TECHNICAL REGULATIONS
No. 1210-1

WAR DEPARTMENT,
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# RADIO SETS, TYPES SCR-AA-183 AND SCR-AA-192

Prepared under direction of the
Chief Signal Officer



## SECTION I

## GENERAL USE AND DESCRIPTION



**1. Use.**—*a.* Radio set, type SCR-AA-183, is a complete transmitting and receiving equipment designed for use as a command set on airplanes. It will transmit either tone modulated or voice modulated signals in the range 6,200 to 7,700 kilocycles, but is designed primarily for voice transmission. This set will receive modulated signals within either of the two bands 224 to 448 kilocycles and 4,150 to 7,850 kilocycles. It will not transmit continuous-wave signals, and will not receive continuous-wave signals unless operated in conjunction with the oscillator equipment, type RC-12, which is not a part of this radio set. The set may be installed in any type of airplane and is designed for use with fixed antennas. This radio set is designed for a distance range of 15 miles. It must be understood that with one or both airplanes banked so as to shield the antennas, this distance range will be reduced below 15 miles. The strength of a received signal is also materially reduced when one airplane is directly below the other or in a flying altitude which would shield the antennas. The distance range using tone telegraph will normally be greater than that with voice telephone.

*b.* Radio set, type SCR-AA-192, is a complete receiving set for use in airplanes. It will receive modulated signals over the entire range from 224 to 7,850 kilocycles. It accomplishes reception over this wide range by use of six sets of plug-in coils. The components of this set, less the four intermediate coil sets (types C-98, C-99, C-100, and C-101), are also components of the radio set, type SCR-AA-183. The SCR-AA-192 is of greatest use as a receiver of radio beacon signals and weather reports. Under normal atmospheric conditions this receiver, when working properly, will receive the signals broadcast from the Department of Commerce radio range beacons up to distances of 200 miles, and weather reports broadcast by voice should be intelligible up to about 100 miles.

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**2. General description.**—*a.* Radio set, type SCR-AA-183, includes the following principal units (the additional accessories are included in paragraph 15):

(1) Radio transmitter, type BC-AA-180.
(2) Radio receiver, type BC-AA-179.
(3) Radio control box, type BC-AA-181.
(4) Radio control box, type BC-AA-182.
(5) Junction box, type TM-AA-153.
(6) Dynamotor unit, type BD-AA-69 or type BD-AB-69.
(7) Coil sets, types C-97 and C-102.
(8) One each of cords, types CD-110, CD-111, CD-112, CD-113, CD-114, CD-115.
(9) Tuning shaft, type MC-124, and one each of tuning units, types MC-125 and MC-127.
(10) Antenna system.

The transmitter, receiver, junction box, and dynamotor are fastened to mountings by means of slide fasteners. In each case the mounting is part of the

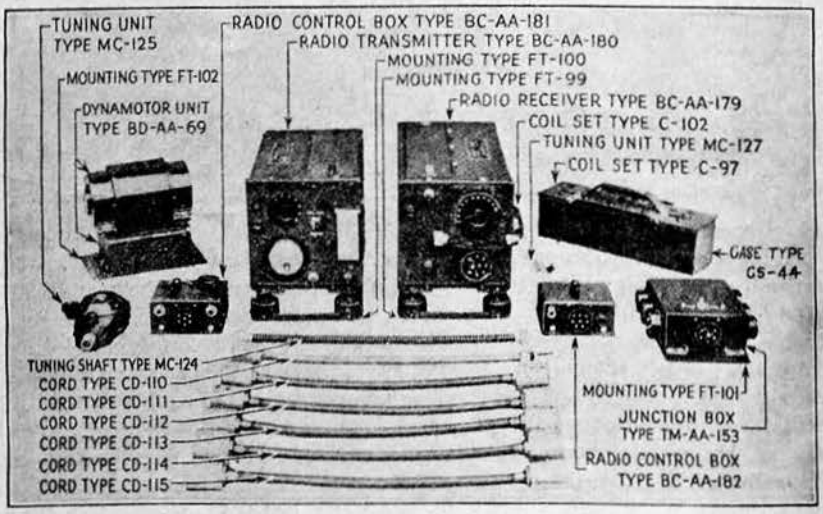



FIGURE 1.—Principal units of radio set, type SCR-AA-183.

unit which is mounted thereon. The transmitter, receiver, junction box, and control boxes include riveted aluminum cases. This gives these units sturdy construction without adding unnecessary weight. Figure 1 shows each of the principal units of the radio set, type SCR-AA-183, with its nomenclature. Coil set, type C-102, is shown in place in the receiver. Dynamotor unit, type BD-AB-69, is similar to the type BD-AA-69 except the end covers are flush with the body and are rounded off at the ends.

*b.* The principal units comprising radio set, type SCR-AA-192, are shown in figure 2. It will be seen that the transmitter, type BC-AA-180, radio control box, type BC-AA-182, and cords, types CD-113 and CD-114, are not included in the radio set, type SCR-AA-192. On the other hand, coil sets, types C-98, C-99, C-100, and C-101, which are not part of the radio set, type SCR-AA-183, are included in the radio set, type SCR-AA-192.

## SECTION II

## INSTALLATION FOR SERVICE



**3. Detailed description of the sets as issued.**—*a. Radio transmitter, type BC-AA-180.*—This transmitter consists of a case enclosing the apparatus (other than the vacuum tubes) which is required for the generation, amplification, and modulation of radio-frequency currents. It is shown together with its mounting, type FT-100, in figure 3.

The weight and external dimensions of the transmitter are given in figure 18. Internal views are shown in figures 4 and 5.

The transmitter case 344 has an opening in one end for the power plug and the other end is entirely open. It has an opening in one side for the antenna coil

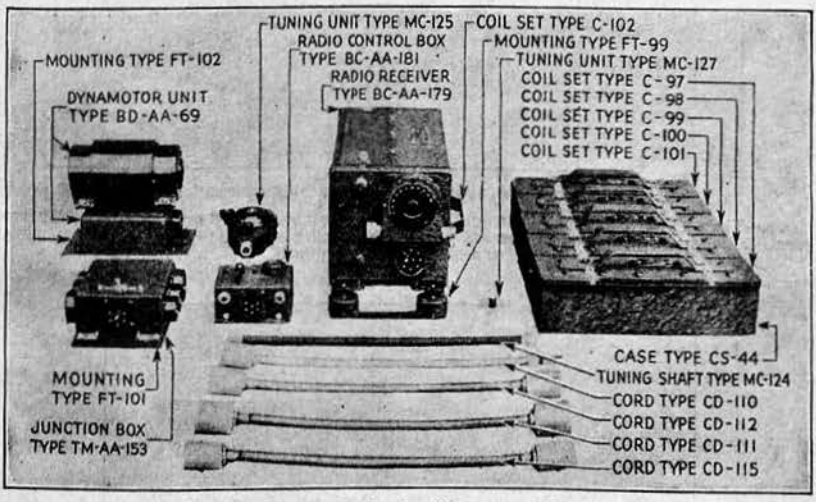



FIGURE 2.—Principal units of radio set, type SCR-AA-192.

assembly 98 and another opening in the top closed by the tube cover 346. The open end of the case is closed by the panel 345 on which are mounted the antenna and ground binding posts, 149, 150, frequency calibration chart 347, frequency control knob 153, dial 154, antenna condenser knob 155, locking knobs 303, 304, and antenna current ammeter 106. The frame or chassis of the transmitter is permanently fastened to panel 345. The chassis can be removed from the case by removing the eight screws around the edge of panel 345 and the two bright-headed screws in the lower edge of the opposite end of the case. The antenna coil assembly 98 must be removed before the chassis can be removed from the case. The general layout of the transmitter is as follows: Lengthwise through the center is a vertical partition. On one side of this partition the tubes are placed in a row. The radio-frequency oscillator tube (VT-25) is next to panel 345. Then in order come the amplifier (VT-25), the modulator (VT-52), and the audio-oscillator (VT-25). On the other side of the partition is a shelf constructed about half-way between the top and bottom. On this shelf are mounted the condensers 93, 94, 95, and the transformers 100, 101. Beneath the shelf are mounted the

ammeter 102 and various small resistors and condensers. The location and arrangement of parts can be well ascertained from a study of figures 4 and 5.

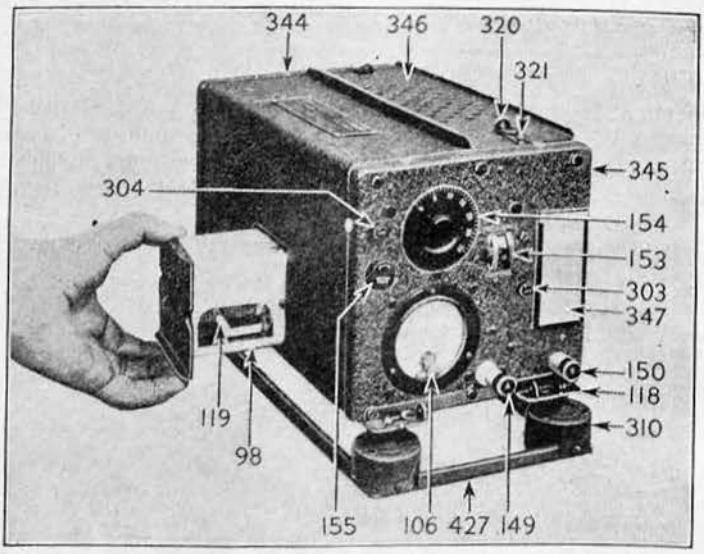



FIGURE 3.—Radio transmitter, type BC-AA-180, including mounting, type FT-100.

NOTE.—The various parts in this figure and in others to follow are referred to by numbers. This means of identification will be adhered to throughout so that any given part bears the same number in all figures and diagrams. For meanings of reference numbers see paragraph 16.

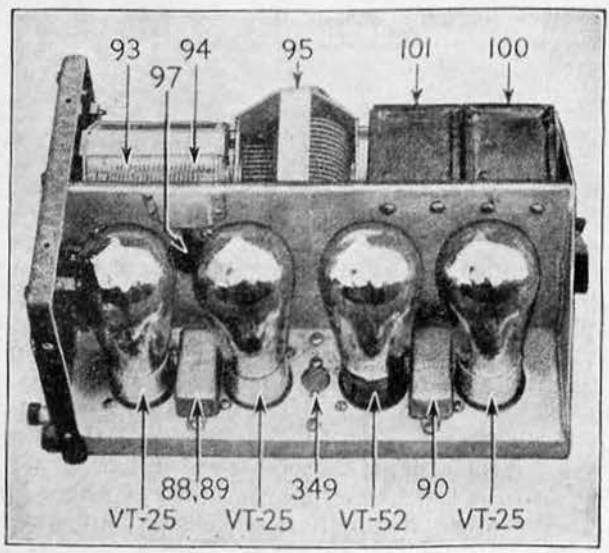



FIGURE 4.—Radio transmitter, type BC-AA-180, side view.

*b. Radio receiver, type BC-AA-179.*—The receiver is very similar in construction to the radio transmitter, type BC-AA-180. A picture of the receiver with its mounting, type FT-99, and one plug-in coil set is shown in figure 6. The weight and dimensions of the receiving set are shown in figure 18. Internal

views of the receiver are shown in figures 7 and 8. One end of the receiver case is blank while the other end is open. It also has an opening in one side for the

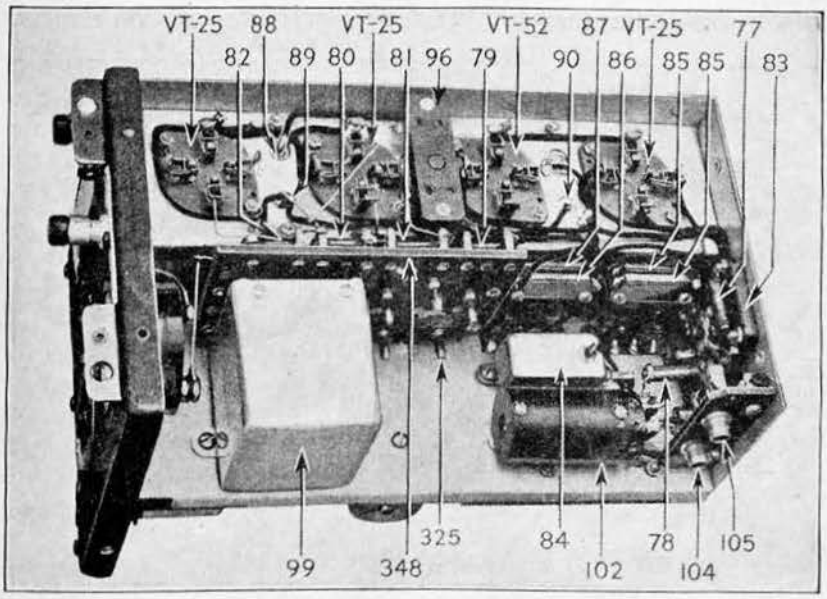



FIGURE 5.—Radio transmitter, type BC-AA-180, bottom view.

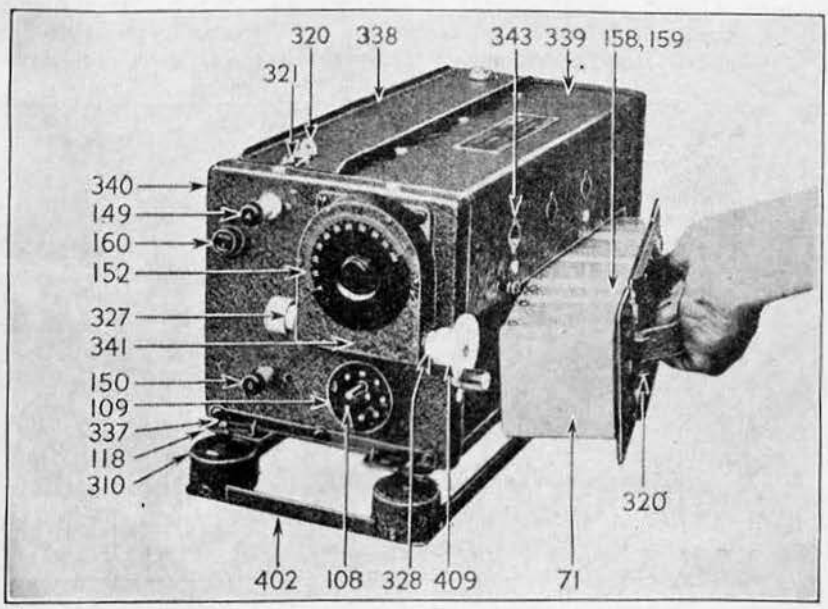



FIGURE 6.—Radio receiver, type BC-AA-179, coil set, type C-102, mounting, type FT-99, and tuning unit, type MC-127.

coil set and a second opening in the top closed by the tube cover 338, which allows access to the tubes. The open end of the case is covered by the metal panel 340

on which the antenna and ground binding posts 149, 150, and the series antenna condenser knob 160 are mounted, together with the tuning gear unit 341, carrying dial 152, and the power plug receptacle 108. The receiver chassis is permanently attached to the front panel 340. The case and front panel form a complete

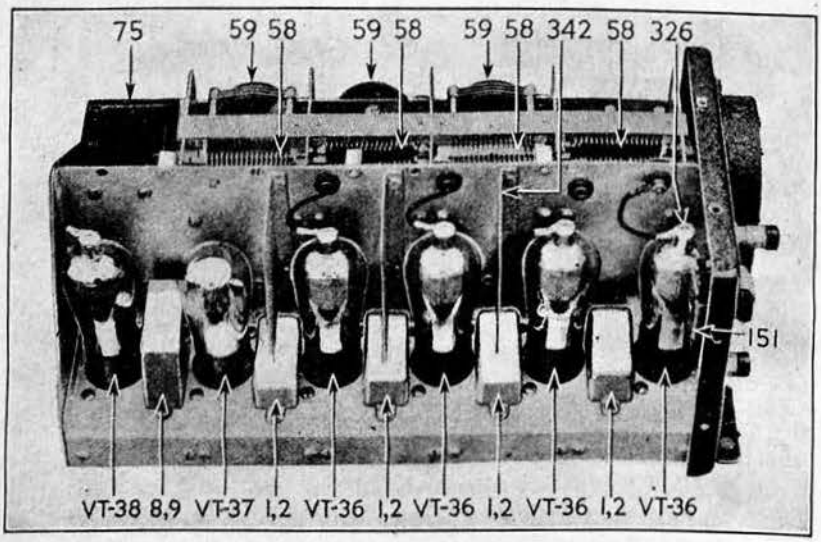



FIGURE 7.—Radio receiver, type BC-AA-179, side view.

shielded receptacle for the receiver. The chassis can be removed from the case by removing the 7 bright-headed screws around the edge of panel 340, also the 3 beside the tube cover, and 2 beside the coil set. It is necessary to

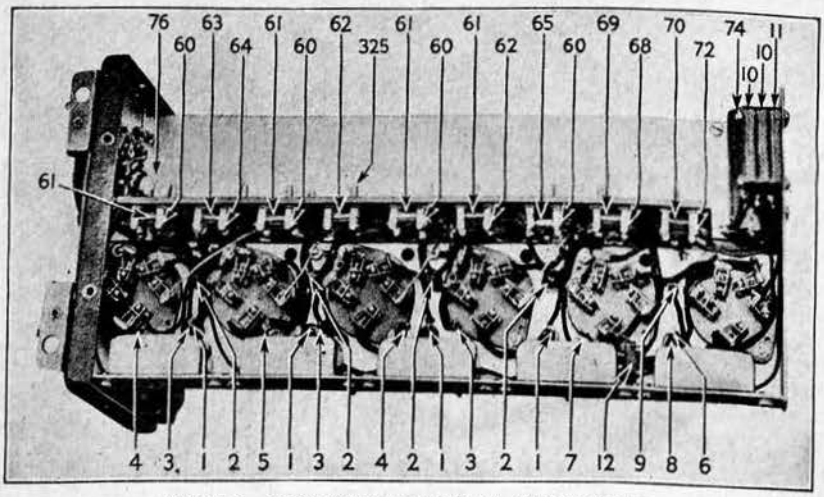



FIGURE 8.—Radio receiver, type BC-AA-179, bottom view.

remove the coil set before the chassis can be removed from the case. The 6 tubes are arranged in a row on one side of the vertical partition. Four of these are type VT-36 tubes used as radio-frequency amplifiers, 1 VT-37 used as detector, and 1 VT-38 as an audio-frequency amplifier. The tube compart-

ment is divided into cells by the tube shields 342 which serve to reduce the capacity coupling between the tuned stages of the radio-frequency amplifier. By-pass condensers 1, 2, 8, 9 are mounted between the tube bases. Mounted on the shelf on the other side of the vertical partition are the tuning condensers 58, the alining condensers 59, and the output transformer 75. The plug-in coil set

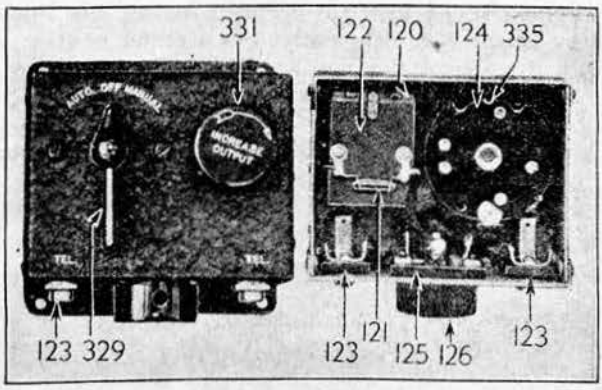



FIGURE 9.—Radio control box, type BC-AA-181.

occupies most of the space below the shelf, while various small condensers and resistors are secured below the tube sockets. The exact location of the various components can be determined from a study of figures 7 and 8.

*c. Radio control box, type BC-AA-181.*—This control box is a part of both radio set, type SCR-AA-183, and radio set, type SCR-AA-192. It is a small

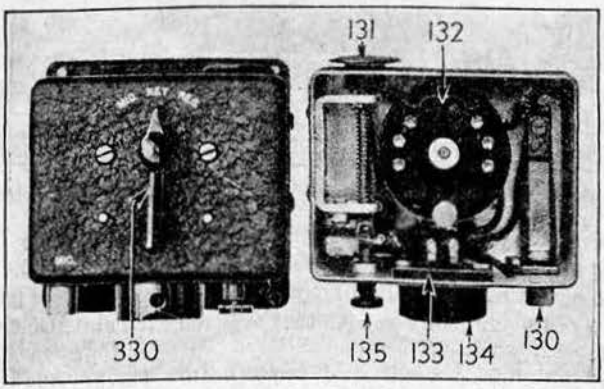



FIGURE 10.—Radio control box, type BC-AA-182.

unit carrying a switch, control resistors, and telephone receiver jacks. It is designed for remote control of the electrical power and amplification circuits of the receiver. Figure 9 shows a front view and also a rear view with the cover removed. Its dimensions and weight are given in figure 18. This control box carries two manually-operated controls: The switch 124 operated by handle 329 and the volume control 122, 120, operated by knob 331. The switch has a center position, OFF, a side position, MANUAL, and a second side position, AUTO. Both side positions are operating positions. A plug receptacle 126 is located on the bottom between the 2 telephone jacks 123.

*d. Radio-control box, type BC-AA-182.*—This control box is a part of the radio set, type SCR-AA-183, only. It is identified with the control of radio transmitter, type BC-AA-180. It carries a selector switch, a telegraph key, and a microphone jack. Figure 10 shows a front view and also a rear view with the cover removed.

Its dimensions and weight are given in figure 18. This control box carries, besides the telegraph key, 1 manually-operated control, the 3-position switch 132, operated by handle 330. The switch has a center position KEY, a side position MIC, and a second side position REC. The plug receptacle 134 is located in the bottom of the control box between the microphone jack 130 and the telegraph key adjusting screw 135. This adjusting screw regulates the spacing between key contacts. The key 131 can be locked shut by means of this screw for test purposes.

*e. Junction box, type TM-AA-153.*—This unit is the central interconnecting element for all circuits of the radio set, type SCR-AA-183, or radio set, type

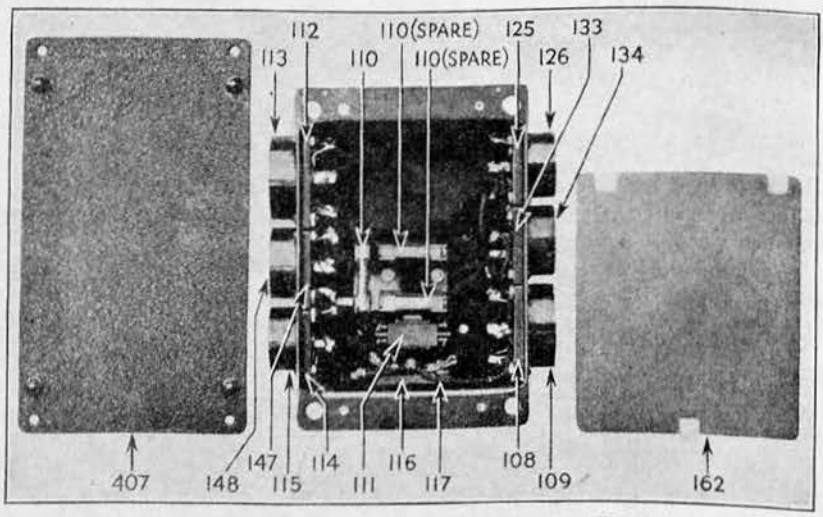



FIGURE 11.—Junction box, type TM-AA-153, and mounting, type FT-101, bottom view.

SCR-AA-192. It comprises an assembly of receptacles for the plugs of the several cords, a fuse block, and a toggle switch, all mounted in a housing which is attached to mounting, type FT-101, by means of snap slides. Figure 11 shows a bottom view of the junction box with the cover removed and also the mounting, type FT-101.

The weight and dimensions are given in figure 18. The housing cover 162 is a metal plate or cover which is attached to the junction box by means of three screws to form a protecting closure for the wiring. There are 3 receptacles on each side and 1 on the end of the junction box. These receptacles are all labeled according to the plug which each takes. When the junction box is used as a part of radio set, type SCR-AA-192, only 4 of these 7 receptacles are used. These are the ones that are labeled as follows: PL-60, PL-61, PL-62, and PL-65. When used as part of the radio set, type SCR-AA-183, all six of the receptacles on the sides of the junction box are in use. The seventh receptacle labeled PL-56 is located in the bottom of the junction box and furnishes connection to an oscillator, type RC-12, which was referred to in paragraph 1 *a*, but which is not a part of either radio set.

The fuse 110 is a 20-ampere cartridge fuse, type FU-11. It is placed in series with the positive side of the voltage supply. Two spare fuses are also mounted in clips inside the case. The switch 111 is a toggle switch having two positions, TRANS-REC and REC ONLY. In radio set, type SCR-AA-183, this switch is kept permanently in the TRANS-REC position. In radio set, type SCR-AA-192, it is kept permanently in the REC ONLY position.

*f. Dynamotor units, types BD-AA-69 and BD-AB-69.*—These units each consist of a dynamotor mounted on a box containing a filter circuit and a voltage divider. The box is the same for both types of dynamotor units. Both types have essentially the same electrical rating and are designed to be interchangeable as regards their use with either the radio set, type SCR-AA-183, or radio set, type SCR-AA-192. They are distinguished by the fact that type BD-AA-69 is fitted with dynamotor 145 (Westinghouse ADS34-A) and type BD-AB-69 is fitted with dynamotor 146 (Eclipse AD-2M-2749-C). A photograph of dynamotor unit, type BD-AA-69, is shown in figure 1 and an interior view of the box of both dynamotor units is shown in figure 12. Clearance dimensions and the weight of either unit are shown in figure 18. The dynamotors are of the totally

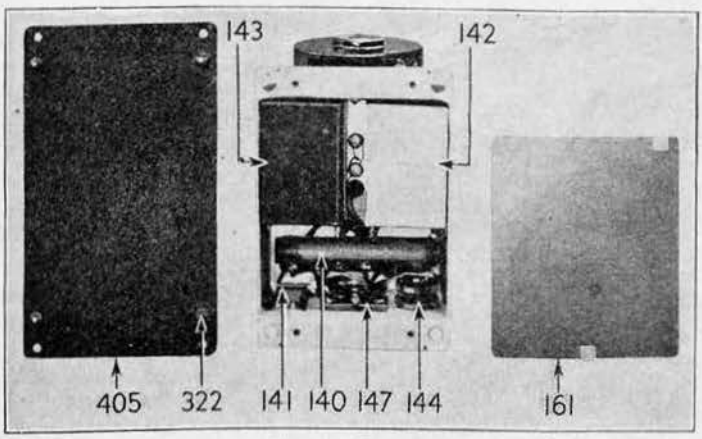



FIGURE 12.—Dynamotor unit, type BD-AA-69, and mounting, type FT-102, bottom view.

enclosed types, each having a low-voltage commutator and brushes at one end and a high-voltage commutator and brushes at the other end. Four leads pass from the machine into the box, 2 serving as low-voltage input leads to the machine and 2 as high-voltage output leads from the machine. The power-plug receptacle is located on one end of the box. Mounting, type FT-102 (405), is a base plate having studs 322 to which the remainder of the dynamotor unit is attached by means of snap slides. The interior of the unit is protected when it is not attached to the mounting by a box cover 161, which is screwed to the filter box at three points.

*g. Coil sets, types C-97, C-98, C-99, C-100, C-101, and C-102.*—Each coil set consists of an assembly of four shielded plug-in radio-frequency transformers 71, and a shielded band-pass coil assembly 158, 159. Each coil is identified by a certain frequency range (shown on each coil set handle) which is the range throughout which the receiver can be continuously tuned when that coil set is in the receiver. This tuning is accomplished by rotating the tuning condenser between its maximum and minimum positions indicated respectively by end points 0 and 100 on the tuning dial 152. Figure 13 shows a view of a coil set

and a case, type CS-44. The frequency bands of the various coil sets are as follows:

| Coil set, type | Frequency band | Coil set, type | Frequency band |
|---|---|---|---|
| | *Kilocycles* | | *Kilocycles* |
| C-97 | 224- 448 | C-100 | 1, 400-2, 600 |
| C-98 | 400- 800 | C-101 | 2, 500-4, 700 |
| C-99 | 775-1, 500 | C-102 | 4, 150-7, 850 |

Increasing numbers on the dial 152 correspond to increasing frequency on any coil set. Increments in frequency in any band are approximately proportional to increments in dial setting. A calibration chart showing received frequency plotted against dial setting for each coil set of a typical receiver is shown in figure 14. In addition a chart, type MC-128, showing the frequency of each coil set for every 10 points on the dial is fastened to the tube cover on each receiver and a second is furnished with each set to be mounted in some conspicuous place in the airplane. This chart is intended merely as a general guide in locating a transmitting station on the dial; however, the error of calibration does not exceed 2 percent for any coil set in any receiver. Coil sets of all types are plugged into the side of the receiver as shown in figure 6 and secured by snap slides 320 at four points. All six of the coil sets are a part of the radio set, type SCR-AA-192, but only the two sets, types C-97 and C-102, are a part of the radio set, type SCR-AA-183.

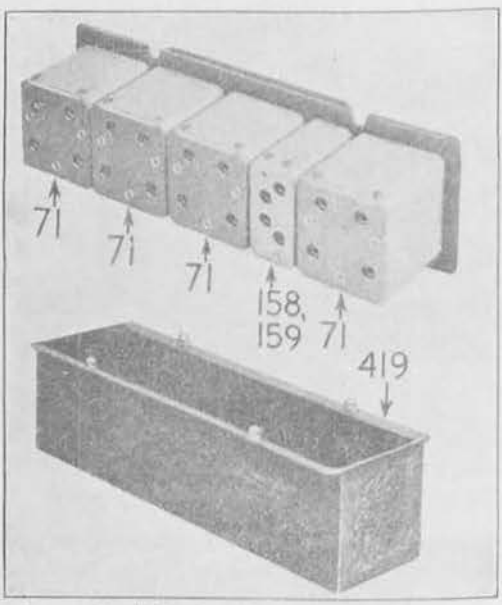



FIGURE 13.—Coil set, type C-101, and case, type CS-44.

*h. Cords, types CD-110, CD-111, CD-112, CD-113, CD-114, and CD-115.*—The cords included in these radio sets each consist of a length of shielded cordage terminated at one or both ends by a plug. These cords are of various lengths depending on the type of airplane for which they are intended. (See par. 15.) The function of the cords is to connect each electrical unit of the equipment to the junction box. The cords are shown in figure 1 and their description and use are given in the table below:

| Cord, type | Made of cordage, type | Number of conductors | Fitted with plugs, type | Use |
|---|---|---|---|---|
| CD-110 | CO-121 | 2 | PL-60 (1) | Junction box to 12-14.25-volt source. |
| CD-111 | CO-120 | 8 | PL-61 (2) | Junction box to receiver. |
| CD-112 | CO-120 | 8 | PL-62 (2) | Junction box to dynamotor. |
| CD-113 | CO-120 | 8 | PL-63 (2) | Junction box to control box, type BC-AA-182. |
| CD-114 | CO-120 | 8 | PL-64 (2) | Junction box to transmitter. |
| CD-115 | CO-120 | 8 | PL-65 (2) | Junction box to control box, type BC-AA-181. |

All six of the cords described above are part of the radio set, type SCR-AA-183. However, only cords, types CD-110, CD-111, CD-112, and CD-115, are part of the radio set, type SCR-AA-192. As was stated previously oscillator equipment, type RC-12, can be used with either radio set for the reception of continuous-wave signals. If this oscillator equipment is used it should be connected to the bottom receptacle of the junction box by means of the cord, type CD-122, which is a part of the oscillator equipment. However, the oscillator equipment is not a part of either radio set.

*i. Tuning shaft, type MC-124, and tuning units, types MC-125 and MC-127.*—Tuning unit, type MC-125, is designed for the remote tuning of radio receiver, type BC-AA-179. It is shown in figure 15. It comprises a housing enclosing a gear train, an exposed crank 302, a dial 300 graduated 0 to 100 divisions, and an adjustable pointer 301. Rotation of the crank rotates the dial under the fiducial mark of the pointer, and also rotates the coupling spline 332. Tuning shaft, type MC-124 (shown in fig. 1), consists of a laterally flexible steel shaft enclosed in a hose-type metal housing and terminates at each end in an internally splined collar. This collar of the tuning shaft engages the externally splined shaft 332, inside of the threaded outlet 333 of the tuning unit when the coupling nut on the end of the shaft housing is screwed on this outlet. A similar collar on the opposite end of the shaft engages a splined shaft which is geared to the tuning condenser shaft and dial of the radio receiver when the coupling nut on this end of the shaft housing is screwed on outlet 328 of the receiver. A second outlet 327 provides access to the opposite end of the splined shaft. The motion of the crank on the tuning unit is transmitted to the gang tuning condenser shaft of the receiver successively through the gears of the tuning unit, the tuning shaft, and the gear train between the receiver spline-shaft and the condenser shaft. The several gears are so related that dial 300 on the tuning unit makes one complete excursion between 0 and 100 divisions as dial 152 on the radio receiver rotates between 0 and 100 divisions. In figure 6, outlet 327 of the receiver is shown closed by a cap nut 334, and outlet 328 is shown closed by tuning unit, type MC-127.

Tuning unit, type MC-127, shown as 409 in figure 15, is used solely for local tuning of the receiver. It consists of an external spline 336 housed in a threaded bearing support which may be screwed on receiver tuning outlet 328. The spline is rotated manually by a small disk and crank which form a part of the unit.

*j. Antennas.*—The radio set, type SCR-AA-183, requires separate transmitting and receiving antennas. These two antennas form a complementary system, and theoretically a sacrifice in electrical efficiency of one will harm the system just as much as a sacrifice in the other. But it is a fact of considerable practical importance that the reduction of the transmitting antenna below a certain mini-

mum of size and efficiency will render the transmitter practically inoperative on account of the unavoidable physical limitations inherent in the antenna coupling

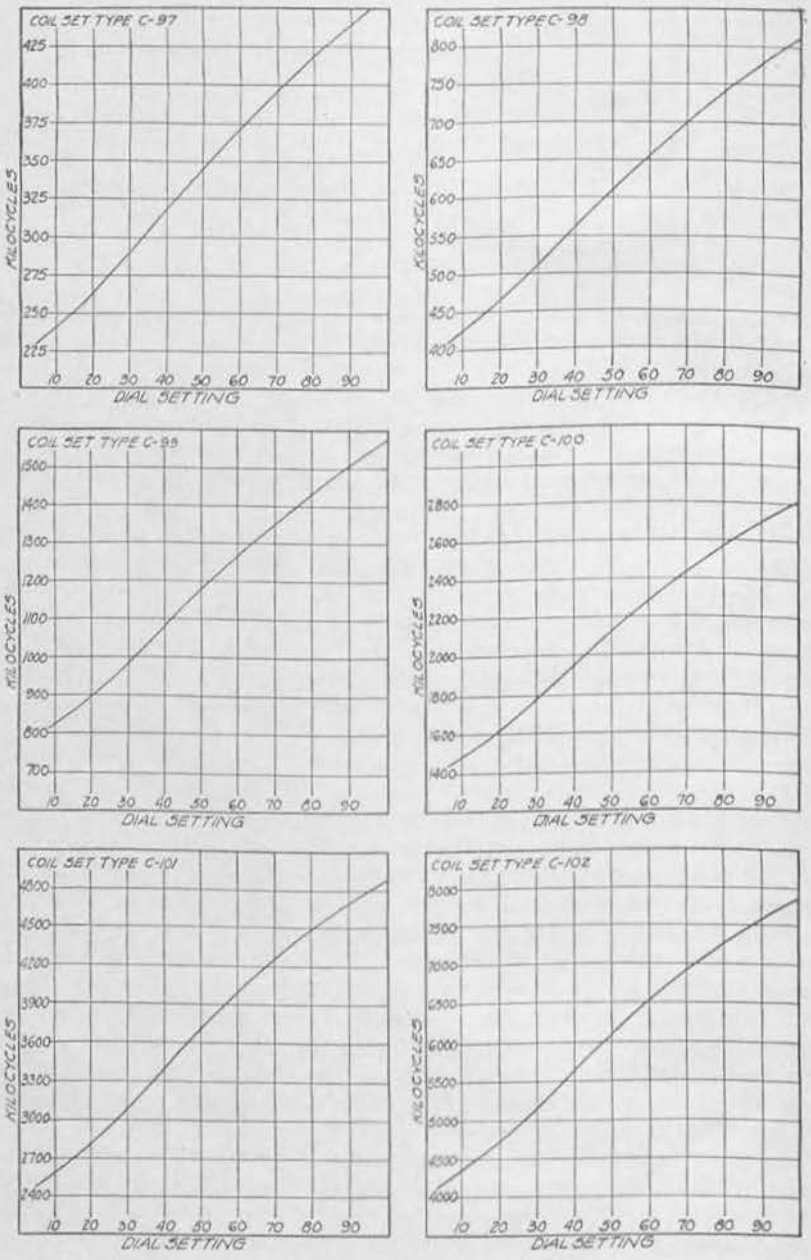



FIGURE 14.—Frequency calibration, radio receiver, type BC-AA-179.

of this unit to its antenna. The transmitter must always be used with an antenna at least large enough to draw from the set enough current to deflect the antenna

current ammeter, since this deflection is the only direct evidence available to the operator as to the activity of his own transmitter. The transmitting antenna should have the following three characteristics:

(1) It should have sufficiently high capacity at the operating frequency, in the portion spaced away from the airplane, so that the greater part of the radio energy goes out into the spaced part and is not dissipated internally in the coupling circuit or fuselage.

(2) The antenna resistance should be due largely to radiation and not to conductor or dielectric losses.

(3) The directions of minimum radiation should be at angles from the airplane which will coincide with the direction of the receiving airplane only in the least probable attitudes of flight.

The radio transmitter, type BC-AA-180, in combination with an antenna operates with the greatest over-all efficiency as a generator and radiator of radio waves if the antenna has a capacity of from 90 to 150 micromicrofarads and a resistance of from 5 to 10 ohms within the operating frequency range. Of this resistance not more than 3 ohms should be dielectric or loss resistance. Figure 16 shows a diagram of a transmitting antenna which is suitable structurally for a

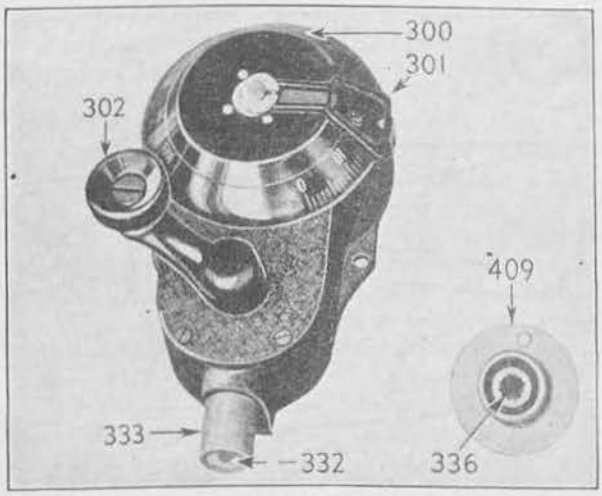



FIGURE 15.—Tuning units, types MC-125 and MC-127.

single-seat pursuit type biplane; this antenna is an efficient radiator, and the directivity, while by no means ideally small, is such that the zones of minimum radiation are relatively narrow and widely spaced. It consists of a flat top section AB, which should be between 16 and 18 feet long, suspended between a fitting on the wing tip and a stub mast mounted on the tail. The higher this stub mast, the better the antenna; a height of 15 inches is not impractical for this type of airplane. The down lead CD slants into a lead-in insulator D mounted near the base of the fuselage at a point just over the step on the lower wing. Point C where the down lead joins the top section should be at least 2 feet back of the aileron, making CD 8 to 9 feet long. BC is at least 7 feet long, and while the location of this point is not critical, it must neither be close to the aileron and flying wires nor far enough aft to make an angle of more than 20° with the vertical in level flight.

The receiver antenna consists of top section FL, not more than 11 feet long with down lead LG about 7 feet long. This antenna is also shown in figure 16. The lead LA is a stay wire, insulated from both antennas. LA should not be less than 5 feet long in order to space the receiving antenna as far as possible from the transmitting antenna. If possible, LA should be broken at two points by strain

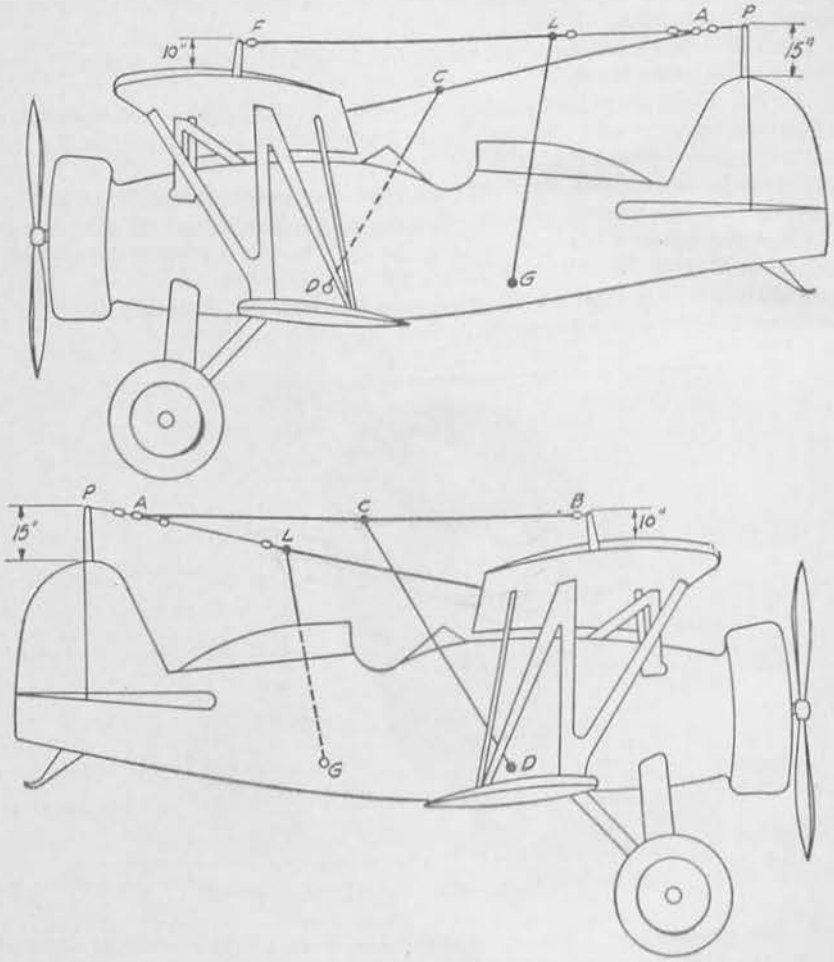



FIGURE 16.—Antennas for radio set, type SCR-AA-183.

Transmitting antenna consists of flat top ACB and down lead CD. Receiving antenna consists of flat top FL and down lead LG.

AB=17 feet. AL=stay not connected in circuit.
CD= 9 feet. AP= shock cord.
FL=11 feet. Strain insulators at B, A, L, F.
LG= 7 feet. Lead-in insulators at D, G.

insulators to reduce coupling between the two antennas. For the radio set, type SCR-AA-192, a 5-foot vertical mast mounted in the fuselage of the airplane forms a suitable antenna, provided that the lead to the receiver inside the fuselage is not too long. Also this type of antenna should be located not less than 2 feet away from the base of the vertical fin, if installed back of the cockpit. This mast antenna is probably the best type to use with the radio set, type SCR-AA-192,

when the receiver is to be used for the reception of weather broadcasts and radio-beacon signals. On high-speed airplanes a single wire slanting from a lead-in insulator in the head rest fairing up to a stub mast on top of the rudder is sometimes used. This antenna is fairly effective if broken by a strain insulator from 6 to 10 inches ahead of the stub mast, but is not a particularly good antenna unless this stub mast extends at least 12 inches above the top of the rudder. A flat-top antenna consisting of a top section strung between the wing tip and rudder with a down lead connected to this top section at a point well ahead of the rudder is an effective receiving antenna for all biplanes and high-wing monoplanes.

4. **Installing the sets.**—*a. General.*—The receiver of a radio set, type SCR-AA-183 or type SCR-AA-192, is the same general type of equipment as radio receiver, type BC-SA-167, and the same general considerations apply to the installations. The airplane must be shielded, bonded, and metalized if satisfactory results are to be obtained. The specifications and requirements for shielding and bonding set forth in Air Corps Technical Orders are adequate for airplanes in which radio sets, type SCR-AA-183 or SCR-AA-192, are to be used. It must be realized that the interference produced by the radiation of electrical disturbances from the engine ignition system, charging generator, unbonded contacting metal surfaces, etc., with signal reception, bears no direct relation to the sensitivity of radio receivers. The relative magnitude of such disturbances at the receiving antenna in comparison with the incoming radio wave field is the factor of prime importance. If the radio field intensity is equal to or greater than the local electrical noise level, reception will be possible with any radio receiver sensitive enough to operate on that radio field. The more sensitive the radio receiver, the weaker the radio signal which it will receive, but only so long as the local noise or interference level is less than the incoming radio waves can the signal be heard. Frequently a highly sensitive radio receiver is considered to be noisy when the airplane is in flight simply because it will receive both radio signals and local disturbances which are weaker than those receivable on a relatively insensitive receiver. The high sensitivity of radio receiver, type BC-AA-179, is no handicap to its performing as well as less sensitive types under conditions of bad static or local disturbances, since a continuous control of the sensitivity is provided by the volume control knob on the radio control box, type BC-AA-181. The proper criterion of a complete job of bonding and shielding is that with the airplane in flight (or with the engine running on the ground) in clear cold weather where static is negligible, no sound will be audible in the telephone receivers except radio signals, when the receiver volume control is set at maximum. If the airplane is maintained in this condition, extremely long-distance ranges of reception will be obtained with this equipment.

Radio set, type SCR-AA-183, is intended primarily for the transmission and reception of commands within an assembly of airplanes and will in most cases be operated by the airplane pilot. In large airplanes this radio set will usually be carried in addition to equipment of higher power operated by an observer or navigator. The problems of installation and arrangement are therefore chiefly centered about the rigid requirements which are associated with pilot operation. The proper interconnections of the units of this radio set by means of the various cords are shown in figure 17.

*b. Radio transmitter, type BC-AA-180.*—Mounting, type FT-100, should be mounted at the chosen location in the airplane and the transmitter attached to it by means of the snap slides. The transmitter must be located so that it can be easily tuned and is accessible for changing tubes. It should be remembered that coil assembly 98 must be removed from the set box in order to change the

position of arm of the antenna tap 119. The transmitter must be so located that the transmitting antenna lead-in will be short. This is absolutely necessary for efficient operation. All cords and conductors attached to the transmitter must have sufficient slack to allow the transmitter to move freely on its mounting. If this precaution is not taken, vibration in the airplane will be imparted to the transmitter. The ground binding post should be connected to the fuselage by the shortest lead possible (leaving proper slack) using a good soldered joint. In a pursuit type airplane, it can be conveniently mounted in front of the pilot between the rudder pedals as shown in figure 19. Figure 20 shows the transmitter located in the front cockpit with the mounting bracket 118 reversed for pilot operation in an observation type airplane. While this installation may not be ideal, due to the very limited space available, it will be noted that the transmitter is conveniently located for tuning and that the antenna lead-in is extremely short.

*c. Radio receiver, type BC-AA-179.*—Mounting, type FT-99, should be mounted at the chosen location in the airplane and the receiver attached to it by means of the snap slides. Each snap slide stud is provided with a transverse hole at a point which is above the snap slide when the latter is engaged. After the snap slides have been closed, safety wires should be passed through these holes and through the holes in the ends of the slides. These wires should not be twisted too tightly. The other units of equipment, such as the transmitter, junction box, and dynamotor, should also be safety-wired to their respective mountings.

The choice of location for the receiver and mounting in an airplane is governed by several factors:

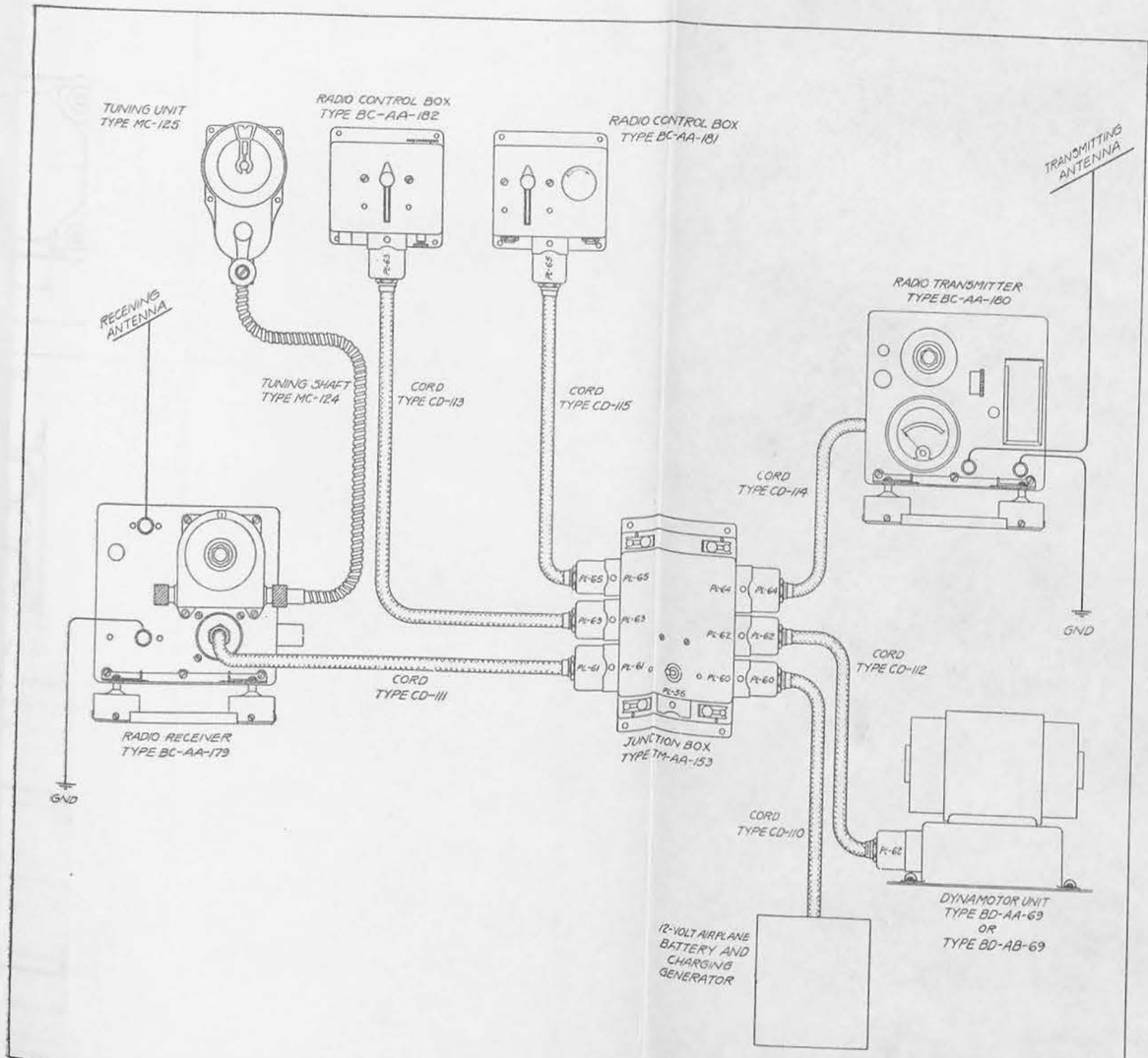
(1) Accessibility for coil set and tube replacements.

(2) Proximity to a suitable location for the receiving antenna lead-in.

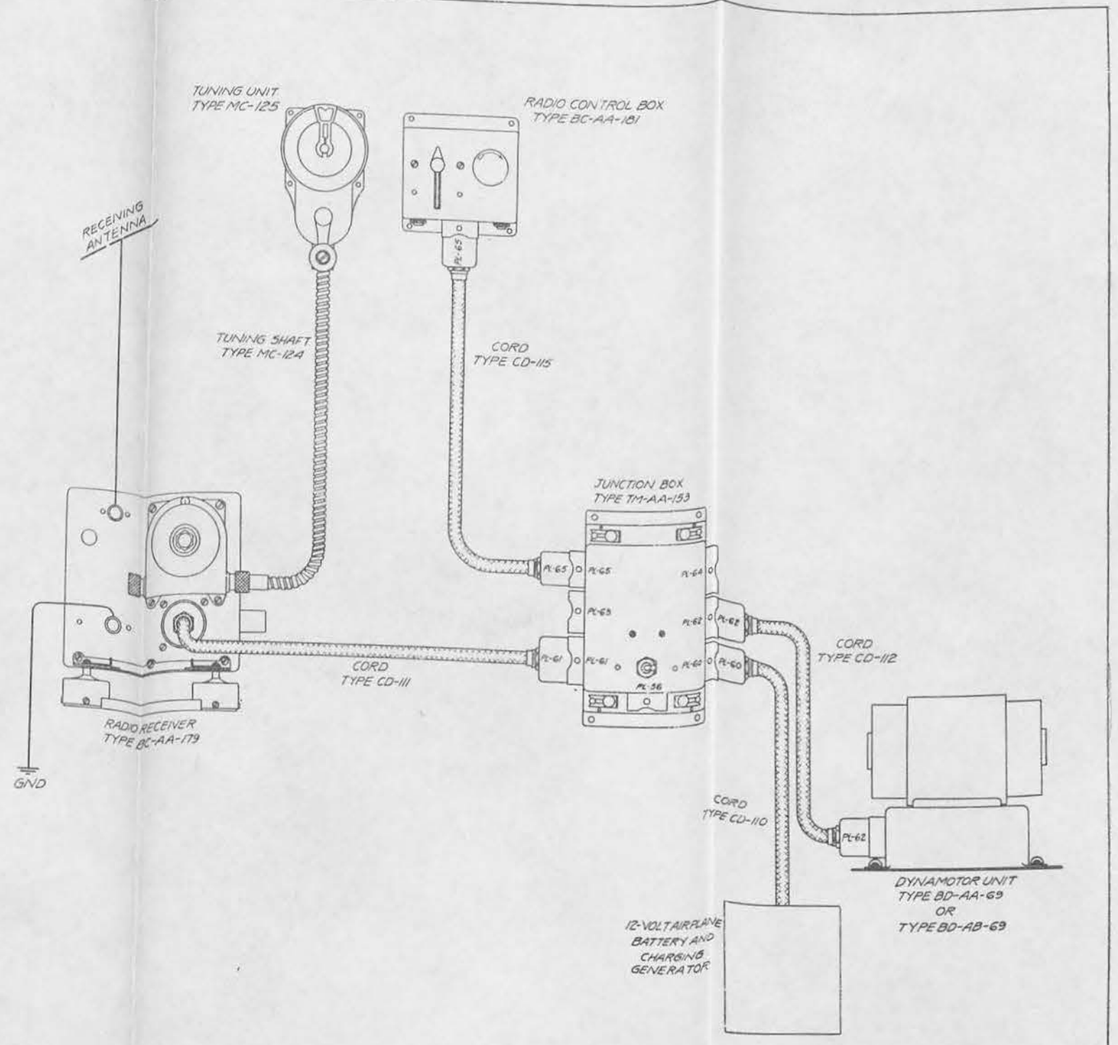
(3) Avoidance of sharp bends in the tuning shaft and cables.

Item (1) is of vital importance if coil sets are to be changed in flight. Item (2) is particularly important when the equipment is to be used in the high-frequency band. To item (3) must be added the caution to provide sufficient slack in every cord, shaft, and conductor attached to the receiver so that the receiver is free to move in every direction with respect to its mounting. The ground binding post should be connected by a slack wire to the nearest metal member of the fuselage. In a pursuit-type airplane the receiver can usually be located back of the pilot's seat. In other type airplanes, such as attack, observation, and training, the receiver can be placed back of the observer's seat, on a shelf in front of the observer, or at times under his seat. Extra coil sets must be so located that they are easily accessible for use in the receiver. Figure 21 shows the receiver located just in rear of the baggage compartment in an observation type airplane.

*d. Radio control box, type BC-AA-181; radio control box, type BC-AA-182, and tuning unit, type MC-125.*—All three of these units are used to control the transmitter and receiver from a distance. All should be mounted inside the cockpit within easy reach of the pilot. They have no shock proofing and may be screwed directly to the cowling or to a panel inside the cockpit. In most cases, radio control box, type BC-AA-182, must be located with greatest regard to accessibility by the pilot, since the throw-over switch from "transmit" to "receive" is done with the switch on this unit. It also carries the telegraph key. If voice communication is to be used, it may be most convenient to mount the two control boxes side by side near the throttle to permit a minimum shifting of the hands on the part of the pilot between the airplane controls and the radio




① Cording diagram for radio set, type SCR-AA-183.




② Cording diagram for radio set, type SCR-AA-192.

FIGURE 17.—(Weights, installation dimensions, and clearances are shown in fig. 18.)

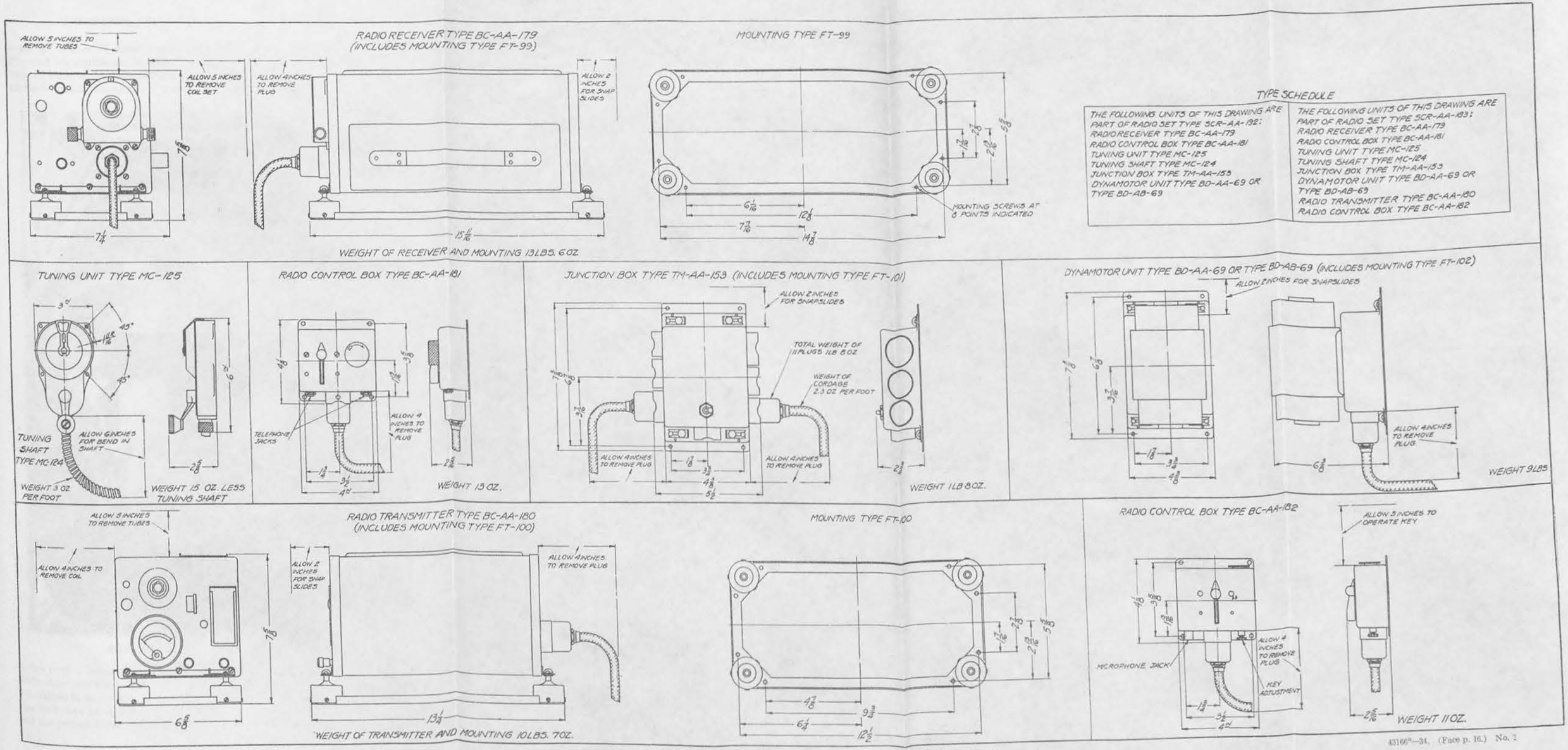



FIGURE 18.—Installation dimensions of units used in radio sets, types SCR-AA-192 and SCR-AA-183.

controls. Figure 22 shows such an arrangement. Brief acknowledgments or precoded key signals can be sent with the left hand. Some pilots may desire to have all three of the units mounted on the right side as shown in figure 20. It is probable that in the course of a series of communications, the pilot must reach

FIGURE 19.—Location of transmitter in pursuit airplane.

to the control boxes oftener than to the tuning unit, so their location should have preference over the tuning unit location. The pointer 301 of the tuning unit is adjustable to any one of seven positions around the housing of the unit, so that this unit may be mounted in practically any position with respect to the pilot, and the pointer located so that its fiducial mark is clearly visible.

In some cases it may be that the radio set will be installed in larger airplanes where the receiver can be tuned directly by an observer or navigator. In such cases tuning unit, type MC–127, would be used and the remote tuning unit, type MC–125, with its shaft will not be needed.

*e. Junction box, type TM–AA–153.*—The mounting, type FT–101, should be secured to the airplane and the junction box attached to it by means of the snap slides. While the junction box can be removed at any time from the airplane by detaching all the cords which go into it, it is desirable that it be sufficiently accessible and that enough slack be left in the cords adjacent to it so that it may be unsnapped from its mounting and inverted while the radio set is operating, in order to check the voltages on the various circuits. When locating the junction box with respect to the other units it should be borne in mind that cords, types CD–112 and CD–115, both carry the dynamotor supply current, and should be

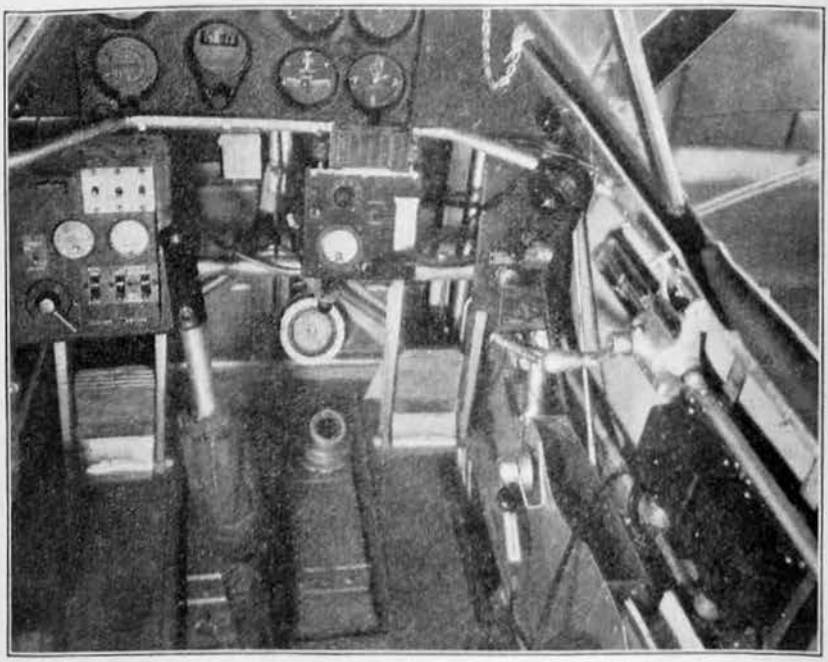


FIGURE 20.—Location of transmitter in observation airplane.

kept as short as possible. The junction box must be so located as to minimize the possibility of external short circuits between contacts in the open receptacles. The junction box may be mounted on the fire wall or in front of the observer in a two-seater type airplane. Figure 23 shows the junction box located on the side of the rear cockpit in an observation type airplane. Figure 24 shows the junction box mounted in the fuselage just above the lower wing of a pursuit airplane.

*f. Dynamotor, type BD–AA–69 or type BD–AB–69.*—The location of the dynamotor is a matter of comparative indifference insofar as the operation of this unit itself is concerned, but it is not advisable to mount it close to the antenna lead-in. As with several of the other units, the dynamotor is attached by means of snap slides to its mounting, which is fastened to the airplane. The dynamotor may be mounted on the cockpit floor or on a shelf inside the engine cowling, as shown in figure 25. In several types of airplanes arrangements are made by the manufacturer for mounting a dynamotor under the motor cowling.

*g. Cords, types CD–110, CD–111, CD–112, CD–113, CD–114, and CD–115, and tubing shaft, type MC–124.*—All cords which interconnect the various units are normally lashed or clamped to structural members of the airplane along their length. There is one very important point to be observed in the installation of these cords. They are armored with metal braid and their outer surface will produce electrical noises in the radio receiver, unless they are carefully bonded to metal airplane members wherever they are likely to touch or rub thereon. Perhaps the best way to overcome this difficulty is to solder "pigtails" made of small pieces of metal braid at intervals of 12 inches along each cord. The entire cable is then carefully wrapped with a layer of rubber tape, allowing the "pigtails" to protrude. The tape is then given a coating of shellac. Figure 26 shows a cord assembly with "pigtails" attached. In installing the cords, they can be bonded every 12 inches to metal members of the airplane. In case a metal member is not close to any one "pigtail", this one can be cut off next to the cord.

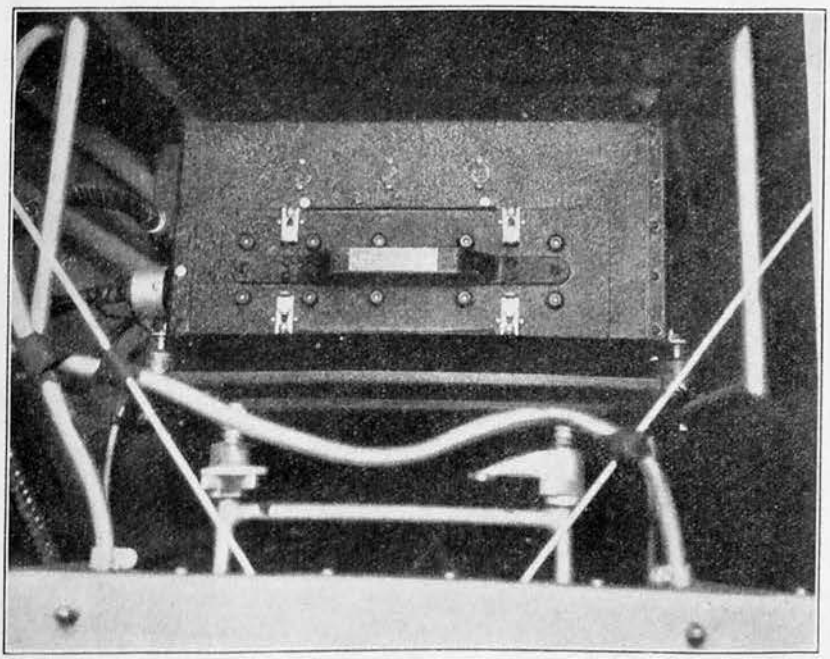


FIGURE 21.—Location of receiver in observation airplane.

It is very probable that at least every other "pigtail" will fall close to a metal member so each cord can be bonded at least every 24 inches, fulfilling Air Corps Technical Regulations. The entire cord assembly can be prepared in this manner before the installation of the equipment in the airplane. Cord, type CD–110, must be connected directly to the battery in order to minimize receiver noises.

The tuning shaft may be bent but no bends should be made having a radius of less than 6 inches. The shafting must be firmly supported at frequent intervals along its length except at points close to the receiver. If these precautions are not observed it will be difficult to tune the receiver accurately. When properly installed, even with lengths of 20 feet or more of tuning shaft, both dials will rotate smoothly as the tuning unit crank is turned, and the receiver dial may be set to coincide with the tuning unit dial without appreciable backlash. When

the tuning shaft is attached to the radio receiver and the tuning unit, the reading of dial 300 on the tuning unit must be made to coincide with the reading of dial 152 on the receiver. This is done by rotating either one of the dials separately before the final coupling is made.

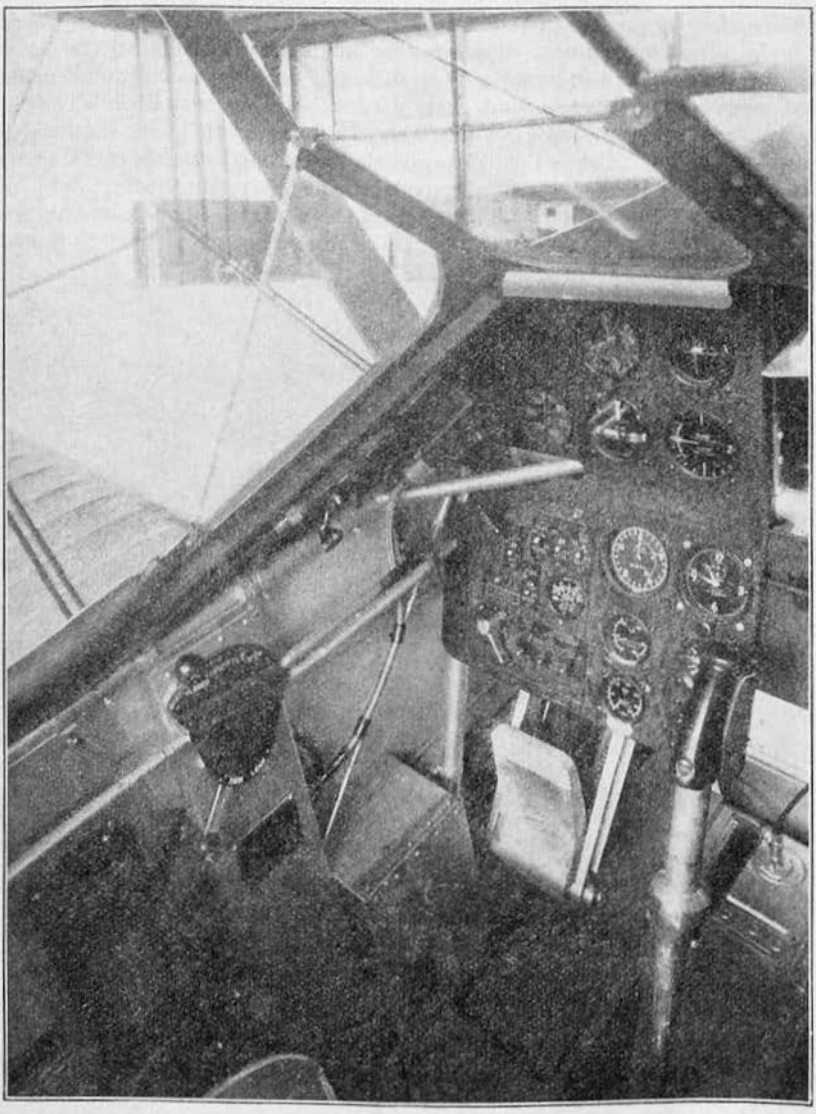


FIGURE 22.—Antenna installation on observation airplane. Location of controls near throttle.

NOTE.—Little mention has been made in the preceding paragraphs concerning the location of the various units of these radio sets in large airplanes such as bombers, transports, etc. This is not necessary as ordinarily no difficulties in locating these units are encountered due to the fact that plenty of space is available. Figures 27 and 28 show other locations for various parts of the sets in observation and pursuit airplanes.

*h. Antennas.*—(1) *Transmitting.*—The transmitting antenna should be constructed of wire, type W-106, or its equivalent. The dimensions of the antenna

are given in figure 16. The strain insulators at A and B should be of glass or isolantite. Phenolic insulators such as bakelite should not be used if it can be avoided. The apex of the antenna A should be suspended from point P by an elastic cord such as a shock cord. The lead inside the fuselage to the transmitter antenna binding post must be short and must be either bare or insulated with high quality insulation regardless of the location of the transmitter. The lead-in must not be run around inside the fuselage. The ideal form for this lead is a conductor of no. 16 or no. 18 bare wire, insulated by beads of glass or porcelain. (Isolantite, type 1084, beads are suitable for this purpose.) Ignition cable should not be used. Wherever space is available this lead should be supported by glass or porcelain stand-off insulators. The portion adjacent to the transmitter should not be taut. These precautions which would not be vital at intermediate frequencies are extremely important at the frequencies on which the transmitter

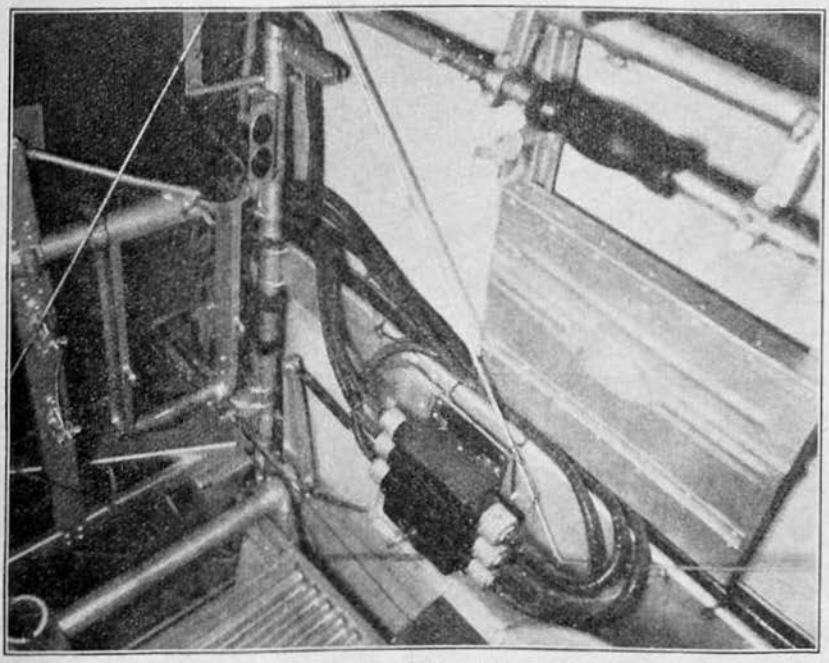


FIGURE 23.—Location of junction box in observation airplane.

operates. Figure 29 shows a picture of the transmitting antenna installed on an observation-type airplane. In arranging new transmitting antennas, the fact must be borne in mind that the length of wire is not a criterion of efficiency. Even when the antenna extends wholly away from the airplane (as in a trailing antenna) a total length greater than about 25 feet will not operate efficiently with this transmitter throughout the frequency range of 6,200 to 7,700 kilocycles.

(2) *Receiving.*—The dimensions of the receiving antenna are also shown in figure 16. This can be constructed of the same type of wire as the transmitting antenna. As stated in connection with the transmitting antenna, the lead-in must be short in order to reduce capacity between it and the fuselage. Such a capacity actually shunts the receiver, thus giving inefficient operation. No. 16 or no. 18 wire should be used for the lead-in. The lead-in should be located where it is not apt to be struck or subjected to undue stress and spaced as far as possible from metal members of the fuselage. It is a good rule that the remote

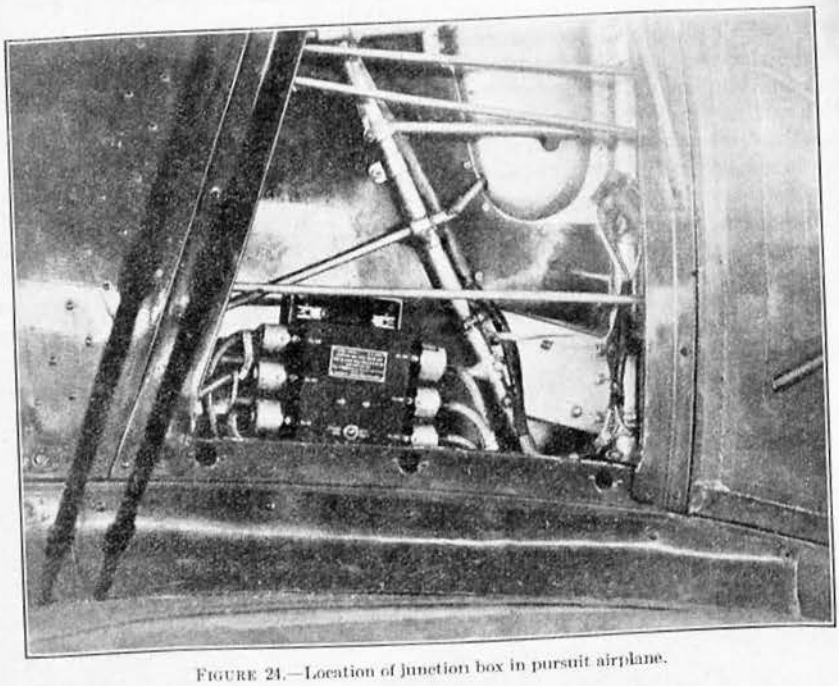


FIGURE 24.—Location of junction box in pursuit airplane.

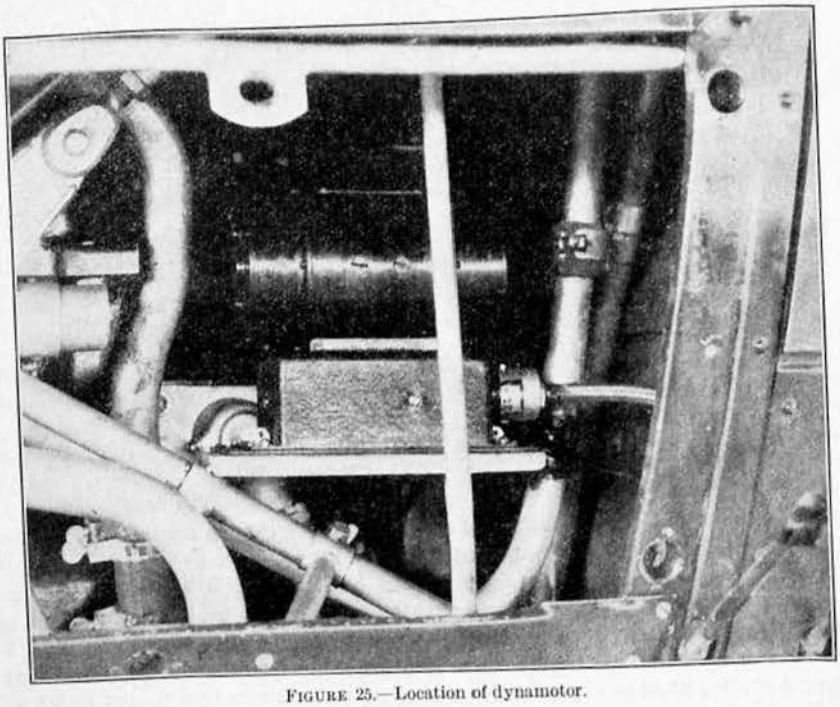


FIGURE 25.—Location of dynamotor.

ends of any wire antenna should not be brought to close proximity with metal end supports by stays; the strain insulators separating the stays from the antenna wires should be spaced 1 foot or more from the metal supports if possible. Down leads from flat-top antennas supported by a high wing should be brought into the fuselage as near the bottom as possible, since this increases the effective spacing

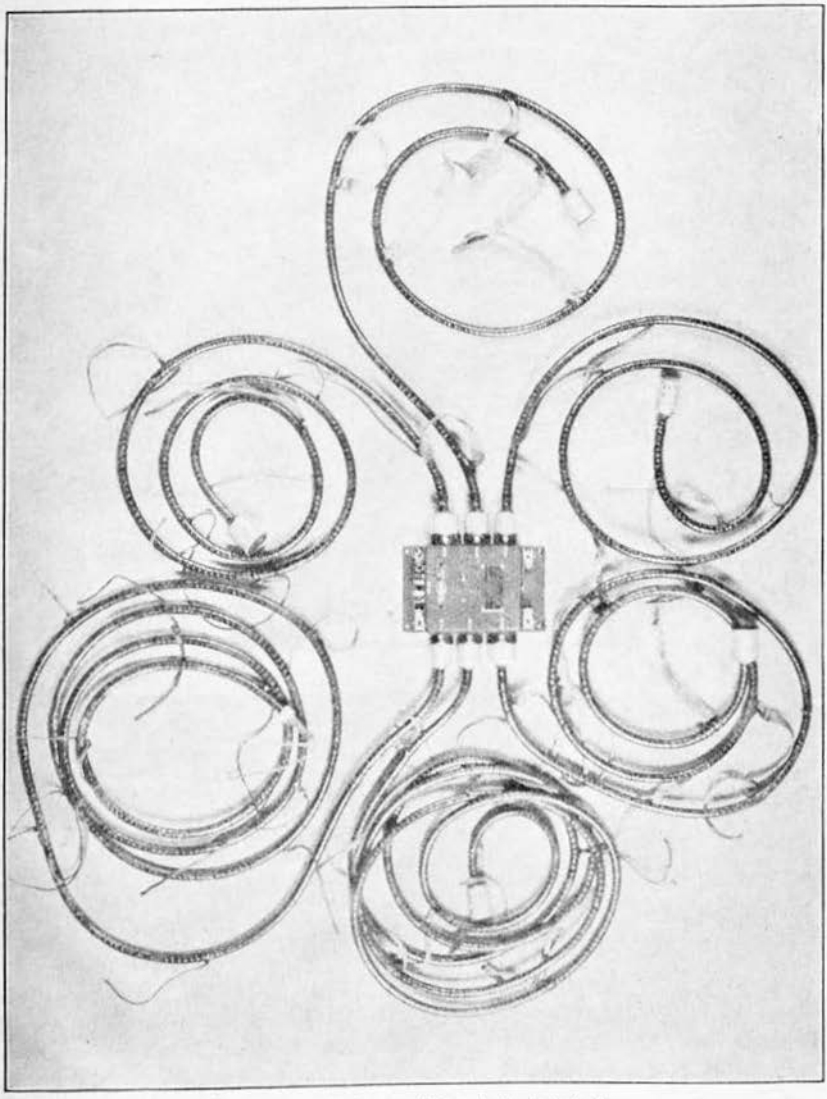


FIGURE 26.—Cord assembly ready for installation.

of the top section from the fuselage. In figure 29 the mast shown is used as a receiving antenna.

If the ends of the transmitting and receiving antennas are brought close together, the transmitting current will be reduced by absorption in the receiving antenna when the receiver is tuned to the same frequency as the transmitter. When designing antennas which differ from those indicated in the above dia-

grams, this effect should always be checked after the transmitter is tuned by tuning the receiver to the same frequency, using coil set, type C-102. If the transmitter antenna current ammeter dips by more than about 15 percent as

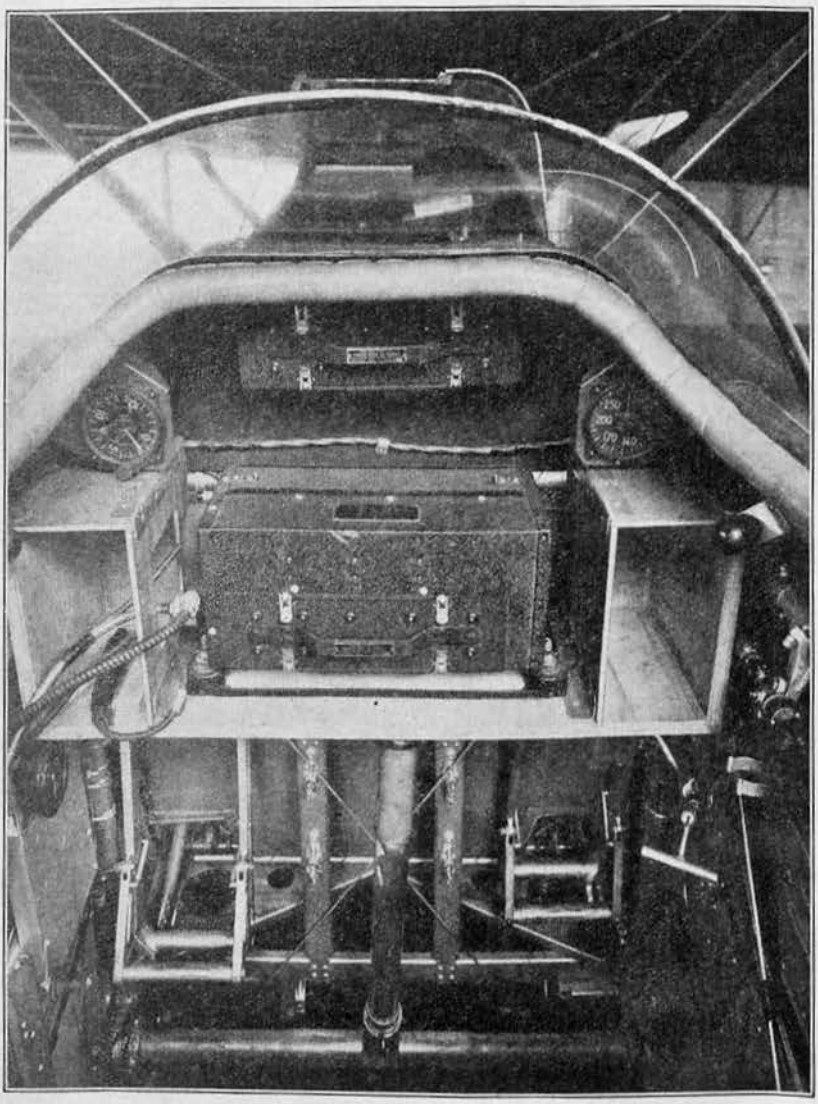


FIGURE 27.—Receiver in rear cockpit of observation airplane.

the receiver is tuned through the transmitting frequency the two antennas must be spaced farther apart.

**5. Tests and inspections for serviceability and precautions to be observed.**—*a. Transmitting equipment.*—After radio set, type SCR-AA-183, has been installed and all connections made, the radio transmitter should be tuned to some desired frequency and an operating test made on the ground. Before tuning the transmitter on the ground the airplane should be located outside the

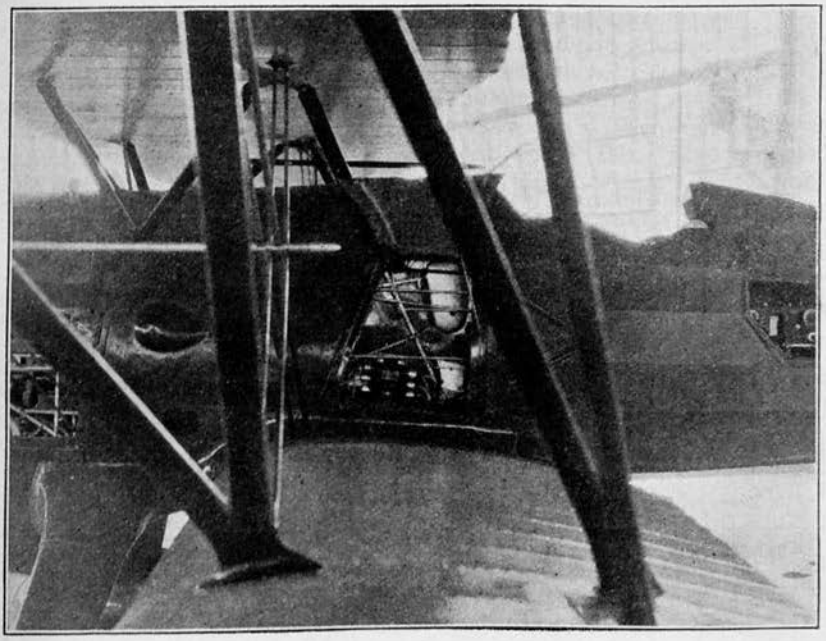


FIGURE 28.—Location of equipment in pursuit airplane.

FIGURE 29.—Antenna installation on observation airplane.

hangar over dry soil. If the transmitter must be adjusted inside a hangar or over wet soil, the antenna tuning should be readjusted after the airplane is in the air. Three controls must be adjusted for any given frequency:

(1) The frequency control 153.
(2) The antenna coupling tap, adjusted by arm 119.
(3) The antenna tuning condenser adjusted by knob 155.

First set the frequency control 153 to the desired frequency according to chart 347, interpolating if necessary or by using the calibration curve, figure 30. Second, set tap arm 119 on a turn of the antenna coupling coil which is appropriate for the frequency used. Use the following table for obtaining this setting.

| Frequency | Antenna coil tap [1] | Modulator, oscillator plate current | | Amplifier plate current | | Antenna current | |
|---|---|---|---|---|---|---|---|
| | | 12 volts | 14 volts | 12 volts | 14 volts | 12 volts | 14 volts |
| | | *Ampere* | *Ampere* | *Ampere* | *Ampere* | *Ampere* | *Ampere* |
| 6,200 | 13 | 0.041 | 0.047 | 0.015 | 0.024 | 0.50 | 0.67 |
| 6,500 | 12 | .042 | .046 | .018 | .027 | .53 | .70 |
| 6,800 | 10 | .043 | .049 | .020 | .027 | .49 | .71 |
| 7,100 | 7 | .043 | .049 | .020 | .027 | .49 | .71 |
| 7,400 | 4 | .043 | .048 | .018 | .027 | .45 | .68 |
| 7,700 | 3 | .043 | .050 | .020 | .031 | .45 | .68 |

[1] The figures in this column represent the number of turns on the antenna coil between the tap arm 119 and the base of the coil for maximum power output, adjusting knob 155 for the final resonance point in each case.

Third, adjust the antenna condenser knob until ammeter 106 shows a maximum current reading with the switch on radio control box, type BC-AA-181, at either AUTO or MANUAL and the switch on radio control box, type BC-AA-182, at MIC. The above table also shows approximately what current to expect in the antenna circuit. If antenna ammeter 106 shows such a current, it indicates that the transmitting equipment is functioning properly. This test does not show whether or not the transmitting antenna is radiating the power it should. Such a test can best be made by actual communication between two airplanes equipped with these radio sets. In general, it will be found that antenna resonance at any given frequency may be obtained on the condenser knob 155 at 1 or 2 or even 3 positions of tap 119, but only one position of this tap arm will give an absolute maximum of current, and this one should be used. Increasing frequency always requires fewer turns of the coil between the tap arm and the ground end of the coil. With antennas of the dimensions shown in figure 16 the tap giving maximum power output is, for the lower half of the frequency range, the highest tap on the coil (greatest number of turns) at which resonance can still be obtained by rotating the knob 155. In other words, maximum power output is usually obtained with the coil so tapped that the antenna is resonated with its condenser 95 at or near its minimum capacity position (decrease capacity by turning knob to the right, that is, in direction of arrow). At the higher frequencies above 7,000 kilocycles, where the antenna resistance is higher, maximum power (current) output will be obtained on taps requiring the use of more of the capacity controlled by knob 155.

It is important that the transmitter be always operated with the antenna circuit tuned to resonance. If it is operated with the antenna circuit off resonance, excessive current will be drawn from the dynamotor unit and poor modulation as well as low power output may result. When the transmitter controls have been set, they may be locked by lock screws 303 and 304.

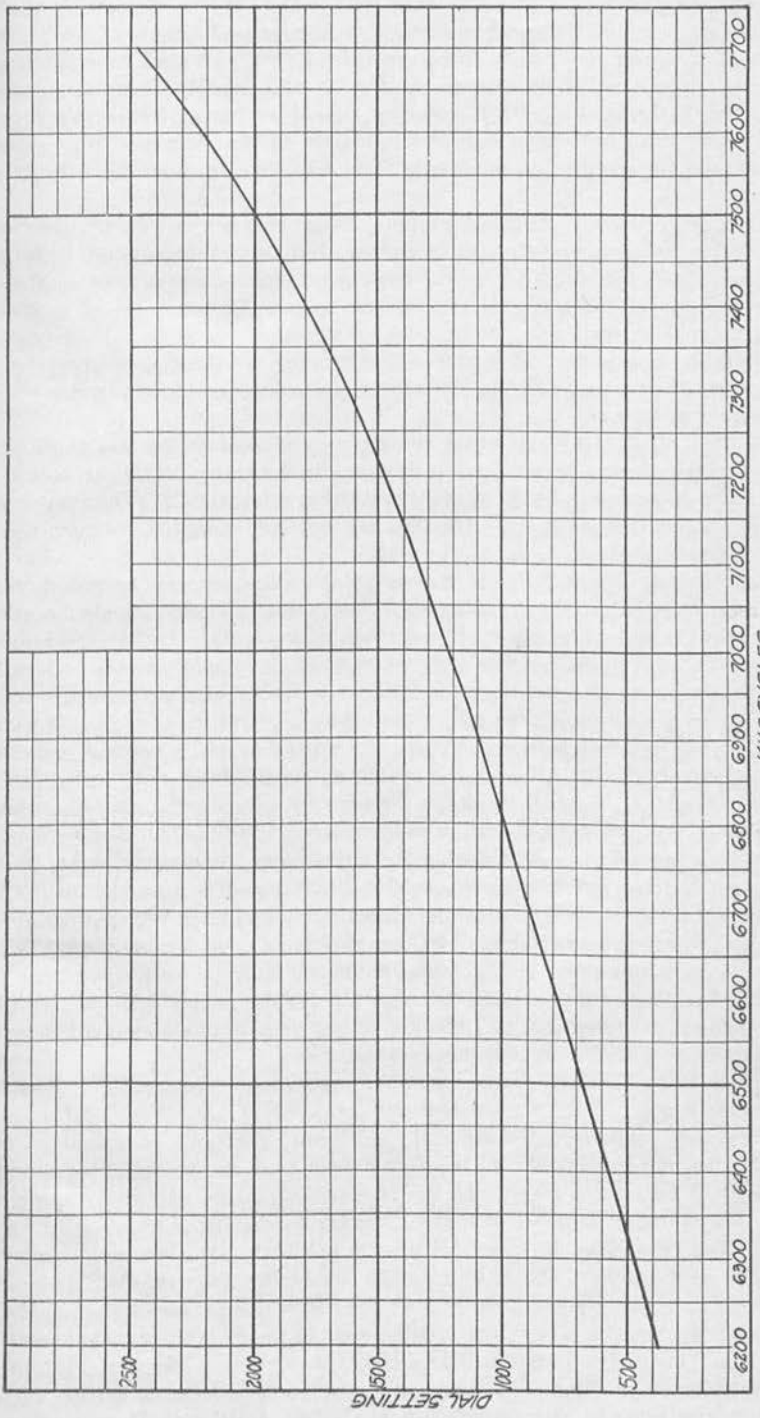



FIGURE 30.—Frequency calibration radio transmitter, type BC-AA-180.

Do not take off with other airplanes with whom communication is desired without first establishing communication on the ground. This is particularly important if communication is to be carried on with airplanes transmitting at different frequencies. Whenever possible, with an assembly of airplanes which are to work on the same assigned frequency, tune in all transmitters on the ground by adjusting them until their carrier frequencies all beat together in a common receiver used for monitoring purposes. This will save considerable retuning of receivers.

Do not expect uninterrupted communication between airplanes which are maneuvering unless they are close together. For consistent communication at distances greater than about 5 miles, the communicating airplanes should be in substantially level flight. Vertical banks are usually the attitudes of minimum received signal between two communicating airplanes unless they both bank in the same direction at the same time. Furthermore, a "dead spot" may be observed when the receiving airplane is off the pole of the transmitting down-lead, either above or below.

Radio field strengths received on the ground will always be less than those received in the air at a given time of day, unless the transmitting airplane is so high that an optical path lies between it and the ground station. The frequencies of radio transmitter, type BC-AA-180, are not well adapted for airplane to ground communications.

*b. Receiving equipment.*—Before the receiving equipment can be tested, there is one adjustment that should be made. The antenna circuit should be alined by means of the series condenser 151, adjusted by knob 160. If the antenna used is so large that its characteristics vary widely with frequency over the operating range, this adjustment must be made for each coil set. If the antenna is small, or consists of a rigid mast, one adjustment may give satisfactory results for all coil sets. The receiver is operated with the switch on radio control box, type BC-AA-181, at MANUAL and the switch on control box, type BC-AA-182, on REC. A signal is tuned in at the high-frequency end of one of the bands, preferably on coil set, type C-101, or coil set, type C-102. The volume control must be progressively retarded during the adjustment to keep the signal at the lowest audible level. Knob 160 is turned until the signal is a maximum. Then the receiver tuning must be readjusted for maximum, and knob 160 again adjusted for resonance. If the receiver is to be operated for a considerable period in the low-frequency bands only, this antenna alinement may be performed near the maximum frequency (dial) setting on one of the low-frequency coil sets. But for use throughout the range 224 to 7,850 kilocycles, the antenna alinement must be performed on one of the high-frequency bands.

The first test of the receiving equipment should be made without running the airplane engine. With the control switches on REC and MANUAL respectively and the volume control near the maximum position, atmospheric and electrical disturbances should be heard, showing that the receiving equipment is "alive." Under most conditions the receiver cannot be expected to operate satisfactorily on signals so weak that maximum sensitivity is required to make them audible, because such signals are usually below the atmospheric noise level. Tune in several different signals by rotating the tuning unit crank. The tuning unit should turn easily and smoothly over the entire dial range without binding. As a signal is tuned in, adjust the volume control for suitable signal intensity. Switch to AUTO position after a desired signal is tuned in. The signal intensity in the telephones will not necessarily be the same for the same setting of the volume control knob in both AUTO and MANUAL positions. Do not attempt

to tune in signals with the switch on AUTO. The resonance effect in the amplifier is apparently broadened so that the proper tuning point cannot be found in the AUTO position except for very weak signals. The AUTO position is not designed for constant use throughout a series of communications on different frequencies, but only as an aid to reception after a signal has been tuned in on the MANUAL position.

Before flying, the receiving equipment should be further checked on the ground with the airplane engine running. If with the volume control set at maximum in any position of the tuning dial, the electrical noise in the telephones is increased on starting the airplane engine, this indicates imperfect shielding of the ignition or generator system, or difficulty with the voltage regulator of the charging generator. If circumstances render necessary the operation of the receiving equipment under these conditions, only those radio signals can be satisfactorily received which are of greater electrical intensity than the local disturbance.

The switch on the control box, type BC–AA–181, should never be left in the MANUAL or AUTO positions on the ground when the radio is not in use.

An important use of this receiving equipment is the reception of weather reports and signals from radio-range beacons. When receiving signals from radio-range beacons, the pilot should use the MANUAL position of the switch. The automatic-gain control will not destroy the course indication on either visual or aural radio-range beacons, but it will appreciably broaden the course of the aural radio-range beacon, and it eliminates the possibility of employing the strength of the received signal as an indication of the observer's distance from the radio-range beacon.

When the transmitter is properly tuned it may be operated in conjunction with the receiver by throwing the switch on the control box, type BC–AA–182, to REC, KEY, or MIC. It is impossible to receive signals on the KEY or MIC positions and it is impossible to transmit signals in the REC position. When the receiver of radio set, type SCR–AA–183, is to be used for a considerable period without using the transmitter, the toggle switch 111 should be thrown to REC only. This cuts the radio control box, type BC–AA–182, out of the circuit and turns off the filaments of the transmitting tubes, saving power and prolonging the life of these tubes. It should be remembered that it is impossible to transmit with the switch in this position.

## Section III

## OPERATION



**6. To transmit.**—In order to transmit with the radio set, type SCR–AA–183, throw the switch on radio control box, type BC–AA–181, to either the MANUAL or the AUTO position. The switch on radio control box, type BC–AA–182, must then be thrown to either the KEY or the MIC position, depending upon which type of signal it is desired to transmit. The next step is to tune the transmitter to the desired frequency. This is done in three steps as follows:

*a.* Set the frequency control 153 to the desired frequency, using either chart 347 or a calibration curve such as shown in figure 30.

*b.* Set arm 119 on proper turn of antenna coil. (See table in par. 5*a*.)

*c.* Adjust antenna condenser control 155 until ammeter 106 shows a maximum reading.

If the switch on radio control box, type BC-AA-182, is on KEY, it is necessary to hold key contacts closed while tuning. The set is now ready for transmitting. Either the microphone (voice) or the key (tone telegraph) can be used by merely throwing the switch on radio control box, type BC-AA-182, to the proper position.

NOTE.—The toggle switch 111 on the junction box must be at its left-hand (TRANS-REC) position.

7. **To receive.**—To receive a signal with the radio set, type SCR-AA-183, place the proper coil set in the receiver. Throw the switch on radio control box, type BC-AA-181, to MANUAL and then move the switch on radio control box, type BC-AA-182, to REC. Tune in the signal by means of the tuning-unit crank, using either chart, type MC-128, or calibration curves as shown in figure 14. Adjust the volume control on the control box, type BC-AA-181, until the desired signal strength is obtained. After the signal is tuned in, the switch 329 may be thrown to AUTO position if desired. To change the radio set back for transmitting, it is only necessary to move the switch on radio control box, type BC-AA-182, from REC to either KEY or MIC.

## SECTION IV

## REMOVAL FROM SERVICE



8. **Repacking the sets.**—There are no standard chests or boxes which are a part of either the radio set, type SCR-AA-183, or radio set, type SCR-AA-192. The only time these sets would be packed is for shipment. This is a relatively simple process. The cords and tuning shaft are formed in convenient coils about 12 to 18 inches in diameter and fastened with friction tape. Each unit is then wrapped with heavy wrapping paper and packed in a strong wooden box with sufficient excelsior or similar substance to prevent the various units from being jarred together and broken. All of the units of one radio set may be packed in one box without injury if they are carefully packed. One set of tubes may be packed in the set.

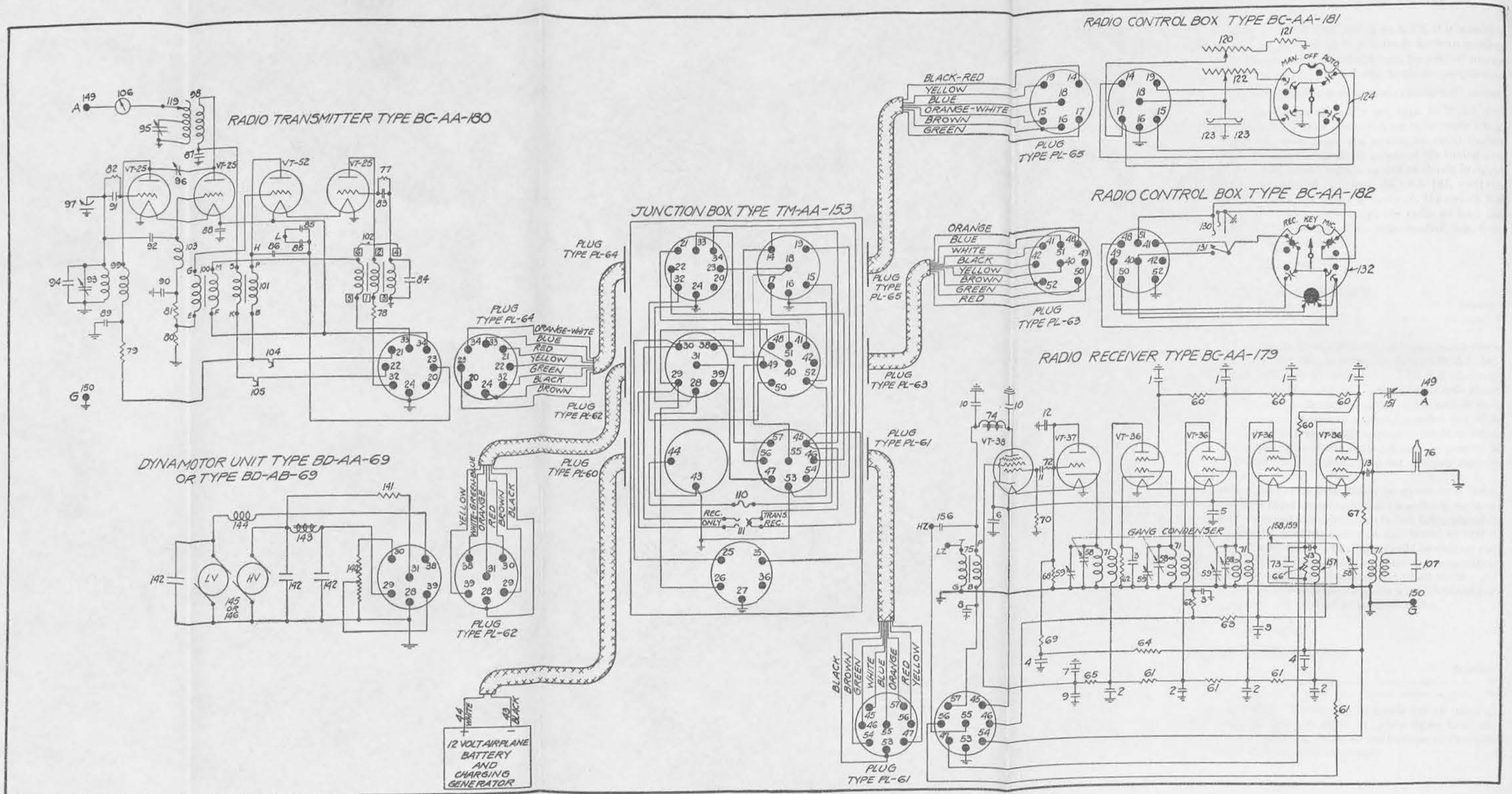
9. **Preparation for storage.**—These radio sets should be stored in a clean, dry place. Any storeroom suitable for other signal equipment is suitable for these radio sets. The entire set should be cleaned and overhauled before being placed in storage. It should be placed in perfect working condition and tested so that it will be ready for use at any time. The dynamotor bearings should be cleaned and greased. This grease should be changed before placing the dynamotor in operation again. Sets in storage must be kept free from dust and dirt of all kinds. Air Corps Circular 15-44 requires that sets in storage be given a maintenance test every 30 days. If this is done the sets will be kept in good condition.

## SECTION V

## FUNCTION OF PARTS



10. **Radio set, type SCR-AA-183.**—The circuit diagrams for all units of the radio set, type SCR-AA-183, are shown in figure 31, while figure 32 shows the wiring diagrams. In order to simplify the study of the purpose or function of each part, the various units will be considered separately.




43166°—34. (Face p. 31.) No. 1

FIGURE 31.—Circuit diagram, radio set, type SCR-AA-183.

If the switch on radio control box, type BC-AA-182, is on KEY, it is necessary to hold key contacts closed while tuning. The set is now ready for transmitting. Either the microphone (voice) or the key (tone telegraph) can be used by merely throwing the switch on radio control box, type BC-AA-182, to the proper position.

NOTE.—The toggle switch 111 on the junction box must be at its left-hand (TRANS-REC) position.

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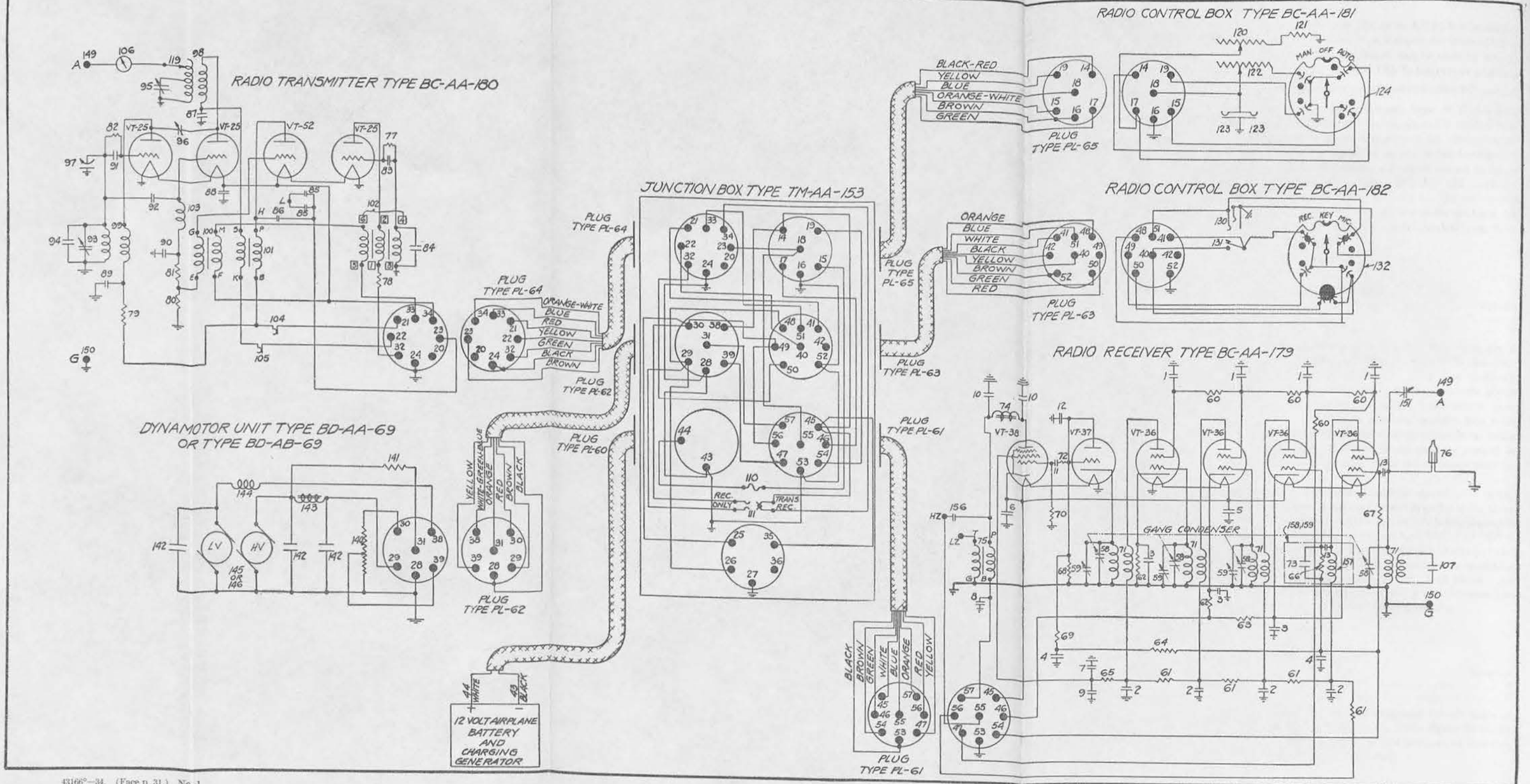
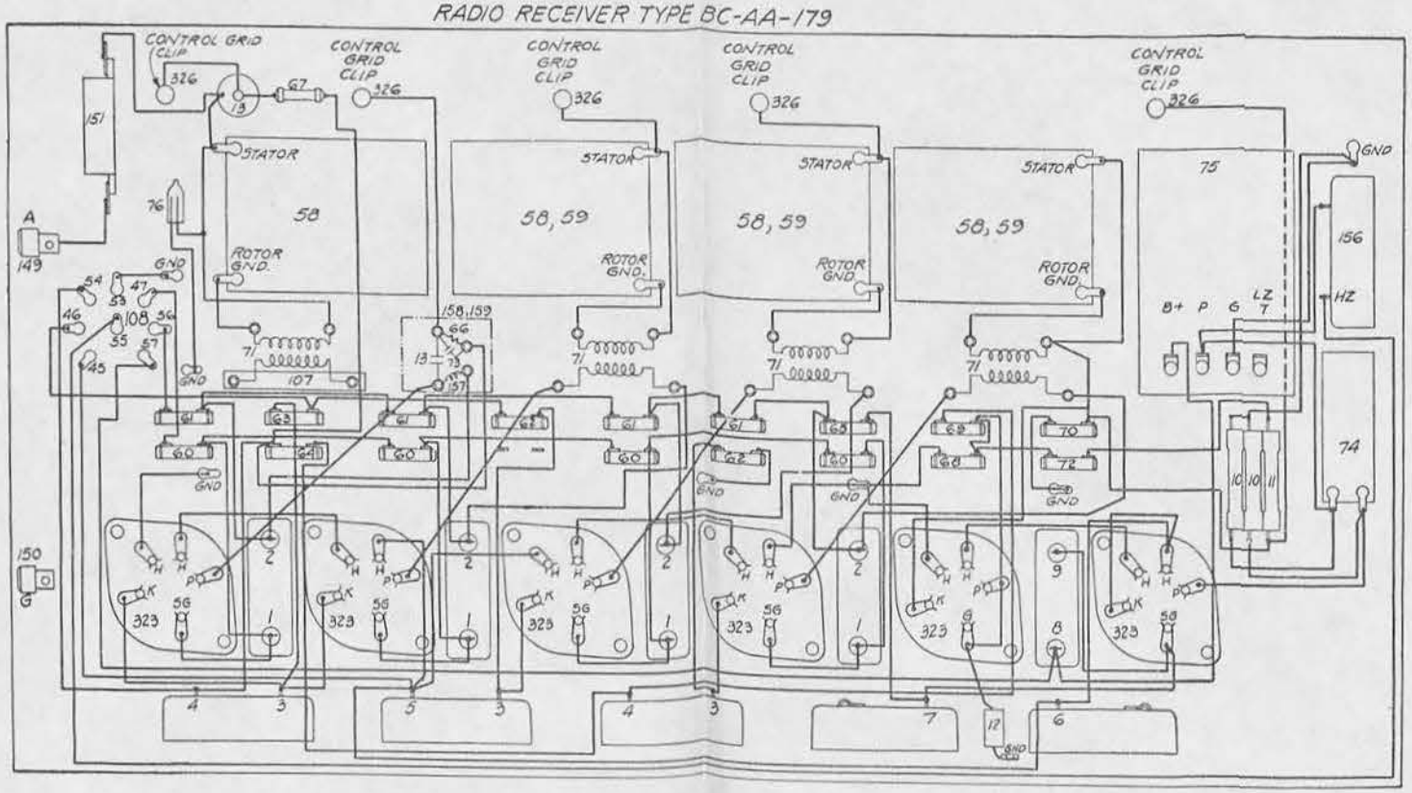


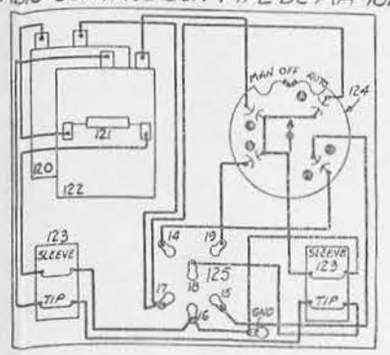

43166°—34. (Face p. 31.) No. 1

FIGURE 31.—Circuit diagram, radio set, type SCR-AA-183.

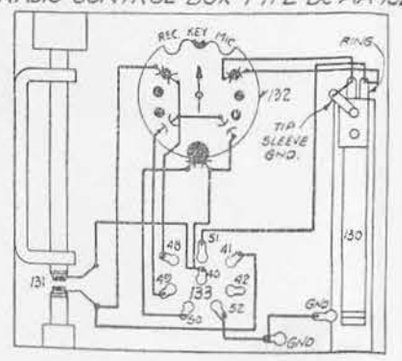
RADIO RECEIVER TYPE BC-AA-179

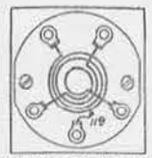



RADIO CONTROL BOX TYPE BC-AA-181

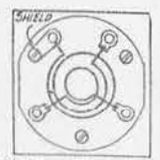



RADIO CONTROL BOX TYPE BC-AA-182

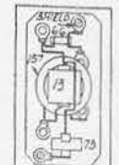


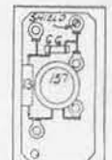

98 ANTENNA COUPLING COIL ASSEMBLY. RADIO TRANSMITTER TYPE BC-AA-180




71 TUNED RADIO COIL ASSEMBLY. COIL SETS TYPES C-97 C-98, C-99, C-100, C-101, C-102

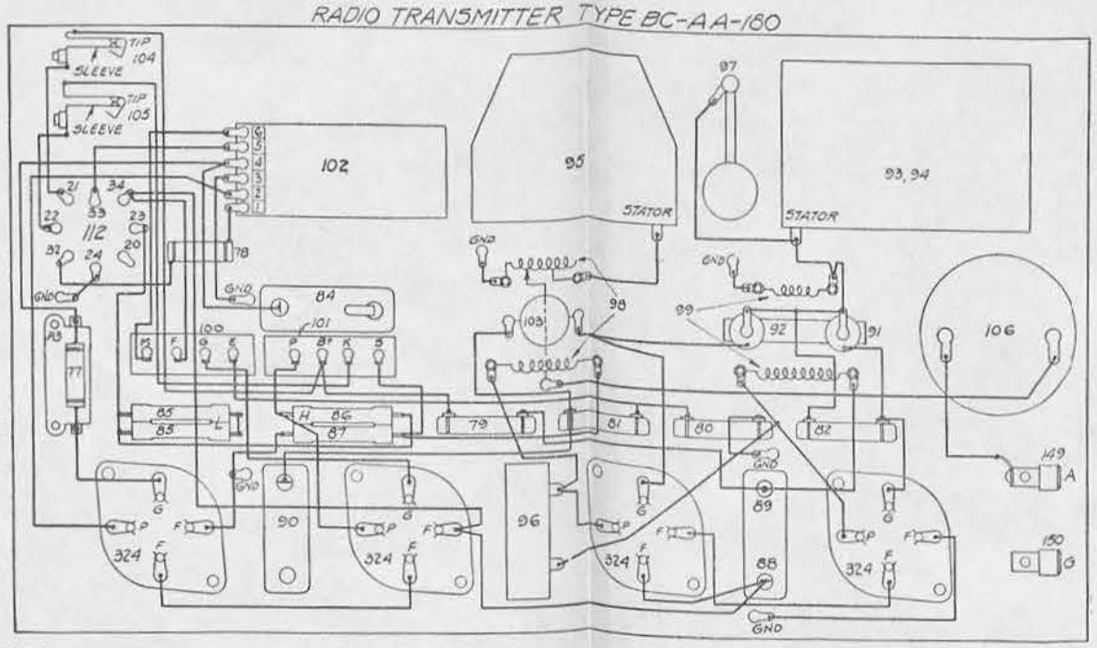



158 BAND-PASS RADIO COIL ASSEMBLY. COIL SETS TYPES C-97, C-98.

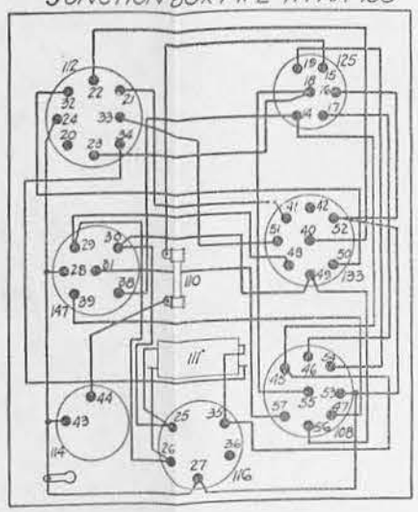



159 BAND-PASS RADIO COIL ASSEMBLY. COIL SETS TYPES C-99, C-100, C-101, C-102

RADIO TRANSMITTER TYPE BC-AA-180




JUNCTION BOX TYPE TM-AA-153




DYNAMOTOR UNIT TYPE BD-AA-69 OR TYPE BD-AB-69

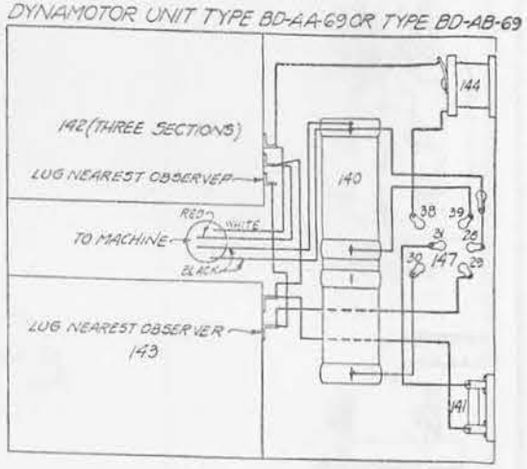





FIGURE 32.—Wiring diagram, units of radio sets, types SCR-AA-192 and SCR-AA-183.

*a. Radio transmitter, type BC-AA-180.*—This is a four-tube transmitter comprising a radio-frequency oscillator, a radio-frequency amplifier, a coupling circuit for transferring radio-frequency power from the amplifier to the antenna, a modulator stage and a tone oscillator for generating modulating current used in tone telegraphy. The radio oscillator, amplifier, and tone oscillator use tubes, type VT-25. The modulator uses a tube, type VT-52. All connections to the transmitter except antenna and ground leads are made through the cord connecting the transmitter to the junction box. The tube filaments require seven volts, and for this reason two filaments are connected in series since current is drawn from the airplane 12- to 14.25-volt battery. This voltage is on terminal 34 of the receptacle and the circuit is completed to ground. The left tube of the circuit diagram in figure 31 is the radio oscillator. The frequency-determining circuit consists of one coil of the assembly 99 shunted by the two condensers 93 and 94; 93 is the tuning condenser controlled by knob 153 and carries dial 154. The dial is graduated in equal divisions from 0 to 30, each division corresponding to one rotation of the knob 153, which itself is graduated 0 to 100. This calibration covers the range 6,200 to 7,700 kilocycles. The oscillatory circuit is coupled directly to the grid circuit and by means of the coil assembly 99 to the plate circuit of the tube; 82 is the grid biasing resistor and 91 its by-pass condenser; 97 is a small bimetallic condenser whose capacity varies with the temperature in the tube compartment to compensate for frequency drift caused by changes in temperature. The high voltage for the plates of the oscillator and modulator tubes is obtained from terminal 21. Resistor 79 is placed in the lead to the oscillator plate to reduce this voltage to the proper amount; 79 is by-passed by condenser 89. The oscillator is coupled to the grid circuit of the amplifier through condenser 92, coil 103 being a radio-frequency choke. Condenser 96 is a leaf-type mica condenser used for balancing out the grid-plate capacity of the amplifier tube. It is controlled or varied through the small opening 349 located between the amplifier and modulator tubes. The amplifier output is coupled to the antenna circuit by means of coil assembly 98. This is the assembly which can be removed from the transmitter and contains the adjustable tap arm 119. As has been previously explained, this arm is used for tuning the antenna circuit; 95 is the antenna tuning condenser controlled by knob 155. Condenser 87 completes the path for radio-frequency current in the amplifier-plate circuit. The grid bias of the amplifier tube is developed by the flow of grid current through resistors 80 and 81 to ground. These resistors are by-passed by condenser 90. The plate of the radio amplifier tube is supplied with high voltage from terminal 22 through the secondary winding SK of the modulation transformer 101. High voltage to the plate of the modulator tube is fed through the primary PB of this modulator transformer from terminal 21. Thus variations in the current through the winding PB cause corresponding changes in the winding SK, modulating the output of the transmitter. The grid of the modulator tube is biased through the secondary GE of the microphone transformer 100 by the amplifier grid current drop through resistor 80. When the switches are set for tone telegraph, high voltage is placed on the plate of the tone oscillator tube through the key, terminal 32, and the 1–2 winding of coil assembly 102. This causes this tube to oscillate at an audio frequency (approximately 1,000 cycles) when the key is closed. This frequency is fixed and determined by the oscillatory circuit, condenser 84, and the 3–4 winding of the coil assembly. Since this oscillatory circuit is in the grid circuit of the tube and coupled inductively to the plate circuit all conditions for oscillation are fulfilled. The circuit including the 5–6 winding of coil assembly 102 and the MF winding of transformer 100 is a link

circuit by means of which these audio variations are impressed on the grid of the modulator tube. This link circuit is completed through other equipment connected to terminals 33 and 34 (34 to positive filament, 33 to grid).

When arranged for voice transmission, there is no high voltage on the plate of the audio oscillator. Instead, the microphone is connected between terminal 33 and ground. The microphone circuit is thus completed through the 5–6 winding of coil assembly 102, the MF winding of transformer 100, terminal 34 to positive filament battery. Speaking in the microphone causes the current in this circuit to vary. These variations are impressed on the grid of the modulator by means of transformer 100; 78 is a voltage drop resistor. Resistor 77 and condenser 83 are the grid biasing resistor and condenser, respectively; 104 and 105 are jacks for plugging in meters in case it is desired to read the current in these circuits. A meter reading obtained by plugging in 104 would include both modulator and radio-oscillator plate currents. Terminal 23 is coupled to the plate of the modulator tube for the withdrawal of side-tone voltage through condenser 86. Condenser 86 is adapted for use with high-impedance telephone receivers. Two parallel connected condensers 85 are included in the transmitter for use with low-impedance telephone receivers. When such telephone receivers are used a soldered jumper connection should be made between points H and L. These two points are so marked inside the transmitter. The various parts of the transmitter discussed above can be easily located in the transmitter by referring to figures 3, 4, and 5.

*b. Radio receiver, type BC-AA-179.*—The receiver has four stages of radio-frequency amplification, which amplify at the incoming frequency, a detector and one stage of audio frequency amplification. The four radio-frequency amplifier stages use tubes, type VT–36. The detector is a tube, type VT–37, and the audio-amplifier stage uses one tube, type VT–38. Each of the coil sets includes the same essential parts of the radio-frequency amplifier circuit, and except where otherwise noted, the following discussion applies to the receiver where using any one of the 6 coil sets. The 4 radio-frequency stages are coupled by 5 coupling circuits, 4 of which consist of radio-frequency transformer coils 71, tuned by equal capacity sections 58 of the gang tuning condenser. The fifth consists of a fixed band-pass coupling circuit 158, 159, which is made up of a coil 157 and a resistor 66, coupled together with a fixed condenser 13. These three elements are included in the band-pass stage of all coil sets. Coil assembly 158 is used in coil sets, types C–97 and C–98, only, and is characterized by an additional fixed condenser 73 shunted across resistor 66. Coil assembly 159 is used in coil sets, types C–99, C–100, C–101, and C–102, and is characterized by the omission of fixed condenser 73. The function of the fixed band-pass coupling between the first and second tubes of the radio-frequency amplifier is to equalize the amplification over any frequency band which is covered by rotation of the gang tuning condenser through 180°. All tubes coupled by the tuned transformers 71 amplify considerably more at small values of tuning capacity than at large values of tuning capacity. The band-pass coupling unit is designed for each coil set, so that the amplification of the vacuum tube nearest the antenna is greatest at the low-frequency end of each frequency band.

The capacities of the equal sections 58 of the gang condenser which tune the coupling coils 71 to resonance with the incoming signal are augmented by compensating or alining condensers 59. These alining condensers are built into the respective sections of the gang condenser and are separately adjustable through openings 343. This is not a receiver operating adjustment and in general this

adjustment is correctly made by the manufacturer and should not be tampered with by anyone except an expert radio mechanic.

The antenna is coupled to the input coil through variable series condenser 151 which is adjustable by knob 160. Condenser 151 is adjusted for any given receiving antenna until the series combination of its capacity with the antenna capacity is equal to the residual or minimum capacity introduced into the remaining tuned stages by condensers 59. When this is done the four tuned circuits are in resonance at all settings of the gang tuning condenser.

After successive amplification through the four radio-frequency stages the incoming signal voltage is impressed by the last tuned coil 71 between the cathode and the grid-plate anode of the detector, a tube, type VT-37. This tube acts as a 2-electrode detector or rectifier and develops across resistor 68 a steady direct voltage which is the result of rectification of incoming carrier, plus an audio-frequency signal voltage which is the result of the rectification of the incoming modulation (audio) frequencies. This audio-frequency signal voltage across 68 is impressed through resistor 72 and condenser 11 on the grid of the audio-frequency amplifier tube. This tube amplifies the audio signal which passes from its plate through a low-pass filter section comprising choke coil 74 and condensers 10, to the output transformer 75. The low-pass filter strongly attenuates all audio frequencies above 3,000 cycles. It is included in the circuit to reduce noise occurring at the higher audio frequencies. Resistor 72 is a filter resistor operating in conjunction with condenser 12 to keep radio frequencies out of the audio stage. Resistor 70 is a grid return for the output tube. Two terminals are provided for the telephone receiver circuit from terminal 55, identified on the chassis by the letters HZ and LZ. The HZ terminal is connected through condenser 156 to the primary winding of output transformer 75. When output terminal 55 is connected to HZ as shown in figures 31 and 32, the receiver is adapted for use only with a high-impedance load. Transformer 75 is a step-down transformer. When terminal 55 is disconnected from HZ and connected to LZ, the receiver is adapted only for a low-impedance load. These terminals LZ and HZ are accessible at the rear end of the coil set compartment.

NOTE.—When high-impedance telephones are used with this radio set, both transmitter and receiver must be connected for high-impedance telephones. When low-impedance telephones are used, both must be connected for low-impedance load. Never try to operate the radio set with the transmitter connected one way and the receiver the other.

The sensitivity of the receiver is controlled by varying the control grid bias, and hence the radio-frequency amplification of either the first 2 or first 3 radio amplifiers. This is done either externally by a manually-operated variable resistor or internally by an automatic gain control circuit. The heavy line in figure 31 represents the grounded frame of the receiver and is the common return terminal of all supply and bias voltages. The cathodes of the first three tubes are connected for direct current to terminal 46. The grids of the first two tubes are connected for direct current to terminal 54 as well as to a line running to the detector circuit. If terminal 54 is grounded externally, thus completing all grid circuits to ground, an external variable resistance between terminal 46 and ground will control the amplification of the first three tubes by controlling the difference in potential between their cathodes and ground. If terminal 46 is grounded externally, bringing all cathodes to ground, a direct voltage between terminal 54 and ground will determine the grid bias and hence the amplification of the first two tubes. Such a voltage is developed automatically when terminal 46 is grounded externally, by rectification of the incoming carrier wave at the detector tube. This direct voltage which appears across the output resistor

68 of the detector is approximately proportional to the incoming carrier, owing to characteristics of the 2-electrode detector. This voltage is led back through resistors 69 and 64 to the grid circuits of the first two tubes. Resistors 69 and 64 and the two condensers 4 form a low-pass filter which suppresses from this automatic gain control line all of the audio-frequency signal voltage developed by the detector across resistor 68, leaving only a direct-current voltage between the grids of the two tubes and ground. This direct-current voltage biases the grids of the two tubes more and more negatively with respect to their respective cathodes as the incoming signal increases. The radio-frequency amplification is decreased as the radio-frequency signal increases, and the signal output of the receiver is held substantially constant over a wide range of incoming signal strengths. The connections of the control circuits external to the power plug are such that terminals 46 and 54 cannot be grounded at the same time; either 54 is grounded, permitting external adjustment of the radio-frequency amplifications, or 46 is grounded, permitting automatic control of the radio-frequency amplification by the direct-current voltage from the detector. The grid bias of the fourth radio-frequency amplifier is fixed.

Terminal 45 is the positive 12- to 14.25-volt terminal and is connected within the receiver to each of three series connected pairs of heaters of the six vacuum tubes. The cathode of the output tube, type VT-38, is connected to terminal 45 in order to bias the control grid of this tube 12 to 14.25 volts negatively. A residual negative bias is imparted to the grids of the tubes, type VT-36, by including between ground and their cathodes two resistors, 62 and 63. Terminal 47 is a high-voltage terminal to which the screen grids of tubes, type VT-36, are connected. Resistors 60 and condensers 1 are filter elements used to reduce radio-frequency interaction between the several stages. Terminal 56 is a high-voltage terminal supplying the plate circuits of all the radio-frequency amplifiers and the screen grid of the output tube. Resistors 61 and condensers 2 are decoupling filter elements, while resistor 65 is used to reduce the voltage on the screen grid of the pentode. Terminal 57 is a high-voltage terminal connected to the plate of the pentode. Terminal 55 is connected externally to the telephone receivers.

A 2-element neon tube 76 is permanently connected in parallel with the secondary winding of the first radio-frequency transformer 71 in the antenna stage. This tube is a voltage-limiting device designed to protect the amplifier from damage if it is accidentally tuned to the frequency of a nearby transmitter. The tube 76 ionizes at a voltage of 80 to 100 volts and a gaseous discharge occurs which effectively short-circuits the input stage, but only so long as the high incoming voltage is present.

Condenser 107 is a small fixed condenser connected across the terminals of the primary of the first radio-frequency transformer to compensate in tuning alinement for the interelectrode tube capacities present across the primaries of all the other radio-frequency transformers. Reference should be made to figures 6, 7, and 8 for the location of the various parts in the receiver.

*c. Radio control box, type BC-AA-181.*—This unit carries two controls, the switch 124 operated by handle 329 and the volume control 331. The contact portions of switch 124 consist of a group of spring contacts arranged in pairs, associated with a group of short-circuiting studs. The various pairs of spring contacts are mounted about the circumference of a circle and are fixed with respect to the frame of the control box. The studs are mounted in a similar circle upon a rotatable member of the switch and short-circuit the respective pairs of spring contacts as they rest between them. In figures 31 and 32 the rotatable member

of the switch is shown as a serrated circle, and three positions of the switch correspond to the three positions of alinement of these serrations with the top spring 335. The studs, indicated by black circles, are to be considered as rotating with switch member between each of the three positions and the contact springs are fixed with respect to the remainder of the diagram.

All connections are made to this control box by means of plug, type PL-65, in the control box receptacle. Terminal 18 is wired to the tip contacts of two telephone receiver jacks. Terminal 17 is connected to the switch and to the manual gain control resistor 120. Terminals 14, 15, and 19 are connected to the switch. Variable resistor 122 is an audio-frequency level adjuster which is connected in parallel with the telephone jacks in the AUTO position of the switch. Resistor 121 is connected in series with variable resistor 120 to give a fixed residual bias to the control grids of the first three radio-frequency amplifiers. Resistors 120 and 122 are varied simultaneously by a single shaft which is rotated by knob 331. This knob is in both operating positions a volume control knob, controlling the receiver output. In the MANUAL position of the switch it controls the volume by varying the gain of the first three tubes in the receiver. In the AUTO position it controls the volume by varying the resistance in shunt with the telephone receivers. In order to ascertain just how the radio control box functions it is necessary to consider figure 31 as a whole. (See *d* below.)

*d. Radio control box, type BC-AA-182.*—This control box carries one control switch 132 operated by handle 330 and the telegraph key 131. The method of operation of this switch is similar to that discussed under control box, type BC-AA-181. The key closes the contacts between terminals 40 and 41. The wiring of the other terminals is easily followed from figure 31. The function of this control box can be better understood from a study of the complete radio set.

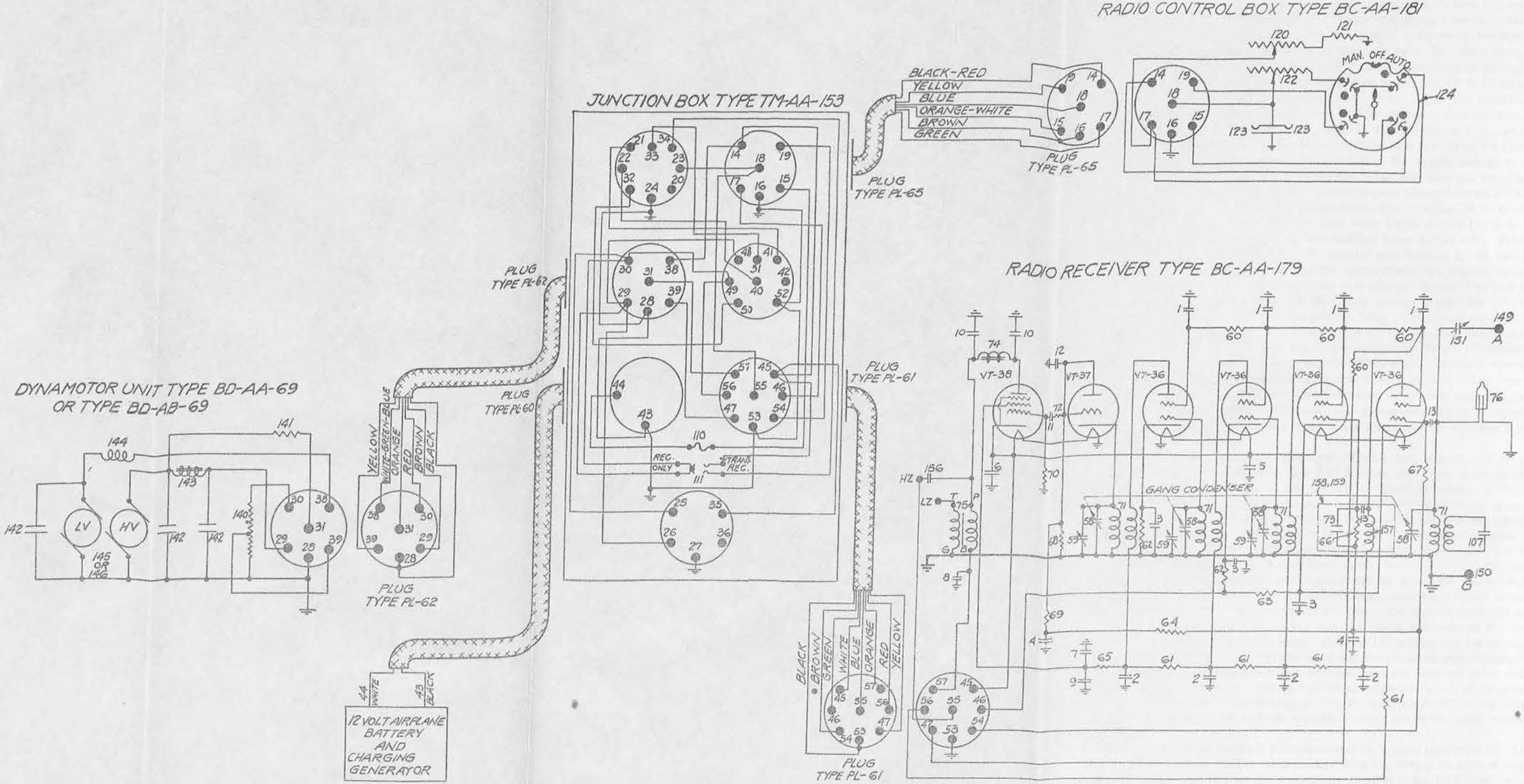
*e. Junction box, type TM-AA-153.*—This unit is the central interconnecting unit of the radio set. The cords from all other units lead to this one, hence it is a very convenient place to make voltage tests, etc. This unit has only the one switch, a toggle switch 111. When in the TRANS-REC position, it closes the circuit between terminals 34 and 46, opening the circuit between 29 and 30. When in the REC ONLY position the circuit is open between 34 and 46 and closed between 29 and 30. The junction box contains the fuse 110 in the positive 12- to 14.25-volt lead.

*f. Dynamotors, type BD-AA-69 and type BD-AB-69.*—These are shunt-wound machines. Current is supplied to the low-voltage armature and common field winding from the 12- to 14.25-direct current source. Current is drawn from the high-voltage commutator at 185 to 235 volts, depending upon the value of the applied voltage. At 12 volts, direct current drawn from the battery should be 3 amperes. At 220 volts, direct current drawn from the dynamotor should be 0.080 ampere. Terminal 28 is a grounded common negative for high- and low-voltage circuits. Terminal 38 is a positive 12- to 14.25-volt terminal and is wired through radio-frequency choke 144 to the low-voltage terminal. Condenser 142 aids the choke 144 in suppressing radio-frequency disturbances from this supply line. The high-voltage commutator feeds terminal 31 through filter resistor 141; the high-voltage output is also led through the low-pass filter section comprising iron core choke 143 and two condensers 142 to terminal 29. When terminal 29 is externally connected to terminal 30 the voltage divider resistor 140 is across the filtered high-voltage output. The center tap of this voltage divider is connected to terminal 39. The three condensers 142 are mounted together in one metal case.

*g. Cooperation of units.*—In an operating installation where the various units of radio set, type SCR-AA-183, are connected through cords to the junction box and the 12- to 14.25-volt source as indicated in figure 17, the circuits of the whole system are interconnected as indicated in figure 31. Each terminal in the junction box is connected through a cord to the terminal bearing the same number in one of the operating units. Current is drawn from the 12- to 14.25-volt source through the positive supply line from terminal 44. When the switch on control box, type BC-AA-181, is in the OFF position this line through terminal 15 is open and there is no voltage on the receiver, transmitter, or dynamotor. When this control switch is in the MANUAL position and the switch on radio control box, type BC-AA-182, is in the REC position, the supply voltage is impressed through terminals 15, 14, and 38 upon the dynamotor through terminals 15, 14, and 45 upon the heaters of all receiving tubes and through terminals 15, 14, 45, toggle switch 111 (in TRANS-REC position) and terminal 34 to heaters of all transmitting tubes. Thus it is seen that when toggle switch 111 is in the REC ONLY position the heaters of the transmitting tubes will be cold. High voltage is supplied from terminal 29 of the dynamotor unit through 48, 49, and 56 to the plates of the tubes, type VT-36, and the screen grid of the pentode tube. Lower voltage is supplied from the dynamotor unit through terminal 39 and 47 to the screen grids of the tubes, type VT-36. High voltage is supplied from terminal 31 through 57 to the plate of the pentode tube. Telephone receivers at jacks 123 are connected through 18 and 55 to the output circuit of the pentode tube and through 18 and 23 to the transmitter side-tone circuit. Variable resistor 122 is open-circuited and variable resistor 120 in series with fixed resistor 121 is connected between ground and the cathodes of the first three tubes, type VT-36, through 17 and 46. Variation of this resistance by rotating knob 331 varies the gain of the radio amplifier. The automatic gain-control action is suppressed in this position by grounding the circuits of the first two receiver tubes through 54 and 19.

When the switch on control box, type BC-AA-181, is in the AUTO position with the switch on control box, type BC-AA-182, still in the REC position, the dynamotor and receiver power circuits are energized as before. In the AUTO position the manual gain-control resistor 120 is short-circuited to ground, thus connecting the cathodes of the first three tubes of the receiver to ground. The grid circuits of the first two tubes, type VT-36, connected to terminal 54, are disconnected from ground and the gain-control voltage developed by the detector across resistor 68 controls the bias on these tubes. Variable resistor 122 is shunted across the telephone receivers and is controlled by knob 331. It is used as an audio-level adjuster for setting the automatically-controlled signal output at a level suitable for use in the telephone receivers. Rotation of knob 331 now has no effect upon the sensitivity of the receiver, which decreases as the incoming radio signal increases, and vice versa. Resistor 122 is placed in the circuit in the AUTO position of the switch because a suitable level of audio-signal output cannot be permanently predetermined but depends upon the external noise and aural acuteness of the operator. The automatic gain-control circuit of the receiver is so designed that the controlled signal output, with knob 331 in its maximum position, is too great for suitable reception except under the most unfavorable conditions.

Other cases can be assumed with the switch on control box, type BC-AA-181, in the MANUAL or AUTO positions and with the switch on control box, type BC-AA-182, in the MIC or KEY position instead of in the REC position. After a little practice it is comparatively easy to trace the various circuits in figure 31.




43166°—34. (Face p. 37.)

FIGURE 33.—Circuit diagram, radio set, type SCR-AA-192.

As a summary, assuming toggle switch 111 in the TRANS-REC position, the following table is given:

*Control box, type BC–AA–181:*

OFF: Dynamotor off. Receiver and transmitter filaments off.

MANUAL: Dynamotor on. Transmitter and receiver filaments on. Plate voltage on either transmitter or receiver but not both.

AUTO: Dynamotor on. Transmitter and receiver filaments on. Plate voltage on either transmitter or receiver but not both.

*Control box, type BC–AA–182:*

(With control box, type BC–AA–181, on MANUAL or AUTO.)

REC: Plate voltage on receiver. Plate voltage off transmitter.

KEY: Plate voltage off receiver. Plate voltage on transmitter radio oscillator and modulator; on radio amplifier and tone oscillator through key.

MIC: Plate voltage off receiver. Plate voltage on transmitter radio oscillator, radio amplifier, and modulator. Off tone oscillator.

**11. Radio set, type SCR–AA–192.**—All of the parts of this radio set are also parts of the radio set, type SCR–AA–183, with the exception of the four coil sets, types C–98, C–99, C–100, and C–101. The function of the coils and other parts was discussed in paragraph 10. Figure 33 shows the circuit diagram of the radio set, type SCR–AA–192. This is included, as it is somewhat simpler than figure 31, which includes the additional units which are a part of the radio set, type SCR–AA–183, but not of this radio set.

## Section VI

## CARE, MAINTENANCE, AND REPAIR



**12. Care of sets.**—All units of both radio sets, types SCR–AA–183 and SCR–AA–192, are ruggedly built. They are made to stand the shocks of landing and the shaking and vibration that are encountered in an airplane. They should not, however, be subjected to needless dropping, rough handling, etc. All units should be kept clean and dry and the same care given to them as to any other precision apparatus.

**13. Maintenance and repair of sets.**—*a.* On account of certain guarantees by the makers, it is not contemplated that any repairs will be made on these radio sets in the field. If any part fails, the unit containing the failure must be handled in accordance with supply letters nos. 2 and 3, office of the Chief Signal Officer, 1933.

*b.* Each radio set should be given an inspection before each flight covering the following:

(1) See that the proper coil set is in the receiver for the required frequency band.

(2) Examine tubes in both receiver and transmitter. Be sure that each tube is in the socket marked for that type and that all control grid clips are attached. Push each tube all the way into its socket.

(3) See that all snap slides are securely closed and each plug is locked in its receptacle.

(4) Check operation of switch controls. Set controls at MANUAL and REC and be sure the receiver is operating. If possible, tune in signals from a distant station.

(5) Set selector switch at MIC and note transmitter current reading. Talk into the microphone. If the transmitter is modulating properly the antenna current will vary slightly with the modulation. Note side tone in telephones.

(6) Check telephone cord and plug.

(7) Check receiver antenna alinement.

(8) Check ignition and generator noise in the receiver.

(9) Measure supply voltage with airplane engine running at least 1,500 revolutions per minute. Do not allow radio set to be operated if this voltage is less than 12 volts or more than 14.25 volts.

NOTE.—Never operate the radio set on the ground longer than is necessary to complete this inspection Never leave the airplane without turning control box switch OFF.

*c.* Assuming that the above inspection has been made before each flight, the following inspection should be made every 30 hours or at least once a month. (Instructions are put out from time to time by means of inspection circulars from the office of the Chief of the Air Corps. These instructions should be strictly followed. Items listed in this paragraph are given as an aid or reminder in making inspections and *do not* take the place of these inspection requirements.)

(1) Check airplane battery with hydrometer.

(2) Check operation of voltage regulator of charging generator and adjust to assure its consistent operation at 14.25 volts.

(3) Using a high-resistance voltmeter, measure the voltages to ground of the various terminals in the junction box as listed in the following table. Satisfactory operation cannot be expected unless all these voltages are within 10 percent of their rated values.

*Controls at MANUAL and MIC*

| Voltages to ground with 12 volts supply | Voltages to ground with 14 volts supply | Terminals |
|---|---|---|
| *Volts* | *Volts* | |
| 12 | 14 | 14, 15, 34, 38, 44, 45. |
| 10 | 10. 7 | 33, 51. |
| 188 | 220 | 21, 22, 29, 40, 41, 48. |
| 195 | 232 | 31, 57. |

*Controls at MANUAL and REC*

| Voltages to ground with 12 volts supply | Voltages to ground with 14 volts supply | Terminals |
|---|---|---|
| *Volts* | *Volts* | |
| 12 | 14 | 14, 15, 38, 44, 45. |
| 2 | 2. 5 | 17, 46. |
| 100 | 117 | 39, 47. |
| 175 | 205 | 31, 57. |
| 200 | 235 | 29, 30, 48, 49, 56. |

*Total input*

| Supply voltages | Supply current |
|---|---|
| *Volts* | *Amperes* |
| 12 | 5. 6 |
| 14 | 6. 1 |

(4) Check voltages on the tubes in the receiver. The following table shows typical values for 14 volts' supply with the control switches on MANUAL and REC, control grids short-circuited to ground and volume control MAX.

| Tube | Heater | Cathode to ground (control grid bias) | Screen grid to ground | Plate to ground |
|---|---|---|---|---|
| | *Volts* | *Volts* | *Volts* | *Volts* |
| First R.F. (VT-36) | 6. 9 | 5. 5 | 117 | 220 |
| Second R.F. (VT-36) | 6. 9 | 5. 5 | 117 | 209 |
| Third R.F.(VT-36) | 6. 9 | 5. 4 | 115 | 199 |
| Fourth R.F. (VT-36) | 6. 9 | 4. 4 | 114 | 192 |
| Det. (VT-37) | 6. 9 | | | |
| Audio (VT-38) | 6. 9 | 13. 9 | 137 | 175 |

(5) Check voltages on transmitter tubes. The following table shows typical plate and bias voltages, assuming 14 volts' supply with controls on MANUAL (or AUTO) and MIC.

| Tube | Grid bias to ground (not filament) | Plate voltage to ground |
|---|---|---|
| Radio oscillator (VT-25) | Variable | 200 volts. |
| Radio amplifier (VT-25) | −75 volts | 220 volts. |
| Modulator (VT-52) | −32 volts | 220 volts. |
| Audio oscillator (VT-25) | Variable | 0 (185 on KEY). |

(6) Check bonding of cords and antenna and ground wire connections.

(7) Clean all antenna insulators, particularly those which may be exposed to the engine exhaust, and check contacts on the lead-in insulators.

NOTE—The bearings of the dynamotor units are to be lubricated about every 300 hours.

**14. Troubles and their remedies.**—The following general principle should be remembered and constantly followed in connection with this equipment:

***When looking for trouble in a radio set always examine all the simple causes of failure first.***

Many good radio sets have been ruined by internal alterations when the service failure was really due to a cord, a plug, a power supply, or a tube. Radio receiver, type BC-AA-179, is electrically a complicated system, depending upon precise design, workmanship, and adjustment for its successful operation. Inspections and operations performed on the interior of this equipment which are suggested in the following paragraphs should be done only as a last resort, and after it is certain that the fault is not be to found outside the receiver.

*a. Receiver operative but noisy.*—(1) Probably the most common cause of poor radio reception in all airplane installations of high-sensitivity receivers is electrical "noise" of both local and atmospheric origin. Operators of these radio sets should learn by experience to identify those "noises" in the telephone receivers which indicate faults in the apparatus or installation. Such identification by ear will greatly facilitate the correction of the fault. The following tabulation may be used as a guide:

(*a*) *Atmospherics (static), external man-made interference.*—Should be identified on the ground, engine not running. Static will be heard with coil sets, types C–97, C–98, and C–99, at all seasons of the year and most times of day. The general static level grows progressively lower with increasing frequency. The receiver cannot be adequately tested or inspected in ground locations where power-line interference, motor interference, and the like are excessive. Disconnecting the antenna at the receiver binding post will generally give a satisfactory test, since if the noise encountered is static or power-line interference it will greatly diminish or disappear when the antenna is disconnected.

(*b*) *Dynamotor noise.*—Should be identified on the ground, engine not running; usually related to the speed of the machine and can be identified by switching the power on and off at the control box.

(*c*) *Intermittent contact in phone cord, plug, or contacts to telephone receivers.*—Should be identified on ground, engine not running.

(*d*) *Loose bond or terminal plug on any receiver cord.*—Should be identified on ground, engine not running.

(*e*) *Ignition noise.*—Should be identified on ground, engine running, by varying the speed of the engine and by switching from one magneto to the other.

(*f*) *Generator noise.*—Should be identified on ground, engine running, by advancing the throttle to the point at which generator cuts in. If it originates in the generator itself, it will be a characteristic "machine noise"; if in the voltage regulator it will probably be intermittent and appear only above a certain critical engine speed (usually 800 to 1,000 r.p.m.). Noise originating in the generator or voltage regulator can be distinguished from ignition noise by the fact that generator and voltage regulator noise is usually suppressed by opening main line switch.

(*g*) *Vacuum tube noise.*—Should be identified on ground, engine running; usually a crackling or ringing sound. It will sometimes appear under sustained vibration and never be heard at all when the receiver set box is jarred intermittently by hand.

(*h*) *Intermittent contact in an internal circuit of the receiver.*—May be identified with the engine running or by jarring the receiver by hand. Disconnecting the antenna and vibrating the receiver is not necessarily a test because noises of this character may be increased to audibility by a strong incoming signal.

(2) With regard to (1) (*a*) above it should be noted that it is no uncommon occurrence for man-made interference to be received with destructive force when flying over certain areas, and to be of such nature that it is easily confused with generator or dynamotor noise on the airplane itself. If "machine" noises are suddenly heard in flight they may possibly be identified solely with a particular ground area. Also it should be remembered that when flying through mist, rain,

or snow, a noise is sometimes heard which sounds like a machine noise; it is produced by the impact of the charged particles on the receiving antenna and airplane, and is irremediable.

(3) With regard to (1) (*b*) above the interruption of current in the commutators of the dynamotor machine sets up radio-frequency oscillations in the connecting cords, which oscillations enter the receiver by way of the antenna (never through the conductors of the cords themselves; this fact may be verified by disconnecting the antenna at the receiver binding post). The transmission of dynamotor noise to the receiver is related to the condition of bonding of the cords, particularly at high frequencies. A dirty commutator will produce more noise than a clean one, but complete suppression can never be obtained if the shielded cords are not thoroughly bonded and grounded. This fact should be remembered when making bench installations of the radio set for test purposes. When this noise occurs in an airplane installation the bonding of all cords to the airplane should be checked for poor contacts. If the noise persists the commutators of the machine may be cleaned with fine sandpaper, grade 000 or finer, while the machine is turning over. Never use emery on a commutator. A trace of oil or grease on a commutator may cause more trouble than a dirt deposit. The low-voltage commutator is more apt to produce noise than the high-voltage commutator. Access to the brushes and commutators of dynamotor 145 is obtained by removing the cover bands 177 which are each secured by one bolt. Similar access in dynamotor 146 is obtained by removing end covers 213 which are secured by screws 216. Brushes 190 and 192 on dynamotor 145 are held in their respective holders by springs which pass through slots in the sides of these holders. See that these springs are centered in their slots and are free to exert pressure on the brushes as the brushes wear. If these springs catch or bind, the brushes will wear unevenly and the machine will become noisy. See that the pigtail connections attached to the brushes are clear of the holders and do not catch on the holder as the brushes wear. Under normal operating conditions the commutators of these enclosed machines should not require cleaning oftener than about 300 hours. But if the dynamotor is noisy or inefficient and the cause of the trouble cannot be located elsewhere, the commutators may be cleaned with fine sandpaper as described above. In case it becomes necessary to install new brushes the machine must be run for approximately 20 hours at normal load to form and set the new brushes. Quiet operation cannot be expected until the brushes are properly seated by this process.

(4) The fault in (1) (*c*) above is a very common but easily remedied cause of complete interruption of service because of the severe wear to which these items are subjected.

(5) With regard to (1) (*f*) above generator and voltage regulator noise is frequently a more elusive fault than ignition interference. A temporary remedy if the generator becomes noisy in the air is to open its field while receiving, but this is not a cure and should not be permanently tolerated. Complete shielding will not always cure voltage-regulator interference. For best results the voltage-regulator output should be electrically filtered. A method of doing this which is effective in many installations is to connect a condenser of ½-mfd. capacity between the positive generator field terminal and ground and a second condenser of ½-mfd. between the positive 14.25-volt output terminal and ground. To be effective this must be done at the generator, using the shortest possible leads.

(6) With regard to (1) (*g*) above, an intermittent contact inside a tube is sometimes the first indication that its useful life is over. Noises originating in the tubes are greatly accentuated by the presence of a strong incoming radio signal, particu-

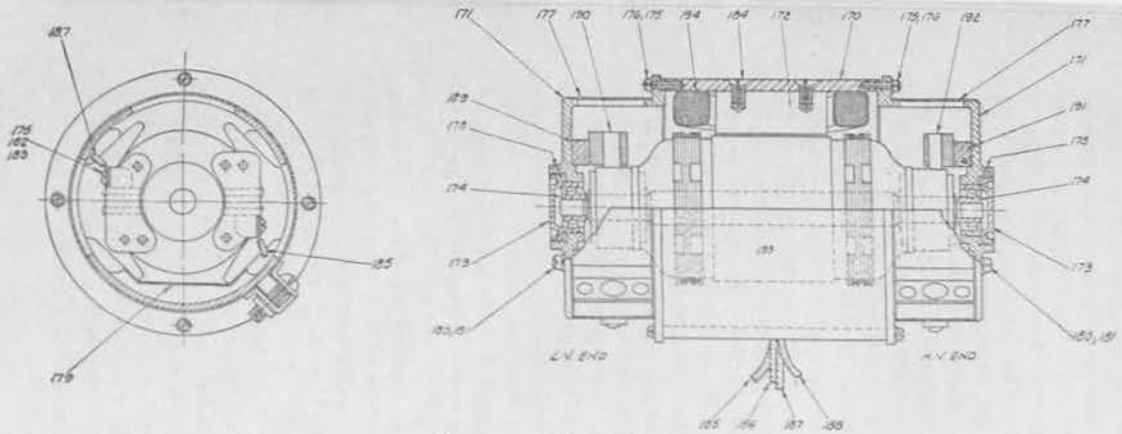



FIGURE 34.—Views of dynamotor 145 for dynamotor unit, type BD-AA-69.

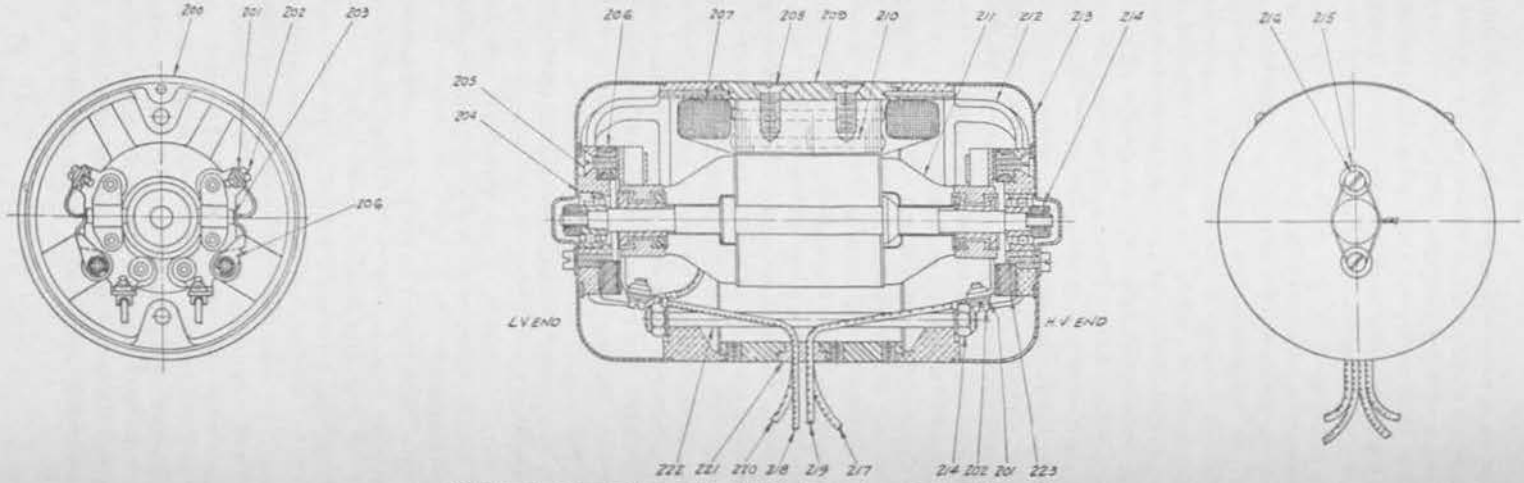



FIGURE 35.—Views of dynamotor 146 for dynamotor unit, type BD-AB-69.

larly an unmodulated signal, and this may be used as a means of identifying such a noise. The faulty tube must be isolated by replacing the tubes one by one with new ones and observing when the disturbance vanishes.

(7) If the trouble is due to faults in (1) (*h*) above the receiver must be dismounted and inspected internally for loose connections. To remove the receiver chassis from its case, first take out the coil set, then remove from the set box 12 bright-finished (dull silver) screws. Do not lose the lock washers from these screws; these washers must all be replaced when screws are replaced. The front panel may then be separated from the case which slides backward off the frame. Black-headed screws and rivets must not be removed from any part of the receiver. Do not disarrange the internal wiring of the receiver during this inspection.

(8) Operating the receiver at excessively high voltage tends to make it noisy during operation and to increase the residual causes of noise. ***Never allow the radio set to be operated at a supply voltage greater than 14.25 volts.*** Operation at less than 12 volts will not damage the equipment but the radio reception will be unsatisfactory.

*b. Receiver dead—No sounds.*—(1) Having checked all plug and cord connections, dismount the junction box with cords attached and check all voltages with reference to the tables in paragraph 13c. Inspect junction box wiring for open circuits. Try another coil set. Be sure that coil sets are securely seated. If dynamotor does not run—

(*a*) Check fuse 110 and renew if it is open;

(*b*) Substitute another dynamotor unit and if it runs, look for an open circuit at the low-voltage brushes of the first machine;

(*c*) Check circuit through control box switch in MANUAL or AUTO position, starting at 44 and ending at 38 in junction box. If dynamotor runs, but voltage on terminal 29 or 31 is low, check the continuity of high-voltage circuits through resistor 141, choke 144, and choke 143 in dynamotor unity base. Check condensers 142 for short circuits. If all voltages on receptacle 108 of plug, type PL-61, are normal, check volume-control circuit with switch at MANUAL, through terminal 17 to ground. This circuit should show 300 ohms resistance at maximum INCREASE position of volume control. If this circuit is normal and receiver is still inoperative it should be dismounted for a bench test.

(2) Remove the receiver case and inspect the wiring for short circuits. Check transformer 75, condenser 156, and coil 74 for open circuits between their respective terminals. Check the coil set for open circuits between the respective pairs of terminals which are closed by windings. (See fig. 32.) Inspect contacts of all tube sockets. Mount coil set and plug receiver into a complete radio set; throw the power on and with switch at MANUAL, check the voltage on each electrode of each tube by connecting a high-resistance voltmeter between the different electrodes and ground. Compare the readings with those of the table in paragraph 13c (4).

*IMPORTANT NOTE.*—All readings of electrode bias voltages and supply voltages in the receiver should be made with the switch on MANUAL and the control grid of each of the four type VT-36 tubes connected to ground and with the control grid clips in place on their respective tubes. If this condition is not fulfilled the receiver will oscillate, since it is out of its shielding case and the voltage readings will be abnormal.

(3) If there is no plate voltage on one tube, check the contacts made between the various pin plugs 325 and their respective receptacles on the coil set. These pin plugs may become distorted after long use; their ability to make contact can

be restored, unless the springs are fractured, by tapping each plug on the end to spread the contact springs. If the cathodes or screen grids do not show approximately the same voltages as those in the table in paragraph 13c (4), check the circuits through the various decoupling resistors in supply lines from 46 to the cathodes, 47 and 56 to the screen grids, and 56 to the plates. If an ohmmeter is available check the values of these resistors. Check all by-pass condensers 1, 2, 3, 4, 5, 6, 7, 8, and 9 for internal short circuits. Check resistors 66, 62, 67, 68, 70, and 72 for open circuits. Check the continuity of the line starting at the grids of the first two VT-36 tubes on one side and passing through terminal 19 of the junction box and control box. Check the neon tube 76 for a short circuit. Under normal service conditions this tube will last for the life of the receiver without replacement. Replace each vacuum tube with a new one of the same type. A tube may lose its emission without becoming noisy.

*c. Receiver operative but insensitive.*—(1) Check alinement of antenna.

(2) Check junction box voltages with the radio set turned on. Dead 12-volt batteries are the reason for a large number of communication failures. If voltages are normal, check the tubes by replacing them with new ones, one at a time.

(3) Try another coil set.

(4) As a last resort check the alinement of each tuned amplifying stage. This operation should not be done in the field but must be done on the bench, since it is an operation requiring considerable care. Access to the alining condensers 59 is obtained through the rotatable snap covers 343 on the side of the receiver case. Connect the receiver to an antenna (or to a dummy antenna if a local signal source is available) and tune in a signal on any coil set at the high-frequency end of the scale (75 to 100 scale divisions). Retard the volume control until the signal is just audible. This operation should be performed on a steady tone modulated signal, not a radiophone signal, or a signal that is fading. Aline the antenna carefully with knob 160. Insert an insulated screw driver into the 3 slotted adjusting screws which control the 3 condensers 59 and adjust them successively for maximum signal.

NOTE.—If it is impossible to find a maximum or if the maximum signal is not located very close to the original positions of these screws, the fault is in the circuit or the gang condensers and not in the settings of these condensers, and they should be restored as closely as possible to their former positions.

(5) If the tuned stages are in proper alinement or if it is impossible to tune to maximum signal on the alining condensers, the fault must be in the circuits of the receiver or in the gang-tuning condenser.

*d. Receiver oscillates.*—(1) The presence of sustained oscillations in the receiver is always identified by—

(*a*) A heterodyne beat note with incoming signals which varies as the receiver is tuned.

(*b*) An increase in all noise levels.

(*c*) Occurrence at or near the maximum INCREASE position of the volume control, with reduction or suppression as this control is retarded.

While abnormal in this radio receiver, self-oscillation is not always a bar to the reception of signals because if the receiver is otherwise normal such oscillation can usually be entirely controlled by the volume control. The receiver will usually oscillate at the maximum INCREASE position if the supply-voltage source is too high, and this is not an indication of a fault. If the receiver oscillates at 12 volts in one or more frequency bands, it indicates a fault.

(2) Check all snap slides on the coil set and the tube cover. If any of these snap slides do not make good contact with their respective studs, due to the presence of dirt or other reasons, the receiver may oscillate.

(3) Check the radio-frequency tubes by replacements with different tubes but not old ones. Occasionally a tube with imperfect internal shielding is encountered; this can cause self-oscillation.

(4) Check all the screws in the receiver case. See that there is a lock washer under the head of each screw. If one of the bright-plated screws is omitted or not screwed down tight, the receiver may be unstable and oscillate.

(5) If the condition of oscillation is permanent and violent, the case should be removed from the receiver and an internal inspection carried out. Open circuits in the supply lines will not cause oscillation. The various grid and plate voltages should be measured as outlined under *b* above. Abnormally high screen and plate voltage or abnormally low-control grid bias may be sufficient cause for oscillation.

(6) A sufficient cause for oscillation in the receiver is an open circuit in one of the various by-pass condensers 1, 2, 3, 4, 5, 6, 7, 8. Since the terminals of these condensers are connected together through other condensers or through resistors of various sizes it is necessary first to disconnect all leads from the ungrounded terminal of each condenser under test. A rough test for capacity between the condenser terminals can then be made if a capacity meter is not available by charging the condenser with a 45-volt or 90-volt B battery. Ground one side of the battery on the receiver frame and touch the other side of the battery to the open condenser terminal. Remove the battery connection and touch this terminal with a grounded wire. If the condenser is in good condition it will discharge with a visible flash or spark. A by-pass condenser which is not open or leaky will retain for at least 10 seconds enough charge to spark visibly when discharged to ground. When leads to condensers 1, 2, 3, 4, 5, 6, 7, 8 are unsoldered or restored great care must be taken not to melt out the lugs of these condensers. These lugs must under no circumstances be heated for any length of time. If this soldering is done carelessly the condensers may open up internally as a result of the soldering operation.

*e. Low transmitter current on MIC or KEY.*—(1) Examine all insulators for short circuits, moisture, and carbon deposits and terminals for open or dirty contacts in the transmitting antenna.

(2) Retune the antenna coupling circuit by varying either the antenna condenser or coil tap, or both. Do not allow dirt to get into the antenna coil assembly.

(3) Check supply voltage and junction box voltages.

(4) Replace with new tubes the radio oscillator and amplifier tubes, type VT–25.

(5) If these tests show no results the transmitter should be dismounted for a bench test. For use in bench testing it is necessary to provide an artificial or dummy antenna or the tests will mean nothing. Never operate the transmitter unless an antenna circuit is connected between antenna and ground binding posts. This will ruin the tubes and shorten the life of the whole equipment. The following extra equipment is required for bench testing the transmitter:

(*a*) Antenna, type A–55.

(*b*) High-resistance voltmeter.

(*c*) Direct-current milliammeter, scale 0–100 milliamperes, with plug to fit the transmitter jacks 104, 105. The table in paragraph 5*a* gives a typical set of values of the significant currents in the transmitter

at 12 and 14 volts supply. The antenna current is obtained in this case in antenna, type A–55, connected between the transmitter binding posts. The controls are set at MANUAL and MIC.

(6) The current values given in the table (par. 5*a*) are not exactly reproducible but will serve as a general guide to show the average or approximate values that should be obtained when testing the transmitter.

(7) If no current is indicated by the antenna ammeter for any combination of settings of the controls when antenna, type 55, is connected between the binding posts this may indicate an open circuit in the antenna ammeter. The continuity of the circuit through the ammeter and antenna coil may be checked by connecting a voltmeter and dry cell between binding posts A and G. Never use an external source of voltage in series with an external ammeter as this may burn out the antenna ammeter if this circuit is complete.

(8) It should be noted that the readings given above for the various plate currents are all for resonance in the antenna circuit. If the antenna circuit is not tuned to give a maximum of current on the antenna ammeter the plate current readings for all the tubes will have no significance. In general, the antenna tuning adjustment which gives resonance and maximum current on the antenna ammeter is the point of greatest efficiency of operation, and is accompanied by minimum currents in the plate circuits of all the tubes.

(9) If the plate currents depart widely from the above at resonance at a given frequency setting the transmitter chassis should be removed from its case (first dismounting the antenna coil) for internal examination. Measure with a high-resistance voltmeter the bias voltages across resistors 80 and 81. If the plate current is zero from one tube the various plate supply circuits should be traced from the junction box through the control box, type BC–AA–182, and through resistor 79 to the radio oscillator and transformer 101 to the radio amplifier and modulator tube.

*f. No side-tone from voice modulation.* (MIC position.)—(1) The side-tone circuit is connected to the plate circuit of the type VT–52 modulator tube, so this may indicate a lack of modulation. Check the microphone, its cord, and plug.

NOTE.—It is recommended that with microphones having a button switch on the side of the handle, this switch be kept locked in its closed position since it serves no useful purpose in radio set, type SCR–AA–183.

(2) Jar the microphone. Try another microphone.

(3) Be sure the modulator tube is lighted and is firmly in its socket. A burned-out filament in the audio-oscillator tube will open the filament circuit of the modulator. Try different modulator tubes.

(4) Dismount the transmitter and check the continuity of the microphone circuit from terminal 33 through winding 5–6 of coil assembly 102, through winding MF of transformer 100 back to terminal 34. Terminal 34 is a 12- to 14.25-volt terminal which supplies energizing current to the microphone through the circuit just traced, to tip of the microphone jack 130 which is grounded.

(5) If the antenna current varies when talking into the microphone but side-tone is weak or absent, the transmitter output is probably being modulated but the fault is in the side-tone circuit, which should be checked for continuity from the side-tone condenser 86 through terminals 23 and 18 to the telephone jacks 123. The side-tone voltage will be low if a radio receiver connected for low-impedance phones is connected to cord, type CD–111, and side-tone condenser 86 is left in the circuit alone, whether high-impedance telephone receivers are used or not.

NOTE.—For satisfactory operation the microphone must be operated with its diaphragm in a vertical plane.

*g. No side-tone on KEY.*—(1) Having applied the tests for operation of the modulator tube described in *f* above, try a new audio-oscillator tube, type VT–25.

(2) Measure the voltage at terminal 32 of the transmitter and the plate voltage of the audio oscillator at terminal 1 of coil assembly 102. This voltage should be about 30 volts lower than the voltage on terminal 32. Check all three windings of coils 102 for continuity. Check condenser 84 for short circuit and open circuit.

*h. Antenna ammeter shows current on KEY.*—(1) Position when key is not pressed.

(2) This is an indication that the balancing condenser 96 is out of adjustment. The proper adjustment of this condenser is an operation requiring great care and should not be attempted unless it is certain that the apparent departure from balance is not due to a damaged condition of the amplifier tube. A new radio amplifier tube, type VT–25, should be plugged into the set. If the effect persists set the controls on MIC and MANUAL and tune the antenna circuit carefully. Do not remove the chassis from the set box. Remove tube cover and open the snap cover 349, under which there is a hexagonal cone nut which adjusts condenser 96. Use socket wrench entirely constructed of insulating material; do not try to adjust this condenser with a metal wrench. Throw the transmitter control to KEY, but do not depress key. Observe current reading on antenna ammeter. Keeping the antenna in resonance by simultaneously varying the antenna condenser 95, carefully adjust the cone nut on condenser 96 until the current reading becomes zero on the antenna ammeter. This will occur at only one point; the current will appear again at values of capacity in condenser 96, which are above and below the balance point. The antenna current will be extremely small near the balance point on condenser 96, and this ammeter should be carefully watched.

## SECTION VII

## LIST OF PARTS AND REFERENCE LIST



**15. List of parts.**—*a. Radio set, type SCR–AA–183:*

2 books, instruction
1 case, type CS–44
1 chart, type MC–128
1 coil set, type C–97 (224 to 448 kc)
1 coil set, type C–102 (4,150 to 7,850 kc)
*1 cord, type CD–110 (18, 13¾, 8, 6, 4½, or 2½ feet long)
*1 cord, type CD–111 (13, 10, 9, 7, 6, or 3 feet long)
*1 cord, type CD–112 (16, 8, 6, 4½, 3, or 1½ feet long)
*1 cord, type CD–113 (20, 9, 8, 6½, 5½, or 5 feet long)
*1 cord, type CD–114 (24, 13, 8, 6½, or 4½ feet long)
*1 cord, type CD–115 (20, 9, 7½, 6½, or 6 feet long)
1 dynamotor unit, type BD–AA–69 or BD–AB–69 (includes mounting, type FT–102)
1 headset, type HS–18
12 insulators, type IN–78
4 insulators, type IN–79
1 junction box, type TM–AA–153 (includes mounting, type FT–101, and 2 spare fuses, type FU–11)

* Lengths vary to fit various types of aircraft.

1 radio control box, type BC–AA–181 (for receiver)
1 radio control box, type BC–AA–182 (for transmitter)
1 radio receiver, type BC–AA–179 (includes mounting, type FT–99)
1 radio transmitter, type BC–AA–180 (includes mounting, type FT–100)
1 transmitter, type T–11
9 tubes, type VT–25 (3 in use—6 spare)
12 tubes, type VT–36 (4 in use—8 spare)
3 tubes, type VT–37 (1 in use—2 spare)
3 tubes, type VT–38 (1 in use—2 spare)
3 tubes, type VT–52 (1 in use—2 spare)
*1 tuning shaft, type MC–124 (20, 12, 9½, 8, or 6 feet long)
1 tuning unit, type MC–125
1 tuning unit, type MC–127
150 feet wire, type W–106

*b. Radio set, type SCR–AA–192:*

2 books, instruction
5 cases, type CS–44
1 chart, type MC–128
1 coil set, type C–97 (224 to 448 kc)
1 coil set, type C–98 (400 to 800 kc)
1 coil set, type C–99 (775 to 1,500 kc)
1 coil set, type C–100 (1,400 to 2,600 kc)
1 coil set, type C–101 (2,500 to 4,700 kc)
1 coil set, type C–102 (4,150 to 7,850 kc)
*1 cord, type CD–110 (18, 13¾, 8, 6, 4½, or 2½ feet long)
*1 cord, type CD–111 (13, 10, 9, 7, 6, or 3 feet long)
*1 cord, type CD–112 (16, 8, 6, 4½, 3, or 1½ feet long)
*1 cord, type CD–115 (20, 9, 7½, 6½, or 6 feet long)
1 dynamotor unit, type BD–AA–69 or BD–AB–69 (includes mounting, type FT–102)
1 headset, type HS–18
6 insulators, type IN–78
2 insulators, type IN–79
1 junction box, type TM–AA–153 (includes mounting, type FT–101 and 2 spare fuses, type FU–11)
1 radio control box, type BC–AA–181
1 radio receiver, type BC–AA–179 (includes mounting, type FT–99)
12 tubes, type VT–36 (4 in use—8 spare)
3 tubes, type VT–37 (1 in use—2 spare)
3 tubes, type VT–38 (1 in use—2 spare)
*1 tuning shaft, type MC–124 (20, 12, 9½, 8, or 6 feet long)
1 tuning unit, type MC–125
1 tuning unit, type MC–127
75 feet wire, type W–106

**16. Reference list.**—Following is a reference list of the individual parts of the radio sets, types SCR–AA–183 and SCR–AA–192, listed with their respective reference numbers. These are the numbers associated with these parts in the various illustrations and throughout the text.

* Lengths vary to fit various types of aircraft.

NOTE.—The oscillator equipment, type RC–12, is not a part of either radio set but can be used with either set for the reception of CW signals. If used, this oscillator would be attached to the junction box, type TM–AA–153, with the cord, type CD–122, which is furnished with the RC–12.

| Reference no. | Description |
|---|---|
| 1 | By-pass condenser, screen grids. 0.1 mfd. (2×0.1). |
| 2 | By-pass condenser, plates. 0.1 mfd. (2×0.1). |
| 3 | By-pass condenser, cathodes. 0.1 mfd. (2×0.1). |
| 4 | Filter condenser, A.G.C. 0.1 mfd. (2×0.1). |
| 5 | By-pass condenser, heaters. 0.1 mfd. (2×0.1). |
| 6 | By-pass condenser, cathodes. 0.5 mfd. |
| 7 | By-pass condenser, screen grid. 0.5 mfd. |
| 8 | By-pass condenser, plate. 0.5 mfd. (2×0.5). |
| 9 | By-pass condenser, screen grid. 0.5 mfd. (2×0.5). |
| 10 | Filter condenser. 0.002 mfd. |
| 11 | Coupling condenser. 0.006 mfd. |
| 12 | Filter condenser. 0.0001 mfd. |
| 13 | Coupling condenser. 0.0001 mfd. |
| 14–57 | Plug and receptacle terminals. |
| 58 | Amplifier tuning condenser (unit of gang). |
| 59 | Amplifier alining condenser. |
| 60 | Decoupling resistor, screen grid. 1,000 ohms. |
| 61 | Decoupling resistor, plates. 1,000 ohms. |
| 62 | Bias resistor. 1,000 ohms. |
| 63 | Bias resistor, cathodes. 500 ohms. |
| 64 | Decoupling resistor, A.G.C. 5,000 ohms. |
| 65 | Drop resistor, screen grid. 30,000 ohms. |
| 66 | Grid resistor. 100,000 ohms. |
| 67 | Grid resistor. 500,000 ohms. |
| 68 | Coupling resistor. 500,000 ohms. |
| 69 | Filter resistor, A.G.C. 1,000,000 ohms. |
| 70 | Grid resistor. 2,000,000 ohms. |
| 71 | Tuned radio coil assembly for—<br>Coil set, type C–97.<br>Coil set, type C–98.<br>Coil set, type C–99.<br>Coil set, type C–100.<br>Coil set, type C–101.<br>Coil set, type C–102. |
| 72 | Filter resistor. 100,000 ohms. |
| 73 | Band-pass coil condenser:<br>500 mmfd. (C–97).<br>150 mmfd. (C–98). |
| 74 | Output filter choke. 2 henry. |
| 75 | Output transformer. |
| 76 | Neon tube. |
| 77 | Grid resistor. 100,000 ohms. |
| 78 | Drop resistor. 5,000 ohms. |
| 79 | Drop resistor. 2,000 ohms. |
| 80 | Bias resistor. 7,500 ohms. |
| 81 | Bias resistor. 10,000 ohms. |
| 82 | Grid resistor. 30,000 ohms. |
| 83 | Grid condenser. 0.006 mfd. |
| 84 | Tone oscillator condenser. 0.07 mfd. |
| 85 | Side-tone condenser. 0.006 mfd. |
| 86 | Side-tone condenser. 0.001 mfd. |
| 87 | By-pass condenser amplifier plate. 0.001 mfd. |
| 88 | By-pass condenser, filaments. 0.1 mfd. (2×0.1). |
| 89 | By-pass condenser, radio oscillator plate. 0.1 mfd. (2×0.1). |
| 90 | By-pass condenser, radio amplifier grid. 0.5 mfd. |
| 91 | Grid condenser. 0.00011 mfd. |
| 92 | Coupling condenser. 0.00011 mfd. |
| 93 | Radio oscillator tuning condenser. |
| 94 | Radio oscillator padding condenser. |
| 95 | Antenna tuning condenser. |
| 96 | Balancing condenser. |
| 97 | Drift compensator. |
| 98 | Antenna coupling coil assembly. |
| 99 | Radio oscillator coil assembly. |
| 100 | Microphone transformer. |
| 101 | Modulation transformer. |
| 102 | Tone oscillator coil assembly. |
| 103 | Radio choke. |
| 104 | Modulator, radio oscillator plate current jack. |
| 105 | Amplifier plate current jack. |
| 106 | Antenna-current ammeter. 0–1 ampere. |
| 107 | Compensating condenser. 13 mmfd. |
| 108 | Socket, type SO–41. |
| 109 | Socket, type SO–41. |
| 110 | Fuse, type FU–11. |
| 111 | Toggle switch. |
| 112 | Socket, type SO–44. |
| 113 | Socket, type SO–44. |
| 114 | Socket, type SO–40. |
| 115 | Socket, type SO–40. |
| 116 | Socket, type SO–36. |
| 117 | Socket, type SO–36. |
| 118 | Mounting bracket assembly. |
| 119 | Antenna tap (part of coil 98). |
| 120 | Manual gain-control resistor. 0–110,000 ohms. |
| 121 | Bias resistor. 300 ohms. |

| Reference no. | Description |
|---|---|
| 122 | A.G.C. level-adjusting resistor. 0–100,000 ohms. |
| 123 | Telephone jack. |
| 124 | Rotary switch assembly (BC–AA–181). |
| 125 | Socket, type SO–45. |
| 126 | Socket, type SO–45. |
| 130 | Microphone jack. |
| 131 | Key. |
| 132 | Rotary switch assembly (BC–AA–182). |
| 133 | Socket, type SO–43. |
| 134 | Socket, type SO–43. |
| 135 | Key adjusting screw. |
| 140 | Voltage-divider resistor. 7,500 ohms. |
| 141 | Filter resistor. 5,000 ohms. |
| 142 | Filter condenser. 0.8 mfd. (3×0.8). |
| 143 | Filter choke. 8 Henry. |
| 144 | Radio choke. 0.015 mh. |
| 145 | Dynamotor, Westinghouse, part of dynamotor unit, type BD–AA–69. |
| 146 | Dynamotor, Eclipse, part of dynamotor unit, type BD–AB–69. |
| 147 | Socket, type SO–42. |
| 148 | Socket, type SO–42. |
| 149 | Antenna binding post. |
| 150 | Ground binding post. |
| 151 | Antenna series condenser. |
| 152 | Receiver dial. |
| 153 | Frequency-control knob. |
| 154 | Frequency-control dial. |
| 155 | Antenna condenser knob. |
| 156 | Output stoppage condenser. 0.5 mfd. |
| 157 | Coil, band-pass radio coil assembly. |
| 158 | Band-pass radio coil assembly for—<br>Coil set, type C–97.<br>Coil set, type C–98. |
| 159 | Band-pass radio coil assembly for—<br>Coil set, type C–99<br>Coil set, type C–100.<br>Coil set, type C–101.<br>Coil set, type C–102. |
| 160 | Antenna series condenser knob. |
| 161 | Dynamotor unit box cover. |
| 162 | Junction box housing cover. |
| 170 | Dynamotor frame. |
| 171 | Bracket. |
| 172 | Pole, complete. |
| 173 | Bearing cap. |
| 174 | Ball bearings. |
| 175 | Lock washer. |
| 176 | 40 by 3/8 filister head iron machine screws. |
| 177 | Cover, complete. |
| 178 | Set screw. |
| 179 | Wedge. |
| 180 | 32 by 3/8 filister head iron machine screws. |
| 181 | Lock washer. |
| 182 | Clip. |
| 183 | 40 by 1/4 round head iron machine screws. |
| 184 | 32 by 3/8 flat head iron machine screws. |
| 185 | Negative lead, black, low-voltage. |
| 186 | Negative lead, black, high-voltage. |
| 187 | Positive lead, white, low-voltage. |
| 188 | Positive lead, red, high-voltage. |
| 189 | Rocker ring, complete, low-voltage. |
| 190 | Carbon brush, complete, low-voltage. |
| 191 | Rocker ring, complete, high-voltage. |
| 192 | Carbon brush, complete, high-voltage. |
| 193 | Armature assembly. |
| 194 | Field coil set. |
| 200 | Low-voltage head. |
| 201 | Brush pigtail and lead screw lock washers. |
| 202 | Brush pigtail and input-output lead screws. |
| 203 | Brush. |
| 204 | Ball bearing. |
| 205 | Brush board screw. |
| 206 | Brush board assembly. Low-voltage. |
| 207 | Field coil assembly. |
| 208 | Pole shoe screw. |
| 209 | Yoke. |
| 210 | Pole shoe assembly. |
| 211 | Armature assembly. |
| 212 | High-voltage head. |
| 213 | End cover. |
| 214 | Elastic stop nut. |
| 215 | End cover screw washer. |
| 216 | End cover screw. |
| 217 | Positive lead, red. High-voltage. |
| 218 | Negative lead, black. Low-voltage. |
| 219 | Negative lead, black. High-voltage. |
| 220 | Positive lead, white. Low-voltage. |
| 221 | Rubber brushing. |
| 222 | Through bolt. |
| 223 | Brush-board assembly. High-voltage. |
| 300 | Tuning-unit dial. 0–100. |
| 301 | Pointer. |

| Reference no. | Description |
|---|---|
| 302 | Crank assembly. |
| 303 | Frequency-control lock screw. |
| 304 | Antenna-condenser lock screw. |
| 310 | Shock-proof cup assembly. |
| 320 | Snap-slide assembly. |
| 321 | Snap-slide stud. |
| 322 | Do. |
| 323 | 5-prong tube socket. |
| 324 | 4-prong tube socket. |
| 325 | Pin plug. |
| 326 | Control grid clip. |
| 327 | Tuning-shaft outlet. |
| 328 | Do. |
| 329 | Switch handle for control box, type BC–AA–181. |
| 330 | Switch handle for control box, type BC–AA–182. |
| 331 | Volume-control knob. |
| 332 | Externally splined shaft (tuning unit). |
| 333 | Tuning-unit outlet. |
| 334 | Cap nut. |
| 335 | Switch stop spring. |
| 336 | Internally splined collar (tuning shaft). |
| 337 | Long snap-slide stud. |
| 338 | Receiver tube-cover assembly. |
| 339 | Receiver case. |
| 340 | Receiver front panel. |
| 341 | Receiver gear unit. |
| 342 | Tube shield. |
| 343 | Alining condenser covers. |
| 344 | Transmitter case. |
| 345 | Transmitter front panel. |
| 346 | Transmitter tube cover. |
| 347 | Transmitter calibration chart. |
| 348 | Transmitter coil panel. |
| 349 | Balancing condenser cover. |
| 401 | Radio receiver, type BC–AA–179. |
| 402 | Mounting, type FT–99. |
| 403 | Dynamotor unit, type BD–AA–69. |
| 404 | Dynamotor unit, type BD–AB–69. |
| 405 | Mounting, type FT–102. |
| 406 | Junction box, type TM–AA–153. |
| 407 | Mounting, type FT–101. |
| 408 | Radio control box, type BC–AA–181. |
| 409 | Tuning unit, type MC–127. |
| 410 | Tuning unit, type MC–125. |
| 411 | Tuning shaft, type MC–124. |
| 412 | Chart, type MC–128. |
| 413 | Coil set, type C–97. |
| 414 | Coil set, type C–98. |
| 415 | Coil set, type C–99. |
| 416 | Coil set, type C–100. |
| 417 | Coil set, type C–101. |
| 418 | Coil set, type C–102. |
| 419 | Case, type CS–44. |
| 420 | Cord, type CD–110. |
| 421 | Cord, type CD–111. |
| 422 | Cord, type CD–112. |
| 423 | Cord, type CD–113. |
| 424 | Cord, type CD–114. |
| 425 | Cord, type CD–115. |
| 426 | Radio transmitter, type BC–AA–180. |
| 427 | Mounting, type FT–100. |
| 428 | Radio control box, type BC–AA–182. |
| 429 | Plug, type PL–56. |
| 430 | Plug, type PL–60. |
| 431 | Plug, type PL–61. |
| 432 | Plug, type PL–62. |
| 433 | Plug, type PL–63. |
| 434 | Plug, type PL–64. |
| 435 | Plug, type PL–65. |

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By order of the Secretary of War:

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*Chief of Staff.*

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