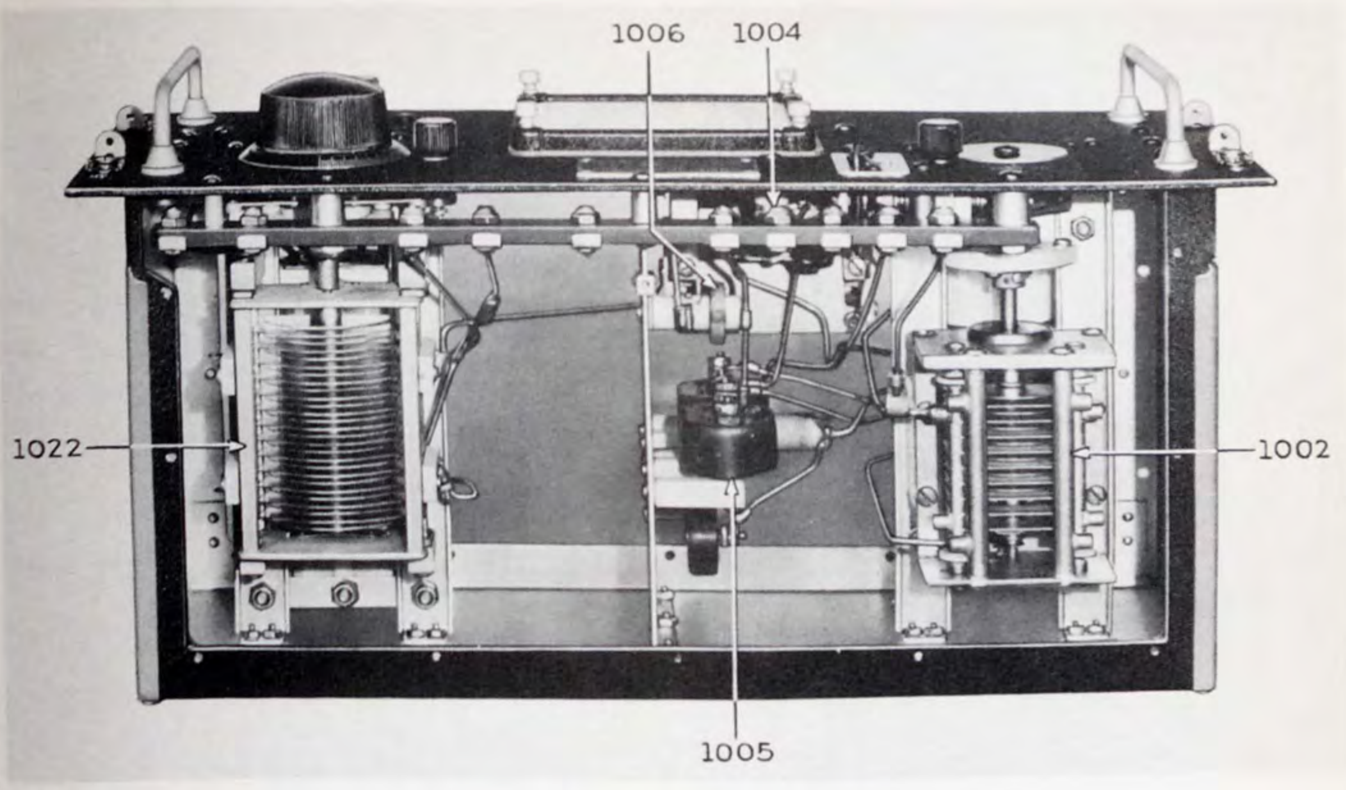


FIG. 51. TRANSMITTER TUNING UNIT TU-10-B, TOP VIEW, COVER REMOVED

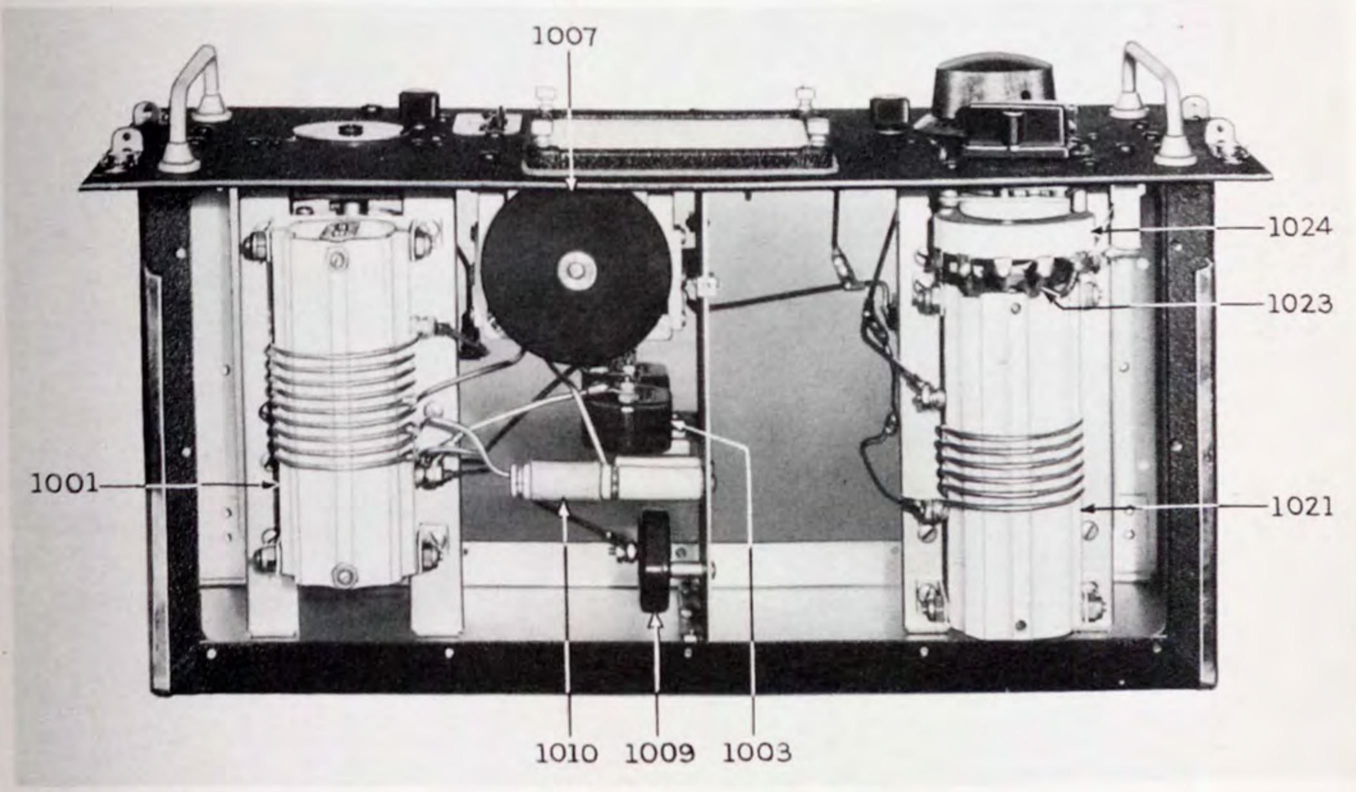


FIG. 52. TRANSMITTER TUNING UNIT TU-10-B, BOTTOM VIEW, COVER REMOVED

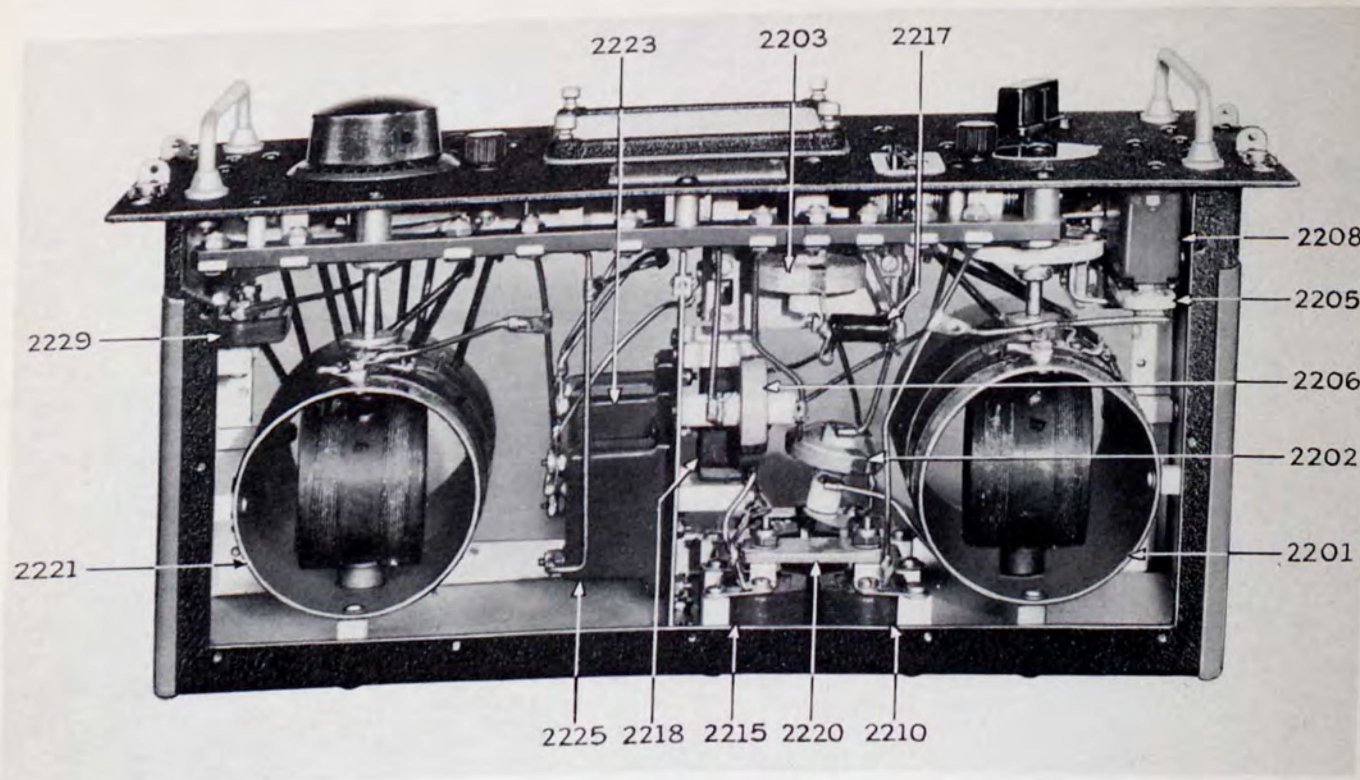


FIG. 53. TRANSMITTER TUNING UNIT TU-22-B, TOP VIEW, COVER REMOVED

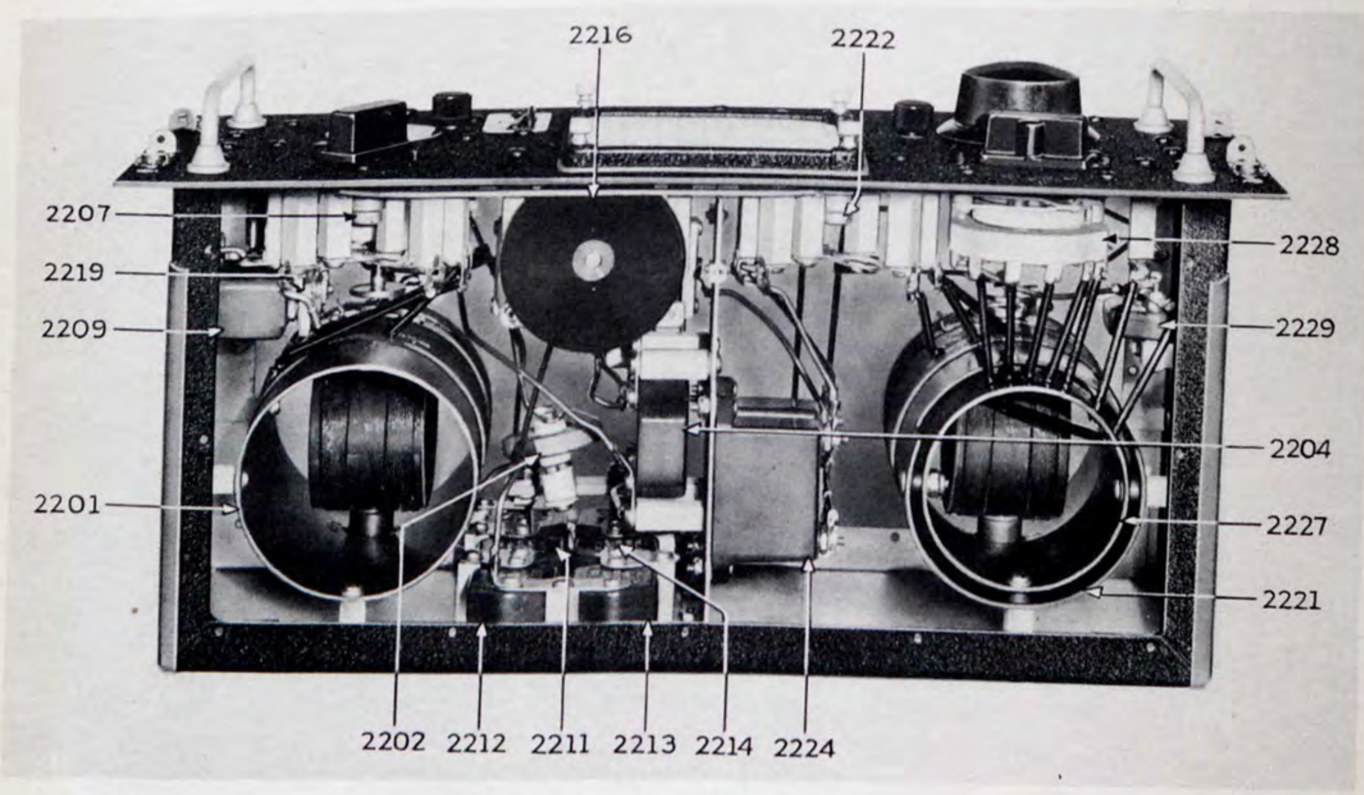


FIG. 54. TRANSMITTER TUNING UNIT TU-22-B, BOTTOM VIEW, COVER REMOVED

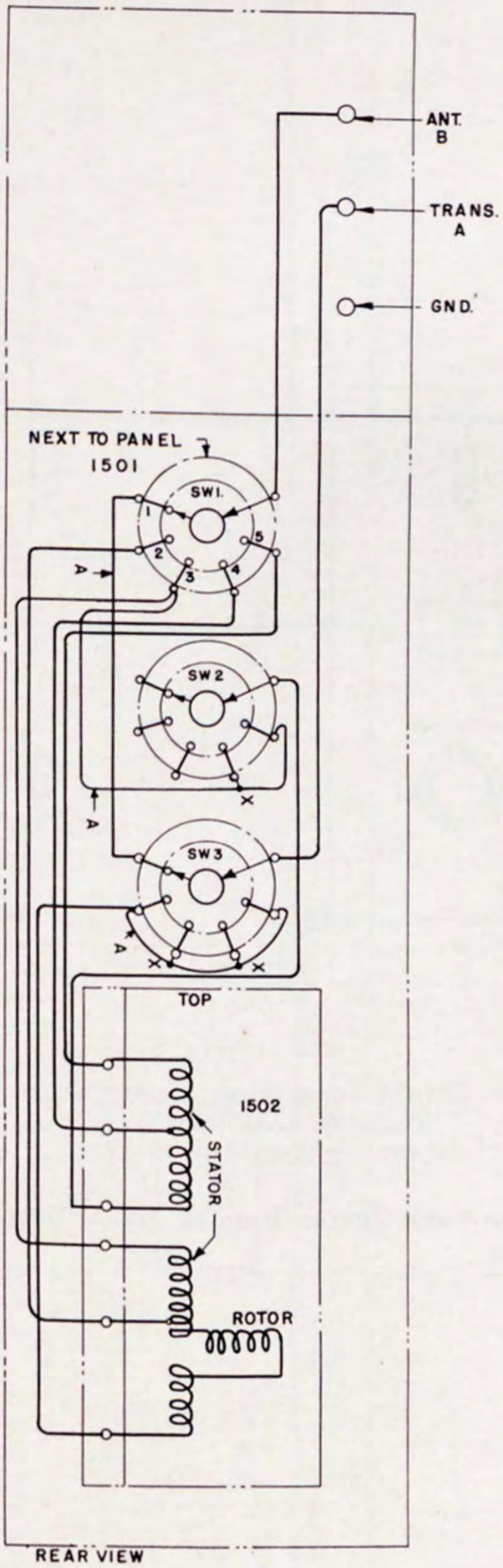
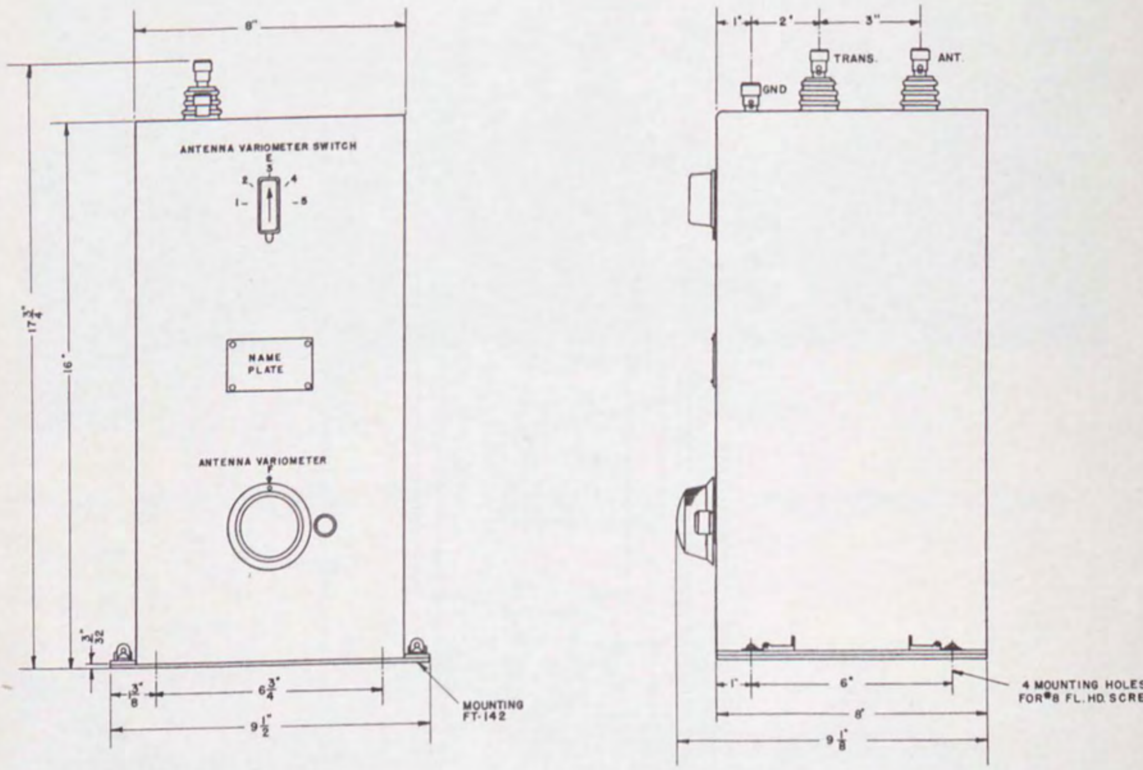
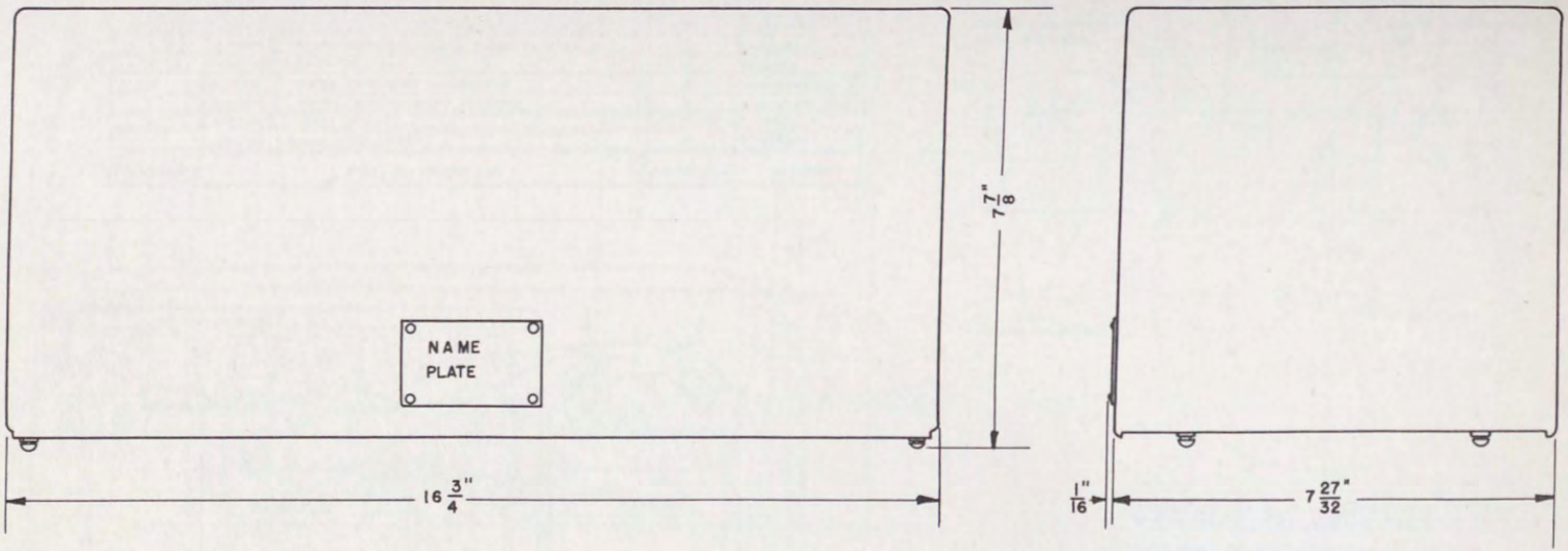


FIG. 55. ANTENNA TUNING UNIT BC-306-A, CONNECTION DIAGRAM



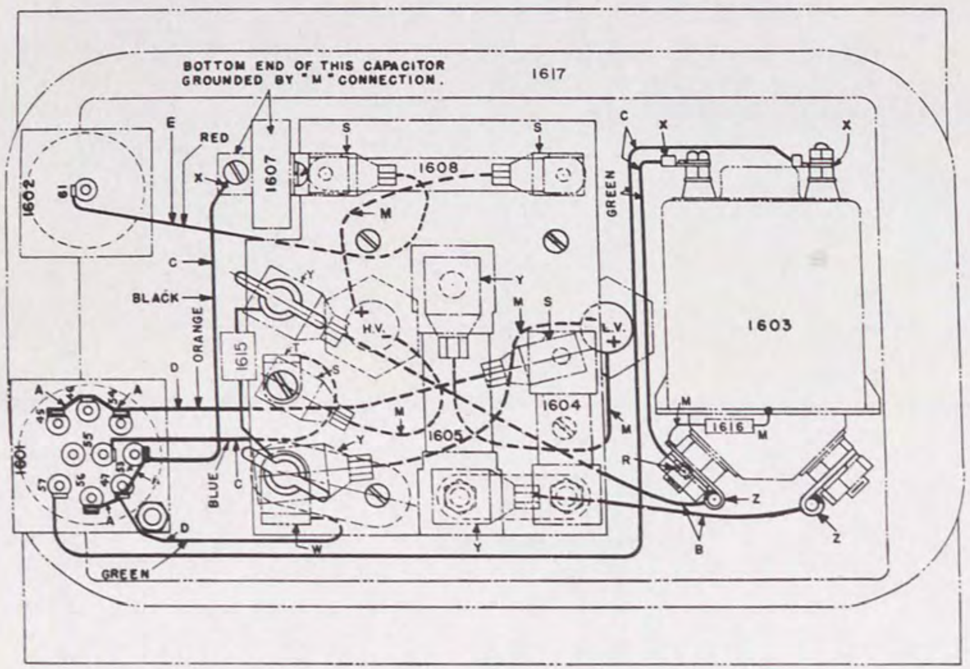
Weight of Antenna Tuning Unit
BC-306-A Less Mounting .... 9.062 lb
Weight of Mounting FT-142 .... 0.687 lb

FIG. 56. ANTENNA TUNING UNIT BC-306-A, OUTLINE DIMENSIONAL SKETCH



Weight of Case CS-48 .... 4.375 lb

FIG. 57. CASE CS-48, OUTLINE DIMENSIONAL SKETCH



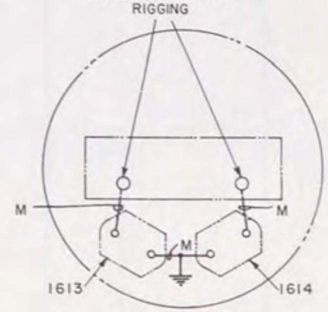
NOTE:- CUT ALL LEADS TO PROPER LENGTH SUCH THAT THEY TAKE THE POSITIONS SHOWN IN CONNECTION DIAGRAM WHEN TERMINAL BOARD IS SECURED IN PLACE.

TO PREVENT EXTERNAL BRAID OF "B" CONNECTIONS FROM FRAYING. ASSEMBLE CAP K-7876391 TO RELAY END OF EACH LEAD BEFORE SOLDERING TO TERMINAL.

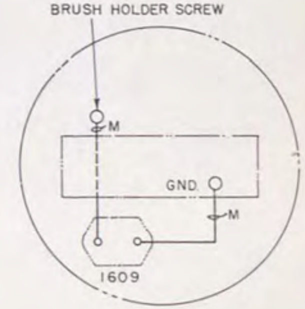
REMOVE METAL IDENTIFICATION TAGS FROM THE FOUR DYNAMOTOR LEADS AFTER CONNECTIONS ARE MADE.

CONNECTION	SIZE OF CONDUCTOR
A	.041" DIA. COPPER WIRE TINNED
B	# 8 AWG. S.I.-12249 (BLACK)
C	# 16 AWG. $\frac{1}{64}$" RUBBER INSULATION K-7872345
D	# 14 AWG. $\frac{1}{32}$ RUBBER INSULATION K-7872345
M	UNIT PIECE OF APPARATUS
E	# 16 AWG. $\frac{3}{64}$" RUBBER INSULATION (RED) K-7872345, PT-11.

CONNECTION	TERMINAL
X	K-7872831
Y	V-416575
Z	K-7870965 PT-2
W	V-1449899 "O" × $\frac{3}{32}$"
S	V-417591
T	V-1450858
R	K-7875573

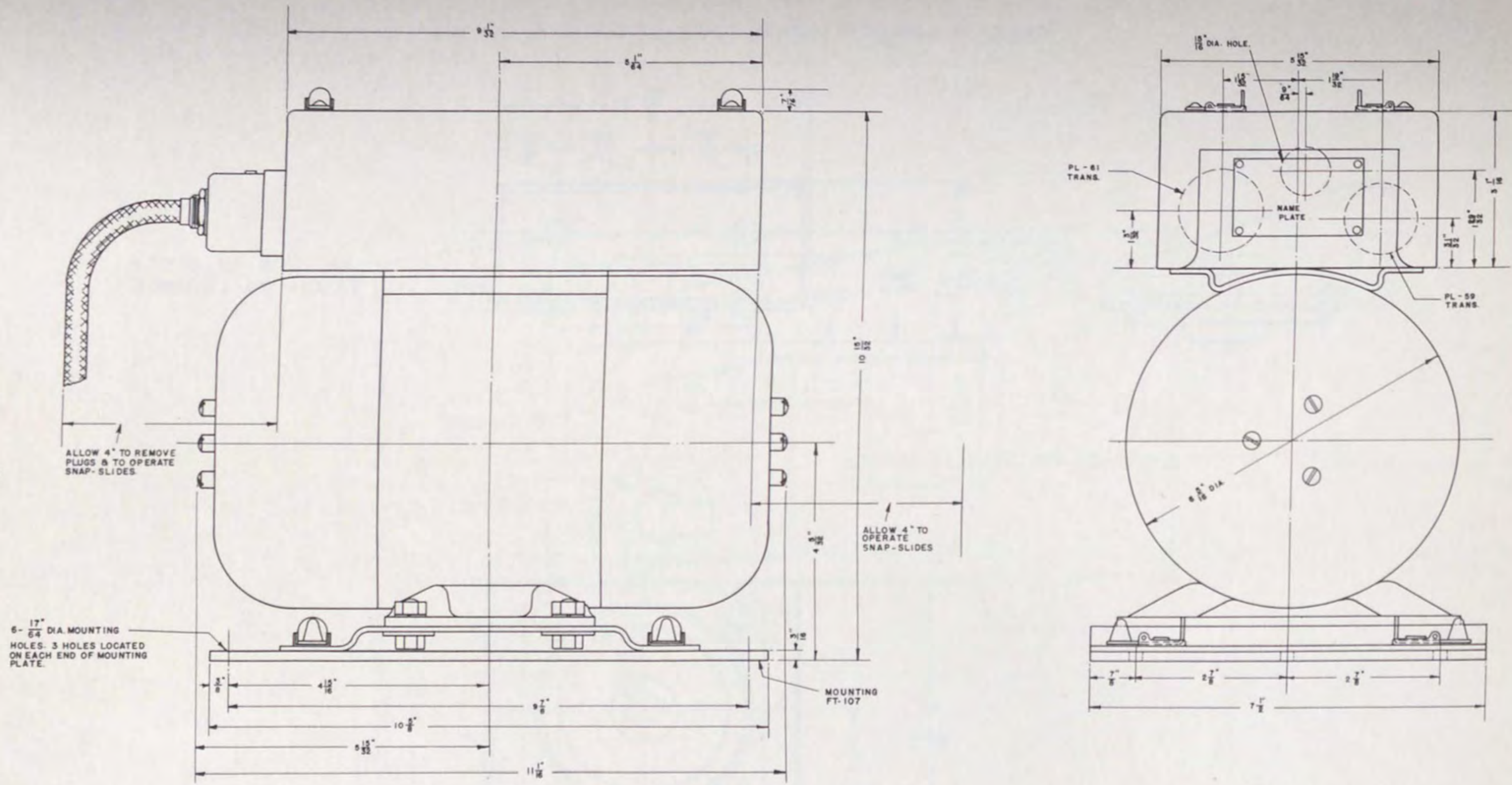


HIGH VOLTAGE
END OF DYNAMOTOR



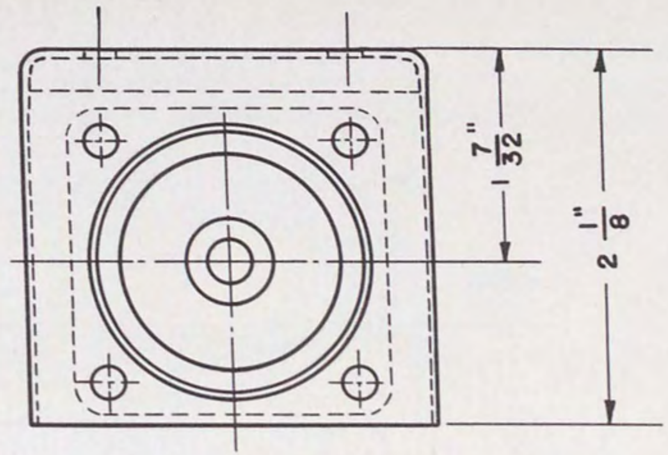
LOW VOLTAGE
END OF DYNAMOTOR

FIG. 58. DYNAMOTOR UNIT BD-77-C, CONNECTION DIAGRAM



Weight of Dynamotor Unit BD-77-C
Less Mounting .... 37.25 lb
Weight of Mounting FT-107 .... 1.45 lb

Fig. 59. Dynamotor Unit BD-77-C, Outline Dimensional Sketch



Weight of Mounting FT-115-B .... 0.195 lb

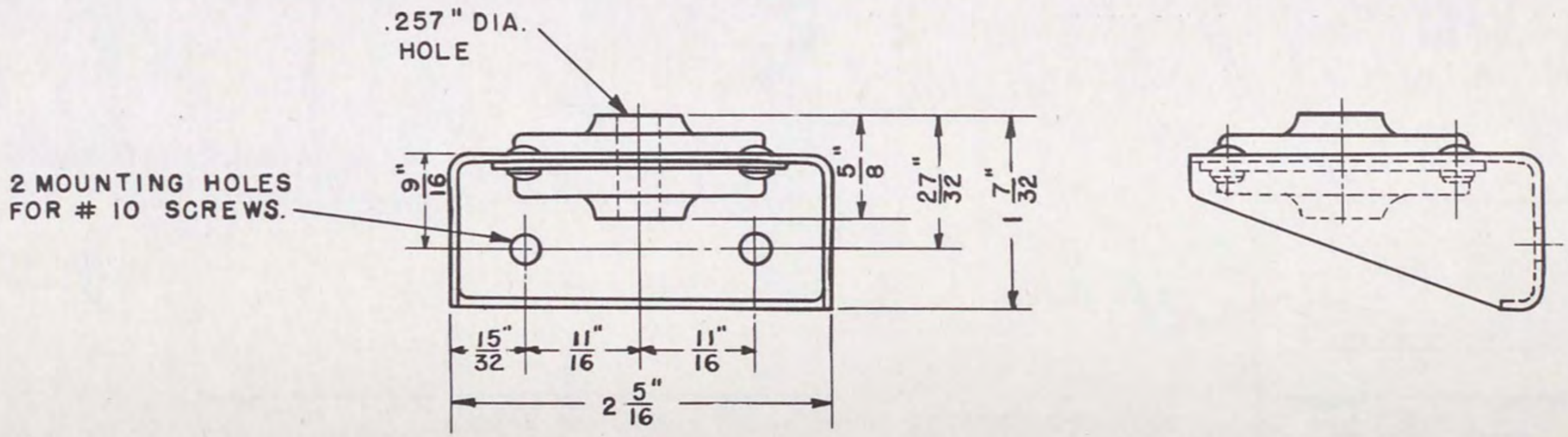


FIG. 60. MOUNTING FT-115-B, OUTLINE DIMENSIONAL SKETCH

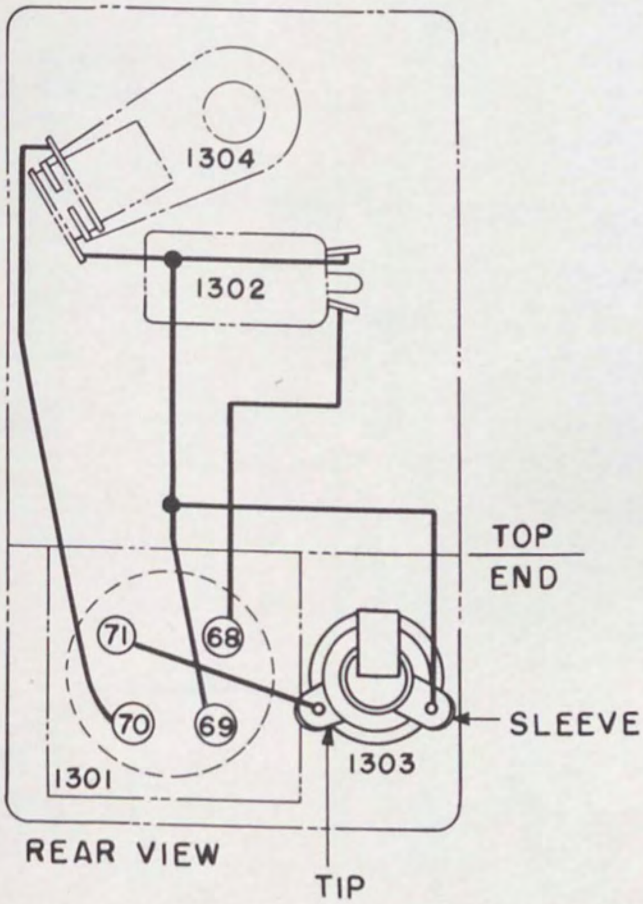
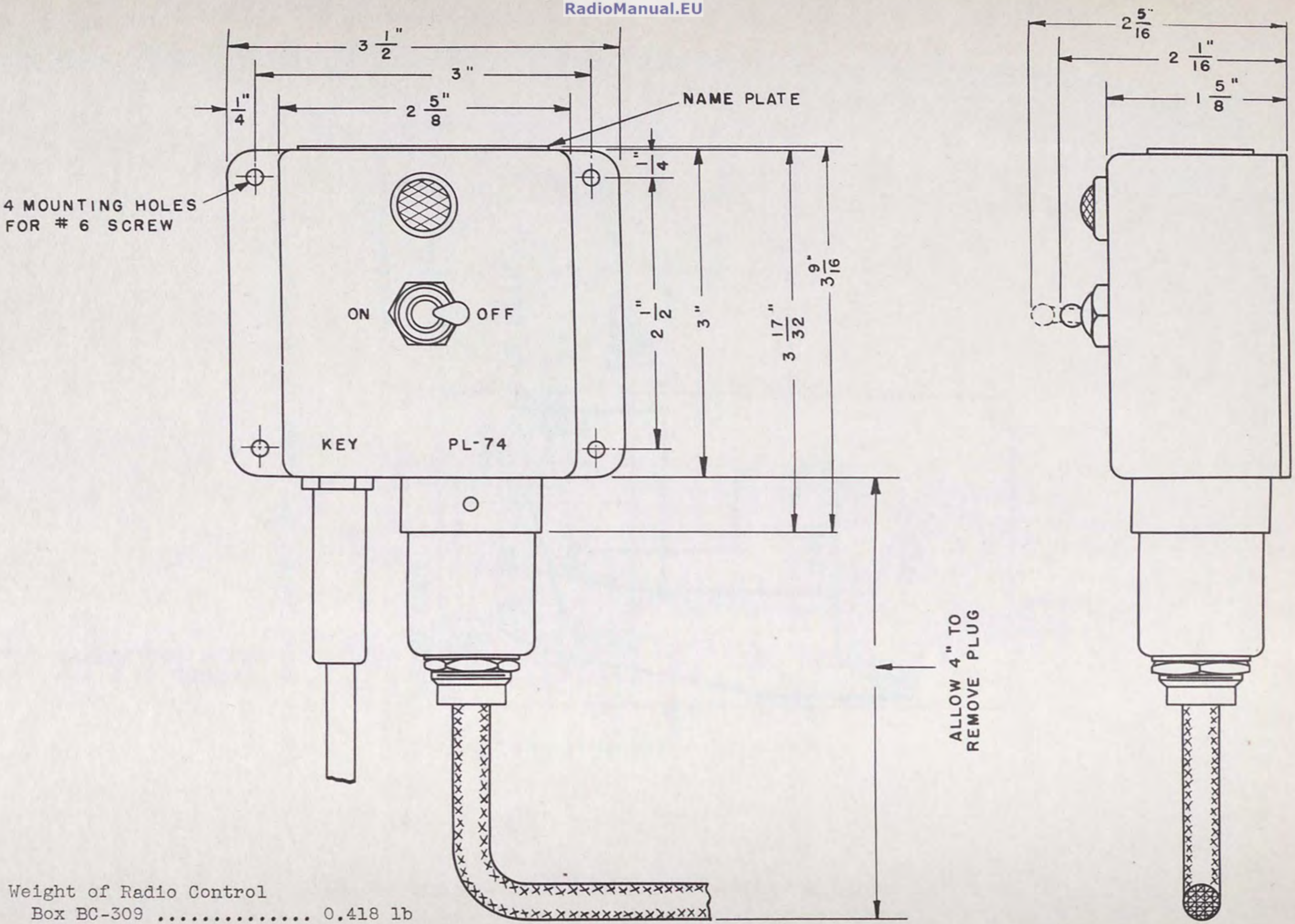


FIG. 61. RADIO CONTROL BOX BC-309, CONNECTION DIAGRAM



Weight of Radio Control
Box BC-309 .... 0.418 lb

FIG. 62. RADIO CONTROL BOX BC-309, OUTLINE DIMENSIONAL SKETCH

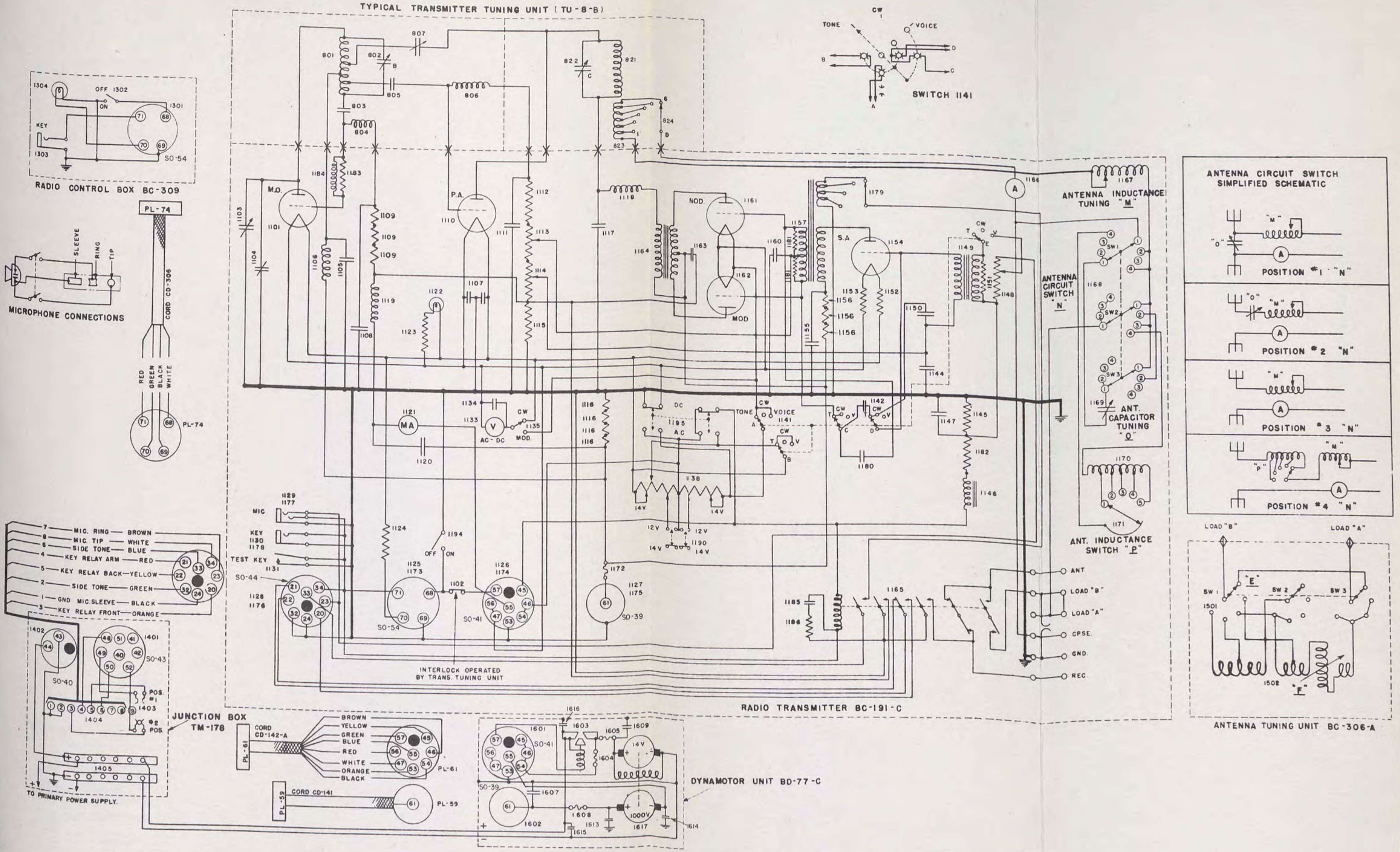
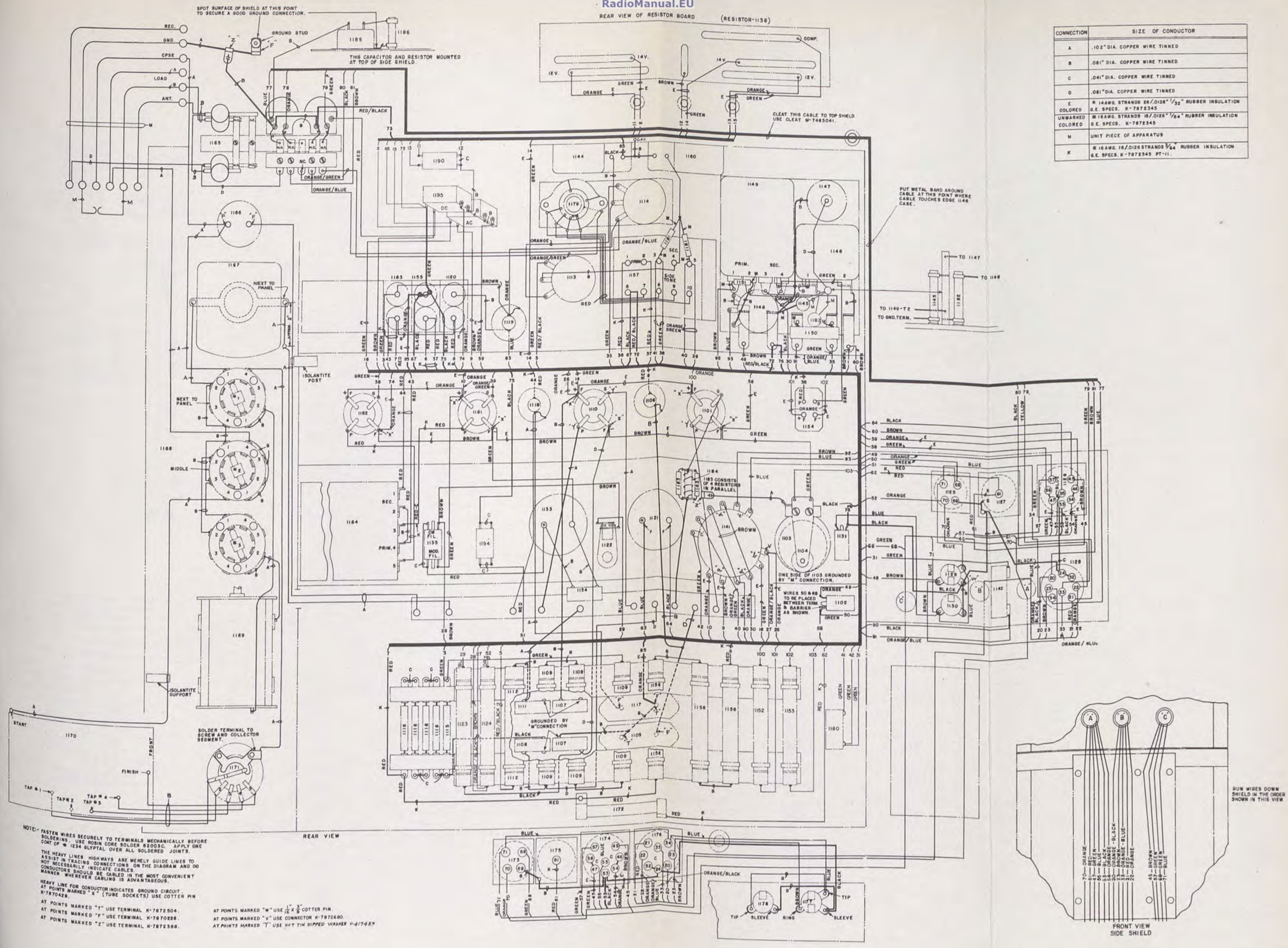


FIG. 63. RADIO TRANSMITTER BC-191-C, SCHEMATIC DIAGRAM



CONNECTION	SIZE OF CONDUCTOR
A	.102" DIA. COPPER WIRE TINNED
B	.081" DIA. COPPER WIRE TINNED
C	.041" DIA. COPPER WIRE TINNED
D	.081" DIA. COPPER WIRE TINNED
E COLORED	# 14AWG. STRANDS 26/.0126" 1/32" RUBBER INSULATION G.E. SPECS. K-7872345
UNMARKED COLORED	# 16AWG. STRANDS 16/.0126" 1/64" RUBBER INSULATION G.E. SPECS. K-7872345
M	UNIT PIECE OF APPARATUS
K	# 16AWG. 16/.0126 STRANDS 3/64" RUBBER INSULATION G.E. SPECS. K-7872345 PT-11.

NOTE:- FASTEN WIRES SECURELY TO TERMINALS MECHANICALLY BEFORE SOLDERING. USE ROSIN CORE SOLDER 82003C. APPLY ONE COAT OF # 1234 GLYPTAL OVER ALL SOLDERED JOINTS.

THE HEAVY LINES HIGHWAYS ARE MERELY GUIDE LINES TO ASSIST IN TRACING CONNECTIONS ON THE DIAGRAM AND DO NOT NECESSARILY INDICATE CABLES. CONDUCTORS SHOULD BE CABLED IN THE MOST CONVENIENT MANNER WHEREVER CABLING IS ADVANTAGEOUS.

HEAVY LINE FOR CONDUCTOR INDICATES GROUND CIRCUIT. AT POINTS MARKED "X" (TUBE SOCKETS) USE COTTER PIN K-7870428.

AT POINTS MARKED "T" USE TERMINAL K-7872504.
AT POINTS MARKED "F" USE TERMINAL K-7870226.
AT POINTS MARKED "Z" USE TERMINAL K-7872368.

AT POINTS MARKED "W" USE 1/16" X 3/8" COTTER PIN.
AT POINTS MARKED "V" USE CONNECTOR K-7872680.
AT POINTS MARKED "Y" USE HOT TIN DIPPED WASHER V-417457

Fig. 64. Radio Transmitter BC-191-C, Connection Diagram

Fig. 64.

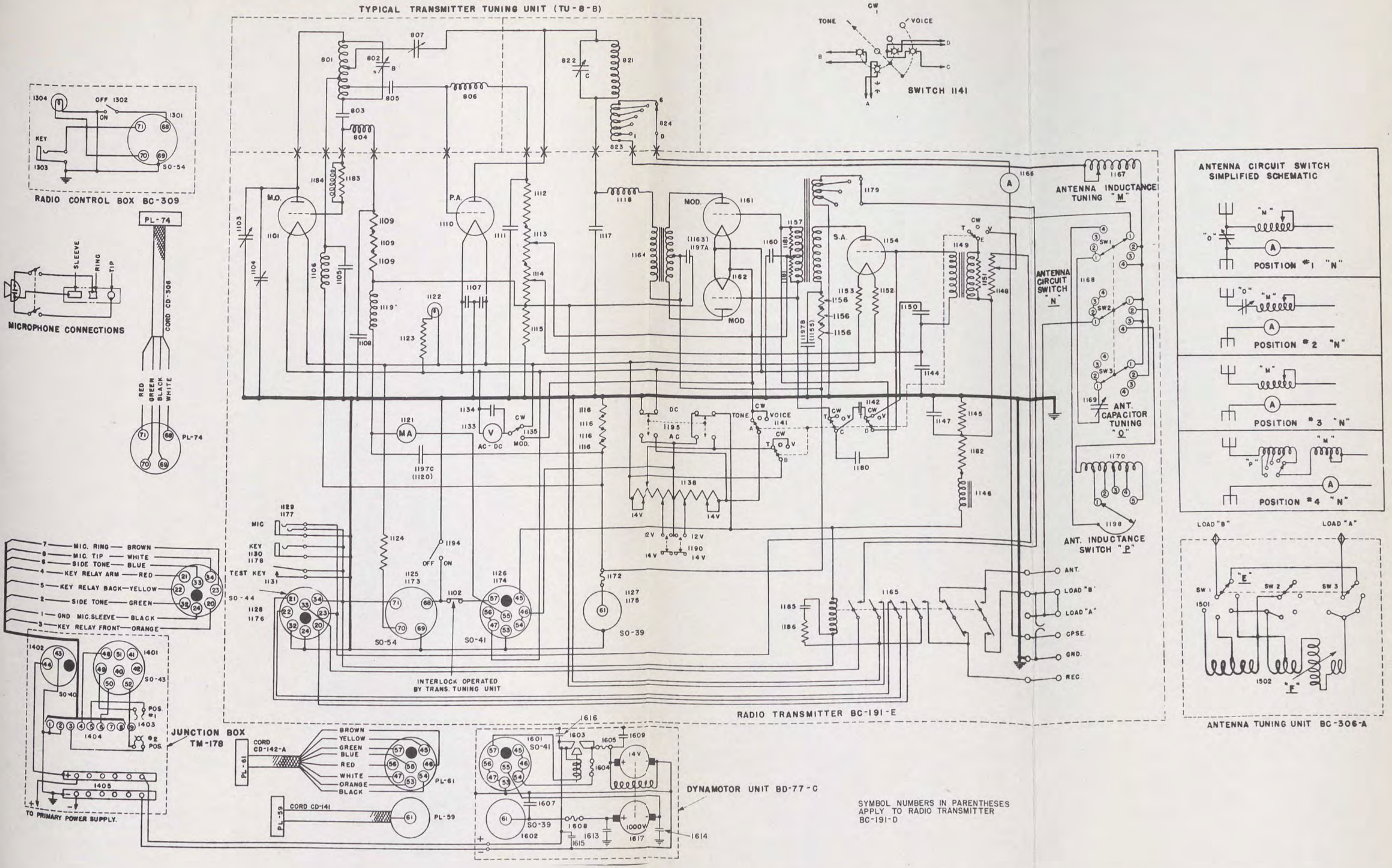
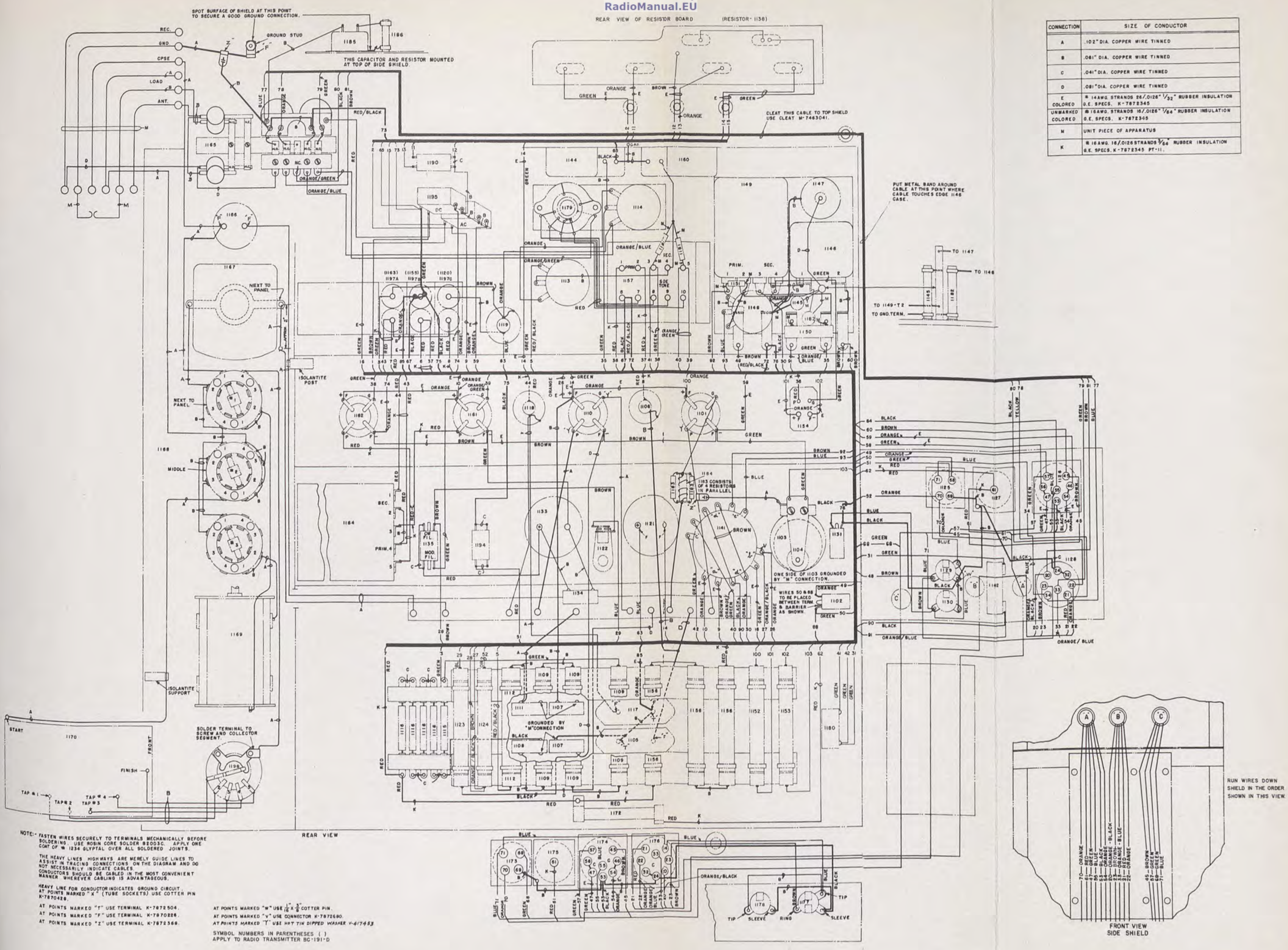


FIG. 65. RADIO TRANSMITTER BC-191-D OR BC-191-E, SCHEMATIC DIAGRAM



CONNECTION	SIZE OF CONDUCTOR
A	.102" DIA. COPPER WIRE TINNED
B	.081" DIA. COPPER WIRE TINNED
C	.041" DIA. COPPER WIRE TINNED
D	.081" DIA. COPPER WIRE TINNED
E COLORED	# 14 AWG. STRANDS 26/.0126" 1/32" RUBBER INSULATION G.E. SPECS. K-7872345
UNMARKED COLORED	# 16 AWG. STRANDS 16/.0126" 1/64" RUBBER INSULATION G.E. SPECS. K-7872345
M	UNIT PIECE OF APPARATUS
K	# 16 AWG. 16/.0126 STRANDS 3/64" RUBBER INSULATION G.E. SPECS. K-7872345 PT-11.

NOTE:- FASTEN WIRES SECURELY TO TERMINALS MECHANICALLY BEFORE SOLDERING. USE ROSIN CORE SOLDER 82003C. APPLY ONE COAT OF # 1234 GLYPTAL OVER ALL SOLDERED JOINTS.

THE HEAVY LINES HIGHWAYS ARE MERELY GUIDE LINES TO ASSIST IN TRACING CONNECTIONS ON THE DIAGRAM AND DO NOT NECESSARILY INDICATE CABLES. CONDUCTORS SHOULD BE CABLED IN THE MOST CONVENIENT MANNER WHEREVER CABLING IS ADVANTAGEOUS.

HEAVY LINE FOR CONDUCTOR INDICATES GROUND CIRCUIT. AT POINTS MARKED "X" (TUBE SOCKETS) USE COTTER PIN K-7870428.

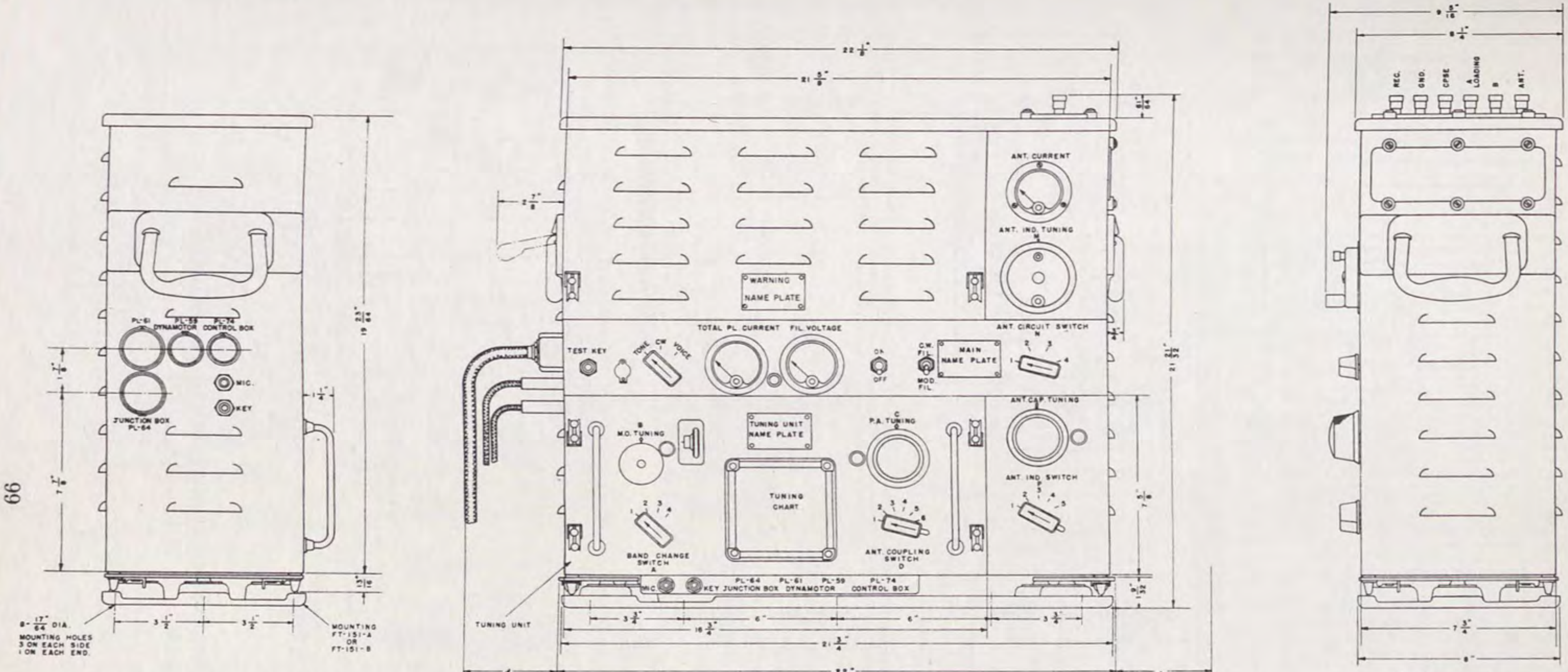
AT POINTS MARKED "T" USE TERMINAL K-7872504.
AT POINTS MARKED "F" USE TERMINAL K-7870226.
AT POINTS MARKED "Z" USE TERMINAL K-7872368.

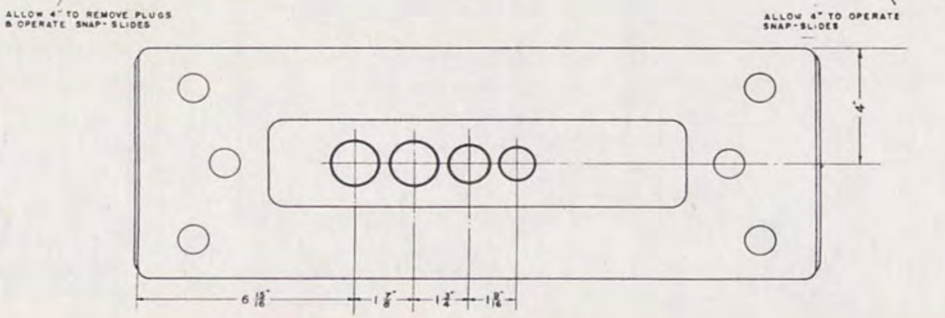
AT POINTS MARKED "W" USE 1/16" X 3/8" COTTER PIN.
AT POINTS MARKED "V" USE CONNECTOR K-7872680.
AT POINTS MARKED "Y" USE HOT TIN DIPPED WASHER V-417453

SYMBOL NUMBERS IN PARENTHESES ( ) APPLY TO RADIO TRANSMITTER BC-191-D

FIG. 66. RADIO TRANSMITTER BC-191-D OR BC-191-E, CONNECTION DIAGRAM

Fig. 66





WEIGHTS IN POUNDS

Radio Transmitter BC-191-C, BC-191-D, or BC-191-E without Mounting, Transmitter Tuning Unit, and Tubes	51.25
Mounting FT-151-A	3.75
One set of Tubes, Consisting of Four Tubes VT-4-C and One Tube VT-25	2.0
Transmitter Tuning Unit TU-3-B	13.0
Transmitter Tuning Unit TU-5-B	14.437
Transmitter Tuning Unit TU-6-B	12.437
Transmitter Tuning Unit TU-7-B	11.687
Transmitter Tuning Unit TU-8-B	11.437
Transmitter Tuning Unit TU-9-B	11.437
Transmitter Tuning Unit TU-10-B	11.437
Transmitter Tuning Unit TU-22-B	12.250

FIG. 67. RADIO TRANSMITTER BC-191-C, BC-191-D OR BC-191-E, OUTLINE DIMENSIONAL SKETCH

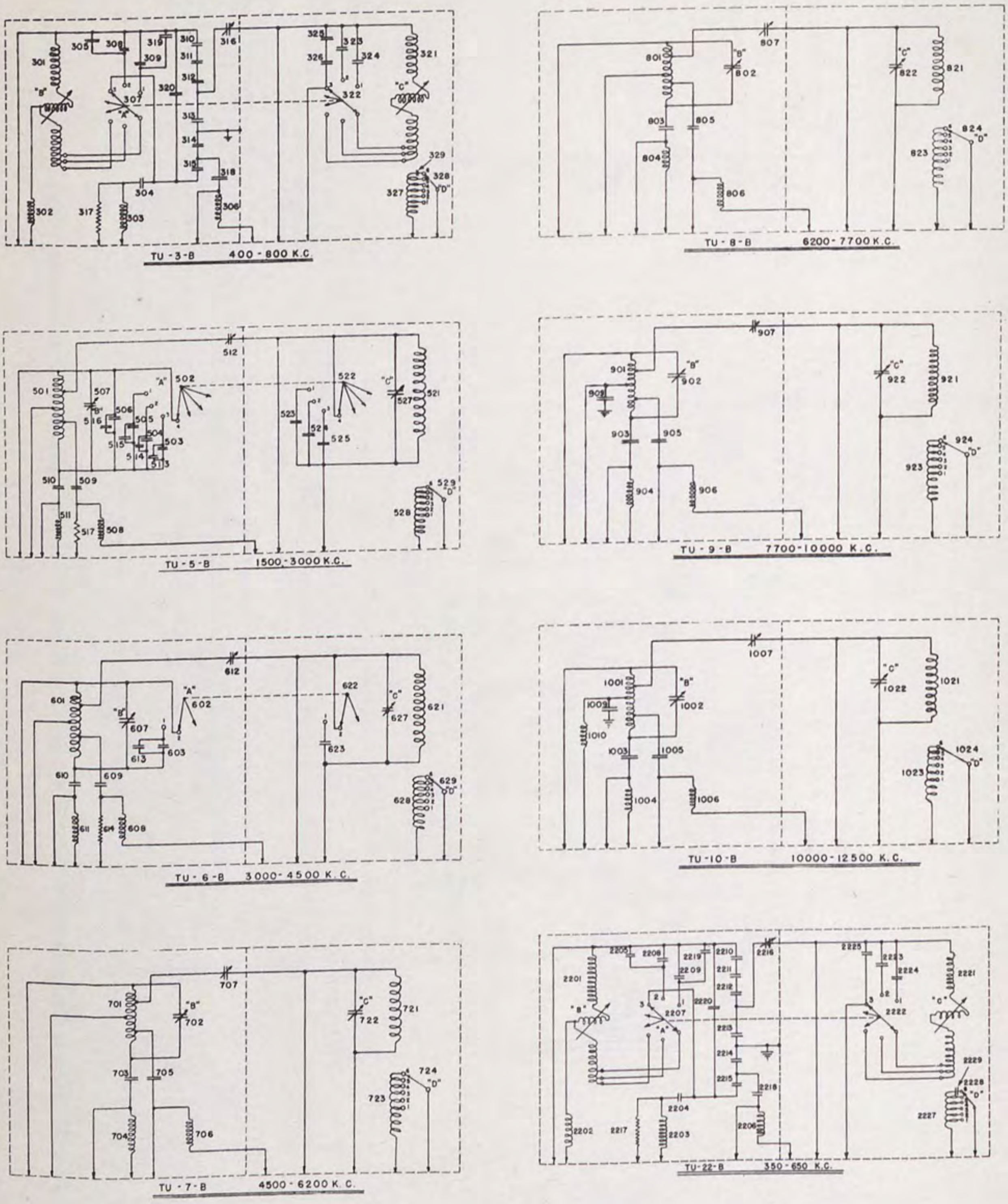
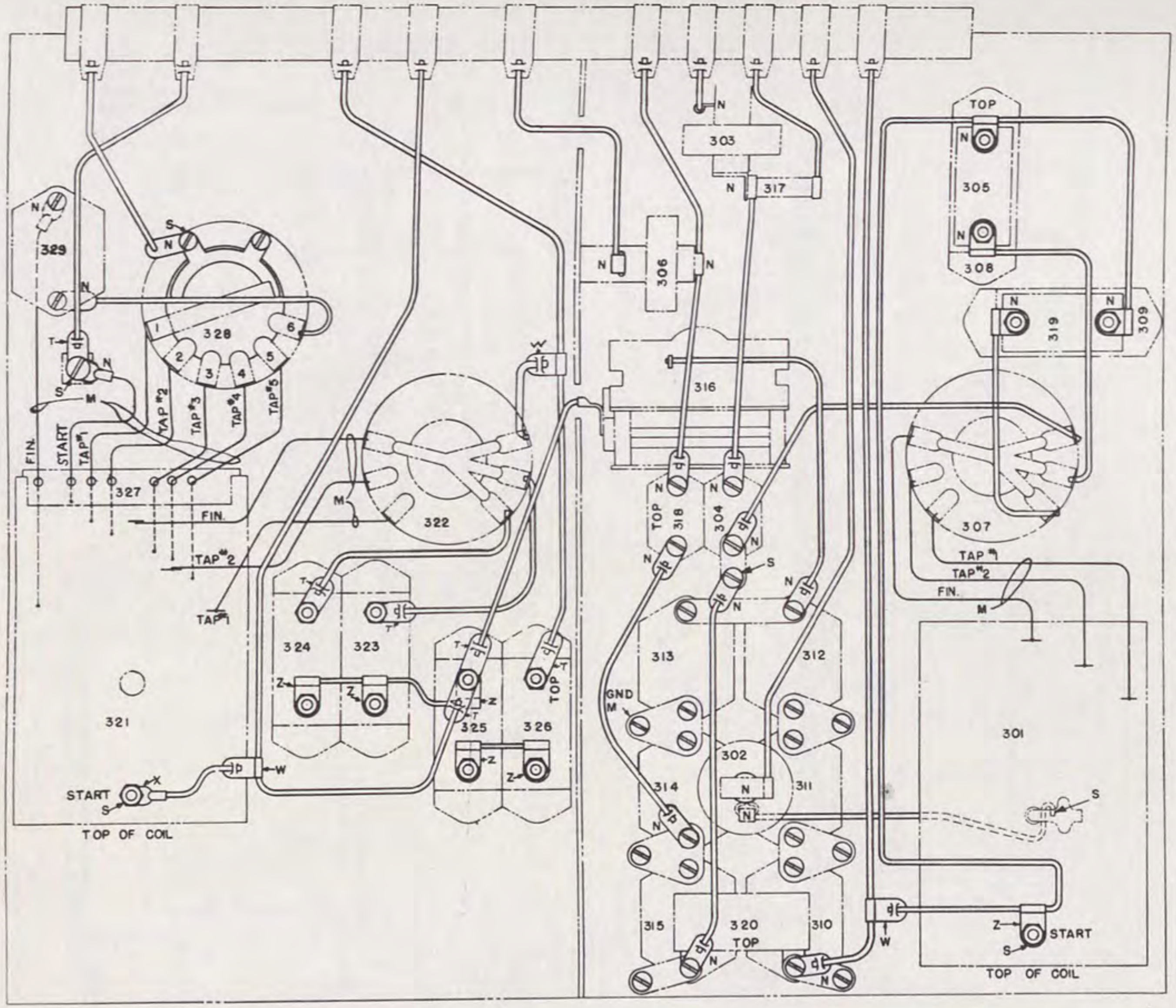


FIG. 68. TRANSMITTER TUNING UNITS, SCHEMATIC DIAGRAM



NOTE FOR SOLDERING:
WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING. USE ROSIN CORE SOLDER B20 D3C.

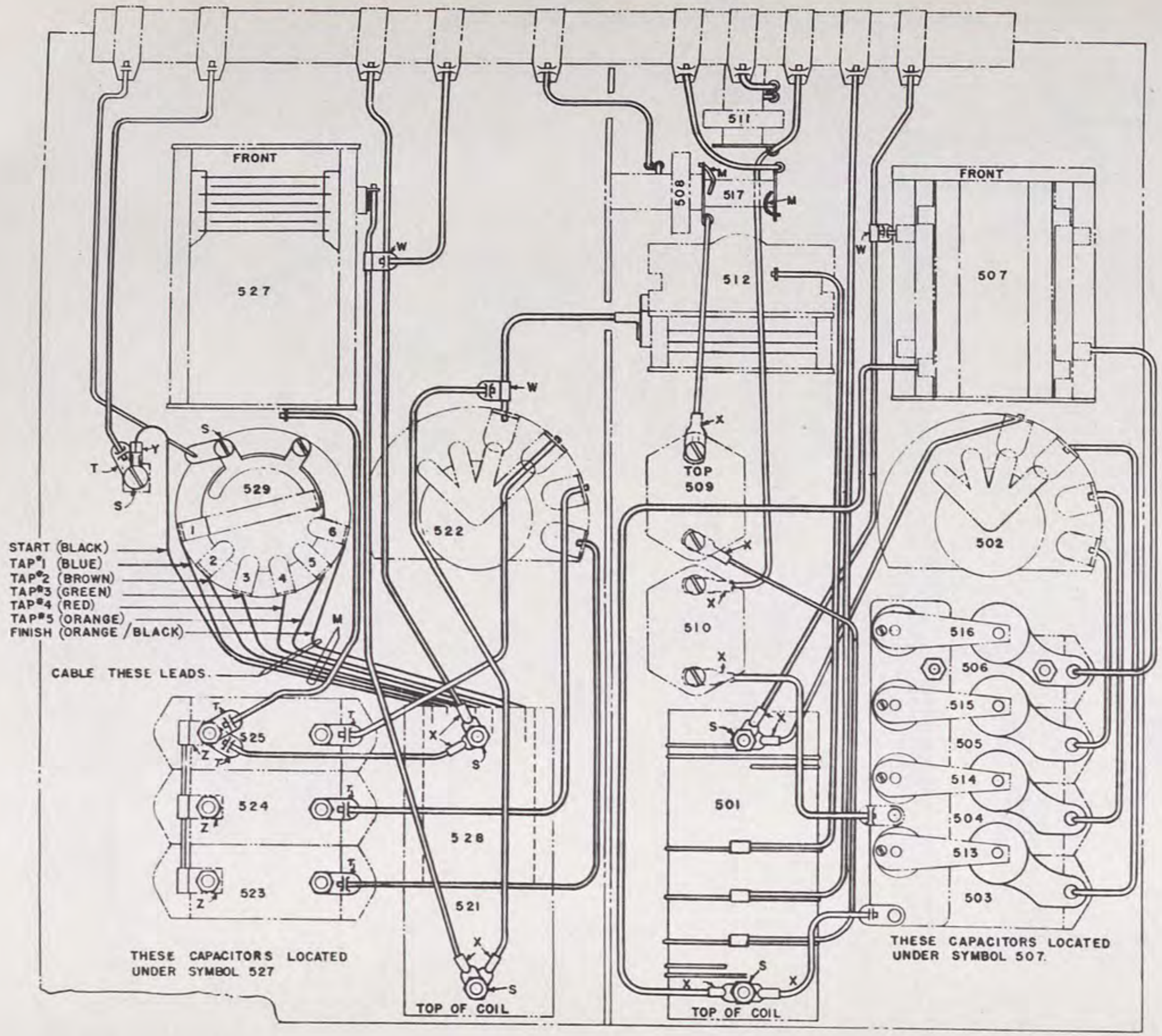
THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.

SYMBOL	NAME OF PART	
301	M.O. TANK INDUCTANCE	
302	M.O. PLATE CHOKE	
303	M.O. GRID CHOKE	
304	M.O. GRID BLOCKING CAPACITOR	
305	M.O. TANK COMPENSATING CAP.	
306	P.A. GRID CHOKE	
307	M.O. BAND CHANGE SWITCH	
308	M.O. FIXED TANK CAPACITOR	
309	" " " "	
310	" CHAIN CAPACITOR	
311	" " "	
312	" " "	
313	" " "	
314	" " "	
315	" " "	
316	NEUTRALIZING CAPACITOR	
317	M.O. GRID PARASITIC RESISTOR	
318	P.A. GRID BLOCKING CAPACITOR	
319	M.O. TANK COMPENSATING CAP.	
320	" " " "	
321	P.A. TANK INDUCTANCE	
322	P.A. BAND CHANGE SWITCH	
323	P.A. FIXED TANK CAPACITOR	
324	" " " "	
325	" " " "	
326	" " " "	
327	ANT. COUPLING COIL	
328	" " SWITCH	
329	" " CAPACITOR	

CONNECTOR	DESCRIPTION
M	UNIT PIECE OF APPARATUS
NOT MARKED	.102" DIA. COPPER WIRE TINNED

NOTE: AT POINTS MARKED "X" USE TERM. V-1444451
" " " "Z" " " K-7872717
" " " "W" " " K-7872368
" " " "T" " " K-7872305
" " " "S" SOLDER COMPLETE JOINT TOGETHER
" " " "N" TERMINALS CALLED FOR ON MECHANICAL DRAWING.

FIG. 69. TRANSMITTER TUNING UNIT TU-3-B, CONNECTION DIAGRAM



NOTE FOR SOLDERING:-

WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING. USE ROSIN CORE SOLDER B20D3C.

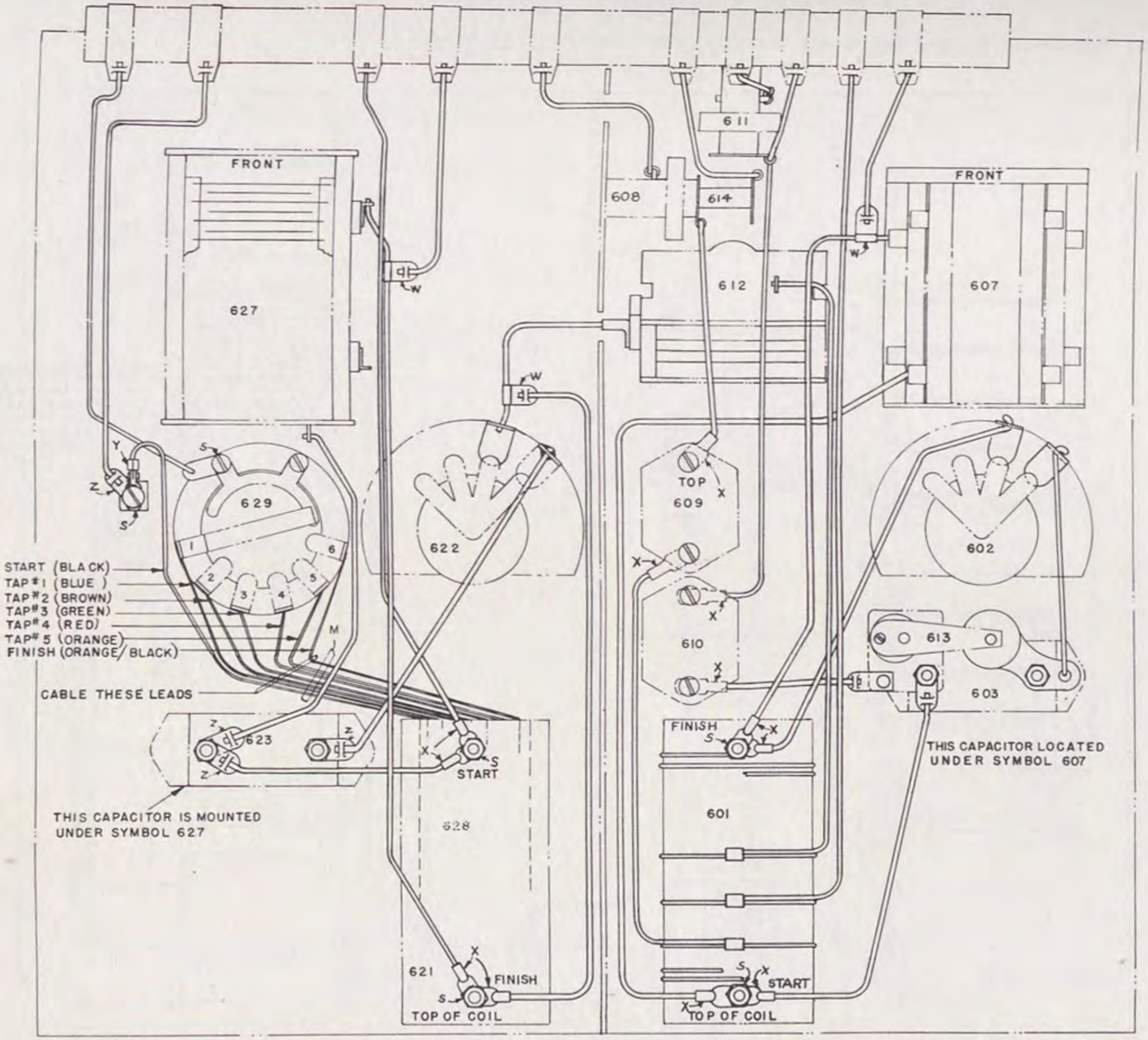
THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.

SYMBOL	NAME OF UNIT	
501	M.O. TANK INDUCTANCE	
502	M.O. BAND CHANGE SWITCH	
503	M.O. FIXED TANK CAPACITOR	
504	" " " "	
505	" " " "	
506	" " " "	
507	M.O. VARIABLE TANK CAPACITOR	
508	P.A. GRID CHOKE	
509	" " BLOCKING CAPACITOR	
510	M.O. " " "	
511	" " CHOKE	
512	NEUTRALIZING CAPACITOR	
513	M.O. TANK COMPENSATING CAP.	
514	" " " "	
515	" " " "	
516	" " " "	
517	M.O. GRID PARASITIC RESISTOR	
521	P.A. TANK INDUCTANCE	
522	P.A. BAND CHANGE SWITCH	
523	P.A. FIXED TANK CAPACITOR	
524	" " " "	
525	" " " "	
527	P.A. VARIABLE TANK CAPACITOR	
528	ANT. COUPLING COIL	
529	" " SWITCH	

CONNECTOR	DESCRIPTION
M	UNIT PIECE OF APPARATUS
NOT MARKED	.102" DIA. COPPER WIRE TINNED.

NOTE:- AT POINTS MARKED "X" USE TERM. V-1444451
" " " "Z" " " K-7872717
" " " "Y" " " V-2454945
" " " "W" " " K-7872368
" " " "T" " " K-7872305
" " " "S" SOLDER COMPLETE JOINT TOGETHER

FIG. 70. TRANSMITTER TUNING UNIT TU-5-B, CONNECTION DIAGRAM



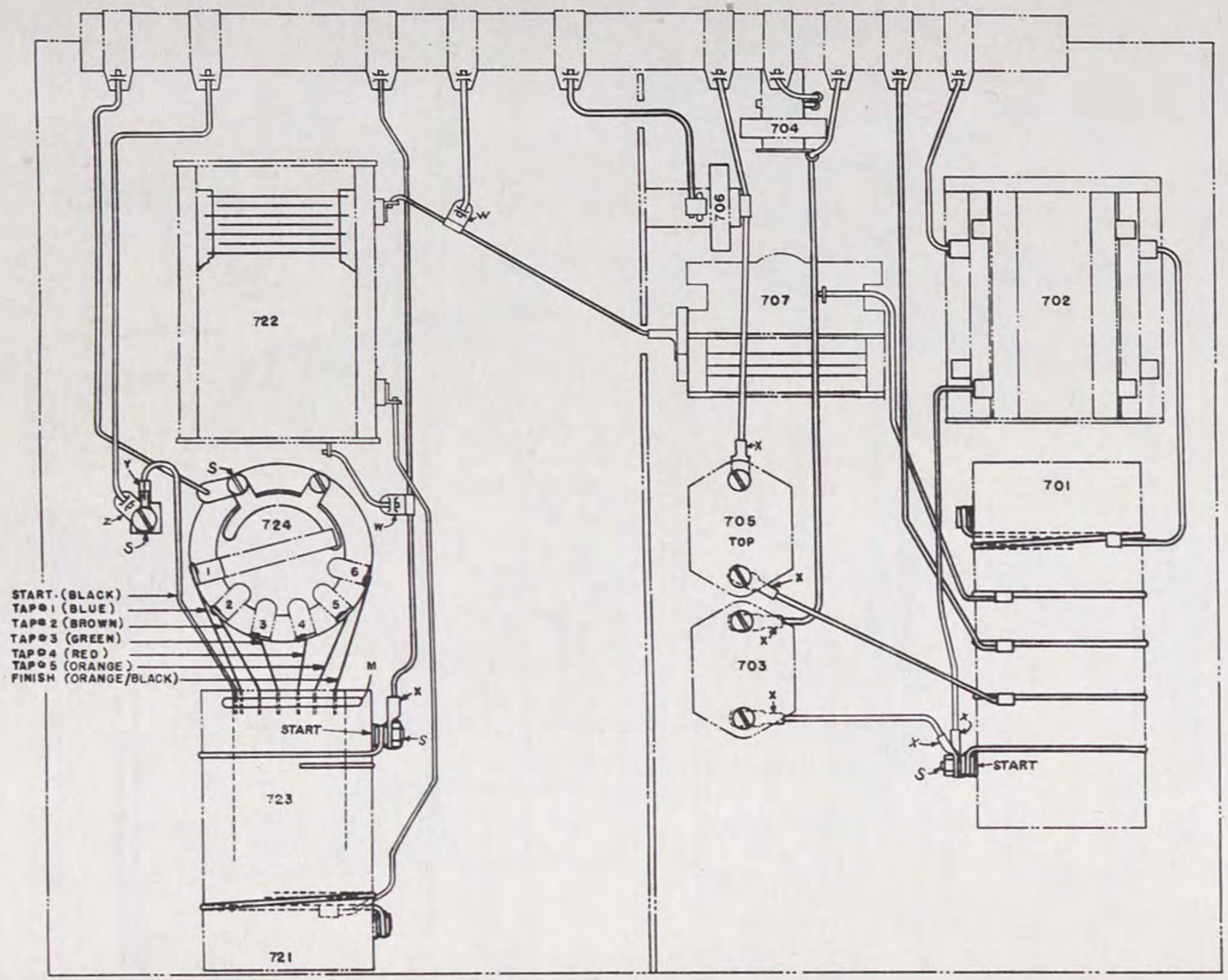
NOTE:
THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.
WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING.
USE ROSIN CORE SOLDER B20D3C

SYMBOL	NAME OF UNIT	
601	M.O. TANK INDUCTANCE	
602	M.O. BAND CHANGE SWITCH	
603	M.O. FIXED TANK CAPACITOR	
607	M.O. VARIABLE TANK CAPACITOR	
608	P.A. GRID CHOKE	
609	P.A. GRID BLOCKING CAPACITOR	
610	M.O. GRID BLOCKING CAPACITOR	
611	M.O. GRID CHOKE	
612	NEUTRALIZING CAPACITOR	
613	M.O. COMPENSATING CAPACITOR	
614	P.A. GRID PARASITIC RESISTOR	
621	P.A. TANK INDUCTANCE	
622	P.A. BAND CHANGE SWITCH	
623	P.A. FIXED TANK CAPACITOR	
627	P.A. VARIABLE TANK CAPACITOR	
628	ANTENNA COUPLING COIL	
629	ANTENNA COUPLING SWITCH	

CONNECTOR	SIZE OF CONNECTOR
M	UNIT PIECE OF APPARATUS
NOT MARKED	.102 DIA. COPPER WIRE TINNED

NOTE: AT POINTS MARKED "X" USE TERM V-1444451
" " " "Z" " K-7872305
" " " "Y" " V-2454945
" " " "W" " K-7872368
" " " "S" SOLDER COMPLETE JOINT TOGETHER.

FIG. 71. TRANSMITTER TUNING UNIT TU-6-B, CONNECTION DIAGRAM



NOTE:
AT POINTS MARKED "X" USE TERM. V-1444451
" " " "Z" " " K-7872305
" " " "Y" " " V-2454945
" " " "W" " " K-7872368
" " " "S" SOLDER COMPLETE JOINT TOGETHER.

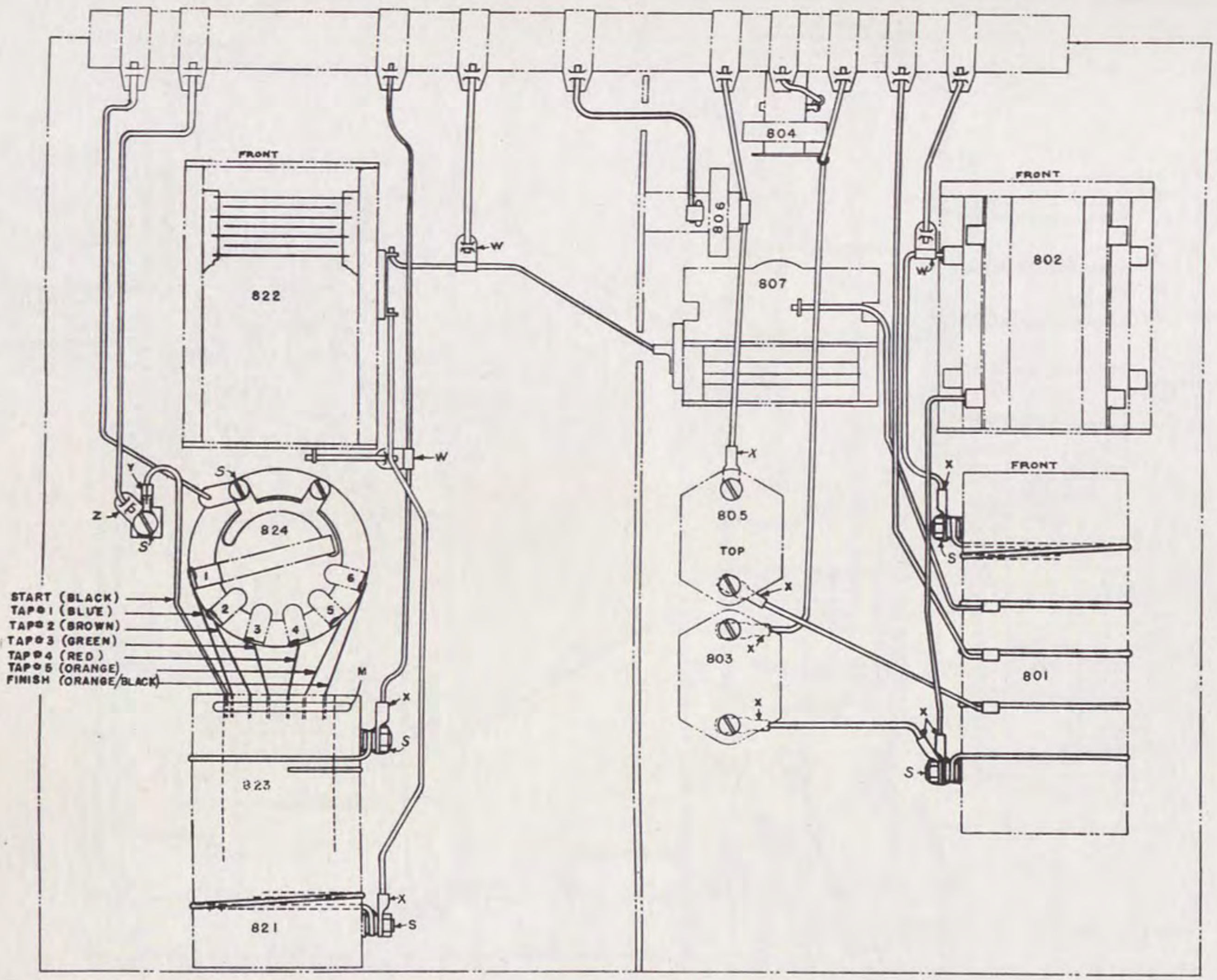
NOTE:-
THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.

WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING USE ROSIN CORE SOLDER B20D3B

SYMBOL UNIT#7	NAME OF UNIT	
701	M.O. TANK INDUCTANCE	
702	M.O. TANK CAPACITOR	
703	M.O. GRID BLOCKING CAPACITOR	
704	M.O. GRID CHOKE	
705	P.A. GRID BLOCKING CAPACITOR	
706	P.A. GRID CHOKE	
707	NEUTRALIZING CAPACITOR	
721	P.A. TANK INDUCTANCE	
722	P.A. TANK CAPACITOR	
723	ANT. COUPLING COIL	
724	ANT. COUPLING SWITCH	

CONNECTION	SIZE OF CONNECTOR
M	SPECIFIED ON MECHANICAL DRAWING
NOT MARKED	COPPER WIRE TINNED .102 DIA.

FIG. 72. TRANSMITTER TUNING UNIT TU-7-B, CONNECTION DIAGRAM



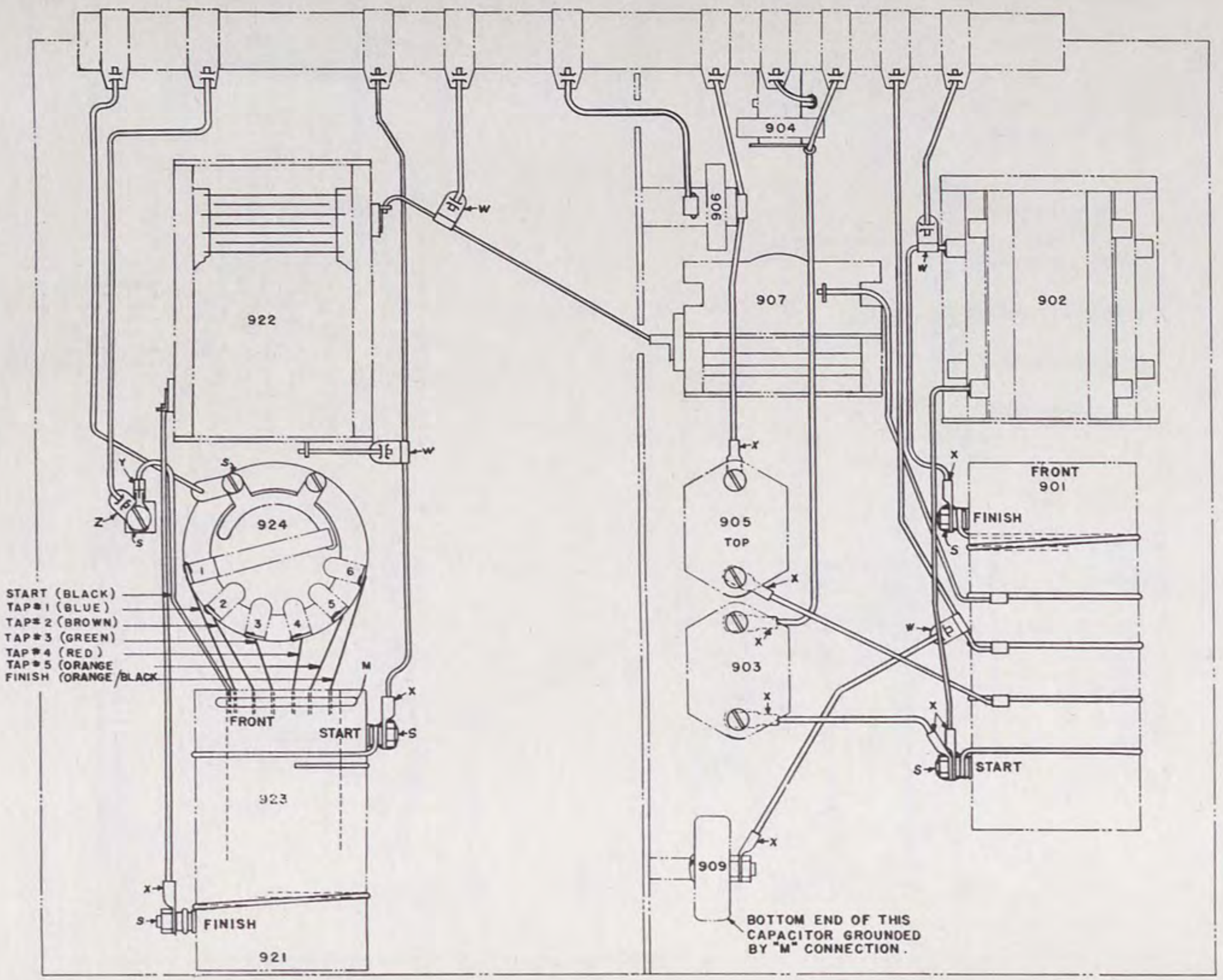
NOTE:
AT POINTS MARKED "X" USE TERM. V-1444451
" " " "Z" " " K-7872305
" " " "Y" " " V-2454945
" " " "W" " " K-7872368
" " " "S" SOLDER COMPLETE JOINT TOGETHER.

NOTE:
THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.
WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING USE ROSIN CORE SOLDER B20D3B

SYMBOL UNIT # 8	NAME OF UNIT	
801	M.O. TANK INDUCTANCE	
802	M.O. TANK CAPACITOR	
803	M.O. GRID BLOCKING CAPACITOR	
804	M.O. GRID CHOKE	
805	P.A. GRID BLOCKING CAPACITOR	
806	P.A. GRID CHOKE	
807	NEUTRALIZING CAPACITOR	
821	P.A. TANK INDUCTANCE	
822	P.A. TANK CAPACITOR	
823	ANT. COUPLING COIL	
824	ANT. COUPLING SWITCH	

CONNECTION	SIZE OF CONNECTOR
M	SPECIFIED ON MECHANICAL DRAWING
NOT MARKED	COPPER WIRE TINNED .102 DIA.

FIG. 73. TRANSMITTER TUNING UNIT TU-8-B, CONNECTION DIAGRAM



NOTE:
AT POINTS MARKED "X" USE TERM. V-1444451
" " " "Z" " " K-7872305
" " " "Y" " " (V-2454945)
" " " "W" " " K-7872368
" " " "S" SOLDER COMPLETE JOINT TOGETHER

NOTE:-
THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.
WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING. USE ROSIN CORE SOLDER B20D3B

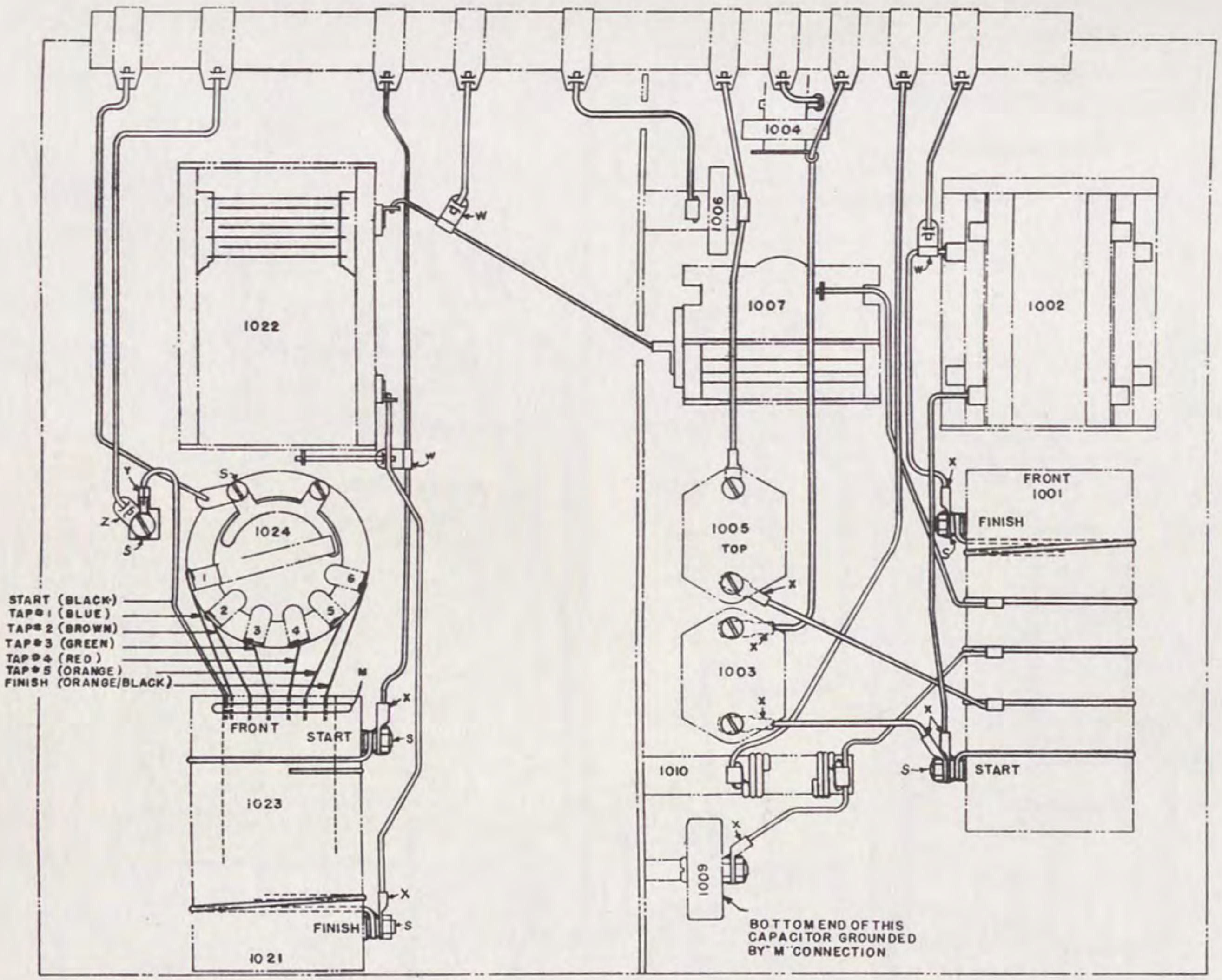
SYMBOL UNIT #9	NAME OF UNIT	
901	M.O. TANK INDUCTANCE	
902	M.O. TANK CAPACITOR	
903	M.O. GRID BLOCKING CAPACITOR	
904	M.O. GRID CHOKE	
905	P.A. GRID BLOCKING CAPACITOR	
906	P.A. GRID CHOKE	
907	NEUTRALIZING CAPACITOR	
909	M.O. BY PASS CAPACITOR	
921	P.A. TANK INDUCTANCE	
922	P.A. TANK CAPACITOR	
923	ANT. COUPLING COIL	
924	ANT. COUPLING SWITCH	

CONNECTION	SIZE OF CONNECTOR
M	SPECIFIED ON MECHANICAL DRAWING
NOT MARKED	COPPER WIRE TINNED .102 DIA.

FIG. 74. TRANSMITTER TUNING UNIT TU-9-B, CONNECTION DIAGRAM

NOTE:
AT POINTS MARKED "X" USE TERM. V-1444451
" " " "Z" " " K-7872305
" " " "Y" " " V-2454945
" " " "W" " " K-7872368
" " " "S" SOLDER COMPLETE JOINT TOGETHER.

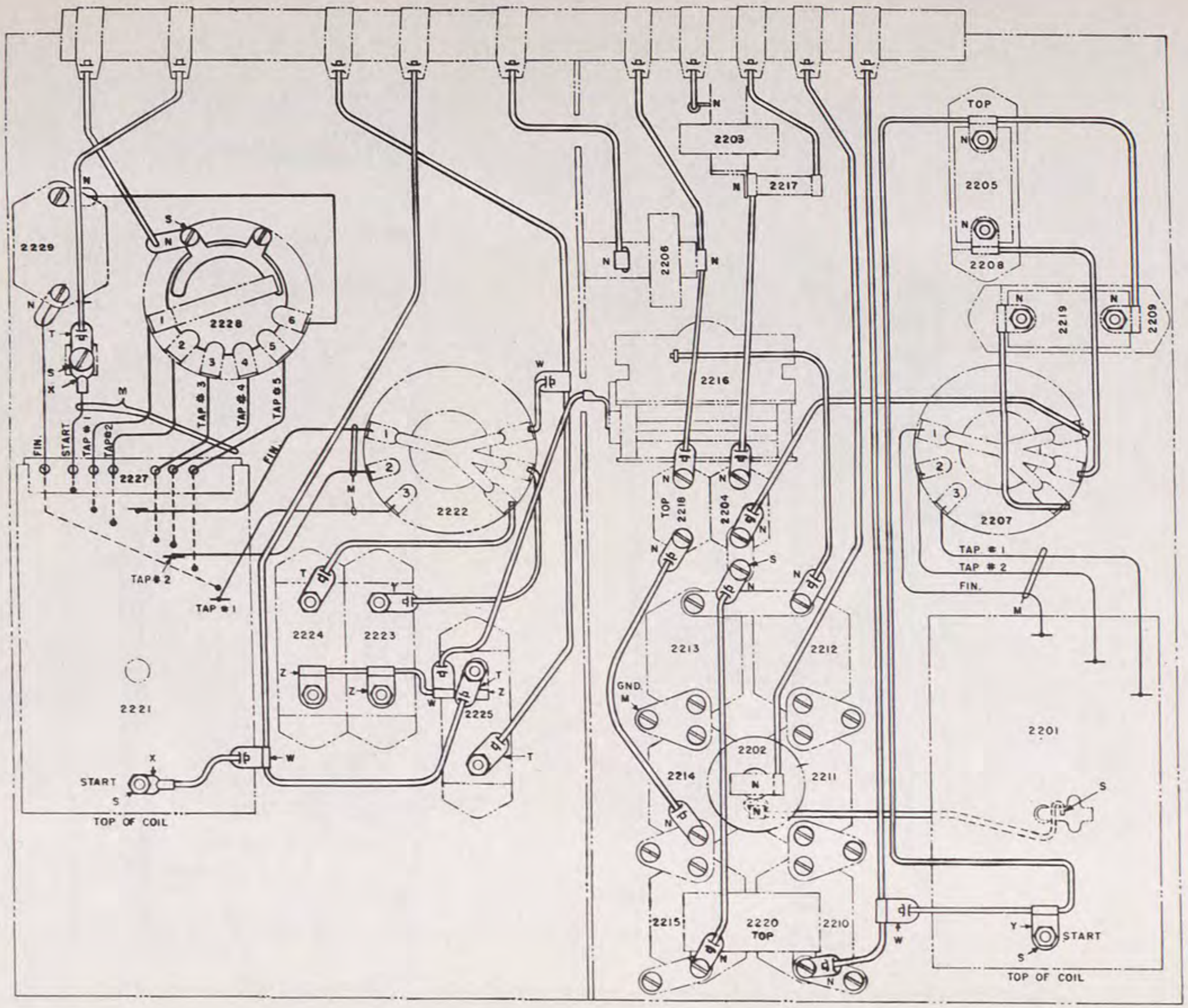
NOTE:-
THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.
WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING USE ROSIN CORE SOLDER B20D3B



SYMBOL UNIT#10	NAME OF UNIT	
1001	M.O. TANK INDUCTANCE	
1002	M.O. TANK CAPACITOR	
1003	M.O. GRID BLOCKING CAPACITOR	
1004	M.O. GRID CHOKE	
1005	P.A. GRID BLOCKING CAPACITOR	
1006	P.A. GRID CHOKE	
1007	NEUTRALIZING CAPACITOR	
1009	M.O. BY PASS CONDENSER	
1010	M.O. CHOKE	
1021	P.A. TANK INDUCTANCE	
1022	P.A. TANK CAPACITOR	
1023	ANT. COUPLING COIL	
1024	ANT. COUPLING SWITCH	

CONNECTION	SIZE OF CONNECTOR
M	SPECIFIED ON MECHANICAL DRAWING
NOT MARKED	COPPER WIRE TINNED .102 DIA.

FIG. 75. TRANSMITTER TUNING UNIT TU-10-B, CONNECTION DIAGRAM



NOTE FOR SOLDERING:-
WIRE TO BE FASTENED MECHANICALLY TO TERMINALS BEFORE SOLDERING. USE ROSIN CORE SOLDER B20D3C.

THERE SHALL BE NO SHARP POINTS LEFT AFTER UNIT IS WIRED EITHER FROM LUMPS OF SOLDER OR IRREGULARLY CUT WIRE ENDS.

SYMBOL	NAME OF PART	
2201	M.O. TANK INDUCTANCE	
2202	M.O. PLATE CHOKE	
2203	M.O. GRID CHOKE	
2204	M.O. GRID BLOCKING CAPACITOR	
2205	M.O. TANK COMPENSATING CAP.	
2206	P. A. GRID CHOKE	
2207	M.O. BAND CHANGE SWITCH	
2208	M.O. FIXED TANK CAPACITOR	
2209	M.O. FIXED TANK CAPACITOR	
2210	M.O. CHAIN CAPACITOR	
2211	M.O. CHAIN CAPACITOR	
2212	M.O. CHAIN CAPACITOR	
2213	M.O. CHAIN CAPACITOR	
2214	M.O. CHAIN CAPACITOR	
2215	M.O. CHAIN CAPACITOR	
2216	NEUTRALIZING CAPACITOR	
2217	M.O. GRID PARASITIC RESISTOR	
2218	P.A. GRID BLOCKING CAPACITOR	
2219	M.O. TANK COMPENSATING CAP.	
2220	M.O. TANK COMPENSATING CAP.	
2221	P.A. TANK INDUCTANCE	
2222	P.A. BAND CHANGE SWITCH	
2223	P.A. FIXED TANK CAPACITOR	
2224	P.A. FIXED TANK CAPACITOR	
2225	P.A. FIXED TANK CAPACITOR	
2227	ANT. COUPLING COIL	
2228	ANT. COUPLING SWITCH	
2229	ANT. COUPLING CAPACITOR	

CONNECTOR	DESCRIPTION
M	UNIT PIECE OF APPARATUS
NOT MARKED	.102" DIA. COPPER WIRE TINNED

NOTE:- AT POINTS MARKED "S" SOLDER COMPLETE JOINT TOGETHER.
AT POINTS MARKED "T" USE TERM. K-7872305.
AT POINTS MARKED "W" USE TERM. K-7872368.
AT POINTS MARKED "X" USE TERM. V-1444451.
AT POINTS MARKED "Z" USE TERM. K-7870226.
AT POINTS MARKED "N" TERMINALS CALLED FOR ON MECHANICAL DRAWING.
AT POINTS MARKED "Y" USE TERM. V-1451309.

FIG. 76. TRANSMITTER TUNING UNIT TU-22-B, CONNECTION DIAGRAM

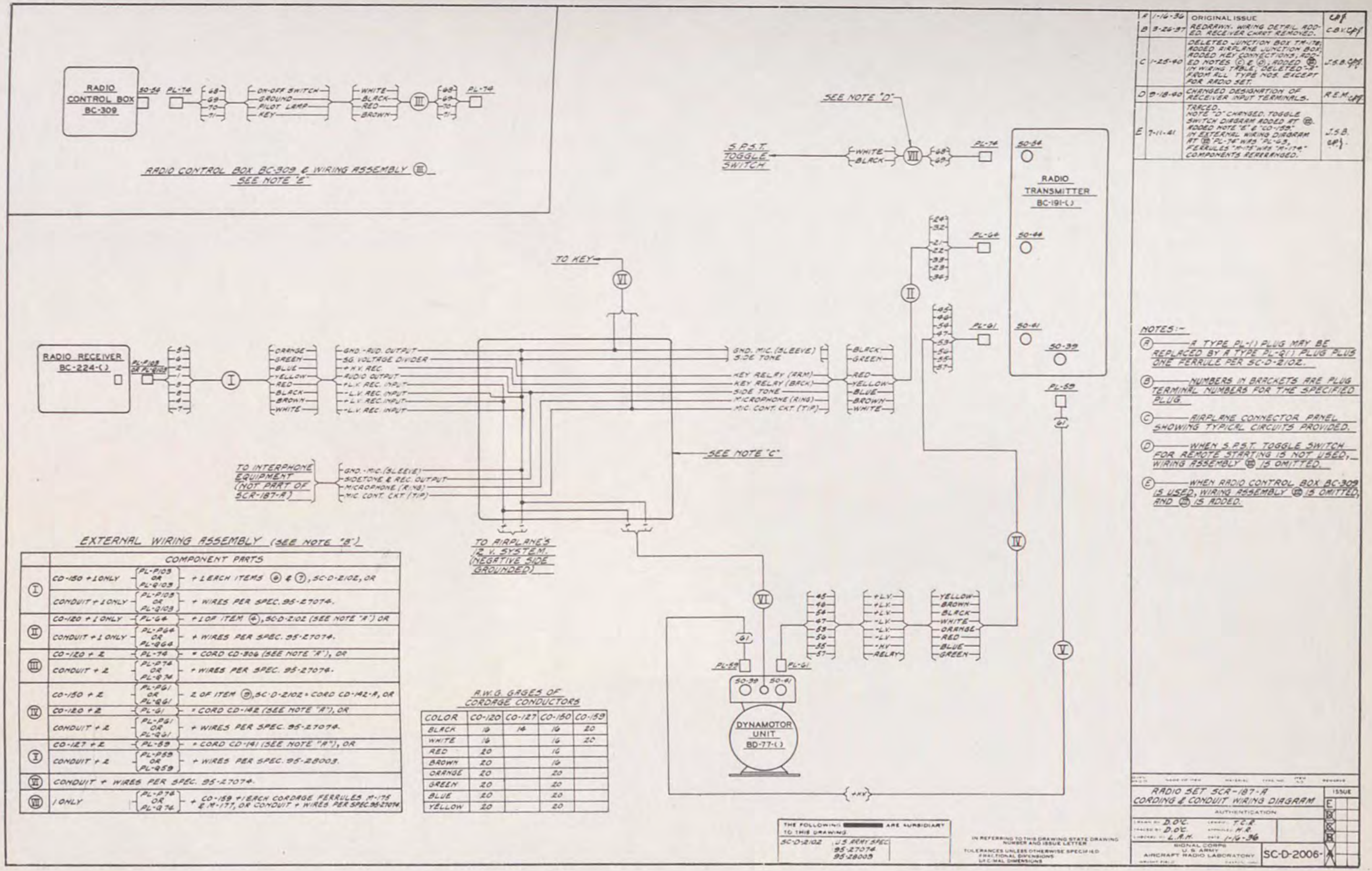


FIG. 77. RADIO SET SCR-187-A, CORDING DIAGRAM