INSTRUCTION BOOK

for

Model ATA and Model ARA Aircraft Radio Telegraph and Telephone Transmitting and Receiving Equipment

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Frequency Range of the Transmitter Units
2.1-9.1 Megacycles (MC) (5 Units). **See page 9**

Nominal Power Output of the Transmitter Units. **See page 10**
CW: 25 watts
TONE: 12 watts
VOICE: 8 watts (carrier)

Frequency Range of the Receiver Units
190 Kilocycles (KC) to 9.1 Megacycles (MC) (5 Units). **See page 9**

SAFETY NOTICE

THE DYNAMOTOR ON THE MODULATOR UNIT OF THIS EQUIPMENT GENERATES 600 VOLTS DC. THIS IS SUFFICIENT TO CAUSE SEVERE SHOCK, OR EVEN DEATH. MAKE ABSOLUTELY CERTAIN THAT THE DYNAMOTOR IS NOT RUNNING BEFORE MAKING ANY ADJUSTMENT WHATEVER EXCEPT TUNING THE TRANSMITTERS.

Opening up the tube covers on the transmitters and modulator unit exposes the high voltage plate connections to the top caps of the Type 1625 tubes. These covers should be safety-wired in place at the time of installation. *Do not attempt to connect or disconnect a transmitter or a power plug while the dynamotor is running.* Do not depend alone upon *hearing* the dynamotor or upon observing the several switch positions to determine whether or not the dynamotor is running—feel it.

In tuning the antenna circuit of the transmitters, be careful to avoid touching the antenna when the power is on, or severe, irritating burns will result. Warn anyone who may be working near the antenna, of your intentions to turn on the power.

FIRE. If the radio set compartment has been exposed to gasoline vapor, make certain that it is aired out well before turning on the power. The antenna must be installed at least an inch from any inflammable material such as fabric covering, canvas baggage compartments, etc., because of the possibility of sparking through this material to a grounded metal member beyond, and setting fire to the material.

The dynamotor on each of the receivers generates 250 volts dc. The danger of exposure to this voltage must not be ignored. Make certain that all dynamotors are "OFF" before performing any adjustment to the equipment other than antenna alignment.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO BUREAU OF ENGINEERING CIRCULAR LETTER NO. 5a OF 3 OCTOBER 1934, OR SUBSEQUENT REVISIONS THEREOF ON THE SUBJECT OF "RADIO-SAFETY PRECAUTIONS TO BE OBSERVED."

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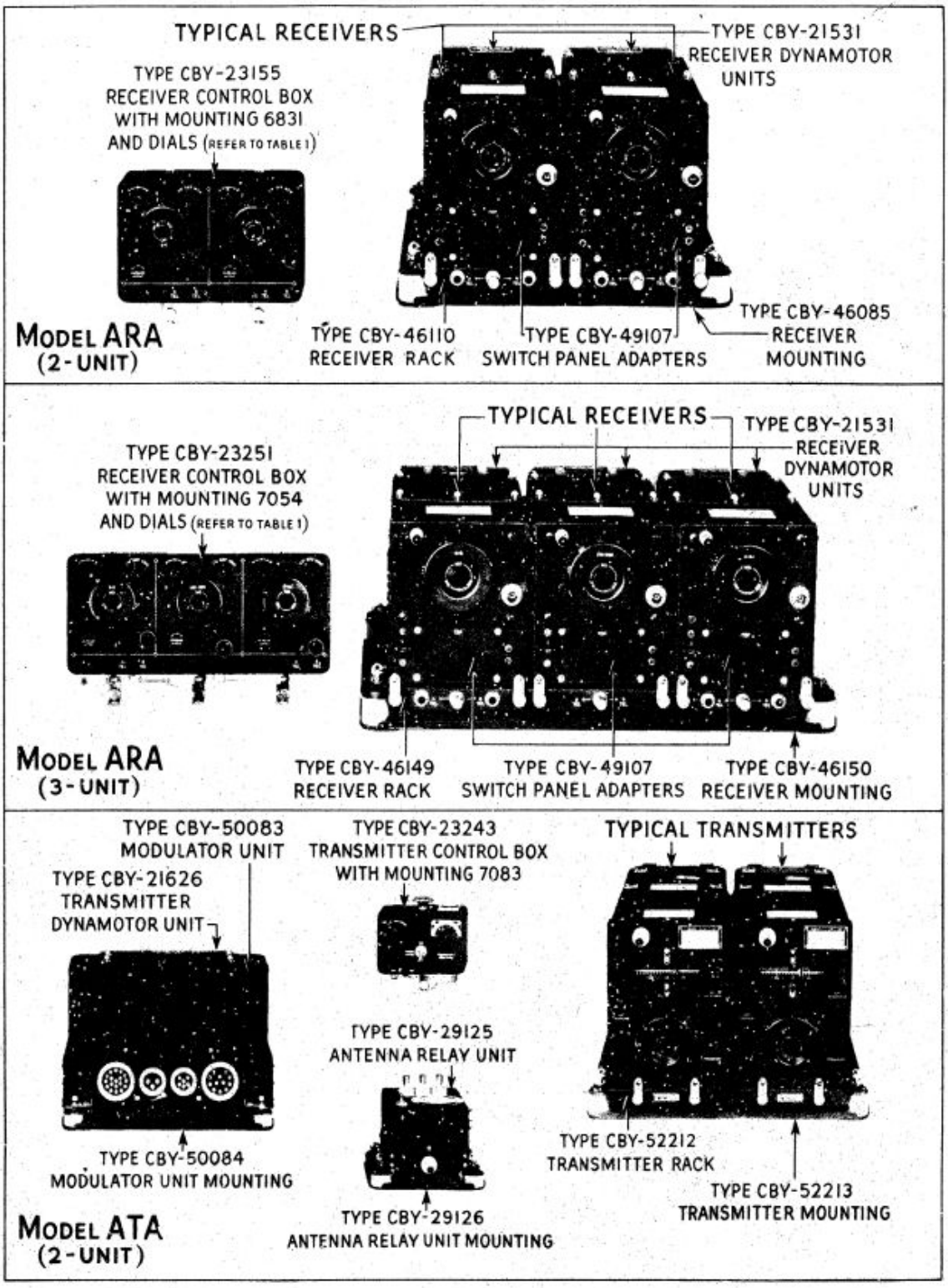

FIG. 1—PRINCIPAL UNITS, MODEL ATA AND MODEL ARA EQUIPMENT

The 2-unit receiving equipment in the top section OR the 3-unit receiving equipment in the center section is supplied with the 2-unit transmitting equipment in the bottom section as part of a complete Model ATA/ARA equipment.

A complete list of the major units and accessories comprising each equipment is shown in Table 1, page 47. Each combination of major units is known as an "assembly" three of which are listed in Table 1. Subsequent editions of this book will list additional "assemblies".

Model ATA and Model ARA Aircraft Radio Equipment

I. DESCRIPTION

GENERAL

Model ATA and Model ARA Aircraft Radio Equipment together make up a complete multi-channel radio transmitting and receiving set for use on airplanes equipped with a 24 volt dc power supply. This equipment is designed to transmit and receive voice, tone-modulated, or continuous-wave signals. The receivers cover the frequency range of 190 to 9100 kilocycles in five independent units, any two (or three) of which may be installed and operated one at a time or simultaneously, depending upon the requirements. The bands are 190-550 KC, 520-1500 KC, 1.5-3 MC, 3-6 MC, 6-9.1 MC. The transmitters cover the frequency range of 2.1 to 9.1 megacycles in five independent units, any two of which may be installed and operated one at a time, depending upon the requirements. The bands are 2.1-3 MC, 3-4 MC, 4-5.3 MC, 5.3-7 MC, 7-9.1 MC.

The receiving equipment consists of the 2-unit group shown in the top row of Figure 1 or the 3-unit group shown in the middle row of Figure 1 but not both. The remaining units of Figure 1 are components of Model ATA transmitting equipment. The complete transmitting and receiving equipment will be referred to as Model ATA/ARA regardless of the particular combination of units. Each combination will be referred to as an "assembly," three of which are listed in Table 1.

FOR LIST OF MAJOR UNITS AND ACCESSORIES SUPPLIED ON CONTRACT NUMBER NOs-74912 AS PART OF MODEL ATA/ARA EQUIPMENT, SEE TABLE 1, PAGE 47.

Model ATA/ARA equipment may be described generally as follows:

RECEIVING EQUIPMENT

(1) Any two (or three) of the receiver units listed in Table 1 may be installed and operated individually or simultaneously by remote control from the receiver control box. Each of the receiver units is not necessarily supplied in quantities equal to the total number of equipments. The particular units supplied or installed will depend upon service requirements.

The weight of the receiving equipment, less cables and mechanical linkages, is 23.6 pounds for a 2-receiver installation and is 35.2 pounds for a 3-receiver installation. See Figure 26 for details.

(2) Primary power is obtained from the 22-30 volt dc supply on the airplane. The current drain is 1.6 amperes per receiver at 28 volts input.

(3) The receiving equipment has been designed for either local or remote control, but only remote control accessories are provided as part of this contract.

(4) Continuous wave (CW), or amplitude-modulated (MCW or Voice), radio signals may be received. Manual control of sensitivity is employed, aided by a built-in high-level auxiliary automatic gain control circuit which prevents strong signals from blocking reception. See page 15 for details.

(5) The outputs of the two (or three) receivers may be paralleled on one line to a single headset, or may be separated and fed to two lines for split or double headset reception by more than one operator. Several 600 ohm headsets, Type 49015 or equal, may be connected into any of the ten headset jacks in the equipment.

(6) A single antenna may be used for all receivers and transmitters provided only that it is suitable for each. It may be desirable to use a long fore and aft "inverted L" or "T" antenna for all receivers and transmitters except the 190-550 KC receiver. If the latter is to be used for reception of airways radio range signals, a suitable antenna such as a 2 or 3-foot vertical mast or a nearly vertical wire should be specified for this receiver only.

(7) All tuning dials are calibrated directly in kilocycles (KC) or megacycles (MC). The accuracy is better than .3%.

(8) The electrical circuits of the receiving equipment, including one typical receiver unit, are shown in Fig. 24. All receivers are of the superheterodyne type, and except for L-C elements forming the RF and IF tuned circuits, they are essentially alike electrically and physically. Each receiver employs six metal 12-volt tubes performing the following functions: RF amplifier (12SK7), mixer (12K8), first IF amplifier (12SK7), second IF amplifier (12SK7), diode detector and CW heterodyne oscillator (12SR7), and audio amplifier (12A6).

(9) The receiver units of Model ARA equipment are interchangeable with those of corresponding frequency ranges in the Model RAV equipment except that the Model RAV receiver units which cover the 190-550 KC and 520-1500 KC bands are equipped with loop binding posts and an antenna-loop switch. The receiver units of Model RAT-1 equipment may be operated in the receiver racks of Model ARA equipment, or vice versa. The receiver units of Model RAT equipment were designed for 12 volt operation and therefore may not be used in the receiver racks of the 24 volt Model ARA equipment.

TRANSMITTING EQUIPMENT

(10) Any two of the five transmitter units listed in Table 1 may be installed and operated one at a time by remote control from the transmitter control box. The particular units supplied or installed will depend upon service requirements. The Type CBY-50083 Modulator Unit and the Type CBY-21626 Transmitter Dynamotor Unit furnish the modulating power and the high voltage dc power requirements for either of the transmitters (but not both at once).

(11) The power output of each of the transmitters under optimum antenna loading conditions exceeds 40 watts CW, and 15 watts voice carrier, for 28 volts input to the equipment. Considerably less power than this will be obtained when using short built-on antennas whose capacitance may be as low as 50 micromicrofarads and whose total resistance may be one ohm or less. Under these conditions a reduction of as much as 10 to 1 in power may be expected. The "nominal" power outputs indicated on the title page of this book are intermediate values. Antenna current into a 5 ohm-100 mmf. antenna is shown in Table 8 for two frequencies on each transmitter and for each type of emission. From these data power output may be calculated by multiplying the square of the antenna current by five.

(12) Primary power is obtained from the 22-30 volt dc supply on the airplane. The current drain is 8.8 amperes at the maximum power output on CW shown in Table 8, and is 2.5 amperes when not transmitting (vacuum tube heater current). See Table 2 for further details.

(13) The electrical circuits are shown in Fig. 25. A master-oscillator excites a pair of beam power-amplifier tubes connected in parallel. The master-oscillator and the power-amplifier tuning capacitors are ganged for simplification of controls. Continuously variable magnetic coupling between the power-amplifier tank circuit and the antenna circuit is controlled by the "ANT. COUPLING" knob on the front panel. The antenna circuit is tuned by a continuously adjustable series inductor. Type 1625 tubes are used as power amplifier tubes, and are screen-grid modulated by audio voltage from the modulator unit. The modulation capability exceeds 85 per cent.

Transmitter dials are calibrated in megacycles to a precision greater than .04%.

A quartz-crystal resonator is supplied with each transmitter for use with an electron resonance indicator tube Type 1629, to check the accuracy of the calibration at one frequency—*it does not control the transmitter frequency.*

(14) The position of the "TONE-CW-VOICE" switch on the transmitter control box determines the type of emission, and the four-position switch on the same box selects a pretuned transmitter. Four positions are provided so that an additional two transmitters may be controlled from the same box when the occasion demands it.

(15) A single antenna may be used for all transmitters providing it has characteristics at the operating frequency within the following limits:

(a) A reactance not greater than that of 50 micromicrofarads or of 4.5 microhenries.

(b) A resistance up to 12 ohms.

NOMENCLATURE

The formal nomenclature for the major units of the equipment will generally be abbreviated in this instruction book as follows:

FORMAL NOMENCLATURE	ABBREVIATED NOMENCLATURE
Type CBY ( ) Aircraft Radio Receiver	"receiver" or "receiver unit" with an indication of the frequency range, if significant.
Type CBY ( ) Aircraft Radio Transmitter	"transmitter" or "transmitter unit" with an indication of the frequency range, if significant.
Type CBY-29125 Antenna Relay Unit	"antenna relay unit."
Type CBY-62036 Auxiliary Outlet Adapter	"auxiliary outlet adapter."
Type CBY-50083 Modulator Unit	"modulator unit."
Type CBY- ( ) Receiver Control Box (2-unit or 3-unit)	"receiver control box" with special reference to the 2 or 3-unit when necessary to avoid confusion.
Type CBY-21531 Receiver Dynamotor Unit	"receiver dynamotor unit" or "dynamotor" unless it can be confused with the "transmitter dynamotor unit."
Type CBY- ( ) Receiver Rack (2-unit, or 3-unit)	"receiver rack" or "rack," with special reference to the 2 or 3-unit when necessary to avoid confusion.
Type CBY-49107 Switch Panel Adapter	"adapter."
Type CBY-23243 Transmitter Control Box	"transmitter control box."
Type CBY-21626 Transmitter Dynamotor Unit	"transmitter dynamotor unit" or "dynamotor" unless it can be confused with the "receiver dynamotor unit."
Type CBY-52212 Transmitter Rack	"transmitter rack."

ABBREVIATIONS

The following abbreviations will be used: RF for radio frequency, IF for intermediate frequency, AF for audio frequency, CW for continuous-wave, MCW for modulated continuous-wave, MO for master-oscillator, PA for power-amplifier, mmf. for micromicrofarad, mfd. for microfarad.

SYMBOL AND PART NUMBERS

The symbol numbers used in the following discussion refer to parts shown in the photographs and drawings, and referenced in the "Parts List by Symbol Designation" in Chapter V.

A symbol number has been assigned to each function, for example "Z-5" to the RF coil set assembly. This assembly is a different one for each of the five receivers in the equipment, hence five "A.R.C. Part Numbers" will be found under "Z-5". Many parts will be found common to all receivers or to all transmitters, but wherever this is not true, a separate listing for each unit will indicate the correct number.

RECEIVING EQUIPMENT

TYPE CBY-46129, CBY-46145, CBY-46104, CBY-46105, CBY-46106, AIRCRAFT RADIO RECEIVERS. TYPE CBY-21531 RECEIVER DYNAMOTOR UNIT. TYPE CBY-49107 SWITCH PANEL ADAPTER. TYPE CBY-62036 AUXILIARY OUTLET ADAPTER. TYPE CBY-( ) RECEIVER RACK (2-UNIT OR 3-UNIT).

The mechanical and electrical design of Model ARA equipment is such that any receiver may be operated in any stall of either the 2 or 3-unit receiver rack from any control section of the 2 or 3-unit receiver control box. Schematic circuit and practical wiring diagrams of the equipment may be found in Fig. 24 and Figs. 32 to 36 inclusive. Photographs of components of the equipment are shown in Figs. 1, and 4 to 10, inc. The following description will refer to those diagrams and photographs.

RF SECTION

The radio frequency (RF) part of the receivers consists of the following circuits and vacuum tubes, starting at the antenna: a tuned antenna input circuit, an RF amplifier tube, Type 12SK7, a tuned RF amplifier circuit, a mixer tube, Type 12K8, and an RF oscillator circuit. The antenna, the RF amplifier and the RF oscillator circuits are tuned by sections of a three equal-section gang capacitor C-4 (A,B,C). The plate current of the mixer tube contains a fre-

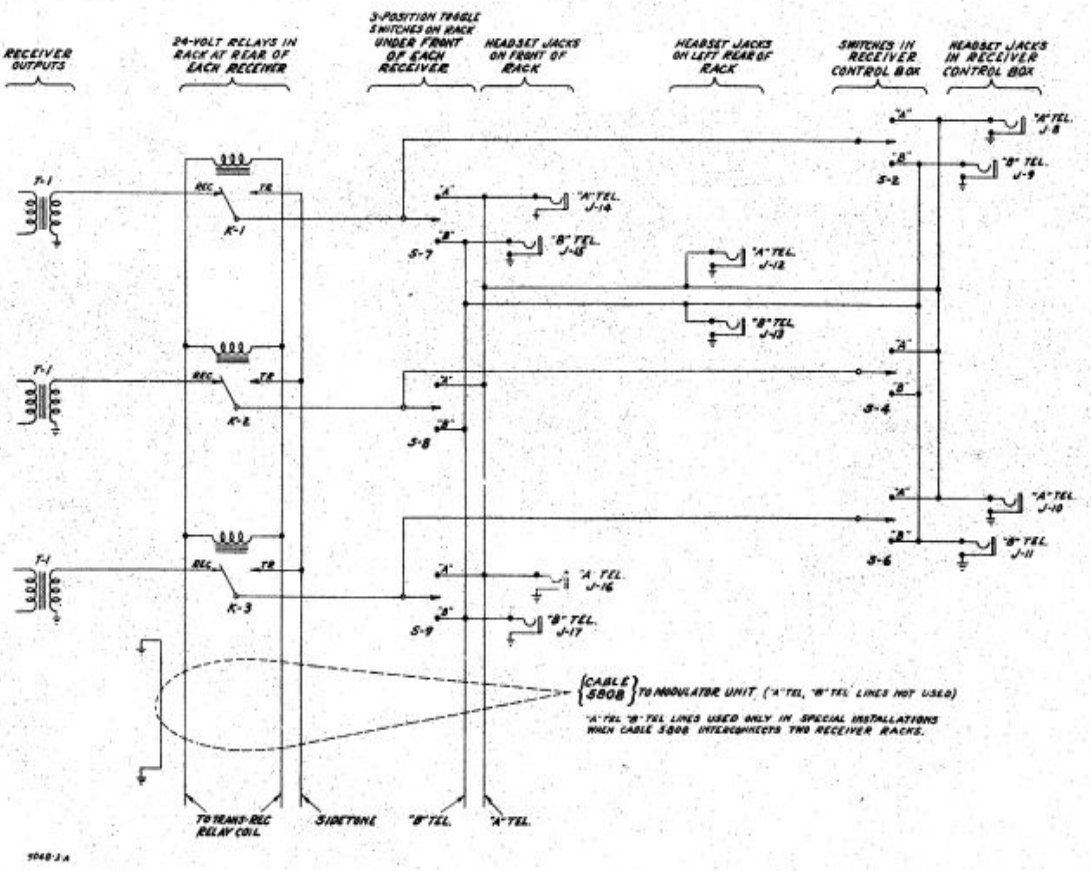

FIG. 2—FUNCTIONAL DIAGRAM OF RECEIVER OUTPUT CONNECTIONS

Circuits shown are for the 3-unit receiver rack. Circuits for the 2-unit rack are similar to those above except that one set of relays and switches is eliminated. see Fig. 24

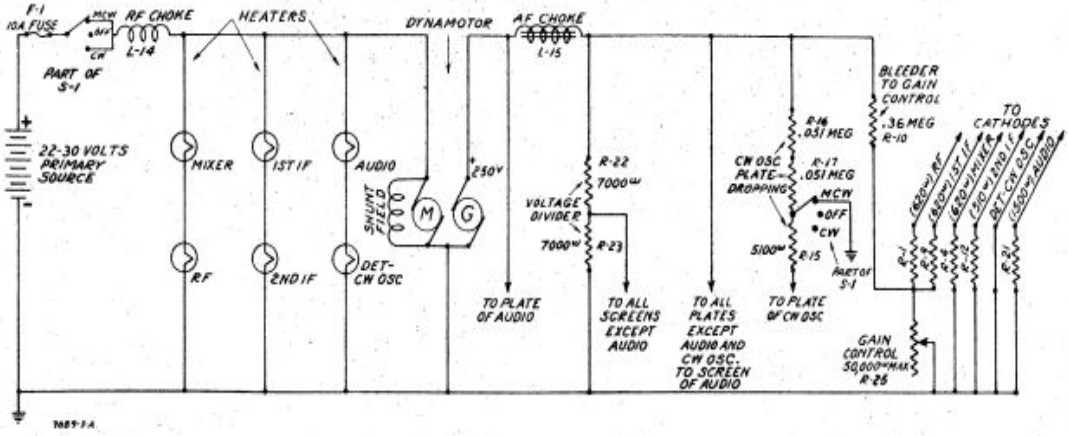

FIG. 3—FUNCTIONAL DIAGRAM OF THE DC CIRCUITS OF A TYPICAL RECEIVER

quency component which is equal to the difference between the frequency of the applied signal and that of the RF oscillator voltage. It is termed intermediate frequency because it is a frequency between that of the input RF signal and that of the output AF signal.

Antenna coil L-1 is contained in Z-5A which is a unit of the plug-in RF coil set assembly Z-5 (Fig. 6). Z-5B contains the RF amplifier coils L-2 and L-3. Z-5C contains L-4, L-5, R-3, and R-6, of the RF oscillator. L-1 of Z-5A, L-3 of Z-5B, and L-5 of L-5C contain iron cores which are used to adjust each coil to a particular value of inductance. After this adjustment at the factory, the iron cores are sealed in position. A subsequent change in the setting of any of these will result in mistracking of that circuit.

C-1 is a small fixed capacitor which couples the antenna to the input tuned circuit. The capacitances of C-1 and C-2 are so designed that for any capacitive antenna, it is possible to resonate the antenna circuit by tuning C-2.

C-39 (across L-2 in the 190-550 KC receiver only) serves to tune L-2 to a frequency lower than 190 KC, and by so doing to increase the amplification of signals at the low frequency end of the tuning range. This assists in producing a reasonably uniform receiver sensitivity over the tuning range. The plate to screen capacitance of the RF amplifier tube, Type 12SK7, and the wiring capacitance to L-2, perform a corresponding function in all other receivers.

L-5 of the RF oscillator has a lower inductance than L-3 of the RF amplifier circuit. This lower value of L-5, aided by the insertion of C-10 between L-5 and ground, results in an RF oscillation which is higher in frequency than the signal frequency. By design, this difference is equal to the intermediate frequency throughout the tuning range of the receiver. L-4 and L-5 are the grid and plate coils of the RF oscillator. C-4C with trimmers C-4E and C-4G, and C-10 with trimmer C-9, together determine the tuning capacitance across L-5. C-8 is a grid blocking capacitor, and R-3 is a grid resistor. R-6 is a series resistor in the plate circuit, which not only serves to drop the dynamotor voltage to the proper value for the RF oscillator, but also acts as an RF filter in conjunction with C-10, to keep RF voltages from appearing on the high-voltage supply line. C-11 is a compensating capacitor connected across the RF oscillator tuning capacitor to reduce the frequency drift during the first half hour of operation.

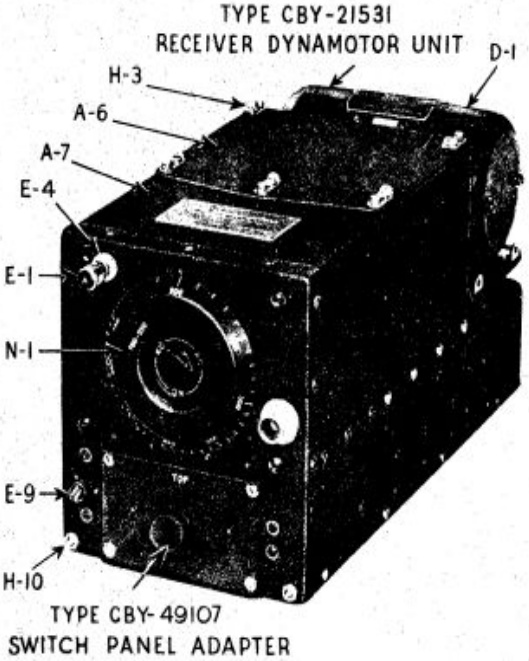

FIG. 4—TYPICAL RECEIVER

IF SECTION

The intermediate frequency (IF) part of these receivers consists of three IF coupling units, Z-1, Z-2, and Z-3 (Fig. 24) following the mixer tube, the first IF amplifier tube, and the second IF amplifier tube respectively. In the 190-550 KC and 520-1500 KC receivers each IF coupling unit contains two tuned circuits, magnetically coupled.

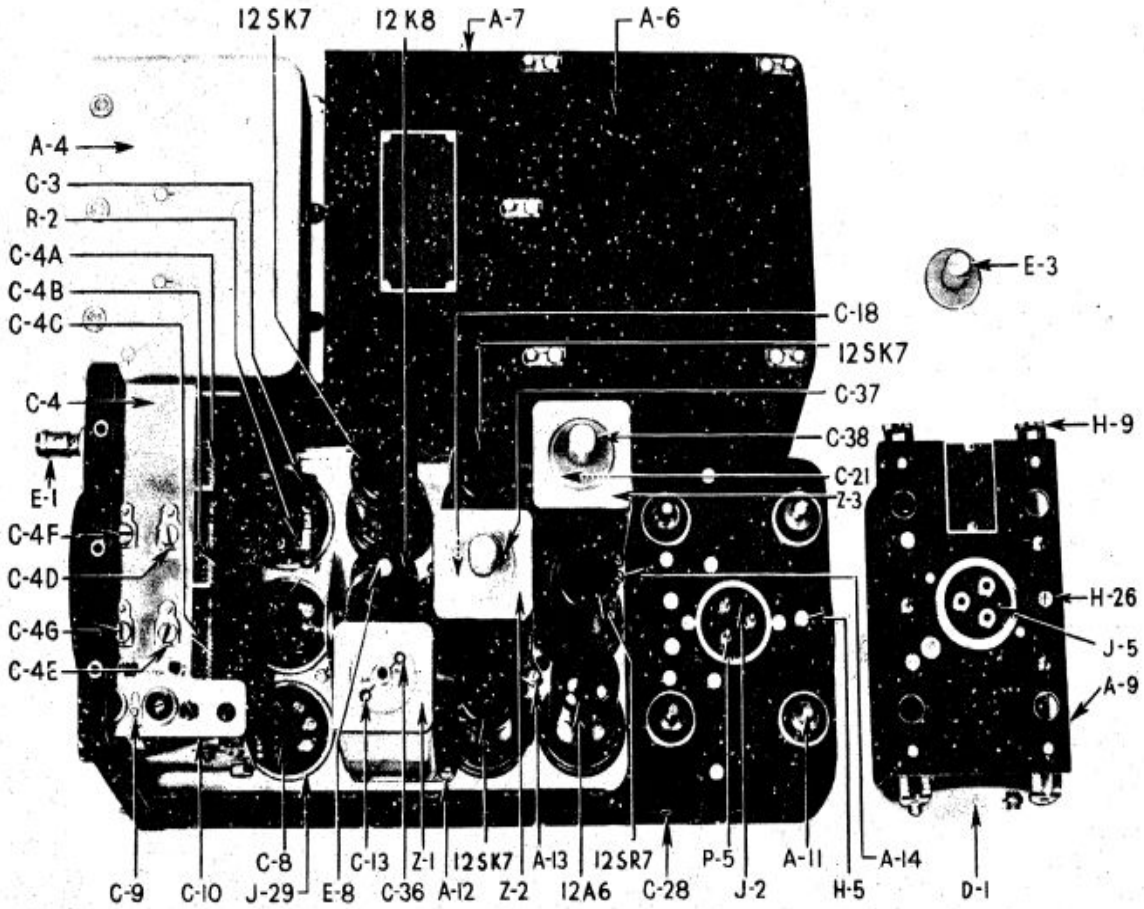

FIG. 5—TYPICAL RECEIVER, TOP VIEW, INSIDE, AND BOTTOM VIEW OF RECEIVER DYNAMOTOR UNIT
Screw cap E-3 has been removed from the 1st IF Coupling Unit in order to show the holes through which C-13 and C-36 may be adjusted.

Z-1, which is representative of the three coupling units, consists of a coil L-6, a fixed tuning capacitor C-12, and a trimming tuning capacitor C-13. The coil and capacitors are designed so that each circuit may be tuned precisely to the IF. Similarly, coil L-7, fixed tuning capacitor C-14, and trimming tuning capacitor C-36, are designed to resonate to the IF. In the 190-550 KC and 520-1500 KC receivers, coupling between the coils in each IF coupling unit is adjustable to either of two values—an overcoupled value (bakelite rod protruding through the top of the IF coupling unit down) or an undercoupled value (bakelite rod up). The normal position for these rods during alignment is up, but for operation, the rod of the second IF coupling unit Z-2, remains up while those of Z-1 and Z-3 remain down. With the couplings so adjusted, a flat-top selectivity curve is obtained, accompanied by better audio fidelity up to 2000 cycles per second. The selectivity 10 kilocycles or more away from resonance is little affected by the position of these rods. The magnetic coupling between coils in Z-1, Z-2, and Z-3 of the 1.5-3 MC and the 3-6 MC receivers is fixed.

There is but one IF tuned circuit in each of the IF coupling units of the 6-9.1 MC receiver. Each of these tuned circuits consists of a coil (for example L-6 in Z-1) with a fixed tuning capacitor C-12 and a trimming tuning capacitor C-13. In this receiver, the single IF tuned circuit is capacitively coupled (for example C-14 in Z-1) to the vacuum tube input circuit following. L-7, L-9 and L-11 act only as RF chokes.

The rotors of trimming capacitors C-13, C-18, and C-21 (Fig. 32) are grounded, but the rotors of trimming capacitors C-36, C-37, and C-38

reached through holes "2" in Z-1, Z-2, and Z-3 of all receivers except the 6-9.1 MC unit are not grounded, hence it is necessary to use a trimming screw driver whose shank is insulated. Fig. 23 shows an external view of each of the three types of IF coupling units.

AF SECTION

The detector and audio frequency (AF) part of these radio receivers consists of a diode section of tube Type 12SR7 acting as a detector, resistance coupled to the input of tube Type 12A6, and an 8 to 1 step-down output transformer. C-24 is an RF by-pass capacitor, and R-18 is the diode series resistor, across which the detected audio voltage is developed R-19 and C-24 act to prevent IF from appearing across the input to the audio amplifier tube. C-29 is a blocking capacitor, and R-20 is the audio grid resistor. C-31, across the primary of T-1 assists C-20B across the secondary in reducing the output of high audio frequencies. The design of transformer T-1 is such that the leakage reactance with the aid of C-31 and C-20B attenuates frequencies above 3000 cycles per second.

V-1 and V-2 are small neon lamps acting as devices to protect the equipment when exceptionally strong signals are received. These lamps glow at approximately 80 volts. As soon as the glow starts, any increase in voltage across the lamp terminals causes a relatively large increase in current through the lamp. In this manner, the voltage is limited to 80 volts across L-1 and likewise across half of the primary winding of T-1.

GAIN CONTROL

"Gain" or "volume" is manually controlled by a 0-50,000 ohm variable resistor R-25 located in the receiver control box. The cathode circuits of the RF amplifier and first IF amplifier are completed to ground through R-25. As this resistor is increased from 0 to 50,000 ohms, the voltage between ground and either cathode increases, and since the grids of these tubes are at ground potential for dc, the grids become increasingly negative with respect to the cathodes. This results in a reduction of amplification in each of the controlled tubes, and in an overall reduction in the gain of the receiver by a factor exceeding 50,000 to 1 as R-25 reaches its maximum resistance. About .6 of a milliampere of dc flows from the +250 volt dynamotor line through R-10 and

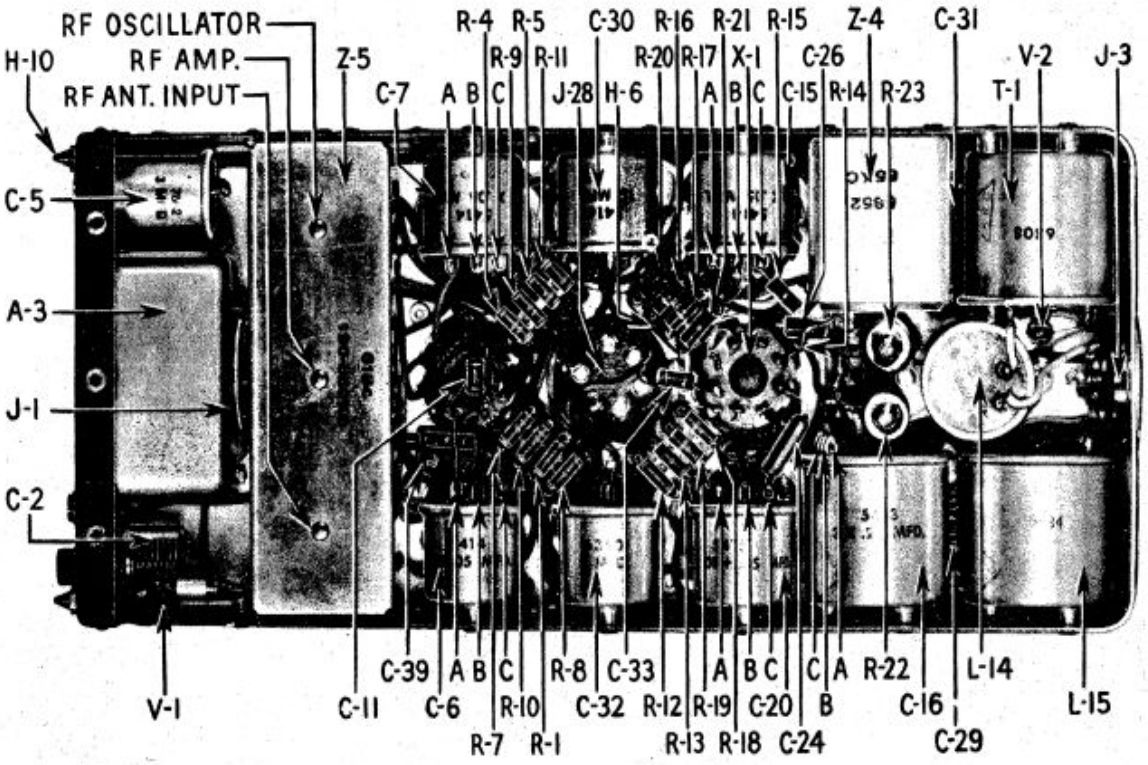

FIG. 6—TYPICAL RECEIVER, BOTTOM VIEW, INSIDE
C-39 and C-33 will be found only in the 190-550 KC receiver

R-25 to ground so that in the minimum gain position of R-25 there is a difference of potential of approximately 30 volts even though the cathode current is negligible. From this it may be seen that R-10 acts to make the control voltage developed across R-25 less dependent upon the cathode current of the tubes being controlled.

The control grids of the RF amplifier and of the first IF amplifier tubes are returned to ground through a common resistor R-11 in the control

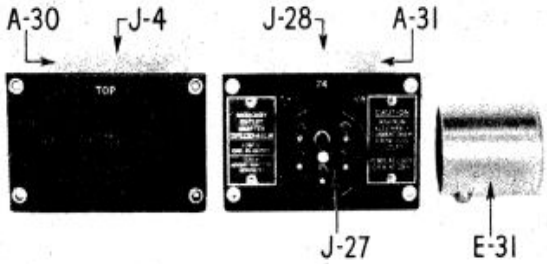

FIG. 7—TYPE CBY-49107 SWITCH PANEL ADAPTER, LEFT. TYPE CBY-62036 AUXILIARY OUTLET ADAPTER AND PROTECTIVE CAP, RIGHT

The Type CBY-49107 Switch Panel Adapter is supplied with all receivers except the 520-1500 KC. Type CBY-62036 Auxiliary Outlet Adapter is supplied with the 520-1500 KC receiver, only.

grid circuit of the second IF amplifier tube, forming an auxiliary gain control circuit. The object of this auxiliary gain control circuit is to prevent overload of the RF or IF amplifier by signals producing as much as 2 volts in the antenna circuit. In effect it is a high-level automatic gain control which is operative only on signals so strong that they would otherwise harmfully overload the receiver. When this condition arises, grid current flows through R-11 to the second IF amplifier in such a sense that the grid side of R-11 is negative with respect to ground. By connecting the grid-to-ground circuits of the RF and first IF amplifier tubes to this potential, the gain of these tubes will be reduced to the point where overload by grid current in the stages is prevented. At the maximum gain position, a uniform output is maintained for all values of radio signals from approximately 100 microvolts to 2 volts. When the gain is manually reduced by 10 to 1 the same audio level is maintained for all radio signals from approximately 1000 microvolts to 2 volts, etc. This high audio level is approximately 800 milliwatts for a 300 ohm load (400 milliwatts for each of two 600 ohm headsets). From these figures it may be seen that the automatic gain control does not come into action on weak signals, and that if the manual gain control is retarded, weak signals may be lost. It may therefore be desirable to keep the gain control near maximum particularly on pilot-operated receivers.

When receiving airways radio range signals the manual gain control resistor R-25, should always be adjusted to a value such that the receiver output is well below the maximum. When this is done there will be no danger of spurious effects such as an apparent reversal or an undue broadening of the course.

Current from the primary source enters the 2 or 3-unit rack at J-24, passes through fuse F-1 (or F-2 or F-3), to switch S-1 (or S-2 or S-3) in the 2 or 3-unit receiver control box, back to the rack and then to the + L.V. line of the receiver. The adapter completes the circuit to terminal 2 on J-2, and to the vacuum tube heater circuits. (Local control of the receivers is not provided for on this contract, but when so required, it is necessary only to replace the adapter with a switch panel containing the equivalent of S-1, S-2, and R-25, and to replace the cables 6693 with wired plugs. The tuning and operation of all controls may then be accomplished locally.) The negative side of the dynamotor and of the primary source is grounded. The dynamotor frame, and all covers and shielding are carefully bonded to insure good grounding.

The dc circuits of all cathodes are connected to ground. C-6C, C-7B, C-15B, C-20A, and C-30 are cathode resistor by-pass capacitors for the six receiver tubes, excepting only the detector-CW oscillator, whose cathode is connected directly to ground. All of these capacitors are of the foil-paper type except C-30 which is a 15 microfarad electrolytic unit. C-30 is an audio frequency by-pass capacitor across R-21, designed to prevent audio degeneration in the output amplifier.

All control grids have a dc path to ground. R-2 and R-20 are each 2 megohms, but the resistance to ground of all other control grids is 100,000 ohms or less.

The screen grid circuits of the Type 12SK7 and 12K8 tubes connect to the junction of a voltage divider or bleeder formed by R-22 and R-23 across the high voltage side of the dynamotor. Resistor R-8, with capacitors C-7A and C-16A, act as a decoupling filter to prevent RF and IF from appearing on the dynamotor high voltage supply line. The screen grid of the audio amplifier tube Type 12A6 connects to the high voltage filtered plate supply line.

The suppressor-grid in each Type 12SK7 tube is connected to the cathode at the tube socket.

The plates of all tubes connect either direct, or through decoupling resistors, to the high voltage dynamotor line. R-6 with C-10, R-7 with C-6A, and R-13 with C-20C, act as RF filters or decouplers to prevent RF from appearing on the high voltage line. C-10 is the fixed series capacitance in the RF oscillator circuit and only incidentally assists in the decoupling function. R-15, R-16, and R-17 act in the dual capacity of voltage dropping and as a filter, with C-15C and

C-25, to prevent CW heterodyne voltage from appearing on the supply line. The plate of the output tube is connected through the primary of T-1 to the dynamotor side of L-15. The object of this is to reduce the possibility of "motor-boating" caused by heavy audio currents in the plate circuit. By connecting the plate across C-16B, the audio voltage across C-32 is considerably reduced, and hence the audio modulation of the screen and plate supplies of all other tubes (which is a cause of "motor boating") is reduced.

CW HETERODYNE OSCILLATOR

The CW heterodyne oscillator circuit is composed of a tuned plate oscillator using the triode section of the Type 12SR7 tube. L-12 and L-13 are the grid and plate coils. C-27 and trimmer C-28 are tuning capacitors. C-26 and R-14 are the oscillator grid capacitor and resistor. C-25, with R-15, is an important RF filter or decoupling element which prevents the oscillator RF voltage from appearing on the plate supply line. C-33 is connected between the plate of the CW oscillator and the control grid of the second IF amplifier. In the 190-550 KC receiver C-33 is a 3 micromicrofarad capacitor outwardly resembling a small composition resistor. In other receivers C-33 is a capacitance formed by proximity of pin plugs in the second IF receptacle, and is less than 2 micromicrofarads. The amplitude of oscillation in the CW oscillator and the capacitance of C-33, are designed to produce the correct heterodyne voltage at the control grid of the second IF amplifier for reception of CW signals. A connection at the junction of R-15 and R-17 goes to a grounding switch on S-1. In the MCW position, S-1 grounds this line thus cutting off the CW oscillator plate supply. In the CW position the ground is removed and normal plate supply is obtained from the dynamotor through dropping resistors R-15, R-16 and R-17. The audio filter circuit in the high voltage supply consists of C-16B, a 0.22 microfarad foil-paper capacitor, C-32, a 5 microfarad electrolytic capacitor, and L-15 a 3 Henry AF choke. This prevents all but a negligible audio ripple from appearing across C-32.

C-16C is an RF filter capacitor designed to reduce RF dynamotor disturbances. (C-34 is a .001 microfarad capacitor which is connected across the motor brush terminals of the dynamotor as an additional suppressor of RF disturbances from the dynamotor.)

L-14 is an RF choke designed to prevent RF disturbances of any type from getting out of the receiver onto the dc primary source line where it might radiate enough energy to be picked up by a receiver.

The Type CBY-49107 Switch Panel Adapter acts as a cover plate and dummy plug to take the

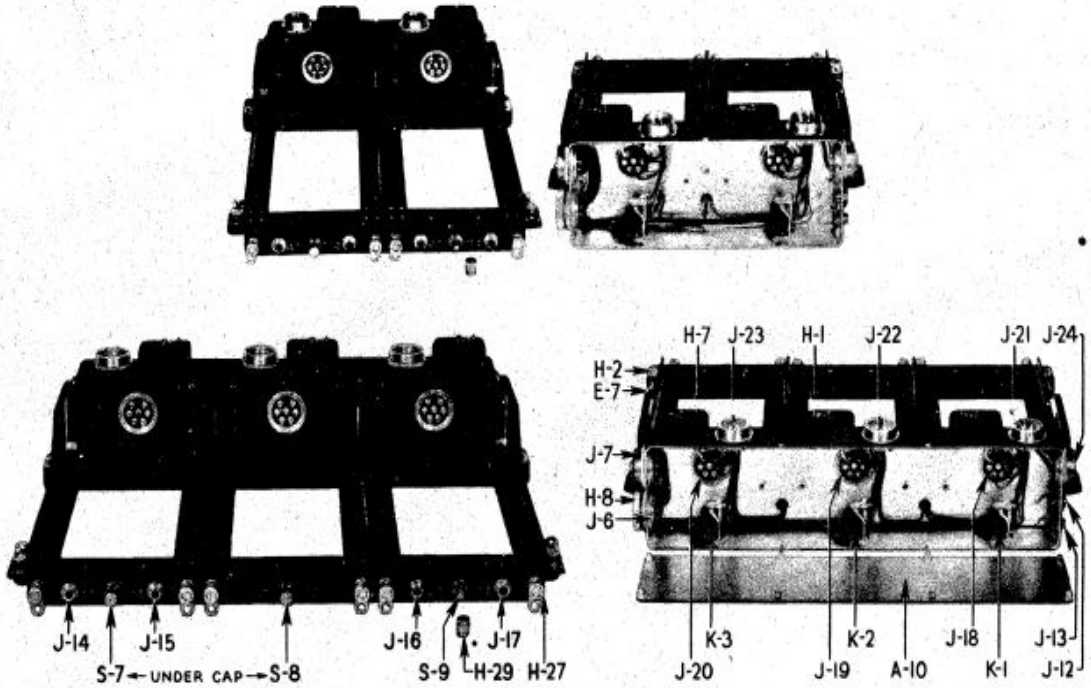

FIG. 8—TYPE CBY-46110 (2-UNIT) AND TYPE CBY-46149 (3-UNIT) RECEIVER RACKS, FRONT AND REAR VIEWS OF EACH WITH COVER REMOVED

For identification of parts in the 2-unit rack, refer to the corresponding part in the 3-unit rack.

place of a switch panel which plugs into the front of the receiver when it is connected for local control. The Type CBY-62036 Auxiliary Outlet Adapter plugs into the front of the 520-1500 KC receiver when that receiver is required to supply not over 0.5 amperes at L.V. and not over 15 milliamperes at H.V. to apparatus which is not a part of this equipment. The Type CBY-49107 Switch Panel Adapter and the Type CBY-62036 Auxiliary Outlet Adapter may be used interchangeably on any of the 520-1500 KC receivers of this equipment (or any of the other receivers except the 190-550 KC, the 3-6 MC, and the 6-9.1 MC receivers having serial numbers under 51.) The + H.V. connection to terminal 8 on J-1 was started with serial number 51 on the 190-550 KC, 3-6 MC, and 6-9.1 MC receivers. All 520-1500 KC and 1.5-3 MC receivers have this connection.

CAUTION: DO NOT EXCEED THE MAXIMUM CURRENT DRAIN FROM OUTLET 74 ON TYPE CBY-62036 AUXILIARY OUTLET ADAPTER of 0.5 AMPERES AT + L.V. TERMINAL OR 15 MILLIAMPERES AT + H.V. TERMINAL. OPERATION BEYOND THESE LIMITS WILL DANGEROUSLY AFFECT THE RELIABILITY OF THE EQUIPMENT.

The 2- or 3-unit rack fulfills three functions: (1) it provides compartments into which the receivers may be slid and locked in place, (2) it provides a convenient electrical junction box for essential interconnections, (3) each section contains a receiver output-sidetone relay, and "A TEL-B TEL" toggle switch, and a fuse. In addition there are three sets of "A TEL-B TEL" headset jacks on each rack.

Cable 7547 from the primary source connects to J-24. Cable 5808 from the modulator unit connects to J-6 or J-7. Whichever of these is not used is covered by a protective cap. The object of the second outlet is to provide a receptacle for interconnection with a second receiver rack when the occasion demands it.

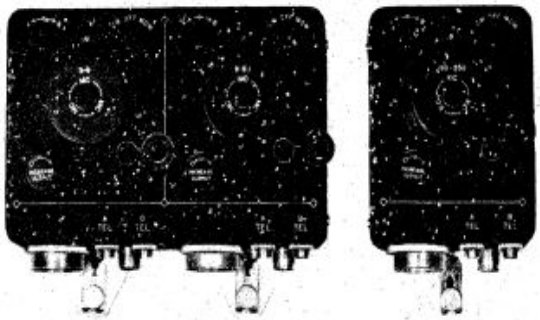

FIG. 9—TYPE CBY-23155 (2-UNIT), LEFT, AND CBY-23261 (1-UNIT), RIGHT, RECEIVER CONTROL BOXES

Refer to Fig. 10 for identification of parts. The 1-unit receiver control box shown above is not supplied on assemblies listed in this edition of the instruction book.

TYPE CBY-23261 (1-unit), TYPE CBY-23155 (2-unit), AND TYPE CBY-23251 (3-unit) RECEIVER CONTROL BOXES

The Type CBY-23261 (1-unit), Type CBY-23155 (2-unit), and the Type CBY-23251 (3-unit) Receiver Control Boxes are shown in Figs. 9 and 10. Schematic circuit and wiring diagrams are shown in Figs. 24 and 40.

Electrically and mechanically, each section of

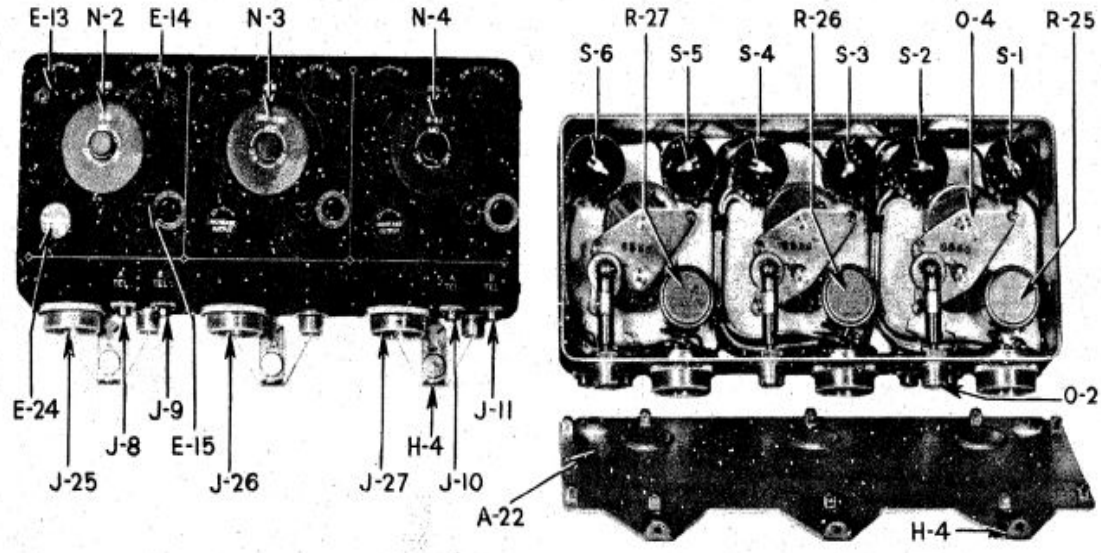

FIG. 10—TYPE CBY-23251 RECEIVER CONTROL BOX (3-UNIT), FRONT VIEW, AND REAR VIEW, WITH COVER REMOVED

these control boxes is like every other section. Each section is used to tune and control one receiver independently of the others.

The following discussion will refer to Fig. 24. When S-1 is turned to "MCW", heater and dynamotor current are supplied to the first receiver only. When S-1 is on "CW" the same is true, but in addition a ground is removed from the CW oscillator plate supply line allowing this oscillator to operate for reception of CW signals. R-25 is a 0-50,000 ohm gain control resistor in the cathode to ground circuit of the RF and first IF amplifier circuits. S-2 is a three-position switch used to connect the receiver output either to headset line "A", line "B", or to neither (open circuit). Fig. 2 is a functional diagram showing the receiver output connections. An examination of this will show that when S-2 is thrown to "A" the output of the receiver connected thereto is connected to line "A", provided that switch S-7 on the receiver rack is in the center position. S-2 may be switched to "B" if desired, or it may be left in the center as a stand-by position. The output of all receivers may be switched to "A" or "B", or one may be on "A" while the others are on "B". The object of the "A TEL-B TEL" system is to provide two separate listening channels which may be reduced to one when the occasion demands.

Type CBY-23261 (1-unit) Receiver Control Box is not supplied as part of assemblies listed in Table 1 of this edition but will be included in assemblies of later editions.

TRANSMITTING EQUIPMENT

TYPE CBY-52232, CBY-52208, CBY-52209, CBY-52210, CBY-52211 AIRCRAFT RADIO TRANSMITTERS. TYPE CBY-52212 TRANSMITTER RACK.

The mechanical and electrical design of the Model ATA equipment is such that any transmitter may be operated in either stall of the transmitter rack. Schematic and practical wiring diagrams may be found in Figs. 25 and 42. Photographs of the transmitter rack and of a typical transmitter may be seen in Figs. 12, 14, 16 and 17. The following description will refer to these diagrams and photographs.

As many as five transmitters are supplied as part of this equipment, any two of which may be installed on the transmitter rack. Each transmitter

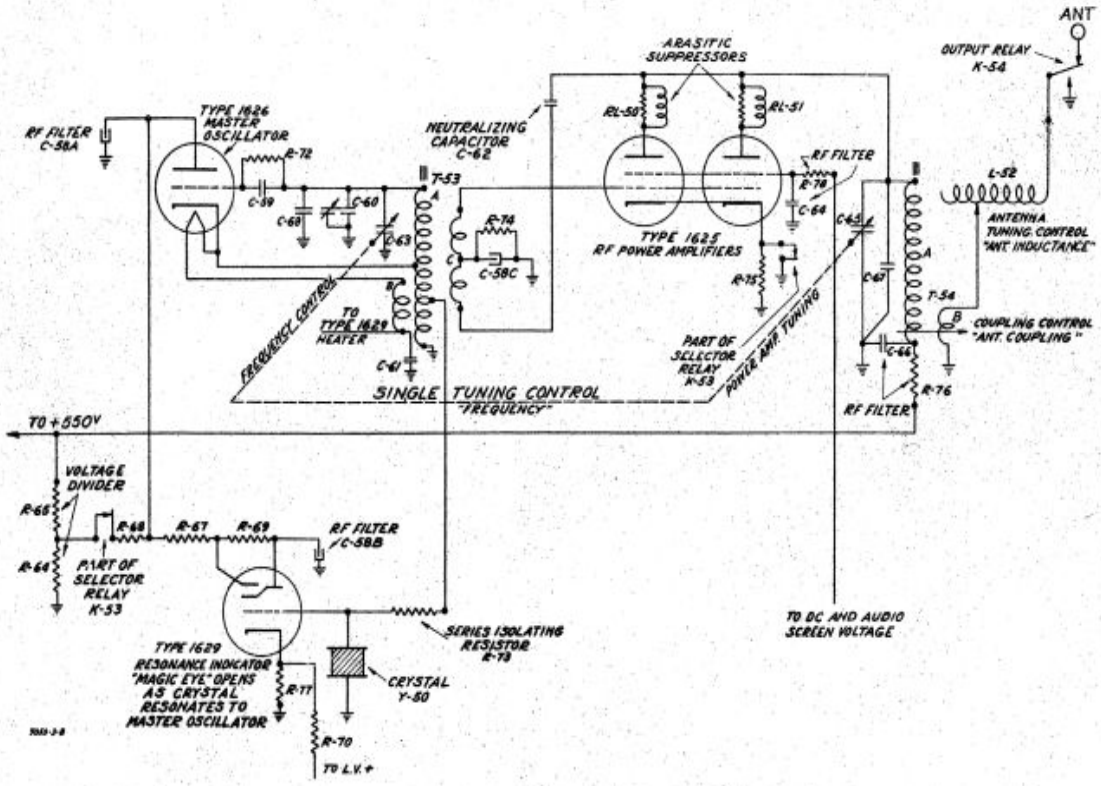

FIG. 11—FUNCTIONAL DIAGRAM OF THE CIRCUITS OF A TYPICAL TRANSMITTER

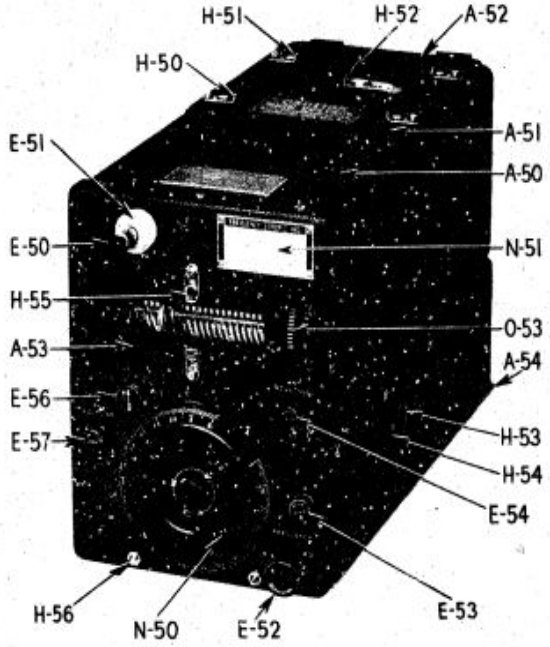

FIG. 12—TYPICAL TRANSMITTER

contains a separate set of master oscillator, RF-power-amplifier, and resonance indicator tubes and associated circuits but depends for its high voltage dc and its modulating voltages on a common modulator unit and transmitter dynamotor, and depends for its entire remote control on a common transmitter control box.

Fig. 25 shows the schematic circuit diagram of a typical transmitter. Schematically, all transmitters are alike although they differ in the inductance and capacitance values in the RF circuits and in the values of R-70 and R-73 associated with the resonance indicator tube.

The Type 1626 tube is the master-oscillator, the Type 1629 tube is the resonance indicator, and the Type 1625 tubes are RF power-amplifiers connected in parallel. The electrical characteristic ratings of each of these tubes are given in Table 16.

T-53A is the master-oscillator coil which is tuned by capacitor C-63. Fixed capacitor and trimmer C-60, and compensating capacitor C-68 are connected in parallel with C-63. R-72 and C-59 are the grid-leak and grid capacitor elements of the master oscillator circuit. T-53B is a twin winding on the master-oscillator coil, wound from the ground to the cathode tap, in order that variations of cathode-to-heater capacitance within the tube will not affect the frequency of oscillation. It is essentially an RF choke. The plate of the Type 1626 tube is grounded for RF by capacitor C-58A hence the plate is essentially connected to the ground end of T-53A. The cathode is connected several turns above ground and the grid is connected to the top of the coil. T-53C has a dual function, (a) it excites the grids of the RF power

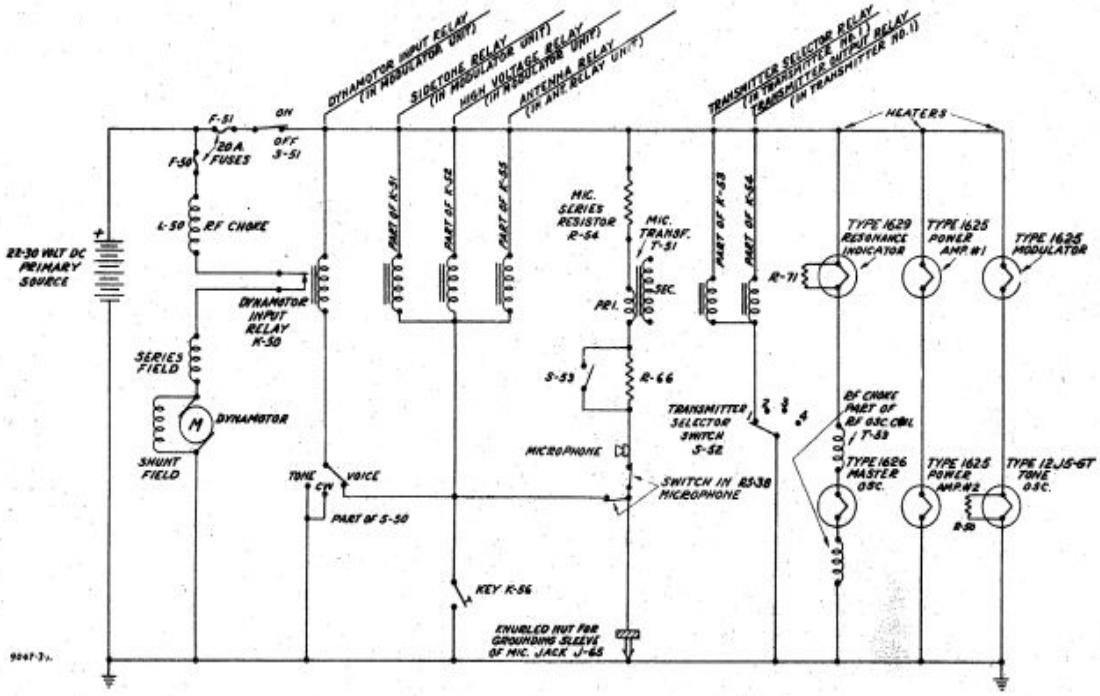

FIG. 13—FUNCTIONAL DIAGRAM OF THE LOW VOLTAGE DC CIRCUITS OF THE TRANSMITTING EQUIPMENT

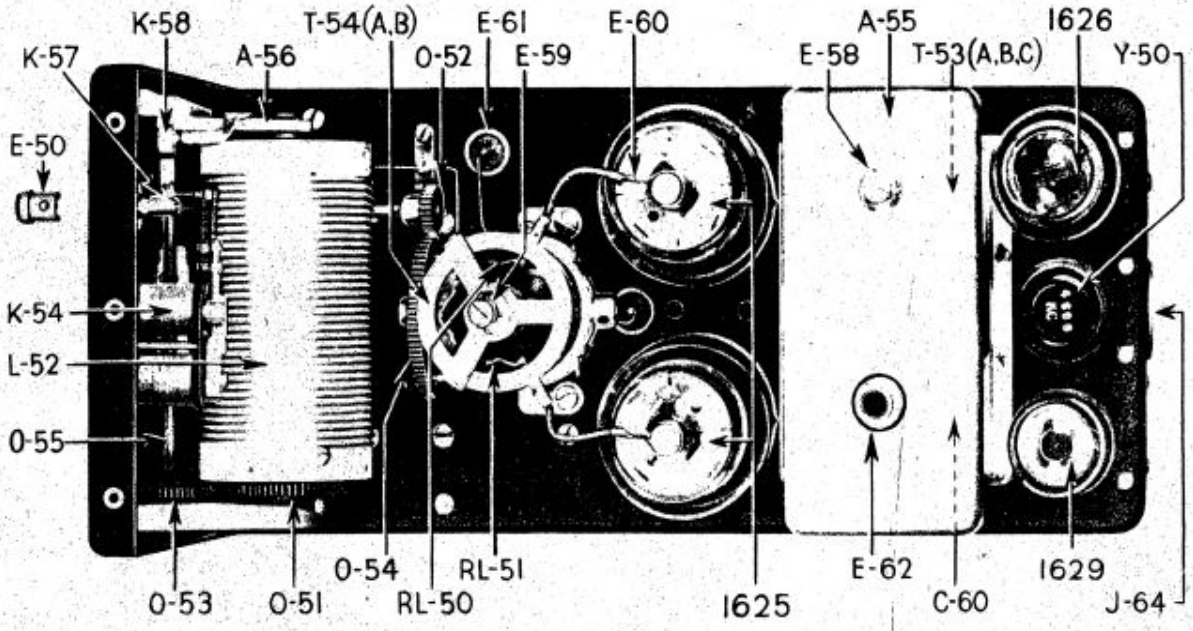

FIG. 14—TYPICAL TRANSMITTER, TOP VIEW, SHIELD REMOVED

amplifier tubes and (b) it provides a neutralizing voltage which is applied to the high voltage side of C-65 through the fixed neutralizing capacitor C-62. R-68 is a decoupling resistor which with the aid of C-58A prevents RF from appearing on the master-oscillator plate supply line. C-61 and C-58C are RF by-pass capacitors designed to keep the low side of T-53B and the tapped point of T-53C at ground potential for RF. R-74 is a resistor in the grid circuit of the RF power amplifier tubes. Grid current in these tubes (which increases with greater excitation from the master-oscillator flows through R-74. The sense of the grid current flow is such as to make the grids of the RF power amplifier tubes more negative with respect to ground as the grid current increases. R-74 therefore may be thought of as a grid auto-bias resistor. The connection from the high voltage side of R-74 to terminal 2 on receptacle J-64 where it dead-ends, is to provide a convenient point in the rack (terminal 2 on J-63) where the dc grid bias or excitation may be measured conveniently.

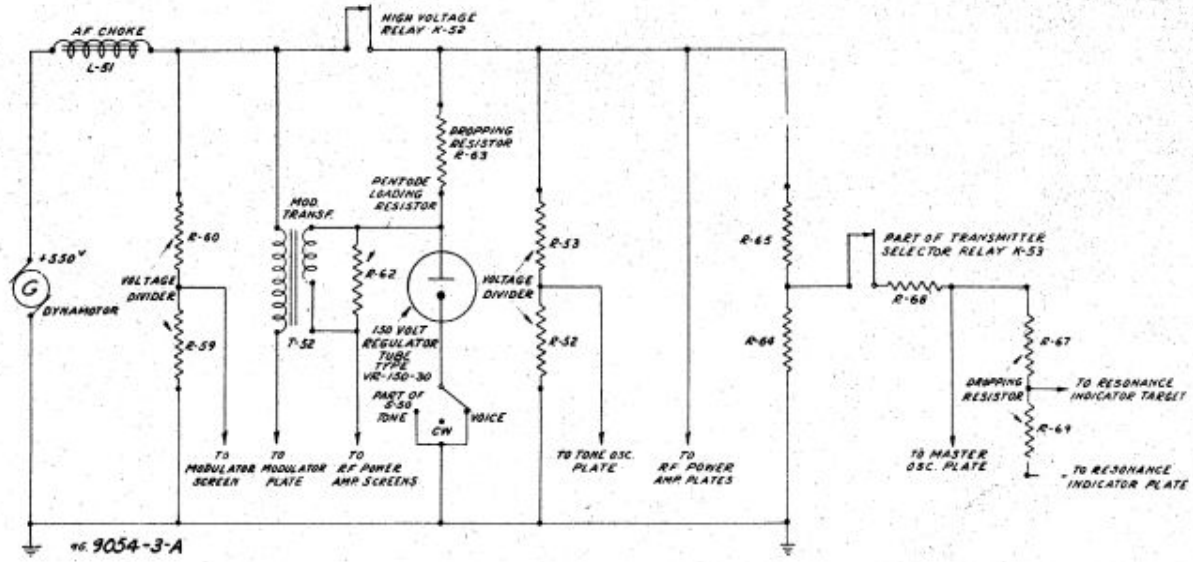

FIG. 15—FUNCTIONAL DIAGRAM OF THE HIGH VOLTAGE DC CIRCUITS OF THE TRANSMITTING EQUIPMENT

The two RF power-amplifier tubes are connected in parallel except for an isolation of the two plates by separate parasitic suppressors RL-50 and RL-51. The power-amplifier tuned tank circuit consists of coil T-54A shunted by fixed capacitor C-67 and tuning capacitor C-65. R-76, together with C-66, act as a decoupling filter to keep RF from appearing on the plate supply line to terminal 7 of J-64. R-78 and capacitor C-64 together, act similarly to keep RF from appearing on the screen-grid supply line to terminal 4 on J-64. T-54B is an antenna coupling coil within T-54A.

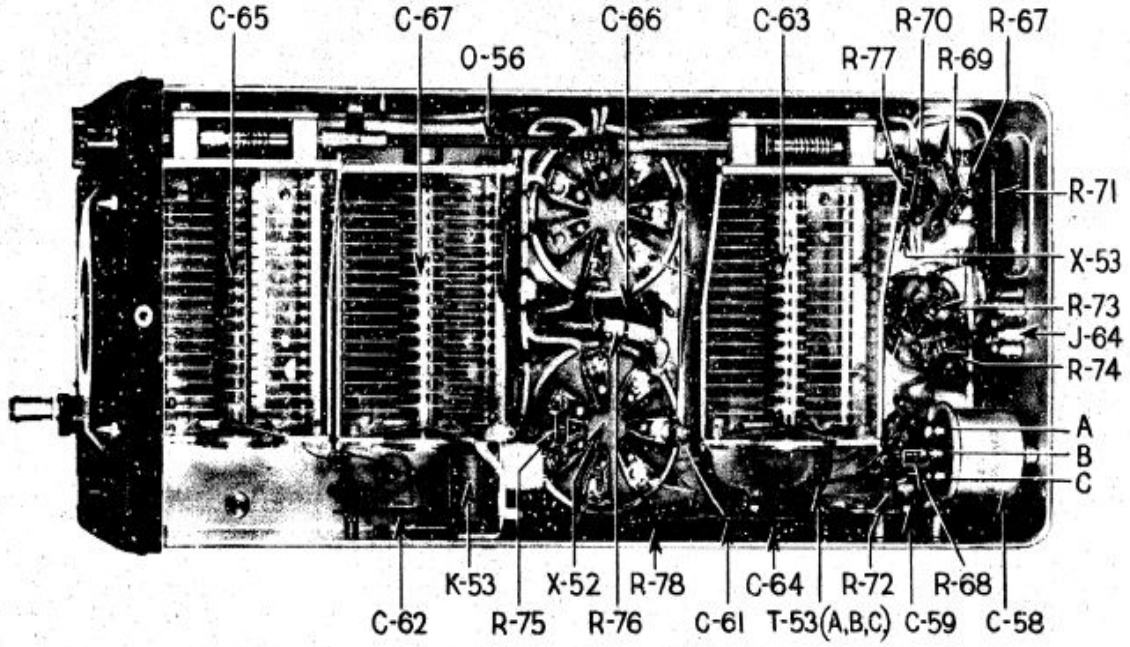

FIG. 16—TYPICAL TRANSMITTER, BOTTOM VIEW, COVER REMOVED
Note that C-63 (master-oscillator capacitor) and C-65 (power-amplifier capacitor) are ganged by means of flexible shaft O-56.

The amount of coupling to T-54A is controlled from the front of the radio transmitter by the "ANT. COUPLING" knob. L-52 is a continuously adjustable inductor in the antenna circuit whose inductance is adjusted from the front of the radio transmitter by the "ANT. INDUCTANCE" knob. This is the only antenna tuning control.

Y-50 is a quartz-crystal resonator mounted in a metal-tube envelope having a standard octal base. The crystal unit may be reached through an opening having a hinged cover, in the top-rear of the transmitter. A similar crystal unit, but of a different nominal frequency, may be substituted for the unit normally supplied if for any reason that is desired. The electrical circuits associated with the Type 1629 tube are such that any crystal unit whose nominal frequency falls within the range of the transmitter may be used. R-77 and R-70 are bias resistors for the Type 1629 tube. R-73 is an isolating resistor which separates Y-50 from the tap on the master-oscillator tuning coil T-53A. (This prevents an interaction between the crystal and master-oscillator which would affect the frequency of the master-oscillator.) RF voltage at this tap will be applied through R-73 to Y-50 and to the grid of the Type 1629 tube. This tube acts as a grid-circuit detector causing an increase in average plate current as the grid input voltage rises due to crystal resonance. When the plate current increases the difference in potential between the target and the plate increases, due to the one megohm resistor R-69 connected between the plate and the target. The greater this difference in potential, the greater will be the area on the target where no electrons reach, hence the shadow angle *increases* at crystal resonance. R-67 is a dropping resistor in the plate circuit of the resonance indicator tube and C-58B is an RF by-pass capacitor between plate and ground on the same tube.

Relays K-53 and K-54 are closed in one of the transmitters when switch S-52 on the transmitter control box is set for that transmitter and the "TRANS. POWER" switch S-51 in the same box is "ON". (The transmitter on the left in the rack is #1 and the one on the right is #2. These numbers correspond to the #1 and #2 positions on switch S-52.) K-53 closes the plate supply to the master-oscillator and resonance indicator tubes, and also short-circuits R-75, a 51,000 ohm resistor in the cathode-to-ground circuit of the RF power amplifier tubes. Plate and screen voltages are constantly

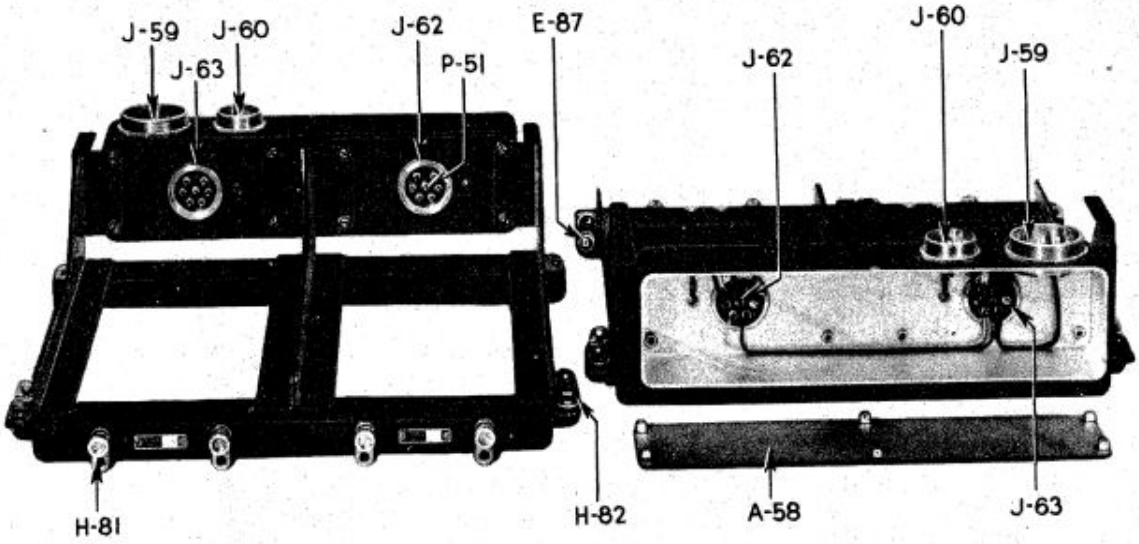

FIG. 17—TYPE CBY-52212 TRANSMITTER RACK (2-UNIT), FRONT VIEW, AND REAR VIEW WITH COVER REMOVED

supplied to the Type 1625 power amplifier in both transmitters, but only the one transmitter whose R-75 is short-circuited, is operative. The bias voltage developed across R-75, when it is *not* short circuited is sufficient to reduce the plate and screen current to nearly zero. There is no excitation on the grids of the power amplifier tubes except in the one transmitter selected, because the plate supply of the master-oscillator tube is closed only for that unit.

K-54 transfers the high potential side of the antenna tuning inductor L-52 from ground to the antenna binding post.

All vacuum tube heater circuits are connected

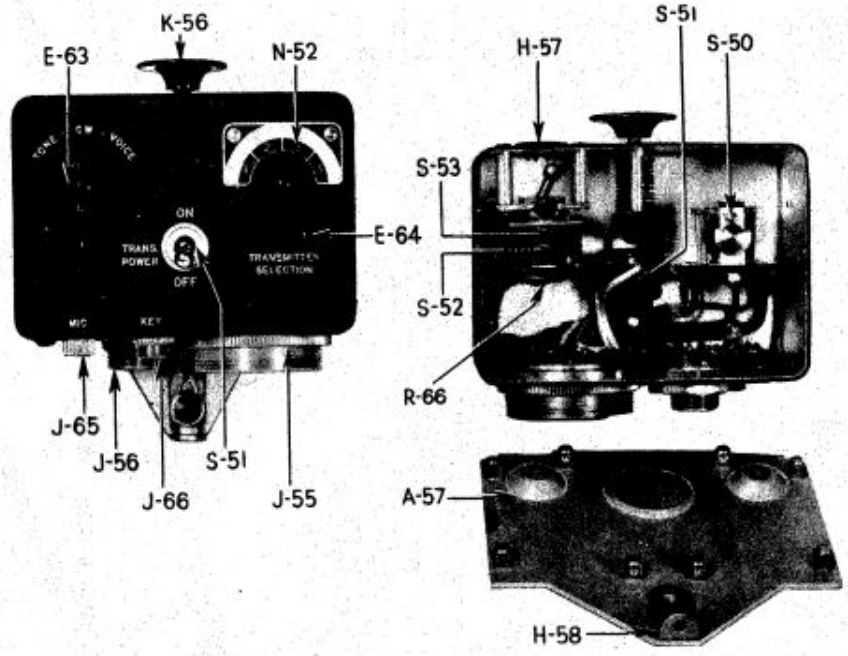

FIG. 18—TYPE CBY-23243 TRANSMITTER CONTROL BOX, FRONT VIEW, AND REAR VIEW WITH COVER REMOVED

S-53 must be in "R–IN" position for use with U. S. Navy microphones RS-38 or equal. See red nameplate on top of box.

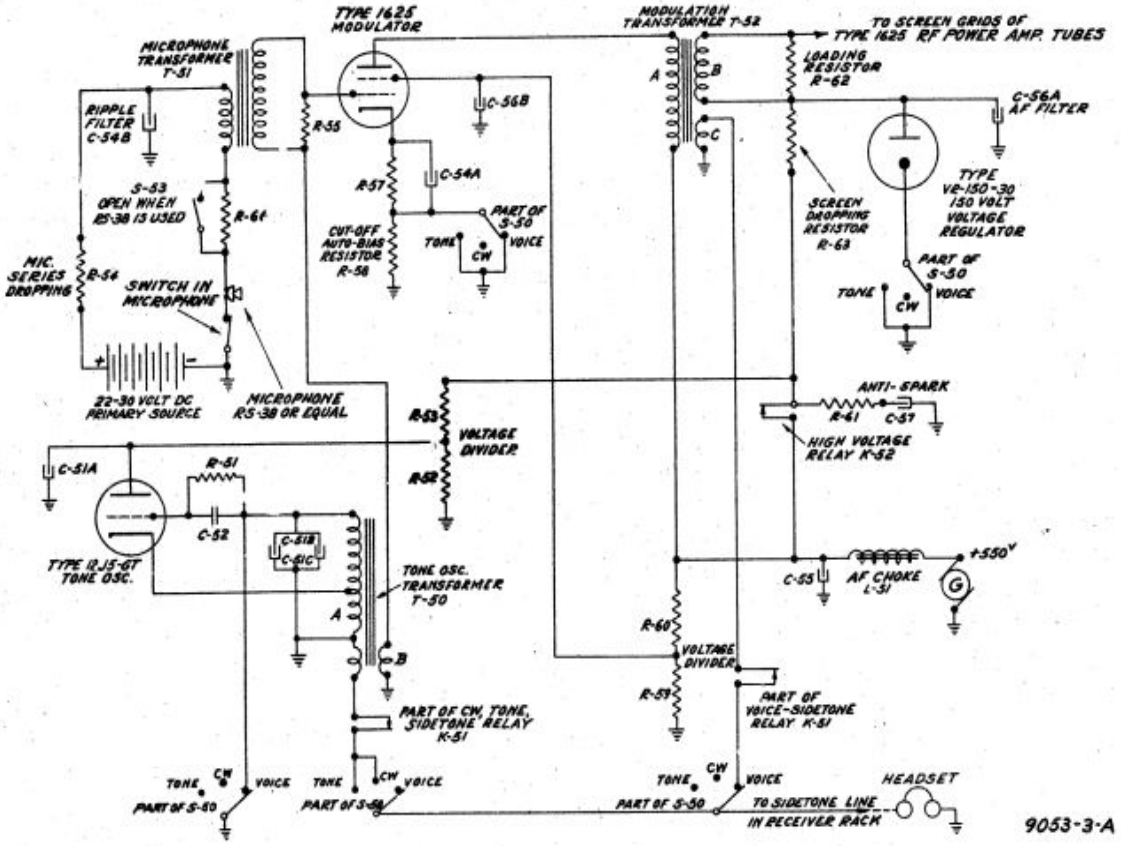

FIG. 19—FUNCTIONAL DIAGRAM OF THE AF CIRCUITS OF THE TRANSMITTING EQUIPMENT

in series parallel and remain "ON" as long as the "TRANS. POWER" Switch S-51 is "ON". This is ordinarily throughout the flight. The arrangement may be seen best in Fig. 13.

The transmitter rack contains two ground binding posts and circuits interconnecting the modulator unit with two of the transmitters and the antenna relay unit.

TYPE CBY-23243 TRANSMITTER CONTROL BOX

The Type CBY-23243 Transmitter Control Box contains a three-position switch S-50 which controls the circuits determining the type of emission, a four-position switch S-52 which controls the circuits determining the choice of transmitter, a microphone jack J-65, an external key jack J-66, a built-in key K-56, a microphone series resistor R-66, and a toggle switch S-51 in the line direct from the primary source. This box contains receptacles J-55 and J-56 for connection to the modulator unit, and to a remote antenna current indicator not supplied on this contract.

Microphone jack J-65 is constructed in such a manner that the sleeve may be grounded to the box, or not, by turning the protruding knurled nut counter-clockwise or clockwise respectively as far as it will go *by hand*. In the counter-clockwise position the sleeve is grounded and the "push-to-talk" button on the microphone will close the microphone and relay circuits to ground when actuated. With the nut in the maximum clockwise sense, the "push-to-talk" button may be locked closed after which the pressing of the built-in key, external key, or throttle switch will perform the same functions that the "press-to-talk" button did when the knurled nut was in the counter-clockwise position.

Although S-52 is a four position switch designed to select one of four transmitters, only positions 1 and 2 are used with one 2-unit transmitter rack. Positions 3 and 4 may be used if a second modified rack is installed. The modification consists of transferring the connections that go to terminals 8 and 9 on receptacle J-59 to terminals 6 and 7. It will then be necessary to add a junction box into which the cable from the Modulator Unit connects with two additional identical cables, one going to each of the racks.

TYPE CBY-50083 MODULATOR UNIT, WITH TYPE CBY-21626 TRANSMITTER DYNAMOTOR UNIT

The Type CBY-50083 Modulator Unit with Type CBY-21626 Transmitter Dynamotor Unit, contains a tone oscillator tube Type 12J5-GT, a speech amplifying and modulator tube Type 1625, a 150-volt voltage regulator tube Type VR-150-30, a dynamotor which supplies dc plate and screen voltage to the tubes of the transmitting equipment, transformers, relays, chokes, and other elements, to be described later, which are necessary to transform the dc from the primary source to the dc and audio requirements of the transmitters. A schematic circuit diagram is shown in Fig. 25. A wiring diagram is shown in Fig. 43.

The Type 12J5-GT tube is the tone oscillator tube. T-50A with capacitors C-51C and C-51B in parallel, form the tuned circuit of this oscillator, R-51 and C-52 are the grid-leak and grid capacitor. R-53 and R-52 form a voltage divider across the high voltage dynamotor supply line which determines the plate voltage on the Type 12J5-GT tube. T-50A is an auto-transformer with the section from the ground tap to the bottom acting as a secondary winding. Voltage developed across this section provides tone sidetone in either "CW" or "TONE" positions of the emission selector switch S-50 of the transmitter control box. T-50B is an additional tone winding which provides a voltage which is applied to the grid of the modulator tube. The magnitude of this voltage is such that under average conditions the resulting modulation depth is about 90 per cent.

T-51 is a transformer, the primary of which is in the microphone circuit. The secondary of this transformer is shunted by a 1500 ohm resistor, R-55. The design of the microphone transformer T-51 and the value of R-55 are such that the voltage applied to the grid of the type 1625 modulator tube is 3 volts for 1.5 volts input at the microphone jack J-65. This voltage is sufficient to produce 85-100% modulation in an average transmitter, and is approximately the voltage obtained when using an RS-38 Microphone. Circuit elements throughout the voice modulation circuits have been designed on the basis of the maximum output from an average RS-38 Microphone. The dc through the RS-38 Microphone is approximately 36 milliamperes (assuming that R-66 is not short-circuited by S-53). *When using the RS-38 Microphone or equal, R-66 should never be short-circuited by S-53.* S-53 is closed only when using microphones equal to Signal Corps Type T-17 or equal.

The dc screen-grid supply to the modulator tube is obtained through a voltage divider R-59 and R-60. C-56B is a by-pass capacitor connected to reduce the AF impedance from screen grid to ground. R-57 and R-58 are auto-bias resistors in the cathode to ground circuit of the modulator tube. While transmitting "TONE" or "VOICE" the junction of these resistors is grounded, leaving only R-57 (390 ohms) as a normal cathode autobias resistor. In the CW position, cathode current

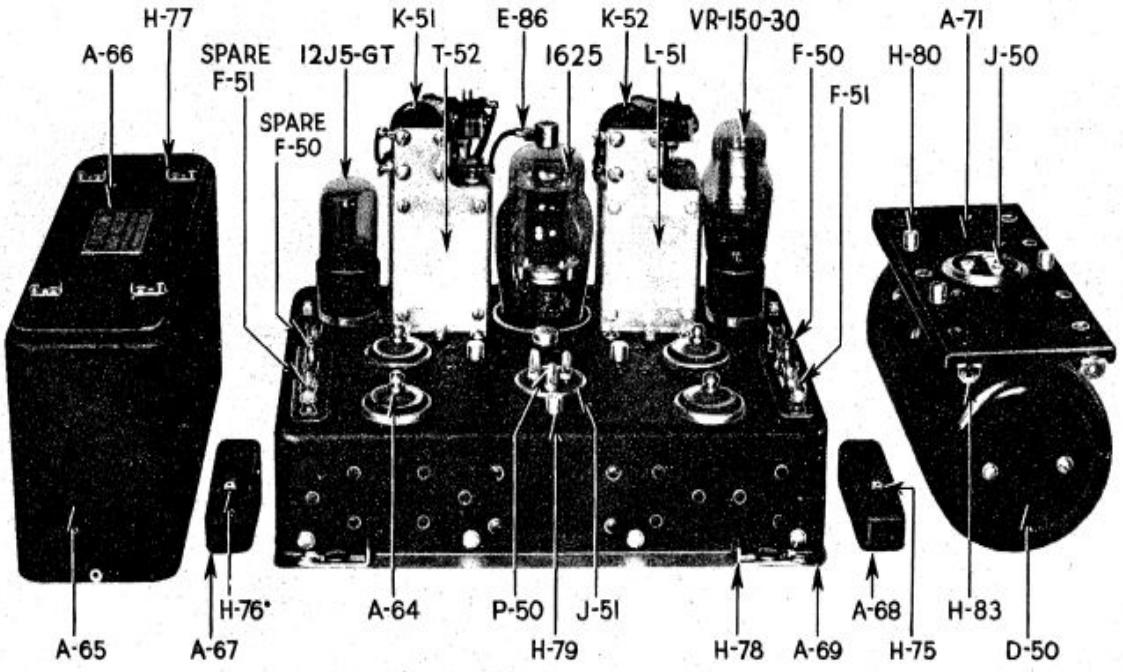

FIG. 20—TYPE CBY-50083 MODULATOR UNIT, TOP VIEW, SHIELD REMOVED, AND BOTTOM VIEW OF, TYPE CBY-21626 TRANSMITTER DYNAMOTOR UNIT

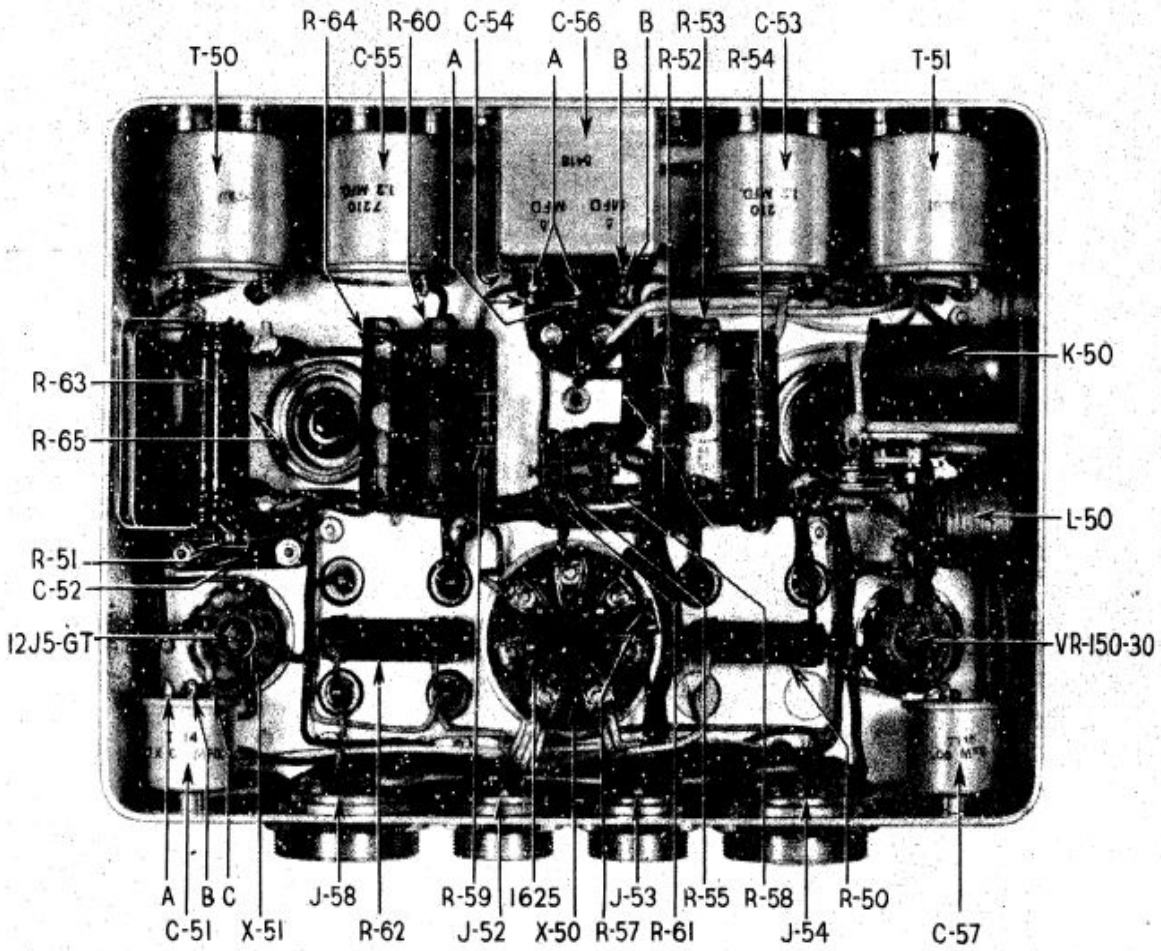

FIG. 21—TYPE CBY-50083 MODULATOR UNIT, BOTTOM VIEW, COVER REMOVED

flows through R-57 (390 ohms) and R-58 (51,000 ohms) to ground, producing a bias which reduces the plate current to less than 1 milliampere. In this way the modulator tube is effectively shut off in the "CW" position, and power is conserved at a time when functioning of the modulator tube is not required. Sidetone in the "CW" and "TONE" positions is obtained directly from T-50C. Sidetone voltage on "TONE" and "CW" is approximately 2.3 volts and on "VOICE" exceeds 5 volts. (See Table 8 for further details.)

T-52 (A,B,C) is the modulation transformer, the primary winding T-52A of which is in the plate circuit of the modulator tube. Two additional windings are provided, T-52C for "VOICE" sidetone and T-52B for the modulating voltage. T-52B is in series with the high-voltage screen grid supply to the RF power amplifier tubes in the transmitters. R-62 is a load resistor designed to keep the load impedance as seen by the plate of the tetrode modulator tube reasonably constant as a function of amplitude. R-63 is a series voltage-dropping resistor in the screen-grid circuit of the RF power amplifier tubes.

The Type VR-150-30 tube is a gaseous voltage-regulator tube designed to maintain the dc voltage between its anode and ground at 150 volts (the normal dc voltage applied to the screen-grids of the RF power amplifier in the "TONE" and "VOICE" positions). C-56A across the voltage regulator tube acts as an AF by-pass.

R-64 and R-65 together act as a voltage-divider for the master-oscillator dc plate supply.

F-50 is a fuse and L-50 is an RF choke, both of which are in the input circuit to the transmitter dynamotor. This circuit is closed by the contacts on K-50 whenever the "push-to-talk" button on the microphone is closed (or a similar operation by the throttle switch, or special switch) in the "VOICE" position. K-50 is actuated, and the dynamotor starts, when S-50 in the transmitter control box is thrown to the "TONE" or "CW" position. The dynamotor will continue to run as long as S-50 remains in either of these positions, but the high-voltage keying relay will not close until the built-in key, external key, microphone button or the throttle switch, is closed. The coil of K-51 is in parallel with that of the high-voltage

keying relay K-52 (see Fig. 13), and therefore operates with K-52. K-51 closes the sidetone circuits from the "TONE" or "VOICE"sidetone windings to the headsets. The setting of S-50 determines which of these circuits is connected to the headsets.

R-50 is a 42 ohm resistor connected across the heater terminals of the tone oscillator tube so that the heater of the modulator tube can be connected in series with the heater of the tone oscillator tube across the 28-volt primary source.

The transmitter dynamotor generates the high-voltage dc for the transmitting equipment. Connections from the dynamotor to the modulator are made through couplings J-51 and J-50. The mica plate in J-50 is designed to be loose in order to reduce the strain on the pin plugs of J-51 during vibration of the units. The motor is compound wound. C-50 across the motor brush terminals attenuates RF-disturbances set up at the brushes. C-53 is a filter capacitor across the 28 volt line to the motor, performing a function similar to C-50.

The transmitter dynamotor has a continuous duty and two intermittent duty ratings which may be found in Table 17. The dynamotor may be operated continuously under the normal load on "VOICE" or "TONE" but must not be operated continuously, key down, in the "CW" position. However, it may be operated in the "CW" position without time limit under ordinary conditions of message transmission.

Four cables enter the modulator unit, the primary source voltage at J-53, the connections to the transmitter control box at J-54, the connections to the transmitter rack at J-58 and the connections to the receiver rack at J-52. The last of these connections is not essential to the operation of the transmitting equipment, but exists for the purpose of introducing actuating voltage for the relays and sidetone from the modulator to the headset lines in the receiver rack, and receiver control box.

TYPE CBY-29125 ANTENNA RELAY UNIT

The Type CBY-29125 Antenna Relay Unit consists of an antenna switching relay K-55 designed to switch a single antenna either to the transmitters or to the receivers of this equipment. This relay is operated simultaneously with the high-voltage keying relay in the modulator unit. In addition to switching the antenna, relay K-55 operates to ground the antenna lead to the receivers when it is thrown to "transmit". T-55 is an RF current-transformer the primary of which is in the antenna circuit and the secondary of which is connected to a thermocouple, TC-50. The output of thermocouple TC-50 may be switched by S-54 to meter M-50 for a local indication of antenna current, or to an external ammeter (not supplied on this contract) for a remote indication. A schematic circuit diagram is shown in Fig. 25.

C-69 connected between terminals "C" is a high-voltage antenna series capacitor of 50 micro-microfarads capacitance. C-69 should be connected in series with the antenna lead to any transmitter (or transmitters) in installations where it is found impossible to resonate the antenna circuit due to its great length. *C-69 should be connected into the antenna circuit only when necessary, and not as standard practice on all airplanes.* Antennas whose overall length from the transmitter "A" binding post do not exceed 20 feet will not require the use of C-69.

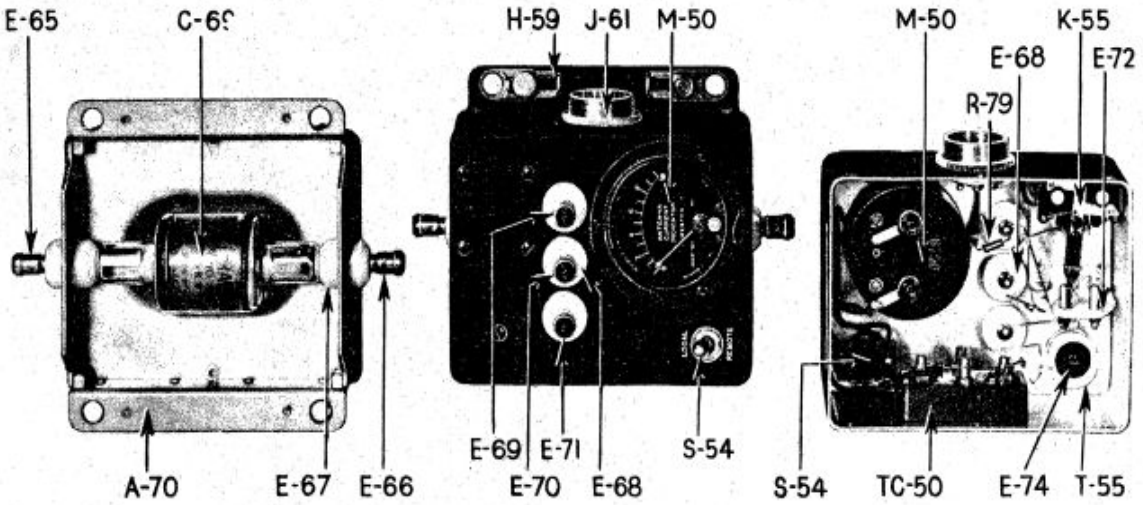

FIG. 22—TYPE CBY-29125 ANTENNA RELAY UNIT, FRONT VIEW, AND REAR VIEWS

II. INSTALLATION

INITIAL INSPECTION AND BENCH TESTING

Check the supply of component units against the list in Table 1, aided by the group photograph in Fig. 1. It is advisable to make a visual inspection of each component to determine that no mechanical fault exists. Such an examination should include at least the following: checking the operation of controls and dials, checking the threads of receptacles and plugs, and the examination of pin plug assemblies for bent or otherwise unserviceable units. Proper fuses should be in place in the modulator unit and receiver rack. Vacuum tubes should be inserted firmly in the sockets identified for the particular type of tube. The type designations will be found marked near the socket in which that particular type of tube should be placed. Grid and plate clips should be firmly attached.

It is strongly recommended that an electrical "bench test" be made of each major unit before it is installed in an airplane. This will insure normal operation of the equipment after installation with the minimum number of man-hours of work in and about the airplane. Trouble shooting on installed radio equipment is difficult and should be assiduously avoided. The practice of removing the cover and blowing out each major unit *before it is found defective*, is not recommended. Where a considerable amount of installation work is to be done, it is suggested that a permanent bench test installation be made consisting of the following parts:

1 Complete Model ATA/ARA equipment. Use a set of cables specially cut for this bench test. Local tuning control 6743, which is supplied as part of Test Set 7918, may be used for local tuning of the receivers.

1 Test Set 7918 (for tests on receiving equipment). See Fig. 30 for instructions in the use of this test set.

1 Test Set 7919 (for tests on transmitting equipment). See Fig. 30 for instructions in the use of this test.

1 Storage battery, 28 volts, preferably at least 100 ampere-hour capacity.

1 Headset (600 ohms).

1 Microphone RS-38 or equal.

GENERAL

Figs. 26 and 27 show the installation dimensions and weights of all units of the equipment. Cabling Diagrams showing the interconnection of these units may be seen in Fig. 28. Installation notes associated with the Cabling Diagrams are included in this chapter.

Model ATA/ARA equipment consists basically of a group of two (or three) receivers and a group of two transmitters, each group with its special rack and mounting. In addition, there is a modulator unit with a high-voltage dynamotor, an antenna relay unit, and separate control boxes for the receivers and the transmitters.

Each of the receivers and transmitters must be carefully slid into its proper rack compartment as far as it will go. When this is done, it will be possible to slip the locking lugs, located on the rack under each unit, over the conical shaped studs on the receivers and transmitters. The knurled-nuts which hold these lugs in place should be hand-tightened and then safety-wired. It is essential that these instructions be followed carefully in order that the several units shall be held securely in place and that a good electrical connection shall exist between these units and the racks on which the ground binding posts are located.

Receivers and transmitters are operated remotely. Only the transmitter and the receiver control boxes need be installed near the pilot or operator. The location of the receiver control box should be such that the dials may be easily read. All dials are etched in aluminum and have a black background. Fluorescent characters on control boxes for operation at night with "black light" sources are not yet in production at the time of going to press. The location of the transmitter control box should be such that the three switches can be easily reached, and such that it is not too difficult to use the built-in key. Space must be left under this box and the receiver control box for inserting the plugs.

The receivers, transmitters, modulator, and antenna relay units need not be installed close to the pilot or operator.

ESSENTIAL INSTALLATION CONSIDERATIONS

(1) Reduction in the length and weight of cable or wiring requires a careful grouping of all units. Fig. 28 shows the cabling connections.

(2) Allow enough clearance around the units so that under maximum possible amplitude of vibration they will not strike anything.

(3) Allow plenty of slack in all connectors near the points of attachment to the units. Reduction in the shockproofing of the units, and at the same time damage to the connectors and mechanical

linkages may result if this precaution is not observed.

(4) *Short antenna leads inside the fuselage are essential.* This requires the use of the minimum practicable spacing between the antenna relay unit, the antenna binding posts on the receivers and transmitters, and the antenna lead-in insulator. Bare wire supported on ceramic insulators, where necessary, should be used for all antenna connections. The use of isolantite beads is not recommended. Three considerations are involved here, namely: safety from voltage-breakdown, low RF losses, and low capacitance to ground of the antenna wiring inside the fuselage.

(5) It will be necessary to change receivers and transmitters occasionally, and to tune them up; hence it is very desirable that a location be provided to facilitate these operations. It is particularly important that the transmitters be installed in such a manner that the reflection of the entire electron resonance indicator screen may be seen in the mirror on the under side of the hinged rear cover on each transmitter. A view of this is essential in checking the calibration of the transmitter against the piezo-crystal in the transmitter.

(6) To attach plugs, "feel" for the proper orientation before using any considerable pressure on the plugs. The locking rings must be *hand-tightened.*

(7) Flexible mechanical linkages should be kept short, and have as few sharp bends as possible. Additional length and sharp bends increase the friction and resulting backlash in tuning. Also, since the only mechanical stop on the receiver tuning control consists of the tie plate of the rotors of the receiver gang capacitors, it is possible to turn the tuning crank with sufficient force to spring the stators from their ball-type supporting insulators, whereupon the rotor and stator become short-circuited. The likelihood of this mechanical damage increases with increased intricacy of tuning shaft layout, since increased friction gives less "feel" of the stop points. In this connection it is well to observe the tuning dial of the receiver control box and not to tune beyond the end-calibration marks of the dials.

(8) Safety-wire the snapslides which lock the several units to their mountings. Safety-wire the snapslides which hold the tube covers on the transmitters and modulator unit. The latter operation is to make accidental access to the high-voltage plate leads of the Type 1625 tubes more difficult.

(9) When the 190-550 KC receiver is installed in a 3-unit rack it should be located in the center compartment. This will physcially separate the remaining receivers and reduce electrical interference between them.

(10) Set each receiver control box dial to correspond with the dial of the receiver connected thereto. Each receiver control box dial may be adjusted to a predetermined position by first loosening the knurled screw in the center and then rotating the dial to the desired reading. The knurled screw must then be *hand-tightened. Do not use pliers for this operation.*

(11) The functional diagram, Fig. 2 indicates that each "A-TEL-B TEL" toggle switch on the rack directly under the front of each receiver *must be in its center position covered by a screw cap.* These switches are never operated when the receivers are remotely controlled. If one of these switches is thrown to "A" or "B," the "A-B" switch on the control box corresponding to this receiver will not function properly.

(12) The output of the receivers will be switched to "A" or "B" lines depending upon operating requirements and cannot be specified in this instruction book.

(13) A relay in the rack behind *each* receiver operates simultaneously with the transmitter keying relay to switch the headset circuit of that receiver to the transmitter sidetone circuit. If one receiver is connected to a separate antenna, it may be desirable to disconnect the sidetone relay associated with this receiver so that reception on it will not be interfered with during keying of one of the transmitters. If this is necessary, the proper relay may be made inoperative by placing a wedge under the armature. *This should be done only with proper authorization however.* If cable 5808 is disconnected from the receiver rack, sidetone is removed from *all* receivers.

(14) The toggle switch, S-53 (Fig. 25) inside the transmitter control box should be in the "R-IN" position. This places a 510 ohm resistor in the microphone line. To gain access to S-53 use a screw driver to pry off the snap cap near the red nameplate. The same screw driver may be used to check the position of the toggle switch. Unless R-66 is in the microphone circuit, the current through the RS-38 microphone will be abnormally high.

(15) If the transmitters are to be controlled by the button on the microphone, turn the knurled nut on the microphone jack as far counter clockwise as possible. If "throttle switch" control is required, *turn the knurled nut as far clockwise as possible and permanently close the "press-to-talk" switch on the microphone.*

(16) In order to secure a good ground to the receivers and transmitters, connect a short flexible lead from the airplane frame to one of the ground binding posts on each of the racks. The knurled nuts which clamp the receivers and transmitters in the racks must be securely hand-tightened and safety-wired. This holds the units securely in place and at the same time provides a short electrical connection between chassis and racks. *Noisy receivers and reduced antenna current from the transmitters will result if this precaution is not observed.*

(17) See that all tubes are securely in place in the proper sockets and all plugs securely locked before

the power is turned on. The following vacuum tubes are required:

Tube set for 1 receiver unit

3—Type 12SK7 (RF and IF amplifier)
1—Type 12K8 (Mixer)
1—Type 12SR7 (Detector and CW osc.)
1—Type 12A6 (Audio amplifier)

Tube set for 1 modulator unit

1—Type 12J5-GT (Tone Osc.)
1—Type 1625 (Modulator)
1—Type VR-150-30 (Voltage-regulator)

Tube set for 1 transmitter unit

2—Type 1625 (RF power-amplifier)
1—Type 1626 (Master-osc.)
1—Type 1629 (Resonance indicator)

The location of each type of tube is indicated by the type number engraved on the outer shield adjacent to the tube.

All tubes supplied with the equipment shall be consumed prior to the employment of tubes from general stock.

SPECIAL NOTES TO BE READ IN CONNECTION WITH THE CABLING DIAGRAMS, FIGURE 28.

Note 1. One receiver control box dial is supplied with each receiver on this contract. A dial may be removed from the receiver control box by unscrewing the knurled nut in the center and lifting the dial assembly off. Before tightening a new dial, rotate it until its reading corresponds precisely with that of the associated receiver dial, then *hand-tighten* the the knurled nut.

Note 2. The relative location of the receivers in the 2-unit receiver rack is immaterial. Interference between receivers in a 3-unit installation can be reduced by separating the receivers covering adjacent frequency bands. For example: the 190-550 KC receiver should be placed in the center compartment with the 3-6 MC and the 6-9.1 MC receivers in the end compartments.

Note 3. (A, B.) The mechanical linkage connection to each receiver should be made with a bend radius as large as practicable and with sufficient slack near the receiver so that its shock-proofing is not materially reduced. The relative lengths of the shafting and casing of the mechanical linkage should be such that when installed in an airplane there is no binding of the shafting or fittings. The alignment of the receiver and receiver control box dials should be performed after the installation of the mechanical linkage. Tune across the dial and check the correspondance of the receiver and receiver control box dials.

Note 4. The antenna binding post of any receiver may be connected to a separate antenna if desired. When the 190-550 KC receiver is to be used for reception of airways radio range signals, it is recommended that a vertical antenna be employed. The object of this is to avoid course errors usually associated with antennas having a horizontal component.

Note 5. (A, B.) Ground connections should be made to the metal frame of the airplane or to a member well-bonded to the frame and should be kept as short as possible except for enough slack to prevent breakage.

Note 6. The plug on cable 5808 may be connected to either outlet on the right rear of the rack.

Note 7. (A, B, C.) Antenna leads must be bare, tinned, approximate size #18 B&S gauge. Support on high quality ceramic insulators. The use of isolantite beads is not recommended. All transmitter antenna leads must be carefully spaced away from grounded surfaces, and the ends of the wires must be bent in close to the metal shells of the binding posts. If any sharp wire ends are allowed to project away from the binding post surface, corona and spark break-down will occur, particularly at high altitude.

Note 8. (A, B.) A 50 micromicrofarad antenna series capacitor is connected between posts "C" on Type CBY-29125 Antenna Relay Unit. This should be connected into the antenna circuit as shown for the upper transmitter unit in Fig. 28 if the antenna is so long that it is impossible to resonate the antenna circuit without it. If the overall length of the antenna does not exceed 20 feet, C-69 should *not* be used. The "A" binding posts on the two transmitters should be connected together, and a single wire should be used to connect them to the "TR" binding post on the antenna relay unit. The cabling diagram shows the antenna series capacitor connected to one transmitter but not to the other, to exemplify both methods of connection.

Note 9. The relative location of the transmitters in the rack is immaterial. Read Note 8 regarding the use of the 50 mmf. antenna series capacitor.

Note 10. The knurled nut on the microphone jack should be turned as far counterclockwise as possible in order to ground the sleeve connection for normal operation of the RS-38 microphone. For "push-to-talk" operation by a throttle switch or key, the knurled nut should be turned clockwise as far as possible. This disconnects the sleeve from ground. With all controls set for operation on "VOICE", and with the microphone jack sleeve grounded, pushing the "press-to-talk" button should start the transmitting dynamotor. If it is necessary to press the built-in key in addition to the microphone switch, the knurled nut is in the wrong position for control at the microphone.

Note 11. In this equipment, the 2-position toggle switch under this snap cap should always be in the "R-IN" position. With the switch in "R-IN" a 510 ohm resistor is connected in series with the microphone. It should be left in the "R-OUT" position only with microphones equal to Signal Corps Type T-17 or equal.

Note 12. This outlet connects to a remote antenna current indicator circuit. A remote antenna current indicator is not supplied as part of this equipment, hence the "Remote-Local" toggle switch on the Type CBY-29125 Antenna Relay Unit should be kept on "Local"

Note 13. An assembly drawing of each of the cable assemblies used in this equipment may be found in the back of this book (Fig. 29). Particular attention should be paid to the note regarding "twisting" of these cable assemblies during installation.

Note 14. Outlet 74 on the Type CBY-62036 Auxiliary Outlet Adapter (Fig. 7) should be covered with a protective cap when a plug from auxiliary equipment is not connected thereto. The upper left terminal is at +240 volts when the receiver dynamotor is running.
The caution regarding maximum current drain from outlet 74 must be carefully observed—not over 0.5 ampere from the L.V. terminal and not over 15 milliamperes from the H.V. terminal.

ANTENNAS

GENERAL

Any "built-on" antenna for the transmitters of this equipment, which is practicable for installation on a modern airplane, is bound to be a compromise so far as transmission efficiency is concerned. Given a certain maximum allowable antenna structure no matter how poor the compromise, there are certain things that should and should not be done to get the best possible efficiency. Some of these points are:

(1) The downlead should go as direct as possible to the antenna insulator and should not be allowed to pass close to the metal fuselage for any considerable length. Capacity currents to the fuselage from an antenna a few inches away contribute little to the signal strength.

(2) Leads inside the fuselage should be reduced to a minimum. This means that the antenna insulator, antenna relay unit, transmitters, and receivers must be positioned with this in mind as well as the length of cables. Capacity currents to the fuselage from an antenna lead inside the fuselage contribute nothing to the signal strength.

(3) Use only bare wire, supported *where necessary*, by ceramic insulators. Wire size should not exceed No. 18 B&S gauge. Never use a heavy or a rubber-covered wire. The object is to reduce the RF losses and capacitance of that part of the antenna which is inside the airplane, so that most of the energy can be radiated from the antenna.

(4) The receiver rack and the transmitter rack each has 2 ground binding posts. It is an essential part of the antenna system that good ground connections from the fuselage be made to one binding post on each of these racks.

TRANSMITTING ANTENNA CHARACTERISTICS

The transmitters of this equipment may be properly tuned to antennas having the following range of characteristics at the operating frequency.

(a) A reactance not greater than that of 50 micromicrofarads or of 4.5 microhenries (10 or 12 feet, up to a little over a quarter wave length).

(b) A resistance up to 12 ohms. Built-on antennas up to 25 feet overall length will not exceed this for frequencies covered by the transmitters of this equipment.

RECEIVING ANTENNA CHARACTERISTICS

The input circuit of the receivers of this equipment may be properly tuned to any practicable airplane antenna.

The 190-550 KC receiver may be used for reception of airways radio range signals. If so, the antenna recommended is a 2 to 3 foot vertical mast or a nearly vertical wire. If an antenna with considerable horizontal component is used a course distortion will result. This distortion is a function of the antenna and not of the receiver.