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HANDBOOK OF

MAINTENANCE INSTRUCTIONS

for

NAVY MODEL ATD AIRCRAFT RADIO TRANSMITTING EQUIPMENT

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SECTION I

1. INTRODUCTION.

1-1. FUNCTION.

1-1-1. Purpose.

The Model ATD Aircraft Radio Transmitting Equipment has been developed for installation in single and double cockpit planes of the United States Navy; however, it is sufficiently flexible for use on larger ships.

1-1-2. Type CRR-52253 Transmitter Unit and Type CRR-55079 Remote Indicator Unit.

The transmitter is designed for location in the cockpit at a point adjacent to the radio operator, front panel controls being available for his use. The remote frequency indicator unit should be mounted where it is visible to the operator when his operating position does not permit him to see the transmitter unit easily.

1-1-3. Type CRR-23280 Remote Control Unit.

The remote control unit should be mounted adjacent to the pilot. This unit permits the pilot to select any one of four frequencies and to start and stop the transmitter. A code key is provided on this unit for telegraphic signalling. When the pilot's microphone plug is inserted in the microphone jack on this unit, he may secure voice emission by closing the switch on his microphone or his throttle switch.

1-1-4. Tuning Units.

Four tuning units are normally provided with each transmitter as follows: One 540–1500 Kcs; one 1500–3000 Kcs; two 3000–9050 Kcs. Tuning units having frequency ranges of 9050–15,800 Kcs and 200–540 Kcs are available. An antenna tuning unit, external to the transmitter, is required whenever the 200–540 Kcs tuning unit is used. Each tuning unit may be tuned to any frequency within its range. Once tuned, it is selected by the operator or pilot by use of their respective channel selector switches.

1-1-5. Power Supply.

The ship's battery furnishes power to the dynamotor unit at 24 to 28 volts DC. The dynamotor unit supplies 28, 380, and 1000 volts DC to the transmitter unit. The dynamotor unit should be located adjacent to the operator so that he may have access to it for fuse renewal.

1-2. MAJOR UNITS.

The Model ATD Airctaft Radio Transmitting Equipment is comprised of the following units: (See Figure 1.)

Item	*Quantity*	*Description*	*Dimensions*	*Weight, lbs. (uncrated)*
A	1	Type CRR-52253 Aircraft Transmitter Unit, complete with 1 set of mounting tracts and 4 tuning units, as follows *Type CRR-47207 Tuning Unit 200-540 Kcs 1—Type CRR-47208 Tuning Unit 540-1500 Kcs 1—Type CRR-47209 Tuning Unit 1500-3000 Kcs 2—Type CRR-47210 Tuning Unit 3000-9050 Kcs *Type CRR-47211 Tuning Unit 9050-15,800 Kcs	23-3/8″ x 10-15/16″ x 13-25/32″	70
B	1	*Type CRR-47206 Antenna Tuning Unit 200-540 Kcs	6-3/4″ x 10-7/32″ x 12-3/32″	9.25
C	1	Type CRR-21748 Dynamotor Assembly Unit	6-7/8″ x 11-7/16″ x 8-13/32″	24.125
D	1	Type CRR-55079 Remote Indicator Unit	2-5/16″ x 3-5/16″ x 2-3/16″	0.75
E	1	Type CRR-23280 Remote Control Unit	2-3/4″ x 5-27/32″ x 3-1/16″	1.06
F	1	†Battery to Dynamotor Cable, per dwg. AC59395-1		2.83 for 10 ft. cable
G	1	†Dynamotor to Transmitter Cable, per dwg. AC59383-1		3.375 for 10 ft. cable
H	1	†Transmitter to Remote Control Cable, per dwg. AC59377-2		5.177 for 15 ft. cable
I	1	†Transmitter to Remote Indicator Cable, per dwg. AC59384-2		2.69 for 10 ft. cable
	1	Set of tubes as follows: 1—Navy Type -814 4—Navy Type -6L6-G 1—Type -12SL7-GT 1—Navy Type -38250		
	1	Waterproof cover for Transmitter Unit		
	1	Waterproof cover for Dynamotor Assembly		

Quantity	*Description*
1	Set of Operating Spare Parts in Spare Parts Box per Material List A50242
1	‡Set of Bulk Spare Parts per Material List A50243 for each 10 equipments
1	Instruction Book

* Quantity of these units shipped with each transmitter unit subject to Navy requirements and orders. Information on these units is included in this instruction book in the event that these units are made available to the service at some subsequent date.

† The cable numbers given are for cables with the end terminations most generally used. However cables with all combinations of straight and right angle end terminations are available. (See Figures 51, 52, 53, and 54.)

‡ Shipped in bulk to supply base.

1-3. ADDITIONAL UNITS.

The following additional equipment (not supplied under the contract) will be required for the satisfactory operation of the Model ATD Aircraft Radio Transmitting Equipment.

1—Power Supply of 28 volts DC
1—Receiver, handheld
2—Carbon Microphones, Navy Type T-38C
or 2—Mask Type Carbon Microphones MC-254-A Signal Corps Spec. 71-1164
or 2—Mask Type Magnetic Microphone MC-253, Signal Corps Spec. 71-1153
or 2—Throat Microphones
1—Telegraph Key
1—Trailing Wire Antenna up to 200 feet in length
1—Fixed Antenna
1—Headset

1-4. POWER CONSUMPTION.

All power for the equipment is supplied by the plane's primary battery supply which is normally 28 volts DC when under charge. Operation can be secured at reduced power if the supply voltage is reduced to 23 volts DC. The following tabulation lists the power requirements at a supply voltage of 28 volts DC.

Operating Condition	*Amperes*
Phone Standby, Dynamotor stopped	5.0
CW Tune-Operate Switch in Tune position	11.0
CW Key up	9.3
CW Key down	17.6
Phone Carrier	18.5
Phone, normal modulation	19.0

1-5. ANTENNA REQUIREMENTS.

1-5-1. 200-540 Kcs Range.

The antenna tuning unit for the above range requires a trailing wire antenna 200 feet in length whose capacitance is 300 Mmf at 200 Kcs and 500 Mmf at 540 Kcs, and whose resistance is 5 to 10 ohms.

1-5-2. 540-1500 Kcs Range.

The tuning unit for the above frequency range requires a trailing wire antenna 70 to 150 feet in length whose capacitance is 250 to 300 Mmf and whose resistance is 5 to 10 ohms.

1-5-3. 1500-3000 Kcs, 3000-9050 Kcs, and 9050-15,800 Kcs Range.

The tuning units for the above three ranges require a fixed antenna such as a single wire "T" approximately 25 feet in length. Its electrical characteristics should be approximately as follows:

Frequency	*Capacitance or Inductance*	*Resistance*
1.5 Mcs	70 Mmf	1.5 Ohms
3 Mcs	80 Mmf	1.2 Ohms
6 Mcs	100 Mmf	2.5 Ohms
9 Mcs	300 Mmf	5 Ohms
12 Mcs	2 μH	15 Ohms
15 Mcs	6 μH	110 Ohms

The resonant frequency of the antenna must exceed 9 Mcs.

These units may use a trailing wire antenna up to about 50 feet in length. This antenna length must be varied until its electrical characteristics are approximately the same as given above for the fixed antenna.

SECTION II

2. DETAILED DESCRIPTION.

2-1. TYPE CRR-52253 TRANSMITTER UNIT.

2-1-1. Location of Components.

2-1-1-1. Left Front Panel Controls (See Figure 3).

This panel carries the following meters and controls: Antenna ammeter, local-remote switch, test key, tune-operate switch, and the following jacks; key, throttle switch, operator's microphone, operator's and pilot's sidetone.

2-1-1-2. Right Front Panel (See Figure 3).

This panel carries the following meters and controls: PA plate ammeter, channel selector switch, channel indicator disc, phone standby-off-code switch, CW-MCW switch, PA grid meter switch, combined PA grid milliammeter and battery voltmeter, and a binding post for connection of a CFI unit.

2-1-1-3. Power and Antenna Connections (See Figures 5 and 6).

Three studs, P-104, P-105, and P-106 are provided on the upper left side of the transmitter for ground, receiver and antenna connections, respectively. These studs are fitted with Rajah plugs. Three receptacles are mounted on the lower left side of the transmitter to receive cable plugs from the remote indicator unit, the remote control unit and the dynamotor unit.

2-1-1-4. Tuning Units.

Front panel space is provided for four tuning units, each of which contain all the RF components for a certain frequency range such as 200-540 Kcs, 540-1500 Kcs, 1500-3000 Kcs, 3000-9050 Kcs, or 9050-15,800 Kcs. These units may be removed by releasing their two locking screws and drawing the unit forward, provided that the channel indicator disc is not set to the channel being withdrawn. Reading from left to right, the channels are lettered "A," "B", "C," and "D" on the top shield. These letters correspond with positions of the channel selector switch and channel indicator disc. Any tuning unit may be inserted in any channel. A detailed description of the tuning units is given in sections 2-5 to 2-10.

2-1-1-5. Vacuum Tubes.

Tubes are mounted at the rear of the transmitter, and are accessible through the top hinged tube door. (See Figure 4). Reading from left to right they are:

V-102 Power Amplifier	Navy Type -814
V-101 RF Oscillator	Navy Type -6L6-G
V-104 Modulator	Navy Type -6L6-G
V-105 Modulator	Navy Type -6L6-G
V-106 Driver	Navy Type -6L6-G
V-103 Voltage Regulator	Navy Type -38250

The microphone amplifier tube V-107, type -12SL7-GT, is mounted on the right side of the transmitter. The right side shield should be removed to secure access to this tube.

NOTE: ALL TUBES SUPPLIED WITH THE EQUIPMENT SHALL BE CONSUMED PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

2-1-1-6. Keying Relay.

The keying relay K-103 is mounted in the compartment behind the left front panel. (See Figures 5 and 6)

2-1-1-7. Audio Circuit Components.

The audio circuit components are mounted in the compartment behind the right front panel. (See Figure 7). The following units are mounted above the shelf: phone relay K-101, modulator grid transformer T-101. The following units are mounted beneath the shelf: microphone switch S-115, microphone amplifier resistors and capacitors, sidetone switch S-111. Access to these switches may be had by removing the tuning unit from the D channel. The modulation transformer T-102 is mounted behind the keying relay.

2-1-1-8. Channel Switch Motor Drive.

The channel switch motor drive assembly is mounted in the upper part of the compartment behind the right front panel. This assembly includes the motor B-101 and its gear train, the channel selector cam S-109, channel indicator switch S-108, channel reversing switch S-110 and motor relay K-104. (See Figure 7.)

2-1-1-9. Channel Switch.

The RF channel switches S-116 and S-117 are mounted behind the tuning units. Its drive shaft is geared to the motor drive gear assembly. Four cams on the drive shaft each operate a vertical push-rod behind each tuning unit. Each push-rod carries five fingers which press down on the switch blades mounted on rear of the tuning units. (See Figures 10 and 11.)

2-1-1-10. Resistor Assembly (See Figure 9).

The major part of the resistors are mounted on a resistor assembly under the tuning units. These resistors include the screen bleeder resistors for the oscillator, PA, modulator, and driver stages. Access to these resistors is secured by removing the bottom shield of the transmitter.

2-1-1-11. RF Circuit Components.

The compartment beneath the tube shelf is used to mount the RF circuit components which are not part of the tuning units. These include the oscillator heater reactor and its bypass capacitors, and the bypass and coupling capacitors for the oscillator and PA tubes. The PA plate reactor and its blocking capacitor are mounted above and to the left of the PA tube.

2-1-2. Control Circuits.

2-1-2-1. Drawing Reference.

Refer to Basic Control Schematic Diagram, Figure 30, and Schematic Diagram, Figure 29.

2-1-2-2. Local-Remote Switch.

The local-remote switch S-102 is normally placed in the REMOTE position and secured in this position with safety wire running through a hole drilled in the switch lever and a stud mounted on the front panel of the transmitter unit. In this case, the pilot only has control of the following functions: Transmitter phone standby; transmitter code start; frequency selection. If the local-remote switch is in the LOCAL position, control of the above functions is transferred to the radio operator.

2-1-2-3. Phone-Code Switch—Code Operation.

If the local-remote switch S-102 is in the LOCAL position, the operator's phone-code switch S-101 is effective. When this swtich is placed in the OFF position, no power is applied to the transmitter. When this switch is placed in the CODE position, filament and plate power are simultaneously applied to the transmitter as follows: Filament and control power is supplied from the ship's battery through the dynamotor unit battery fuse F-201 and filament fuse F-202, the local-remote switch S-102A to the transmitter filament buss shown as a heavy line on Basic Control Diagram, Figure 30. From this buss, the filaments of all tubes are supplied through filament resistor R-101. When power is thus supplied to the filament buss, the dynamotor relay K-201 is energized. Its ground circuit is closed through dynamotor lid interlock switch S-201, transmitter tube door interlock switch S-112, code-phone switch S-101B and local-remote switch S-102D. When the dynamotor relay K-201 closes, it applies power to the dynamotor D-201 which then delivers 380 and 1000 volts DC to the transmitter.

2-1-2-4. Phone-Code Switch—Phone Operation.

If the local-remote switch S-102 is in the LOCAL position and the phone-code switch is placed in the PHONE-STANDBY position, filament power is applied to the transmitter in the same manner as outlined in paragraph 2-1-2-3 operation. The dynamotor relay K-201 and dynamotor D-201 are energized by completing a ground circuit for the dynamotor relay through the dynamotor lid interlock switch S-201, the transmitter tube door interlock switch S-112 and contact K-101B on the phone relay K-101. Closing the phone relay K-101 also energizes the keying relay K-103 through contact K-101A. The phone relay K-101 is closed by closing the throttle switch connected to jack J-106, or the operator's microphone switch connected to jack J-108, or the pilot's microphone switch connected to microphone jack J-301 on the Type CRR-23280 Remote Control Unit.

2-1-2-5. Frequency Selection Control Circuit.

(*a*) When local-remote switch S-102 is in the LOCAL position and the channel selector switch S-107 is placed on position "C", for example, the channel switch motor is energized and rotates until the channel "C" push-rod behind the "C" tuning unit is pushed down by the "C" cam on the switch drive shaft. When the motor shaft reaches this position, the motor stops. The frequency indicator disc on the front panel then exposes the letter "C".

(*b*) The channel switch motor is energized from the filament buss, through the motor armature, the motor forward field, coil of motor relay K-104, channel selector cam switch S-109, channel selector switch S-107, and remote-local switch S-102C to ground. Cam switch S-109 is mounted on the motor drive shaft, and rotates with this shaft. When the shaft reaches the desired position "C", the insulated section on this switch comes under the "C" switch finger. The forward contact of the reversing switch S-110 makes contact and completes the forward field circuit to ground. The motor rotates further and opens the switch S-110, thus breaking this circuit and deenergizing motor relay K-104. This relay is energized only when current passes through the forward field.

(*c*) When the motor relay K-104 is deenergized, contact K-104A closes and closes the circuit to the reverse field. If the motor shaft is not in the exact "C" position, the channel reversing switch S-110 then makes contact on the forward or reverse side and

causes the motor to rotate slightly in one direction or the other until it is in the exact center of the "C" position. At this point, the motor reversing switch S-110 opens and the motor stops. This switch S-110 is mechanically connected to the motor drive gear train so that it rotates twelve times as fast as the main channel switch shaft. Accordingly, the reversing switch S-110 controls the position of the motor with twelve times the precision available from the channel selector cam.

(*d*) The motor relay K-104 has a second contact finger K-104B which deenergizes the keying relay K-103, the phone relay K-101, and the microphone DC circuits whenever the motor is rotating in a forward direction. Thus, the keying relay K-103 is opened until the channel switching is complete.

(*e*) Channel indicator switch S-108 is also mounted on the channel switch shaft. When the motor stops on position "C", this switch places a ground on its "C" contact and thus energizes the "C" indicator relay K-403 in the Type CRR-55079 Remote Indicator Unit.

2-1-2-6. Keying Relay.

The keying relay K-103 is energized from the filament buss if its coil circuit is completed to ground by closing the test key S-106, the operator's telegraph key through key jack J-107, the pilot's key S-303 on the Type CRR-23280 Remote Control Unit, or contact K-101A on the phone relay. The keying relay K-103 has eight contacts which perform the following functions when the relay is energized:

Contact K-103A—Connects the antenna to the transmitter circuits.

Contacts K-103B and K-103H—Connect the antenna to the receiver circuits.

Contact K-103C—Closes the sidetone circuit to the phones through jack J-105.

Contact K-103D—Closes the sidetone circuit to the phones through jack J-104.

Contact K-103E—Closes the 380-volt DC circuit to the oscillator screen and plate, the PA screen, and the driver screen circuits.

Contact K-103F—Grounds the receiver terminal when the antenna is connected to the transmitter circuit.

Contact K-103G—Connects the running coil of the keying relay into the circuit after the relay has been energized and has received its initial pulse from the starting coil.

2-1-2-7. Phone Relay.

The phone relay K-101 is energized when the throttle switch or the pilot's or operator's microphone switches are closed. This relay has four fingers which perform the following functions when it is energized:

Contact K-101A—Energizes the keying relay K-103.

Contact K-101B—Energizes the dynamotor relay K-201.

Contact K-101C—Supplies plate voltage to the modulator tubes V-104 and V-105 and microphone amplifier tube V-107.

Contact K-101D—Converts the driver tube V-106 from an oscillator for code operation to an amplifier for phone operation.

2-1-2-8. PA Grid Relay.

The PA grid relay K-102 is energized whenever the keying relay K-103 is energized. When K-102 is not energized its contact places a bypass *capacitor* C-110 across the oscillator plate circuit to ground, thus preventing any undesired oscillation of the PA tube when the key is open. When the key is closed, relay K-102 opens and removes capacitor C-110 from the circuit, allowing the PA tube to function as an amplifier.

2-1-2-9. Local-Remote Switch—Remote Position.

When the local-remote switch S-102 is in the REMOTE position, the following operator's switches are ineffective: Phone-code switch S-101 and channel selector switch S-107. The pilot's phone-code switch S-301 then has control over the starting of the transmitter in phone or code operation, and the pilot's channel selector switch S-302 must be used to select channels. An indicator relay K-301 is supplied on the remote control unit and is energized whenever the local-remote switch is on REMOTE position and the pilot's phone-code switch is in the CODE or PHONE position. When this indicator relay K-301 is energized, its armature protrudes from the remote control unit, thus indicating to the pilot that he has control of the transmitter and that the transmitter has been started in either code or phone operation as indicated by the position of his phone-code switch. The position of the pilot's channel selector switch indicates which channel is operative.

2-1-3. Power Circuits.

2-1-3-1. Filament and Control Circuits.

Filament and control circuits are supplied from the plane's 28-volt battery through the local-remote switch S-102 and the phone-code switch S-101. The various tube filaments and cathode heaters are arranged in a series parallel combination to minimize power loss due to unnecessary dropping resistors.

2-1-3-2. 380-Volt Circuits.

The 380-volt commutator of the dynamotor supplies plate and screen voltage to all tubes except the PA tube for which it supplies screen voltage only. A fuse F-203 in the dynamotor unit protects the 380 volt commutator against overload. Individual screen dropping resistors are supplied for the oscillator, PA, modulator and driver tubes. Shunt screen resistors are used on the driver and modulator tubes to reduce the drop in screen voltage as an audio frequency signal is placed on the grids of these tubes. A regulator tube V-103, Navy Type VR150-30 maintains a constant voltage of 150 volts on the oscillator screen. As the screen voltage tends to rise, the regulator tube draws more current through the screen dropping resistors and the resultant increased voltage drop across the resistors returns the screen voltage to normal.

2-1-3-3. 1000-Volt Circuits.

The 1000-volt commutator of the dynamotor supplies plate voltage to the PA tube only. Dynamotor fuse F-204 protects this commutator.

2-1-3-4. Tune-Operate Switch.

When the tune-operate switch S-103 is in the TUNE position, the 380-volt supply is removed from the screen and plate circuits of the microphone amplifier, driver and modulator tubes, thus making the complete audio system including sidetone circuits inoperative. At the same time, the high voltage tune operate switch S-114 removes the 1000-volt supply from the PA tube. This reduces the radiated power in the TUNE position to a very small value. The low voltage tune-operate switch S-103 and the high voltage tune-operate switch S-114 are mechanically linked so that they always operate together.

2-1-3-5. Plate Supply to Audio Circuits.

(*a*) When the CW-MCW switch S-105 is placed in the MCW position, plate and screen voltage is supplied to the modulator tubes V-104 and V-105 but not to the microphone amplifier tube V-107 during code operation. Plate voltage is supplied to the driver tube V-106 during code or phone operation. Screen voltage to this tube is supplied through the keying relay K-103E to control the emission of this tube when it is used as a sidetone audio oscillator.

(*b*) When the CW-MCW switch is placed in the CW position, no plate or screen voltage is supplied to the modulator or microphone amplifier tubes during code operation. During phone operation, the phone relay K-101 closes and its contact K-101C supplies plate and screen voltage to the modulator and microphone amplifier tubes.

2-1-3-6. PA Meter Switch.

The PA meter switch S-104 is spring-loaded so that it is normally in the up position. In this case, the PA meter M-103 measures the voltage across the PA grid leak resistor R-124 and thus indicates PA grid current in milliamperes. When this switch is placed in the down position, the meter is placed across the filament buss and indicates the voltage on this buss to ground. Since the filament buss voltage is nearly the same as the battery voltage delivered to the dynamotor, this meter M-103 then gives an indication of battery voltage.

2-1-4. Audio Frequency Circuits.

2-1-4-1. Carbon Microphone Circuit.

(*a*) When a carbon microphone is used, such as the Navy Type T-38C microphone, the microphone switch S-115 is placed in the CARBON position. This switch may be operated by removing the tuning unit from the "D" channel. The switch shaft is then visible on the lower right side of this compartment. It may be adjusted with a screwdriver or coin.

(*b*) DC supply for the carbon microphone is obtained from the 28-volt buss through filter reactor L-101, shunt resistor R-145, and series resistor R-143 to the microphone jack J-108. The three resistors R-143, R-144, R-145 form two L pads which isolate the pilot's and operator's microphone circuits from one another.

(*c*) The audio voltage delivered by the microphone is impressed across R-143 and R-145 and about one-half of it is delivered across R-145, and through microphone switch S-115A to the second grid of the dual triode microphone amplifier tube V-107. A third blade C of switch S-115 grounds the first grid of the microphone amplifier tube V-107.

2-1-4-2. Magnetic Microphone Circuit.

When a magnetic microphone such as the Army Mask Type Microphone MC-253 is used, the microphone switch S-115 is placed in the MAGNETIC position. The B blade of this switch grounds shunt resistor R-145, and the C blade lifts the ground from the first grid of the microphone amplifier tube V-107. The audio voltage developed by the microphone is impressed across R-143 and R-145 in series and about one-half of it is delivered across R-145 and thus to the first grid of the microphone amplifier tube V-107, through the second blade of S-115.

2-1-4-3. Microphone Amplifier.

The microphone amplifier tube V-107 is a dual-triode. It is used as a two-stage resistance-coupled amplifier to amplify the output of the magnetic microphone to a voltage suitable for operating the driver grid. It is used as a single-stage amplifier with the carbon microphone. This amplifier receives no plate voltage during code operation. Plate voltage is applied during phone operation through voice relay K-101C.

2-1-4-4. Audio Driver—Phone Operation.

(*a*) The driver tube V-106 serves as an amplifier to drive the grids of the modulator tubes and to supply the sidetone signal to the operator's and pilot's phones. The plate circuit of this tube comprises the primary of transformer T-101. One secondary of this transformer furnishes push-pull grid excitation to the modulator tubes. The other secondary furnishes sidetone voltage to the phones through sidetone switch S-111 which selects the desired transformer tap and sidetone level.

(*b*) During phone operation, the phone relay contact K-101D connects the driver grid resistor R-104 to the phone feedback resistor R-105. A portion of the audio plate voltage is fed back from transformer T-101 through resistor R-106 and capacitor C-105 to resistor R-105, through phone relay contact K-101D to grid resistor R-104 and so to the driver grid. This negative feedback voltage is reversed in phase as referred to the normal grid excitation voltage received from the microphone amplifier. The negative and normal grid voltages add vectorially to secure the total grid voltage impressed on the driver grid. This negative feedback circuit reduces the gain of the driver tube and also reduces the distortion and hum introduced in this stage.

(*c*) The driver stage uses cathode resistor bias during phone operation. Plate current flows through cathode resistors R-146, R-147 producing a voltage drop which is impressed between the cathode and the grid which is at DC ground potential through resistor R-105.

2-1-4-5. Audio Driver—Code Operation.

(*a*) In code operation, the driver tube becomes an audio oscillator which excites the modulator grids for MCW operation and furnishes a sidetone signal of about 1000 cycles to the phones. This sidetone signal is keyed since the driver tube screen circuit is supplied through keying relay contact K-103E and the sidetone output signal is supplied to the phones through keying relay contacts K-103C and K-103D.

(*b*) During code operation the phone relay contact K-101D connects the driver grid resistor R-104 to the modulator grid transformer T-101 through resistor R-114 and blocking capacitor C-125. Since the primary of this transformer forms the plate circuit of the driver tube, positive feedback occurs from the driver plate to its grid and oscillation takes place. The frequency of oscillation is determined by the oscillator tank inductor L-102 and capacitor C-104. One side of this tank circuit is permanently connected to the driver plate. The other side is connected to the low low potential side of the primary of transformer T-101 through phone relay K-101C for code operation only. Thus, in code operation, this tank circuit is connected in parallel with the driver plate circuit.

(*c*) The driver stage uses grid leak bias only for code operation. The grid resistor R-104 connects through phone relay contact K-101D to shunt resistor R-115 and then to the cathode of the driver tube.

2-1-4-6. Modulator—Phone Operation.

The modulator tubes V-104 and V-105 are used as class AB amplifiers to amplify the output of the driver stage and so to modulate the plate and screen of the PA tube V-102 for MCW and phone operation only. During phone operation, plate and screen voltage is supplied to the modulator tubes through phone relay contact K-101C, regardless of the position of the CW-MCW switch.

2-1-4-7. Modulator—Code Operation.

During code operation, no plate or screen voltage is supplied to the modulator unless the CW-MCW switch is placed in the MCW position. In this case, the 1000-cycle signal received by the modulator grids from the driver is amplified by the modulators and modulates the PA tube. If the switch is in the CW position, no modulator plate or screen voltage is available, and no modulation of the PA tube takes place.

2-1-5. Radio Frequency Circuit.

2-1-5-1. Tuning Units.

Tuning units having the following frequency ranges are available.

Frequency Range	*Navy Type*
*200/540 Kcs	CRR-47207
540/1500 Kcs	CRR-47208
1500/3000 Kcs	CRR-47209
3000/9050 Kcs	CRR-47210
*9050/15,800 Kcs	CRR-47211

* Quantity of these units shipped with each transmitter unit subject to Navy requirements and orders. Information on these units is included in this instruction book in the event that these units are made available to the service at some subsequent date.

Any tuning unit may be inserted in any channel of the transmitter. Tuning units are described in detail in sections 2-5 to 2-10.

NOTE: Schematic diagram, Figure 29, shows the equipment being operated with the 3000-9050 Kcs tuning unit in place. The following circuit description traces the circuit for this tuning unit only. In general, a corresponding description would apply for any other band and tuning unit.

2-1-5-2. Oscillator Grid Circuit.

(*a*) The oscillator is used in an electron-coupled Hartley circuit. The grid circuit uses the screen as an anode and always operates at one-half the output frequency. The oscillator plate circuit is always tuned to the output or PA frequency.†

(*b*) The oscillator grid circuit comprises a variometer and band capacitors. The band capacitors are used to secure four to five bands each having a ratio of maximum to minimum frequency of approximately 1.25 to 1. The low potential side of the oscillator tank is grounded to the tuning unit frame. The cathode tap is fed to the cathode buss and the oscillator-cathode through a blade of the channel SWITCH S-606. The grid connection from the high potential and of the tank circuit is made through a blade of the channel switch to the grid blocking capacitor C-106 and grid leak resistor R-116 and thus to the tube grid.

(*c*) The cathode and heater circuit is maintained at an RF potential above ground by the use of RF heater reactor L-103. Cathode bypass capacitor C-107 maintains the cathode and the heater at the same RF potential. Heater bypass capacitor C-108 bypasses the low end of the heater reactor to ground.

(*d*) Excitation voltage for the CFI unit is secured from heater reactor L-103 through CFI blocking capacitor C-129.

(*e*) The oscillator screen is bypassed to ground by capacitor C-109. Since the oscillator grid tank is grounded and the screen is bypassed to ground, the screen becomes the anode of the grid circuit Hartley oscillator. This screen is supplied with 150 volts DC through its screen dropping resistors R-117, R-118, R-119, and R-120. The screen voltage is maintained at a constant value by the voltage regulator tube V-103.

2-1-5-3. Oscillator Plate Circuit.

The oscillator plate tank circuit comprises a variable capacitor and tapped inductance for the 3000-9050 Kcs and 9050-15,800 Kcs band or a variometer and band capacitors for the 200-540, 540-1500, and 1500-3000 Kcs bands. In any case, the tank circuit is connected to the oscillator plate through the plate blade of the channel switch S-606. Plate voltage is secured from the 380-volt supply through the keying relay contact K-103E and the plate dropping resistor R-121, and individual channel resistors R-148 to R-151. Resistor R-148 supplies channel A, R-149 channel B, etc. Resistors R-148 to R-151 act as decoupling resistors to prevent RF feedback from the PA buss to the oscillator. Bypass capacitors C-117 to C-120 maintain the low end of the plate tank at RF ground potential.

2-1-5-4. PA Grid Relay.

PA grid relay K-102 prevents oscillation of the PA when the key is open. When the key is open, K-102 is not energized: its contact is closed, and it places capacitor C-110 from the oscillator plate buss to ground. This detunes the oscillator plate circuit, which is directly coupled to the PA grid. The PA grid-circuit impedance to ground is thus greatly reduced and self oscillation of the PA tube is prevented.

When the key is closed, relay K-102 is energized, its contact opens, capacitor C-110 is effectively removed from circuit and the oscillator plate circuit operates normally.

2-1-5-5. PA Grid Circuit.

The PA tube receives RF grid excitation from the oscillator plate tank through coupling capacitor C-111. Grid reactor L-104 prevents RF power loss in the PA grid leak resistors R-122, R-123, and R-124. PA grid current passing through these resistors furnishes the only bias used on the PA tube.

2-1-5-6. PA Plate Circuit.

(*a*) The PA plate is parallel fed with 1000 volts DC through the secondary of the modulation transformer T-102, and RF reactors L-105 and L-106. Blocking capacitor C-116 couples the PA plate to its tank circuit and blocks the DC voltage from the plate tank.

(*b*) The PA tube is connected to its tank circuit in the tuning unit through the PA blade of the channel switch S-607. The PA plate tank circuit in the tuning unit comprises a variometer, L-603, and two band capacitors, C-611 and C-612. The low potential end of the tank variometer is connected to the primary or rotor of the coupling inductor L-604. Its secondary is connected in series with the antenna tuning circuit. Thus PA tank current in the primary induces a voltage in the secondary or antenna circuit. Antenna coupling is varied by rotating the primary inside the secondary.

† The only exception is the 200-540 Kcs tuning unit whose grid frequency is the same as the output frequency.

2-1-5-7. Antenna Circuit.

The antenna circuit in the tuning unit is connected to the antenna buss through the antenna blade of the channel switch S-607. The antenna circuit comprises the secondary of the coupling inductor L-604, an antenna variometer L-605, and antenna loading inductor L-606 and its switch S-604. In the 3000 to 9050 Kcs range, a series antenna capacitor C-613 is provided. In the 200-540 Kcs range, the transmitter tuning unit contains only an antenna coupling inductor L-904 in the antenna circuit. The 200-540 Kcs antenna tuning unit external to the transmitter contains the antenna variometer L-1001 and the antenna load tap switch S-1001. With the 3000-9050 Kcs Tuning Unit in operation, antenna series resonance is secured by varying the antenna variometer L-605 and the antenna load tap switch S-604. This condition causes a maximum antenna current to be indicated on antenna ammeter M-101. The antenna circuit is completed from the antenna buss through the antenna ammeter M-101 and through keying relay contact K-103A to the antenna post P-106 at the left side of the transmitter.

2-1-5-8. Idle Tuning Units.

(*a*) When four tuning units are in place in the transmitter, one unit will be active and three will be idle. The tips of the channel switch blades on the rear of each tuning unit will raise until they hit shorting stops on each unit. Each blade will then be shorted as follows:

The oscillator grid and cathode blades short to ground, thus shorting the grid tank.

The oscillator plate blade shorts the plate tank inductance.

The PA plate blade shorts the PA tank inductor to ground. The antenna capacitor blade shorts the antenna inductance and capacitor to ground. The antenna blade does not come up against a shorting stop. The above procedure insures that idle tuning units will never absorb power from a working unit.

(*b*) If possible, the transmitter should be operated with four tuning units in place at all times. *Removal of an idle unit will cause considerable frequency shift in a working unit. If the oscillator of the active unit is retuned to take care of this condition, no harm will result in operation with a missing tuning unit provided no attempt is made to operate the empty channel.* If an empty channel is energized, no RF omission will result, and the PA plate will draw considerable current, all of which is consumed in excessive plate dissipation.

2-2. DESCRIPTION OF TYPE CRR-21748 DYNAMOTOR ASSEMBLY.

2-2-1. Location of Components.

2-2-1-1. Cable Plug Receptacles (Figure 24).

Two cable plug receptacles are located on the front of the unit. One is used for the cable from the battery to the dynamotor, the other for the cable from the dynamotor to the transmitter.

2-2-1-2. Filter Box (Figure 27).

The filter box is mounted on the top of the dynamotor. A removable cover is provided. This cover may be removed by releasing the Dzus fasteners and pulling forward and upward on the cover. A lid interlock switch S-201 is mounted on the front edge of the box. The dynamotor starting relay K-201 and the filter capacitors for the 380- and 1000-volt circuits are mounted on the left side of the filter box. The terminal board is mounted on the right side of the box. It carries terminals for the dynamotor, bleeder resistors for the 380- and 1000-volt circuits, a filter capacitor C-201 for the 28-volt circuit, and fuses for the following circuits:

Battery Fuse F-201 for 28-volt battery
Filament Fuse F-202 for 28-volt filament
LV Fuse F-203 for 380-volt circuit
HV Fuse F-204 for 1000-volt circuit

Brush filter capacitors are mounted inside the dynamotor end bells.

2-2-2. Control and Power Circuits.

The primary power supply for the dynamotor is the plane's 24/28-volt battery. The battery fuse F-201 protects the battery against over current faults. When the transmitter phone-code switch is placed in the PHONE-STANDBY position, filament and control power is supplied to the transmitter through the battery fuse F-201 and filament fuse F-202. If the switch on the operator's or pilot's microphone is closed, the dynamotor relay K-201 closes and starts the dynamotor which delivers 380 and 1000 volts DC through fuses F-203 and F-204, respectively, to the transmitter. If the transmitter phone-code switch is placed in the CODE position, filament and plate power are simultaneously applied to the transmitter.

2-3. DESCRIPTION OF TYPE CRR-23280 REMOTE CONTROL UNIT.

2-3-1. Location of Components (Figure 20).

The following controls are mounted on the front panel of the unit: channel selector switch S-302, remote

indicator K-301, phone-code switch S-301. The code key is mounted on the top face of the unit. The bottom face carries the microphone jack J-301 and a receptacle J-302 for the cable plug from the transmitter. Access to the unit is secured by releasing three knurled head screws on the front of the unit and pulling the unit forward off its base.

2-3-2. Control Circuits.

2-3-2-1. Phone Operation.

When the transmitter local-remote switch S-102 is placed in the REMOTE position, and the remote phone-code switch S-301 is placed in the PHONE-STANDBY position, filament and control power are applied to the transmitter, and the remote indicator button protrudes from the panel. Plate power is applied to the transmitter by closing the switch on the microphone or the throttle switch. The microphone may then be used to secure phone emission from the transmitter.

2-3-2-2. Code Operation.

When the transmitter local-remote switch S-102 is in the REMOTE position, and the remote phone-code switch S-301 is placed in the CODE position, filament power, control power, and plate power are applied to the transmitter, and the remote indicator protrudes from the front panel. The remote code key may then be used to control telegraphic emission from the transmitter.

2-3-2-3. Frequency Selection.

If the transmitter local-remote switch S-102 is in the REMOTE position, and transmitter filament power has been applied from the remote control unit, the remote frequency selector switch may be placed on a desired channel position, such as "A" channel, and the tuning unit in that channel will be energized.

2-4. DESCRIPTION OF TYPE CRR-55079 REMOTE INDICATOR UNIT.

2-4-1. Location of Components (Figure 22).

The front face of the Type CRR-55079 Remote Indicator Unit carries the four indicator units. The bottom face carries the receptacle J-401 for the cable plug from the transmitter. Access to the unit is secured by releasing two knurled-head screws on the front face and pulling the unit forward from its base.

2-4-2. Operation.

When filament and control power are applied to the transmitter by either the operator or the pilot, an indicator button protrudes from the panel. This button will correspond to the energized channel in the transmitter.

2-5. DESCRIPTION OF TYPE CRR-47207 200-540 Kcs TUNING UNIT.

2-5-1. Location of Components (Figure 12).

Section 2-7-1, which describes the location of the components in the Type CRR-47208 540-1500 Kcs Tuning Unit, applies to the Type CRR-47207 200-540 Kcs Tuning Unit also, with the following exceptions:

2-5-1-1. Front Panel Controls.

The following controls appear on the front panel reading from top to bottom:

D—Antenna Coupling Dial
C—PA Tuning Dial
B—Oscillator Plate Tuning Dial
A—Oscillator Grid Tuning Dial

2-5-1-2. Antenna Circuit.

The antenna coupling inductor L-904 is hung from the underside of the top shield of the tuning unit. The remainder of the antenna circuit is housed in the Type CRR-47206 Antenna Tuning Unit. This unit is external to the transmitter and is described in Section 2-6.

2-5-2. Circuits.

2-5-2-1. Nominal Frequency Ranges.

The oscillator grid, oscillator plate and PA circuits each have 5 bands. The same band switch position is always used for all three circuits; thus, if the oscillator grid switch S-901, control G, is set on band 1, the oscillator plate switch S-902, control H, and the PA switch S-903, control J, will also be set on band 1. The frequency ranges of the various circuits are as follows:

Band	*Oscillator Grid, Oscillator Plate and PA Frequency Kcs*
1	200-240
2	240-295
3	295-360
4	360-450
5	450-540

All controls, A to J inclusive, increase setting for an increase in frequency.

2-5-2-2. Oscillator Grid Circuit.

The oscillator grid variometer L-901 is used in a Hartley oscillator circuit which is always tuned to the PA or output frequency. The band 5 capacitors C-901 and C-902 are always in the circuit. Capacitors used for bands 4 to 1 are placed in parallel with the variometer by band switch S-901, control G. This switch

parallels all band capacitors for band 1, all except band 1 capacitors for band 2, etc. Compensating capacitors C-911, C-912, C-913, C-914, and C-915 are used with their respective band capacitors. These compensating capacitors decrease their capacitance as the temperature increases and so counteract the increase in capacitance of the band capacitors and the increase of inductance of the grid variometer with an increase in temperature. The frequency of the oscillator is then relatively unchanged with a change in temperature.

2-5-2-3. Oscillator Plate Circuit.

The oscillator plate variometer L-902 and its band capacitors C-916, C-917, and C-918 comprise a tank circuit which is always tuned to the oscillator grid frequency. The band capacitor C-916 is always in the circuit. Capacitor C-917 is placed in the circuit on bands 2 and 3, and capacitor C-918 is placed in the circuit on band 1. The band switch S-902, control H, makes these capacitor changes and also selects the proper tap on the plate variometer.

2-5-2-4. PA Circuit.

The PA variometer L-903 and its band capacitors C-919 and C-920, comprise the PA tank circuit which is always tuned to the oscillator grid frequency. The band 5 capacitor C-919 is always in the circuit. Band capacitor C-920 is used on bands 1, 2, and 3. The band switch S-903, control J, selects the proper band capacitor and tap on the variometer L-903.

2-5-2-5. Antenna Coupling Inductor.

The primary or rotor of the antenna coupling inductor L-904 is in series with the PA variometer L-903. The secondary or stator is in series with the antenna circuit. Tank current flowing through the primary introduces a voltage in the secondary or antenna circuit. This secondary voltage varies as the rotor is turned inside the stator so that variable coupling is obtained.

2-5-2-6. Antenna Circuit.

The antenna tuning circuit components, antenna variometer L-1001 and antenna switch S-1001, are located in the Type CRR-47206 Antenna Tuning Unit external to the transmitter. The antenna variometer L-1001, control F, is used to secure series antenna resonance with the antenna capacitance. Resonance is indicated by a rise in antenna current or PA plate current. Antenna switch S-1001, control E, is used to select the proper tap on the antenna variometer L-1001. Position 10 on the antenna switch shorts the entire antenna variometer. Best reception will usually be obtained on this switch position.

2-6. DESCRIPTION OF TYPE CRR-47206 200-540 KCS ANTENNA TUNING UNIT

2-6-1. Location of Components (Figure 17).

This unit is mounted external to the transmitter. It comprises an antenna variometer L-1001 and antenna switch S-1001. Front panel controls F and E, respectively, are provided for these components.

2-6-2. Circuits.

The antenna variometer L-1001, control F, and the antenna switch S-1001, control E, are used to secure series antenna resonance with the antenna capacitance formed by the trailing wire antenna. The antenna coupling control is located in the Type CRR-47207 200-540 Kcs Tuning Unit in the transmitter. Switch S-1001, control E, has ten positions. Position 10 shorts the antenna variometer L-1001 and should usually be used for best reception.

2-6-3. Frequency Range.

THIS UNIT IS TO BE USED FOR THE 200-540 KCS RANGE ONLY AND WITH A TRAILING WIRE ANTENNA ONLY. IT SHOULD BE MANUALLY DISCONNECTED WHEN THE TRANSMITTER IS USED ON FREQUENCIES ABOVE 540 KCS TO AVOID DAMAGE TO THIS UNIT AND CONSIDERABLE LOSS OF ANTENNA POWER. This should be done by removing the trailing wire antenna connection from this antenna unit, removing the connection between this antenna unit and the antenna post of the transmitter and connecting the trailing wire antenna or the fixed wire antenna directly to the transmitter antenna post.

2-7. DESCRIPTION OF TYPE CRR-47208 540-1500 KCS TUNING UNIT.

2-7-1. Location of Components (Figure 13).

2-7-1-1. Front Panel Controls.

The following controls appear on the front panel, reading from top to bottom:

Designation	*Control*
F	Antenna Tuning Dial
E	Antenna Load Switch
D	Antenna Coupling Dial
C	PA Tuning Dial
B	Oscillator Plate Tuning Dial
A	Oscillator Grid Tuning Dial

Wing-head locking screws are provided at the top and bottom of the front panel to secure the tuning unit to the transmitter.

2-7-1-2. Oscillator Grid Circuit.

A horizontal shelf divides the tuning unit into two compartments. The oscillator components are mounted below this shelf; the PA and antenna components are mounted above this shelf. The oscillator grid variometer L-501 is mounted at the rear of the oscillator compartment. The oscillator grid capacitors C-501 to C-517 and their band switch S-501, control G are mounted on a panel on the right side of the grid variometer. This panel is marked with the output frequency range in Kcs, corresponding to each band switch position.

2-7-1-3. Oscillator Plate Circuit.

The oscillator plate variometer L-502 is mounted at the front of the oscillator compartment. The plate capacitors C-520, C-521, and C-522 and their band switch S-502, control H, are mounted on a panel on the right side of the variometer.

2-7-1-4. PA Circuit.

The PA variometer L-503 is mounted on the top of the PA-oscillator shelf, near the front panel. Its band capacitors C-523 and C-524 are mounted at the rear of this shelf. The PA band switch S-503, control J, is mounted on the right side of this shelf. The antenna coupling inductor L-504 is mounted at the left center of this shelf.

2-7-1-5. Antenna Circuit.

The antenna circuit components are hung from the under side of the top shield of the tuning unit. Reading from front to rear, the components are mounted as follows: Antenna variometer L-505 and its band switch S-505, control K, antenna load switch S-504, antenna loading inductor L-506.

2-7-1-6. Channel Switch.

The six blades of the channel switch are mounted on the rear panel of the tuning unit. Reading from the bottom, they are connected to the following circuits: oscillator grid, cathode and plate, PA, two antenna blades. When the tuning unit is active, these blades connect the tuning unit's circuit components to the respective busses and thence to the proper tube elements or to the antenna ammeter. When the tuning unit is idle, or deenergized, these blades short the tank circuits in the tuning unit, preventing power loss from an operative tuning unit.

2-7-2. Circuits.

2-7-2-1. Nominal Frequency Range.

The oscillator grid, oscillator plate, and PA circuits each have five bands. The same band switch position is always used for all three circuits; thus if the oscillator grid switch G is set on band 1, the oscillator plate switch H, and the PA switch J will also be set on band 1. The frequency range of the various circuits are as follows:

Band	*Osc. Grid Freq., Kcs*	*Osc. Plate and PA Freq., Kcs*
1	270-325	540-650
2	325-400	650-800
3	400-500	800-1000
4	500-625	1000-1250
5	625-750	1250-1500

All controls, A to K inclusive, increase setting for an increase in frequency.

2-7-2-2. Oscillator Grid Circuit.

The oscillator grid variometer L-501 is used in a Hartley oscillator circuit which is always tuned to one-half the output frequency. The band 5 capacitors C-501 and C-513 are always in the circuit. Capacitors used for bands 1 to 4 are placed in parallel with the variometer by band switch S-501, control G. Compensating capacitors C-513 to C-517, inclusive, are used with their respective band capacitors. These compensating capacitors decrease their capacitance as the temperature increases and so counteract the increase in capacitance of the band capacitors and the increase in inductance of the grid variometer L-501 with an increase in temperature. The frequency of the oscillator is then relatively unchanged with a change in temperature.

2-7-2-3. Oscillator Plate Circuit.

The oscillator plate variometer L-502 and its band capacitors C-520, C-521, and C-522 comprise a tank circuit which is always tuned to the PA frequency and is twice the oscillator grid frequency. The band 5 capacitor C-522 is always in circuit. Capacitor C-521 is placed in the circuit on bands 2 and 3 and capacitor C-520 is placed in the circuit on band 1. The band switch S-502, control H, makes these capacitor changes and also selects the proper tap on the plate variometer L-502.

2-7-2-4. PA Circuit.

The PA variometer L-503 and its band capacitors C-523 and C-524, comprise the PA tank circuit which is

always tuned to the PA frequency and is twice the oscillator grid frequency. The band 5 capacitor C-523 is always in the circuit. The remaining band capacitor C-524 is used on bands 1 to 3. The band switch S-503, control J, selects the proper band capacitor and tap on the variometer L-503.

2-7-2-5. *Antenna Coupling Inductor.*

The primary or rotor of the antenna coupling inductor L-504 is in series with the PA variometer L-503. The secondary or stator is in series with the antenna tuning circuit. Tank current flowing through the primary of antenna coupling inductor L-504 introduces a voltage in the secondary or antenna circuit. This secondary voltage varies as the rotor is turned inside the stator so that variable coupling is obtained.

2-7-2-6. *Antenna Circuit.*

The antenna circuit comprises the antenna variometer L-505 and antenna loading inductor L-506. The variometer uses a tap switch S-505, control K. The antenna variometer switch S-505, control K, is placed in position 1 for frequencies from 540 Kcs to 1060 Kcs and on position 2 for frequencies from 1060 Kcs to 1500 Kcs. The antenna loading inductor L-506 uses a tap switch S-504, front panel control E. The variometer L-505 and loading inductor L-506 are used to secure series resonance with the external antenna capacitance. Resonance is indicated by a rise in antenna current or PA plate current.

2-8. DESCRIPTION OF TYPE CRR-47209 1500-3000 KCS TUNING UNIT.

2-8-1. Location of Components (Figure 14).

Section 2-7-1, which describes the location of the components in the Type CRR-47208, 540-1500 Kcs Tuning Unit, applies to the Type CRR-47209, 1500-3000 Kcs Tuning Unit as well.

2-8-2. Circuits.

2-8-2-1. *Nominal Frequency Range.*

The oscillator grid, oscillator plate, and PA circuits each have four bands. The same band switch position is always used for all three circuits; thus if the oscillator grid switch S-701, control G is set on band 1, the oscillator plate switch H and the PA switch J will also be set on band 1. The frequency range of the various circuits are as follows:

Band	*Osc. Grid Freq., Kcs*	*Osc. Plate and PA Freq., Kcs*
1	750-900	1500-1800
2	900-1100	1800-2200
3	1100-1325	2200-2650
4	1325-1500	2650-3000

All controls, A to K inclusive, increase settings for an increase in frequency.

2-8-2-2. *Oscillator Grid Circuit.*

The oscillator grid variometer L-701 is used in a Hartley oscillator circuit which is always tuned to one-half the output frequency. The band 4 capacitors C-701 and C-702 are always in the circuit. Capacitors used for bands 3 to 1 are placed in parallel with the variometer by band switch S-701, control G. This switch parallels all band capacitors for band 1, all except band 1 capacitors for band 2, all except band 1 and band 2 capacitors for band 3. Compensating capacitors C-706 to C-709, inclusive, are used with their respective band capacitors. These compensating capacitors decrease their capacitance as the temperature increases and so counteract the increase in capacitance of the band capacitors and the increase in inductance of the grid variometer L-701 with an increase in temperature. The frequency of the oscillator is then relatively unchanged with a change in temperature.

2-8-2-3. *Oscillator Plate Circuit.*

The oscillator plate variometer L-702 and its band capacitors C-710, C-711 comprise a tank circuit which is always tuned to the PA frequency and is twice the oscillator grid frequency. The band 4 capacitor C-710 is always in the circuit. Capacitor C-711 is placed in the circuit on bands 1 and 2. The band switch S-702, control H, makes these capacitor changes and also selects the proper tap on the plate variometer L-702.

2-8-2-4. *PA Circuit.*

The PA variometer L-703 and its band capacitors C-712 and C-713, comprise the PA tank circuit which is always tuned to the PA frequency and is always twice the oscillator grid frequency. The band 4 capacitor C-712 is always in the circuit. The remaining capacitor C-713 is used on bands 1 and 2 only. The band switch S-703 control J, selects the proper band capacitor and tap on the variometer L-703.

2-8-2-5. Antenna Coupling Inductor.

The primary or rotor of the antenna coupling inductor L-704 is in series with PA variometer L-703. The secondary or stator is in series with the antenna tuning circuit. Tank current flowing through the primary introduces a voltage in the secondary or antenna circuit. This secondary voltage varies as the rotor is turned inside the stator so that variable coupling is obtained.

2-8-2-6. Antenna Circuit.

The antenna circuit comprises the antenna variometer L-705 and antenna loading inductor L-706. The variometer uses a tap switch S-705, control K. The antenna switch S-705, control K, is placed on position 1 for frequencies from 1500 Kcs to 2500 Kcs and on position 2 for frequencies from 2500 Kcs to 3000 Kcs. The antenna loading inductor L-706 uses a tap switch S-704, panel control E. The variometer L-705 and loading inductor L-706 are used to secure series resonance with the external antenna capacitance. Resonance is indicated by a rise in antenna current or PA plate current.

2-9. DESCRIPTION OF TYPE CRR-47210 3000-9050 KCS TUNING UNIT.

2-9-1. Location of Components (Figure 15).

Section 2-7-1, which describes the location of the components in the Type CRR-47208 540-1500 Kcs Tuning Unit, applies to the Type CRR-47210 3000-9050 Kcs Tuning Unit also, with the following exceptions:

2-9-1-1. Oscillator Plate Circuit.

The oscillator plate variable capacitor C-610 is mounted at the front of the oscillator compartment. The plate inductor L-602 and its band switch S-602, control H, are mounted on a panel below the capacitor.

2-9-1-2. Antenna Circuit.

The antenna circuit components are hung from the under side of the top shield of the tuning unit. Reading from front to rear the components are mounted as follows: Antenna variometer L-605, antenna load switch S-604, antenna loading inductor L-606, antenna series capacitor C-613 and its band switch S-605, control K.

2-9-2. Circuits.

2-9-2-1. Nominal Frequency Range.

The oscillator grid, oscillator plate and PA circuits each have five bands. The same band switch position is always used for all three circuits; thus if the oscillator grid switch S-601, control G, is set on band 1, the oscillator plate switch S-602, control H, and the PA band switch S-603, control J, will also be set on band 1. The frequency range of the various circuits are as follows:

Band	*Osc. Grid Freq., Kcs*	*Osc. Plate and PA Freq., Kcs*
1	1500-1900	3000-3800
2	1900-2500	3800-5000
3	2500-3125	5000-6250
4	3125-4000	6250-8000
5	4000-4525	8000-9050

All controls, A to K inclusive, increase settings for an increase in frequency.

2-9-2-2. Oscillator Grid Circuit.

The oscillator grid variometer L-601 is used in a Hartley oscillator circuit which is always tuned to one-half the output frequency. The band 5 capacitor C-601 is always in the circuit. Capacitors used for bands 1 to 4 are placed in parallel with the variometer by band switch S-601, control G. This switch parallels all band capacitors for band 1, all except band 1 capacitors for band 2, all except band 1 and band 2 capacitors for band 3, and all except bands 1, 2, and 3 capacitors for band 4. Compensating capacitors C-607, C-608, C-609 are used with their respective band capacitors. These compensating capacitors decrease their capacitance as the temperature increases and so counteract the increase in capacitance of the band capacitors and the increase in inductance of the grid variometer with an increase in temperature. The frequency of the oscillator is then relatively unchanged with a change in temperature.

2-9-2-3. Oscillator Plate Circuit.

The oscillator plate variable capacitor C-610 and its inductor L-602 comprise a tank circuit which is always tuned to the PA frequency and is twice the oscillator grid frequency. The band switch S-602, control H, selects the proper tap on the inductor.

2-9-2-4. PA Circuit.

The PA variometer L-603 and its band capacitors C-611 and C-612 comprise the PA tank circuit which is always tuned to the PA frequency and is always twice the oscillator grid frequency. The band 5 capacitor C-611 is always in the circuit. The remaining capacitor C-612 is used on bands 1 and 2. The band switch S-603, control J, selects the proper band capacitor and tap on the variometer L-603.

2-9-2-5. *Antenna Coupling Inductor.*

The primary or rotor of the antenna coupling inductor L-604 is in series with the PA variometer L-603. The secondary or stator is in series with the antenna tuning circuit. Tank current flowing through the primary introduces a voltage in the secondary or antenna circuit. This secondary voltage varies as the rotor is turned inside the stator so that variable coupling is obtained.

2-9-2-6. *Antenna Circuit.*

The antenna circuit comprises the antenna variometer L-605, the antenna loading inductor L-606, and the antenna series capacitor C-613. The antenna loading inductor uses a tap switch S-604, control E, and the antenna series capacitor C-613 has a switch S-605, control K. This switch is set at position 1 for frequencies from 3000 to 5800 Kcs, and on position 2 for frequencies from 5800 to 9050 Kcs. Switch position 1 shorts the series capacitor and position 2 places this capacitor in the circuit.

2-10. DESCRIPTION OF TYPE CRR-47211 9050-15,800 KCS TUNING UNIT.

2-10-1. Location of Components (Figure 16).

Section 2-7-1, which describes the location of the components in the Type CRR-47208 540-1500 Kcs Tuning Unit, applies to the Type CRR-47211 9050-15,800 Kcs Tuning Unit also, with the following exceptions:

2-10-1-1. *Front Panel Controls.*

The following controls appear on the front panel reading from top to bottom:

F—Antenna Inductor Tuning Dial
E—Antenna Capacitor Tuning Dial
D—Antenna Coupling Dial
C—PA Tuning Dial
B—Oscillator Plate Tuning Dial
A—Oscillator Grid Tuning Dial

2-10-1-2. *Oscillator Plate Circuit.*

The oscillator plate variable capacitor C-806 is mounted at the front of the oscillator compartment. The plate inductor L-802 and its band switch S-802, control H, are mounted on a panel below the capacitor.

2-10-1-3. *PA Circuit.*

The PA-variometer L-803 is mounted on the top of the PA-Oscillator shelf near the front panel. The PA band switch S-803, control J, is mounted on the right-hand side of this shelf. The antenna coupling inductor L-804 is mounted at the left center of this shelf.

2-10-1-4. *Antenna Circuit.*

The antenna circuit components are hung from the under side of the top shelf of the tuning unit. Reading from front to rear the components are mounted as follows: Antenna variometer L-805, antenna capacitor C-807 and its band switch controls K, L, M.

2-10-2. Circuits.

2-10-2-1. *Normal Frequency Range.*

The oscillator grid, oscillator plate and PA circuits each have three bands. The same band switch position is always used for all three circuits; thus if the oscillator grid switch S-801, control G, is set on band 1, the oscillator plate switch S-802, control H, and the PA band switch S-803, control J, will also be set on band 1. The frequency range of the various circuits are as follows:

Band	*Osc. Grid Freq., Kcs*	*Osc. Plate and PA Freq., Kcs*
1	4025-5400	9,050-10,800
2	5400-6550	10,800-13,100
3	6550-7900	13,100-15,800

All controls, A to K inclusive, increase settings for an increase in frequency.

2-10-2-2. *Oscillator Grid Circuit.*

The oscillator grid variometer L-801 is used in a Hartley oscillator circuit which is always tuned to one-half the output frequency. The band 3 capacitor C-801 is always in the circuit. Capacitors used for bands 2 and 3 are placed in parallel with the variometer by band switch S-801, control G. This switch parallels all band capacitors for band 1, and all except band 1 capacitors for band 2. Compensating capacitors C-804 and C-805 are used with their respective band capacitors. These compensating capacitors decrease their capacitance as the temperature increases and so counteract the increase in capacitance of the band capacitors and the increase in inductance of the grid variometer with an increase in temperature. The frequency of the oscillator is then relatively unchanged with a change in temperature.

2-10-2-3. *Oscillator Plate Circuit.*

The oscillator plate variable capacitor C-806 and its inductor L-802 comprise a tank circuit which is always tuned to the PA frequency and is twice the oscillator

grid frequency. The band switch S-802, control H, selects the proper tap on the inductor.

2-10-2-4. PA Circuit.

The PA variometer L-803, the PA tube capacitance and the distributed circuit capacitance comprise the PA tank circuit which is always tuned to the PA frequency and is always twice the oscillator grid frequency. The band switch S-803, control J, selects the proper tap on the variometer L-803.

2-10-2-5. Antenna Coupling Inductor.

The primary or rotor of the antenna coupling inductor L-804 is in series with the PA variometer L-803. The secondary or stator is in series with the antenna tuning circuit. Tank current flowing through the primary introduces a voltage in the secondary or antenna circuit. This secondary voltage varies as the rotor is turned inside the stator so that variable coupling is obtained.

2-10-2-6. Antenna Circuit.

The antenna circuit comprises the antenna variometer L-805, the antenna variable capacitor C-807A, and the antenna fixed capacitor C-807B. The antenna capacitor band switches S-810, control K, S-808 control L, and S-809 control M, function as follows: Position 1 of switch S-810, control K, places fixed capacitor C-807B in parallel with variable capacitor C-807A, while position 2 removes the fixed capacitor from circuit. Switch S-808, control L, and switch S-809, control M, are always used on the same relative position. When switches L and M are on position 1 the antenna capacitor C-807A is in series with the antenna. This is the normal position for frequencies from 9050 Kcs to approximately 13,000 Kcs. For frequencies above 13,000 Kcs, the controls L and M are placed on position 2. This switch position connects the antenna to the common point of the antenna inductor L-805 and the antenna capacitor C-807B, one end of which is grounded. Thus the inductor and capacitor form a parallel resonant circuit which is in parallel with the antenna itself. A fairly high voltage is now impressed on the antenna. This is necessary to feed the high-impedance of the antenna which is present above 13,000 Kcs.

SECTION III

3. INSTALLATION.

3-1. INSPECTION OF EQUIPMENT.

3-1-1. Removal of Shields and Tuning Units from Transmitter.

Before installing the equipment, inspect the various units for possible damage during shipment. Remove the top, bottom, rear, and end shields from the transmitter by removing the shield-securing screws which are tapped into the frame. Remove the four tuning units by releasing the two wing-headed locking screws on each tuning unit and pulling the unit forward. BEFORE REMOVING ANY TUNING UNIT FROM A CHANNEL SEE THAT THAT CHANNEL IS INOPERATIVE. For example, if channel A is to be removed, see that the channel indicator disc below the PA plate meter indicates B, C, or D. If it indicates channel A, rotate the manual switch control at the right end of the transmitter until the channel indicator disc indicates B, C, or D. To operate the manual switch control pull outward on the outside edge of the handle until it stands perpendicular to the transmitter side. Then rotate the handle to the desired position. When operation is completed, flip the handle back to its original position parallel to the side of the transmitter.

3-1-2. Inspection of Type CRR-52253 Transmitter Unit.

(*a*) Inspect the Type CRR-52253 Transmitter Unit for loose connections or loose parts. See that no packing material has fallen into the transmitter.

(*b*) Push down on the top of each channel switch push-rod to see that it operates freely and springs up when released. One vertical push-rod is behind each of the four channel openings from which the tuning units have been removed.

(*c*) Rotate the manual switch control by hand to see if it is free. See that the A cam pushes the A push-rod down when the channel indicator disc on the front panel indicates channel A. Check the B, C, and D channels in the same manner.

(*d*) Release the two hexagonal head screws at the front of the transmitter which secure the transmitter to the mounting tracks. See that the two sections of the tracks slide freely.

(*e*) BEFORE REPLACING TUNING UNITS IN THE TRANSMITTER, SEE THAT G, H, J, AND K SWITCHES ARE EACH SET ON A DEFINITE SWITCH POSITION. If the switch blades are off position and the equipment is operated, an arc may form between the blade and the contact which will damage the phenolic panel.

(*f*) Insert a full set of seven tubes in the transmitter. Each tube socket is marked with the type of tube to be used in that socket. MAKE SURE THAT THE FLEXIBLE PLATE LEAD IS CONNECTED TO THE PLATE CAP ON THE TOP OF THE PA TUBE.

3-1-3. Inspection of Type CRR-21748 Dynamotor Assembly.

Remove the cover from the filter box by releasing the two Dzus fasteners on the front edge and drawing the cover forward and slightly upward. Examine the terminal board for loose connections. Remove the unit from its base by releasing the two hex-head bolts near the front face of the dynamotor. Pull the dynamotor forward and slightly upward from its base. REMOVE BOTH END BELLS FROM THE DYNAMOTOR AND MAKE SURE THAT THE ARMATURE ROTATES FREELY AND IS CLEAN. See that all active and spare fuses are in place and correspond to the fuse ratings marked on the terminal board.

3-1-4. Inspection of Type CRR-23280 Remote Control Unit.

Remove the unit from its base by releasing the three knurled screws on its front face and pulling the case forward from the base. Inspect the interior of the unit for loose connections.

3-1-5. Inspection of Type CRR-55079 Remote Indicator Unit.

Remove the unit from its base by releasing the two knurled head screws on the front face and pulling the case forward from the base. Inspect the interior of the unit for loose connections.

3-2. LOCATION OF UNITS (See Figures 2 and 28).

3-2-1. Type CRR-52253 Transmitter Unit.

The actual location of each unit will depend on the type of plane in which it is installed. If the equipment is installed in a double cockpit plane, the transmitter will usually be installed in front of the operator, beneath the pilot's seat, and with the front panel of the transmitter facing aft.

3-2-2. Type CRR-21748 Dynamotor Assembly.

The Type CRR-21748 Dynamotor Assembly will be installed in the rear cockpit so that the operator may have access to this unit for fuse renewal.

3-2-3. Type CRR-55079 Remote Indicator Unit.

The Type CRR-55079 Remote Indicator Unit will be installed in the rear cockpit at such a height that the operator can see the indicators.

3-2-4. Type CRR-23280 Remote Control Unit.

The Type CRR-23280 Remote Control Unit will be installed in the front cockpit on the right side of the pilot.

3-2-5. Type CRR-47206 200-540 Kcs Antenna Tuning Unit.

This unit is supplied for some installations. If it is supplied, it should be mounted near the left side of the transmitter or near the trailing wire antenna reel. In any case, its front panel controls should be accessible to the operator.

3-3. ELECTRICAL CONNECTIONS (See Figures 51, 52, 53, and 54)

CAUTION: DO NOT CONNECT THE BATTERY CABLE TO THE BATTERY UNLESS THE REMOTE-LOCAL SWITCH IS IN THE LOCAL POSITION AND THE PHONE CODE SWITCH IS IN THE OFF POSITION. DO NOT CONNECT THIS CABLE IN A PLANE WHICH HAS ITS POSITIVE BATTERY SUPPLY GROUNDED. THE NEGATIVE BATTERY SUPPLY SHOULD BE GROUNDED. THE WHITE LEAD ON THE BATTERY-TO-DYNAMOTOR CABLE SHOULD BE CONNECTED TO THE POSITIVE BATTERY TERMINAL.

3-3-1. Cables.

See that the cable receptacles on all three major units are clean. Each plug has a locating slot and each receptacle has a locating ridge. The plug must be rotated until the ridge and slot match before the plug can be inserted. Place each cable plug in its proper receptacle and secure its knurled ferrule.

3-3-2. Radio Frequency Connections.

Connect the antenna lead to the ANTENNA post on the left side of the transmitter, the lead from the receiver RF input post to the RECEIVER post on the transmitter, and a ground lead to the GROUND post. Rajah terminals are provided for these three connections. The antenna lead should be well insulated with about one-quarter inch radius of rubber or equivalent insulation, or it should be so supported that it clears all grounded objects and other leads by one-half to one inch. If a Navy type LM frequency indicator is to be used with this equipment, connect a lead from the CFI post on the front of the transmitter unit to the RF input post on the frequency indicator unit.

3-3-3. 200-540 Kcs Antenna Tuning Unit Radio Frequency Connections.

This unit is provided on some installations. If it is supplied, the trailing wire antenna should be connected to the trailing wire antenna post on this unit and the transmitter post on this unit should be connected to the antenna post on the transmitter.

MANUALLY DISCONNECT THIS UNIT FROM THE ANTENNA AND TRANSMITTER WHEN FREQUENCIES HIGHER THAN 540 KCS ARE USED.

THE LEAD TO THE TRAILING WIRE ANTENNA POST ON THIS UNIT SHOULD CLEAR ALL GROUNDED OBJECTS BY 1-1/2 TO 2 INCHES.

SECTION IV

4. PRELIMINARY ADJUSTMENTS.

4-1. CONTROL CIRCUITS.

4-1-1. Preliminary Adjustments.

(*a*) Open the dynamotor lid and remove the high voltage fuse, and replace the lid. PLACE THE TRANSMITTER LOCAL-REMOTE SWITCH IN LOCAL POSITION AND THE TRANSMITTER PHONE-CODE SWITCH IN THE OFF POSITION. Place the TUNE-OPERATE switch in TUNE position.

(*b*) Connect all cables to dynamotor, transmitter, remote control and remote indicator units. Connect the antenna, receiver, and ground leads to their posts on the left side of the transmitter.

(*c*) Remove all tuning units from the transmitter. DO NOT INSERT OR REMOVE A TUNING UNIT FROM A CHANNEL IF THE CHANNEL IS ACTIVE. See Figure 41, notes 1 and 2. The active channel position is shown on the indicator disc on the right side of the front panel of the transmitter unit.

Operate the manual channel switch control on the right end of the transmitter to rotate the channel switch to the desired position.

(*d*) SET THE CARBON-MAGNETIC MICROPHONE SWITCH S-115 ON THE PROPER POSITION. Set this switch on the CARBON position if a carbon microphone such as the Navy Type T-38C microphone is to be used, or on the MAGNETIC position if a magnetic microphone such as the Army Mask Type Microphone MC-253 is to be used. The slotted shaft of this switch may be seen on the vertical shield on the right side of the D channel compartment. Use a coin or screwdriver to rotate the switch until the upper portion of the slot points to the desired microphone designation.

(*e*) Consult the typical tuning chart on top of the transmitter and set all controls, A to K inclusive, on one 3000-9050 Kcs tuning unit for 3000 Kcs operation. Insert this tuning unit in the D channel.

4-1-2. Phone-Code Switch, Local Phone Operation.

(*a*) Place the transmitter PHONE STANDBY-CODE switch in the PHONE STANDBY position. Press down on the P.A. GRID M.A.-BATTERY switch lever. The PA grid-battery meter should indicate a battery voltage of 24 to 28 volts DC. If this meter reads backwards, the connections at the battery end of the battery-to-dynamotor cable are probably reversed. Open the tube access door and see if all tube filaments are lighted. The PA tube filament glows brightly, but the remaining tube heaters are barely visible in daylight.

(*b*) Momentarily close the transmitter TEST KEY. The keying relay behind the left front panel should be heard as it follows hand keying with the test key.

(*c*) Insert a microphone plug in the transmitter MICrophone jack. Momentarily close the hand switch on the microphone. The dynamotor should start when this switch is closed. If it does not start, make sure that the LOCAL-REMOTE switch is in the LOCAL position, the transmitter tube door interlock is closed, and the dynamotor lid interlock is closed. WHEN THE DYNAMOTOR IS RUNNING, 1000 VOLTS DC IS APPLIED TO THE TRANSMITTER. DO NOT REACH INSIDE THE TUNING UNIT COMPARTMENT OR ANYWHERE INSIDE THE TRANSMITTER OR DYNAMOTOR UNTIL POWER IS REMOVED AND THE DYNAMOTOR STOPS.

(*d*) The keying relay should be heard as the microphone switch is closed. The voice relay behind the right front panel will also follow this switch. It may be possible to hear this relay closing or it may be advisable to remove the right side shield and watch its operation. If the microphone used has no switch, use a throttle switch plug or a shorted plug inserted in the THROTTLE SWITCH jack to perform this switching function.

4-1-3. Phone-Code Switch, Local Code Operation.

Place the transmitter PHONE STANDBY-CODE switch in the CODE position. Press down on the P.A. GRID M.A.-BATTERY meter switch lever. The PA grid-battery meter should indicate battery voltage of 24 to 28 volts DC. The dynamotor should start. Close the test key momentarily and see if the keying relay can be heard closing.

4-1-4. Frequency Selector Switch, Local Operation.

Return the PHONE STANDBY-CODE switch to PHONE STANDBY position. See that the MANUAL CONTROL CHANNEL SWITCH segment is in its normal position parallel to the right side of the transmitter unit. Set the transmitter CHANNEL SWITCH on position A. The channel switch motor should rotate until the ACTIVE CHANNEL indicator disc on the front face of the transmitter unit indicates A position.

The push-rod in A channel should be pushed down. Open the tube access door, and see that the A cam on the main channel switch shaft is in the vertical position pushing down on its push-rod. Rotate the CHANNEL SWITCH to the B, C, and D positions and observe the operation of each push-rod. The indicators in the remote indicator unit should operate as the transmitter CHANNEL SWITCH is rotated. The A indicator should protrude from its panel about 3/16 inch when the A channel is selected with the CHANNEL SWITCH; the B indicator should protrude when the B channel is selected, etc.

4-1-5. Phone-Code Switch, Remote Phone Operation.

Place the transmitter LOCAL-REMOTE switch in the REMOTE position. Place the PHONE STANDBY-CODE switch in the remote control unit in the PHONE STANDBY position. The TRANS. INDICATOR on the remote control unit should protrude from its panel about 3/16 inch. Check the battery voltage with the transmitter battery voltmeter. This voltage should be 24 to 28 volts. Insert a microphone plug in the MICrophone jack in the remote control unit. Close the switch on the microphone. The dynamotor should start; the keying relay and the voice relay should close.

4-1-6. Phone-Code Switch, Remote Code Operation.

Place the PHONE STANDBY-CODE switch in the remote control unit in the CODE position. The TRANS. INDICATOR unit on the remote control unit should operate. Check the battery voltage with the transmitter battery voltmeter. The dynamotor should start. Close the CODE KEY on top of the remote control unit and see if the keying relay follows this key.

4-1-7. Frequency Selector Switch, Remote Operation.

Return the PHONE STANDBY-CODE switch on the remote control unit to PHONE STANDBY position. Set the CHANnel SWitch on this unit in the A position. The transmitter channel motor should rotate until the ACTIVE CHANNEL indicator disc indicates A channel and the A indicator should operate in the remote indicator unit.

4-2. RADIO FREQUENCY CIRCUITS.

4-2-1. Preliminary Adjustments.

Set the LOCAL-REMOTE switch in the LOCAL position, the C.W.-M.C.W. switch in the C.W. position, and the transmitter PHONE STANDBY-CODE switch in the OFF position. WAIT UNTIL THE DYNAMOTOR STOPS. Open the dynamotor lid and insert the high voltage fuse. Replace the lid. Open the transmitter tube access door and see that the flexible lead is secured to the PA plate cap. Remove the 3000-9050 Kcs Tuning Unit from the transmitter and set controls A to K for 3000 Kcs operation. SEE THAT INTERIOR SWITCH CONTROL BLADES G TO K INCLUSIVE ARE SET SQUARELY ON THEIR CONTACT POINTS, OTHERWISE POOR CONTACT OR A DESTRUCTIVE ARC MAY RESULT. Consult the tuning chart on top of the transmitter for typical settings of these controls. (See Figures 2 and 55). PLACE THE TUNING UNIT IN CHANNEL D. Connect the CFI lead from the transmitter CFI post to the RF input post of a Navy type LM frequency meter unit. CAREFULLY SET UP THIS CFI UNIT FOR OPERATION AT 3000 KCS.

4-2-2. Oscillator Tuning.

Start the dynamotor by placing the transmitter PHONE STANDBY-CODE switch in the CODE position. Select the D channel by setting the CHANNEL SWITCH on D position. Place the TUNE-OPERATE switch in TUNE position. Close the TEST KEY. Vary the M.O. PLATE tuning dial, control B, ON THE D TUNING UNIT until the PA grid meter reads a maximum. Vary the M.O. GRID VERnier, dial A, until a beat note is heard in the phones used with the CFI unit. The oscillator grid VERnier dial is numbered .1 to .9. This control is varied to tune the oscillator. The main oscillator dial is numbered 1 to 25. The approximate dial setting for 3000 Kcs is 8.8. For this setting the main oscillator dial reads 8 and the vernier dial reads .8.

If the CFI beat note cannot be heard for 3000 Kcs operation when the M.O. Grid dial A is varied from 5.0 to 11.0 and the PA grid meter reads approximately 10 milliamperes, the CFI unit has been improperly tuned or the oscillator grid band switch, control G, is not set on band 1 or the D channel is not energized.

When the beat note is heard in the CFI phones, tune the M.O. PLATE, control B, for maximum PA grid current and readjust the M.O. GRID, control A, slightly to bring the beat note down to a low frequency note. The PA grid milliammeter should indicate 8 to 15 milliamperes, depending on the frequency used and the voltage delivered by the plane's battery.

4-2-3. PA Tuning.

Set the ANTenna COUPLING dial, control D, at 0. Open the TEST KEY. Place the TUNE-OPERATE

switch in the OPERATE position. Close the TEST KEY for five seconds or so and rotate the P.A. TUNING dial, control C, to secure a MINIMUM indication on the PA plate milliammeter. This meter should indicate 20 to 40 milliamperes, depending upon the frequency and the battery voltage used.

4-2-4. Antenna Tuning.

4-2-4-1. General.

(*a*) Normal Antenna

Set the ANTenna COUPLING dial, control D, at 13 to 20. Close the TEST KEY and rotate the ANTenna TUNING dial, control F, until the PA plate milliammeter and the antenna ammeter increase to a MAXIMUM. If the PA plate current is above the red line on the meter, 120 milliamperes, decrease the ANTenna COUPLING, control D, to secure 120 milliamperes or less. If this current is below 120 milliamperes, increase the ANTenna COUPLING, control D, and retune the antenna, using ANTenna TUNING, control F, to secure maximum PA plate current and antenna current. In any case, retune the PA, using control C, for minimum PA plate current. This final PA tuning operation should not cause the plate current to vary over 20 milliamperes. If it does cause a larger variation, the ANTenna COUPLING, control D, is set too high or the ANTenna TUNING, control F, is not properly adjusted. Recheck these two adjustments and finally retune the PA. The M.O. GRID dial, control A, may now be adjusted slightly to bring the CFI beat note down near zero beat frequency. The antenna current will normally be 1.5 to 2 amperes.

(*b*) Abnormal Antenna

In some instances, the antenna capacitance may vary considerably from the specified value and rotation of the ANTenna TUNING dial, control F, will cause no increase in PA plate current. If this happens, close the TEST KEY and rotate the ANTenna SWitch, control E, until the PA plate current increases, then proceed with the antenna tuning as given in section 4-2-4(*a*). If variation of the antenna loading control E gives no increase in plate current, increase the ANTenna COUPLING, control D, and vary controls E and F again until an increase in PA plate current is secured. At frequencies between 5 and 7 Mcs it may be necessary to try a new position of the antenna capacitor switch, control K, located inside the tuning unit, to secure antenna resonance.

(*c*) Trailing Wire Antenna

Tuning units with frequency ranges of 1500 to 3000 Kcs and 3000 to 9050 Kcs are normally used with fixed antennas only. They may be used with trailing wire antennas. If trailing wire antennas are used, set the antenna tuning and coupling controls D, E, F, and K as indicated by the calibration chart. (See Figure 55.) Then reel the trailing wire antenna in or out until the antenna is approximately resonant, as indicated by a rise in PA plate current. Proceed with antenna tuning as outlined in section 4-2-4-1(*a*).

**4-2-4-2. 1500-3000 Kcs Tuning Unit.*

The 1500-3000 Kcs tuning unit is tuned in the same manner as the 3000-9050 Kcs tuning unit except that control K in the 1500-3000 Kcs unit selects a tap on the antenna variometer while control K on the 3000-9050 Kcs unit places the antenna capacitor C-613 either in or out of the circuit. The 1500-3000 Kcs tuning unit is designed for use with a fixed antenna. It may be used with a trailing wire antenna by varying the antenna length to secure antenna resonance as indicated in section 4-2-4-1(*c*).

**4-2-4-3. 540-1500 Kcs Tuning Unit.*

The 540-1500 Kcs tuning unit is tuned in the same manner as the 3000-9050 Kcs tuning unit except that control K in the 540-1500 Kcs unit selects a tap on the antenna variometer, while control K on the 3000-9050 Kcs unit places the antenna capacitor C-613 either in or out of the circuit.

THE 540-1500 KCS UNIT MUST BE USED WITH A TRAILING WIRE ANTENNA ONLY TO PREVENT THE FORMATION OF EXCESSIVE ANTENNA VOLTAGES AND RESULTANT BREAKDOWN AT HIGH ALTITUDES. The approximate antenna lengths are given on the tuning chart on top of the transmitter. (See Figure 55.) Some increase in power may be secured at 540 to 1000 Kcs by using antenna lengths up to 150 feet at 1000 Kcs or 300 feet at 540 Kcs. If a longer antenna is used than is indicated in the calibration chart, the ANTenna load SWitch setting should be increased until an increase in PA plate current indicates resonance.

**4-2-4-4. 9,050-15,800 Kcs Tuning Unit.*

DO NOT OPERATE THIS UNIT ABOVE 15,800 KCS.

(*a*) The 9,050-15,800 Kcs tuning unit is tuned in the same manner as the 3000-9050 Kcs tuning unit except that control K on the 9,050-15,800 Kcs unit places a fixed capacitor C-807B in parallel with the variable antenna series capacitor C-807A for switch position 1 and removes the fixed capacitor for switch position 2. Position 1 on the L and M switches on this unit places

* Section 4-2-5 covers the location in the transmitter and general adjustment of all tuning units other than the 3000-9050 Kcs Tuning Unit.

the antenna capacitor C-807A in series with the antenna: position 2 places this capacitor in parallel with the antenna inductor. Consult the tuning chart on top of the transmitter for the approximate positions of the controls K, L, M switches for the desired frequency. (See Figure 55.) THE L AND M SWITCHES ARE ALWAYS USED ON THE SAME POSITION; THAT IS, L AND M ARE BOTH ON POSITION 1 OR THEY ARE BOTH ON POSITION 2.

(*b*) In this frequency range, the antenna characteristics vary widely with the length and arrangement of the antenna and its lead-in. For this reason, the tuning chart is only a guide to the correct setting of the controls K, L, and M. If no indication of antenna resonance is secured, try a different combination of these switches and retune the antenna, using the ANTenna TUNING control F and ANTenna SWitch, control E.

(*c*) At these frequencies, the antenna resistance is very high and quite a large amount of antenna power may be secured with no indication on the antenna ammeter. This ammeter is then of little use as an indication of antenna resonance. However the PA plate milliammeter may be used as an indicator of antenna resonance as follows: Tune the antenna circuit until the PA plate current increases rapidly. Retune the P.A. TUNING control C for minimum PA plate current. Adjust the ANTenna COUPLING control D for desired PA plate current. Retune the antenna and PA circuits as outlined above until a PA plate current of 80 to 120 milliamperes is secured.

*4-2-4-5. 200-540 Kcs Tuning Unit and 200-540 Kcs Antenna Tuning Unit.

(*a*) Connections.

Connect the trailing wire antenna to the TRAILing WIRE ANTenna post of the 200-540 Kcs antenna tuning unit and the TRANSMITTER post of this unit to the ANTENNA post of the transmitter unit.

(*b*) Tuning the 200-540 Kcs Tuning Unit.

Consult the tuning chart on top of the antenna unit. (See Figure 55.) Set band switches G, H, J inside the tuning unit to the desired band. Insert the tuning unit in the transmitter unit, channel A for example, and use the CHANNEL SWITCH to energize channel A. Tune the oscillator grid and plate circuits as outlined in Section 4-2-2 for the 3000-9050 Kcs tuning unit. Tune the PA circuit as outlined in Section 4-2-3.

* Section 4-2-5 covers the location in the transmitter and general adjustment of all tuning units other than the 3000-9050 Kcs Tuning Unit.

4-2-4-6. 200-540 Kcs Antenna Tuning Unit.

Consult the tuning chart on top of this unit and set the ANTENNA TUNING switch, Control E, accordingly. Use about 200 feet of trailing wire antenna. Proceed with the antenna tuning as outlined in Section 4-2-4 for the 3000-9050 Kcs tuning unit. DISCONNECT THE ANTENNA AND TRANSMITTER LEADS TO THIS UNIT WHENEVER OPERATION IS DESIRED ABOVE 540 KCS.

4-2-5. Adjusting Remaining Tuning Units.

After one 3000-9050 Kcs tuning unit has been adjusted in channel D, the remaining units may be inserted, preferably in the following channels:

540–1500 Kcs unit channel A
1500–3000 Kcs unit channel B
3000–9050 Kcs unit channel C
3000–9050 Kcs unit channel D

If the following units are used, they may be inserted, preferably in the following channels:

200–540 Kcs channel A
9050–15,800 Kcs channel D

SECURE EACH TUNING UNIT BY TIGHTENING UP ITS TWO LOCKING SCREWS. TUNE EACH UNIT AS OUTLINED IN SECTIONS 4-2-4-1 to 4-2-4-6. THEN RESET EACH OSCILLATOR GRID DIAL A AFTER ALL TUNING UNITS ARE IN PLACE.

Use the small tuning chart on the front of each tuning unit to record in pencil the settings of controls A, E, G, K, the frequency to which the tuning unit is adjusted, and the channel in which it is used.

IF ANY TUNING UNIT IS REMOVED FROM THE TRANSMITTER, THE FREQUENCY OF THE REMAINING UNITS WILL BE CHANGED BY SEVERAL KILOCYCLES UNLESS ANOTHER UNIT IS INSERTED IN THE EMPTY CHANNEL. The replacement tuning unit may be tuned to either the same frequency or to a different frequency than the tuning unit which was removed and no frequency change will result in the remaining units as long as all channels are filled with tuning units.

The transmitter will operate with only one, two, or three tuning units in place in the channels. However, whenever the transmitter is operated with a tuning unit missing from any channel *it is necessary to retune the oscillator dial A of all remaining tuning units* to secure the original frequency from the remaining units. Also, care must be exercised to see that the band switch is not placed on a vacant channel position, as the PA tube will draw excessive plate current as a result of no grid excitation.

4-3. AUDIO FREQUENCY CIRCUITS.

4-3-1. MCW Operation.

(*a*) Place the PHONE STANDBY-CODE switch in CODE position, place the CW-MCW switch in the CW position, place the TUNE-OPERATE switch in OPERATE position, and use the CHANNEL SWITCH to select any channel containing a tuning unit which has been previously tuned as covered in Section 4-2. Close the TEST KEY and observe the antenna current.

(*b*) Place the CW-MCW switch on MCW and again observe the antenna current. The MCW antenna current should be five to ten percent greater than the CW antenna current. The PA plate current should not increase or decrease more than fifteen milliamperes in transferring from CW to MCW.

(*c*) Plug a pair of phones into either transmitter SIDETONE jack. As the key is closed, a 1000-cycle sidetone signal will be heard in the phones. This signal will have the same intensity and frequency for either position of the CW-MCW switch. The sidetone signal level may be adjusted by rotating the sidetone switch S-111 with a screwdriver or coin. Access to this switch is secured by removing the tuning unit from the D channel.

4-3-2. Phone Operation.

(*a*) Place the PHONE STANDBY-CODE switch in the PHONE STANDBY position, the TUNE-OPERATE switch in OPERATE position, and use the CHANNEL SWITCH to select a channel that carries a tuning unit which has been previously tuned as covered in Section 4-2.

(*b*) SEE THAT THE CARBON-MAGNETIC MICROPHONE SWITCH IS IN THE PROPER POSITION FOR THE MICROPHONE IN USE. Access to this switch is secured by removing the tuning unit from the D channel. Insert a screwdriver or coin in the slot in the switch shaft and rotate the switch until the top edge of the slot points to the designation, CARBON or MAGNETIC, which applies to the type of microphone in use. Insert a microphone plug in the transmitter MICrophone jack. Press the press-to-talk switch on the side of the microphone to start the transmitter dynamotor and secure phone carrier condition. If the microphone has no switch, use a throttle switch plug or a shorted plug inserted in the throttle switch jack.

(*c*) Note the antenna current under the phone carrier condition. Speak into the microphone and note the antenna current under the modulated condition. The modulated antenna current should be five to ten percent greater than the carrier antenna current if a steady tone, such as whistling, is impressed on the microphone. The PA plate current should not vary over fifteen milliamperes between the phone carrier and phone modulated conditions. The PA plate current for phone carrier condition should not vary over fifteen milliamperes from the PA plate current for CW condition if the battery voltage is normally constant.

(*d*) Plug a pair of phones into either transmitter SIDETONE jack. Close switch on the microphone and talk into the microphone. The sidetone phones should reproduce this speech. The sidetone output level should be about the same for CW, MCW, or phone operation.

(*e*) Place a microphone plug in the MICrophone jack in the remote control unit and check the microphone operation as in sections 4-3-2(*b*) to 4-3-2(*d*).

SECTION V

5. OPERATION.

5-1. PRELIMINARY ADJUSTMENTS.

Routine operation can proceed when all tuning units are adjusted to the desired frequency as described in Section 4-2 and control and audio circuits are tested as indicated in Section 4-1 and Section 4-3. In normal operation, the transmitter LOCAL-REMOTE switch is placed in the REMOTE position and safety-wired in this position. In this case, the operator's PHONE STANDBY-CODE switch and CHANnel SWitch are inoperative. The transmitter TUNE-OPERATE switch is left in the OPERATE position.

5-2. PILOT'S PHONE OPERATION.

Place the PHONE STANDBY-CODE switch on the remote control unit in PHONE STANDBY position, and set the CHANnel SWitch to the desired channel position. After allowing approximately 30 seconds for the tube filaments to heat up, press the microphone or throttle switch and speak into the microphone for voice transmission. This speech will be heard as a sidetone signal in the pilot's and the operator's phones. When transmission is finished, open the pilot's microphone and throttle switch to prevent wasteful battery drain and undesirable carrier emission. The pilot may use his channel selector switch to select any frequency for which a tuning unit has been tuned. The remote frequency indicator will indicate to the operator which channel is operative.

5-3. PILOT'S CODE OPERATION.

(*a*) Place the PHONE STANDBY-CODE switch on the remote control unit in the CODE position and set the CHANnel SWitch to the desired channel position. After allowing approximately 30 seconds for the tube filaments to heat up, operate the pilot's CODE KEY for telegraphic emission. A code sidetone signal will be heard in the pilot's and operator's phones whenever the key is closed. If the pilot desires CW transmission, the CW-MCW switch must be placed in the CW position by the operator. If MCW transmission is desired the operator must place this switch in the MCW position. The pilot may use his CHANnel SWitch to select any frequency for which a tuning unit has been tuned. The remote frequency indicator will indicate to the operator which channel is operative. When the pilot is finished with his code transmission, he should place his PHONE STANDBY-CODE switch in the PHONE STANDBY position to keep the tube filaments heated up for subsequent phone or code transmission.

(*b*) If the pilot's PHONE STANDBY-CODE switch is in either the PHONE STANDBY or the CODE position he may press his microphone or throttle switch and speak into the microphone for phone transmission. If no transmission is to be made for some time, the PHONE STANDBY-CODE switch may be placed in the OFF position to prevent wasteful battery drain.

5-4. OPERATOR'S PHONE OPERATION.

The pilot must apply filament power by placing his PHONE STANDBY-CODE switch in the PHONE STANDBY position. One of the indicators on the remote indicator unit will then protrude from this unit and indicate to the operator that the transmitter is ready for use on a definite frequency. The operator may then press his microphone switch and talk into his microphone for voice transmission. His speech will be heard as a sidetone signal in his and the pilot's phones. When his transmission is finished he should open his microphone switch. The remote indicator unit or the transmitter channel indicator disc indicates to the operator which channel is operative. If he desires to change the operative frequency, he must request the pilot to make this change with the pilot's CHANnel SWitch.

5-5. OPERATOR'S CODE AND PHONE OPERATION.

(*a*) The pilot must place his PHONE STANDBY-CODE switch in CODE position and thus apply filament and plate power. The operator may then operate his telegraph key for telegraphic transmission. A code sidetone signal will be heard in the pilot's and operator's phones whenever the key is closed. The operator may select either CW or MCW transmission by placing his CW-MCW switch in the desired position. If the operator desires to change the operative frequency, he must request the pilot to make this change with the pilot's CHANnel SWitch.

(*b*) If the pilot's PHONE STANDBY-CODE switch is in the PHONE STANDBY or the CODE position, the operator may press his microphone switch and talk into his microphone for phone transmission.

5-6. OPERATOR'S EMERGENCY PHONE OPERATION.

(*a*) If the condition arises where the pilot is unable to start the transmitter for phone or code transmission or to change frequency, the operator may secure full control of the transmitter by breaking the safety wire on the LOCAL-REMOTE switch and placing this switch in the LOCAL position.

(*b*) He may then place his PHONE STANDBY-CODE switch in the PHONE STANDBY position to set his CHANNEL SWITCH to the desired channel position. After allowing approximately 30 seconds for the tube filaments to heat up, he should press his microphone switch and speak into the microphone for voice transmission. His speech will be heard in his and the pilot's phones as a sidetone signal.

(*c*) The pilot may also press his microphone switch and speak into his microphone for phone transmission if the operator's PHONE STANDBY-CODE switch is in the PHONE STANDBY or CODE position.

5-7. OPERATOR'S EMERGENCY CODE AND PHONE OPERATION.

(*a*) If a similar emergency condition arises and code operation is desired, the operator may transfer the LOCAL-REMOTE switch to the LOCAL position. He may then place his PHONE STANDBY-CODE switch in CODE position, and his CHANNEL SWITCH on the desired channel position. After allowing approximately 30 seconds for the tube filaments to heat up, he may operate his telegraph key for telegraphic transmission. A code sidetone signal will be heard in his and the pilot's phones. If the operator desires phone transmission he may press his microphone switch and talk into his microphone. When the transmission is finished the PHONE STANDBY-CODE switch should be placed in the OFF or PHONE STANDBY position.

(*b*) If the operator's PHONE STANDBY-CODE switch is in the CODE position, the pilot may use his CODE KEY for telegraphic transmission, or he may press his microphone or throttle switch and use his microphone for voice transmission.

5-8. 200-540 KCS ANTENNA TUNING UNIT.

MANUALLY DISCONNECT THE ANTENNA AND TRANSMITTER LEAD FROM THIS UNIT WHEN FREQUENCIES ABOVE 540 KCS ARE USED. THIS OPERATION MUST BE DONE BY THE OPERATOR AS THE MOTOR-DRIVEN CHANNEL SWITCH HAS NO CONTROL OVER THESE CONNECTIONS.

SECTION VI

6. MAINTENANCE.

6-1. TYPE CRR-52253 TRANSMITTER UNIT.

6-1-1. Inspection.

If possible inspect the interior of the transmitter every month. Remove it from its mounting tracks, and remove all shields. See that all connections are tight. See that all screws which secure components to the transmitter are tight. Remove dust and dirt from all surfaces with a small dry brush or a piece of clean dry cloth.

6-1-2. Tubes.

See that tubes are secure in their sockets. If a tube checker is available test the tubes every two months or so. Figure 77 gives the proper vacuum tube voltages and currents.

6-1-3. Setscrew Wrenches.

Three setscrew wrenches are mounted on the oscillator tube shield. They may be removed by opening the tube door. See that these wrenches are kept in their proper location.

6-1-4. Channel Switch.

Clean the contacts of the channel switch with a piece of fine sandpaper or emery cloth. Operate the push-rods behind the tuning units, and see that the blades are making good contact with the stationary studs. If necessary, bend the blades slightly to improve the contact pressure. Do not bend blades excessively as this may cause interference between the blade and its individual finger on the push-rod. See that the push-rods move freely and spring upward unless they are held down by hand or by their cams. Lubricate the cams on top of the push-rods with a very small amount of light oil.

6-1-5. Channel Switch Motor Assembly.

Operate the manual motor control at the right side of the transmitter. See that all gears run freely. Inspect gears for worn teeth and excessive play. Lubricate the gears every three months with a small amount of light grease. See that the A channel push-rod is down when the channel indicator disc indicates A channel. Check the B, C and D channels also. Carefully clean the contacts of the reversing switch blades S-110 on the right hand face of the motor.

6-1-6. Relays.

Move the relay armatures by hand, and see if all contacts close properly. See that no connections or adjusting screws are loose. Clean the contact surfaces with fine sandpaper or emery cloth if they appear dirty.

6-2. TUNING UNITS.

Clean the top and bottom metal shields of the tuning units with carbon tetrachloride or a similar mild solvent. Also clean the transmitter tracks on which the tuning unit rests and the transmitter leaf spring which presses down on the top shield of the tuning unit. If dirt collects on these surfaces, it will cause poor contact and a variation in signal frequency. See that all connections are tight. See that no coils contain nicks or dents which would cause shorted turns. The setscrews should not work loose as they have been secured with glyptal but they must be inspected for tightness occasionally, using the wrenches secured to the oscillator tube shield. THIS INSPECTION MUST BE CAREFULLY DONE. This applies particularly to the coil shafts, as they can be broken by excessive setscrew pressure. Press on the small contact points of the antenna load switches. As they are spring loaded, they should drop back into their blocks and should spring back out when pressure is released. The rectangular faced block may be removed for inspection by unscrewing it from its stud to which the antenna load tap leads are soldered.

6-3. MAINTENANCE OF TYPE CRR-21748 DYNAMOTOR-FILTER UNIT.

CAUTION: REMOVE THE DYNAMOTOR UNIT-TO-BATTERY CABLE PLUG BEFORE SERVICING THIS UNIT.

6-3-1. Air Inlet Screen.

KEEP THE AIR INLET SCREEN OF THIS UNIT CLEAN AT ALL TIMES.

6-3-2. Interior Inspection.

Once a month remove the end bells. Use a motor-driven blower if available to blow out the armature and stator sections thoroughly.

6-3-3. Commutators.

If the commutators are rough, use fine sandpaper, not emery paper, to clean them. Place the sandpaper under the brushes and rotate the armature by hand.

See if the brushes seat properly. If their contact surfaces are rough, they may be smoothed down with fine sandpaper placed between the brush and the commutator. Commutators and brushes should be cleaned with a fine rag as a final cleaning operation. After a service period of a year, the commutators may be considerably worn and need trueing-up in a lathe.

6-3-4. Lubrication.

The dynamotor should be lubricated after 300 hours of service. Use a medium weight lubricating oil. Remove the end bells. Unscrew the plug from the end of the bearing, insert grease, and replace plug. See lubrication note on dynamotor nameplate. (See Figure 25.)

6-3-5. Filter Box.

See that all connections on the terminal board are secure.

6-4. TYPE CRR-23280 REMOTE CONTROL UNIT AND TYPE CRR-55079 REMOTE INDICATOR UNIT.

Remove these units from their base occasionally, and see that the interior is clean and dry and that all connections are tight.

6-5. CABLES.

Remove cable plugs from their receptacles and wipe off any moisture that may collect on the phenolic face of the plug. *This check should be made frequently on the dynamotor-to-transmitter cable, particularly when operating under high humidity conditions or when the equipment is subjected to freezing and thawing temperatures.* See that the battery cable connections to the battery are clean and tight.

SECTION VII

7. LOCATION AND REMEDY OF FAULTS.

7-1. LOCATION OF FAULTS.

7-1-1. Familiarity with Equipment.

A good working knowledge of the functioning of the equipment, particularly the control circuits, will enable the operator to avoid errors in operation leading to an apparent indication of an equipment fault which does not actually exist. Such an understanding of the equipment will also permit rapid location and isolation or correction of faults when they exist. Very few of the faults listed here will occur in service if the equipment is properly operated and maintained.

7-1-2. Isolation of Fault.

If possible isolate the fault to one or two of the major components of the equipment:

Battery, dynamotor, transmitter, remote control or indicator units or their cables. The battery, dynamotor, and transmitter are the basic units: the remote units, microphone, and keys may be disconnected to isolate them from the circuit. If the fault occurs in the transmitter, try to isolate it to the control, audio, or radio frequency circuits. If a control circuit fault occurs and it is isolated to a particular unit, check that unit from its cable receptacles, through the suspected circuit with an ohmmeter. SHUT DOWN THE TRANSMITTER AND DISCONNECT BOTH ENDS OF ANY CABLE THAT IS TO BE CIRCUIT CHECKED.

7-1-3. Index to Control and Power Circuit Faults.

Reference Section	*Fault*
7-2-1	General Cause of Fault
7-2-2	No Filament Power Available
7-2-3	Dynamotor Will Not Start For CODE Operation
7-2-4	Dynamotor Will Not Start For PHONE Operation
7-2-5	Phone Relay Will Not Close
7-2-6	Keying Relay Will Not Operate
7-2-7	Channel Selector Switch Inoperative
7-2-8	Channel Switch Motor Will Not Stop Rotating
7-2-9	Channel Indicator Disc Indicates Wrong Channel
7-2-10	Remote Frequency Indicator Inoperative
7-2-11	No PA Grid Current
7-2-12	No Oscillator Plate Voltage
7-2-13	Dynamotor Low Voltage Fuse Open
7-2-14	No PA Screen Voltage
7-2-15	No PA Plate Voltage
7-2-16	Dynamotor High Voltage Fuse Open
7-2-17	No PA Plate Current

7-1-4. Index to Audio Frequency Faults.

7-3-1	General Cause of Fault
7-3-2	No Code Sidetone Signal Available
7-3-3	No Voice Sidetone Signal Available
7-3-4	Antenna Current Does Not Increase With Modulation
7-3-5	Vacuum Tube Faults

7-1-5. Index to Radio Frequency Circuit Faults.

7-4-1	General Cause of Fault
7-4-2	PA Grid Current Too Low
7-4-3	No Signal in Frequency Indicator Unit
7-4-4	Vibration Shifts Oscillator Frequency
7-4-5	Tuning Idle Channel Shifts Oscillator Frequency
7-4-6	PA Plate Current Below Normal
7-4-7	PA Plate Current Above Normal
7-4-8	PA Plate Current Does Not Dip as PA is Tuned
7-4-9	Antenna Ammeter Does Not Indicate Current
7-4-10	Antenna Circuit Breaks Down at High Altitudes
7-4-11	PA Plate Current Above Normal with Antenna Lead Off
7-4-12	Vacuum Tube Faults
7-4-13	Typical CW Antenna Power
7-4-14	Tuning Idle Channel Antenna Circuit Lowers Antenna Current of Adjacent Active Channel

7-2. CONTROL AND POWER CIRCUIT FAULTS.

7-2-1. General Cause of Fault.

Control and power circuit faults are caused by improper operation, defective cables, open fuses blocked relays, poor relay or switch contacts, open resistors, or by failure of the motor drive or indicator mechanism.

7-2-2. Transmitter Tube Filaments Will Not Light, Remote Indicator Does Not Indicate, Battery Voltmeter Does Not Indicate.

(*a*) The proper switches have not been closed.

See that the REMOTE-LOCAL switch is in the REMOTE position, the pilot's PHONE STANDBY-CODE switch is in PHONE STAND-BY or CODE position, or if local operation is used see that the REMOTE-LOCAL switch is in LOCAL position, the operator's PHONE STANDBY-CODE switch is in PHONE STANDBY or CODE position.

(*b*) Remote control unit or its cable are defective.

Place the LOCAL-REMOTE switch in LOCAL position and PHONE STANDBY-CODE switch in PHONE STANDBY position. Press down on the battery voltmeter switch lever. If the voltmeter indicates 23 to 28 volts the fault lies in the remote control unit or its cable.

(*c*) If local operation is not satisfactory faults (*d*) to (*g*) may be present.

(*d*) The dynamotor filament fuse or battery fuse is open.

(*e*) The dynamotor-to-transmitter cable is defective. Check with an ohmmeter with *both ends* of cable disconnected.

(*f*) The transmitter LOCAL-REMOTE switch is defective.

(*g*) The PA tube has an open filament.

7-2-3. Dynamotor Will Not Start for Code Operation.

(*a*) The proper switches have not been closed for remote code operation. See that the transmitter LOCAL-REMOTE switch is in REMOTE position, and the pilot's PHONE STANDBY-CODE switch is in CODE position.

(*b*) No battery power is available. If this fault is present, the remote indicator will not protrude from the panel and the transmitter battery voltmeter will not indicate when its switch is closed. See Section 7-2-2 for possible faults.

(*c*) The remote control unit or its cable are defective. Try LOCAL operation. Place the transmitter LOCAL-REMOTE switch in the LOCAL position, and the transmitter PHONE STANDBY-CODE switch in the CODE position. See that battery voltage is available on the transmitter battery voltmeter. If it is not, see Section 7-7-2 (*d*) to (*g*).

(*d*) The transmitter tube door interlock switch is open or the dynamotor lid interlock switch is open.

(*e*) The cable between the dynamotor and the transmitter is defective on terminals 1 and 4.

(*f*) The dynamotor relay coil is open or its contacts are dirty.

7-2-4. The Dynamotor Will Not Start for Phone Operation.

(*a*) The proper switches have not been closed for remote phone operation. See that the transmitter LOCAL-REMOTE switch is on REMOTE position, the pilot's PHONE STANDBY-CODE switch is on PHONE position, his microphone plug is inserted in its jack and his microphone switch is closed or his throttle switch is closed.

(*b*) Try remote code operation by placing the pilot's PHONE STANDBY-CODE switch in CODE position. If the dynamotor does not start, see Section 7-2-3. If it does, CODE operation is satisfactory and fault (c) is present.

(*c*) The remote control unit or its cable is defective. Place the transmitter LOCAL-REMOTE switch in LOCAL position and the transmitter PHONE STANDBY-CODE switch in PHONE STANDBY position, and close the operator's microphone switch. If the dynamotor starts, the remote control unit or its cable is defective. If it does not start, try local code operation by placing the operator's PHONE STANDBY-CODE switch in the CODE position. If it does not start, see Section 7-2-3(*c*) to (*f*). If it does start on CODE operation and does not start on PHONE STANDBY operation, fault (*d*) is present.

(*d*) Phone relay coil or contact circuit is defective. Close this relay by hand. If dynamotor starts, this relay coil circuit is defective. See Section 7-2-5. If dynamotor does not start, phone relay contact K-101B is dirty.

7-2-5. Phone Relay Will Not Close.

(*a*) The proper switches have not been closed for remote phone operation. See that the transmitter LOCAL-REMOTE switch is in the REMOTE position, the pilot's PHONE STANDBY-CODE switch is on PHONE STANDBY position, his microphone plug is in its jack, and his microphone or throttle switch is closed.

(*b*) No filament voltage is available. If this voltage is available, the indicator on the remote control unit will operate and the battery voltmeter on the transmitter will indicate when its switch is closed.

(*c*) The remote control unit or its cable is defective. Try local phone operation by placing the transmitter LOCAL-REMOTE switch in LOCAL position, the transmitter PHONE STANDBY-CODE switch in PHONE STANDBY position, and closing the operator's microphone switch or the throttle switch.

(*d*) The phone relay coil is open. Close the test key; if the keying relay closes, voltage is available for the phone relay and its coil is probably open or its armature is mechanically blocked.

(*e*) The motor relay contact K-104B is open if the keying relay does not close when the test key is closed.

7-2-6. The Keying Relay Will Not Operate.

(*a*) The proper switches have not been closed for remote code operation. See that the transmitter LOCAL-REMOTE switch is in REMOTE position, the pilot's PHONE STANDBY-CODE switch is in CODE position.

(*b*) A second keying circuit is closed which keeps the keying relay permanently closed. Open and shut the pilot's code key to see if the keying relay can be heard following this keying. See that the pilot's microphone and throttle switch are open, the operator's microphone and key are open, and the phone relay is open.

(*c*) No filament voltage is available. If it is not,

the indicator on the remote control unit will not function and the transmitter battery voltmeter will not indicate when its switch is closed. See Section 7-2-2.

(*d*) The remote control unit or its cable is defective. Try local operation by placing the transmitter LOCAL-REMOTE switch in the LOCAL position, the transmitter PHONE STANDBY-CODE switch in CODE position, and closing the transmitter test key.

(*e*) The motor relay contact K-104B is defective or the keying relay coil is open if local operation covered above does not close the keying relay.

7-2-7. When the Pilot's Channel Selector Switch Is Operated, the Transmitter Channel Indicator Disc Does Not Operate.

(*a*) The proper switches have not been closed. See that the transmitter LOCAL-REMOTE switch is in the REMOTE position, the pilot's PHONE STANDBY-CODE switch is on PHONE STANDBY or CODE position and the pilot's channel selector switch is set on the desired channel.

(*b*) No filament voltage is available. If this is true, the pilot's indicator will not operate and the transmitter battery voltmeter will not operate when its switch is closed. See Section 7-2-2 for possible faults.

(*c*) The remote control unit or its cable is defective. Try local operation by placing the transmitter LOCAL-REMOTE switch in the LOCAL position, the transmitter PHONE STANDBY-CODE switch on the PHONE STANDBY or the CODE positions, and operating the transmitter channel selector switch to select the desired channel. If the transmitter channel indicator disc does not rotate, its chain drive is defective or faults (*d*) to (*f*) may be present.

(*d*) The channel drive mechanism is defective. Remove filament power and operate the manual channel selector control on the right side of the transmitter. Open the tube access door and see that all four cams push down on the push-rods and that the channel A push-rod is down when this channel is indicated on the channel indicator disc. Check the B, C, and D channels also. See that all gears in the motor gear assembly are operative and that the spur gears connecting this assembly to the channel switch cam shaft are operative. Return the manual channel selector control handle to its normal position parallel with the right face of the transmitter.

(*e*) The transmitter channel selector switch is not making contact. Try local operation as indicated in Section 7-2-7(*c*). If the channel selector motor does not rotate when the transmitter channel selector switch is operated, connect one switch contact at a time to ground. If the motor then rotates, this switch is defective.

(*f*) The channel selector cam switch is not making contact. Short its contacts to ground one at a time until the motor rotates.

(*g*) The coil of the motor relay is open. Short both sides of the *coil* to ground.

(*h*) The motor is open. Short first the forward field (red lead) then the reverse field (blue lead) to ground. If filament voltage is available and the motor does not rotate, the motor is open and must be replaced.

7-2-8. The Channel Switch Motor Will Not Stop Rotating.

(*a*) The manual channel control switch on the *right end* of the transmitter is set up for manual operation. Place it in the normal position parallel to the right face of the transmitter.

(*b*) The cam which operates the motor reversing switch S-110 has loosened and moved on its shaft. If this occurs, the motor will rotate in a forward and then in a reverse direction without stopping. Use the manual channel control to rotate the channel cam shaft until the A cam pushes down on the A push-rod. As the manual control is rotated clockwise past this position, the A contact on the channel selector cam S-109 should open. This contact is the upper right hand contact on this switch. Just *before* this contact opens the right or forward blade of the reversing switch S-110 closes. Then this blade opens and the left or reverse blade of this switch closes and then opens. Then this blade-closing sequence repeats. To adjust the cam which operates these blades, use a setscrew wrench to loosen the two setscrews on the cam. Rotate the cam on its shaft until the above described blade sequence is obtained, and then tighten the cam setscrews.

(*c*) The motor relay coil is shorted or its contact K-104A is dirty and does not permit the motor reversing field to close.

7-2-9. The Channel Indicator Disc on the Transmitter Indicates the Wrong Channel.

(*a*) The spur gears on the channel switch cam shaft have slipped, due to a heavy load on the channel switch shaft. This can only occur if the equipment is improperly operated and a tuning unit has been removed while the switching mechanism is rotating, thus jamming the tuning unit lock with the push-rod lock. If such a fault exists, the spur gears will not mesh properly and a grinding noise can be heard as

the gear teeth clash when the channel motor rotates. Remove the tuning unit from A channel. Set the frequency selector switch on the transmitter on A position and see if the A channel push-rod is pushed down. If it is down, this defect is not present. If the A channel push-rod is not down, operate the manual channel control until the A contact on the channel selector cam switch S-109 is open. This is the upper right hand contact on this switch. Then loosen the setscrew and pins in the main shaft collar near the upper spur gear. Move the shaft to the left (front view) until the spur gear disengages. Rotate the shaft until the A cam is vertical and so that it pushes the A push-rod down. Then slide the shaft to the right until the spur gears mesh. Set the collar against the right face of the A bearing block and secure its setscrews and pins.

(*b*) The channel indicator disc drive chain has slipped. Set the channel selector switch on A position and see that the A push-rod comes down. If the channel disc does not indicate A position, loosen the front panel screws holding the disc assembly and rotate the disc and its chain drive until the disc indicates A channel. Tighten up these screws.

7-2-10. The Remote Indicator Unit Does Not Operate Although the Transmitter Channel Indicator Disc Functions Properly.

(*a*) The remote indicator unit or its cable is defective. Remove the transmitter plug on the cable from the transmitter to remote indicator unit. Use an ohmmeter to check continuity from the terminals to ground on the transmitter receptacle J-103 for the cable from the transmitter to the remote indicator unit. Terminal 2 should be grounded when A channel is active; terminal 3 for B channel etc. Terminal 1 should have the same voltage to ground as indicated by the transmitter battery voltmeter, approximately 28 volts. If the above continuity and voltage checks are satisfactory, the fault is in the remote indicator unit or its cable.

(*b*) The channel indicator switch is defective if the above continuity checks are unsatisfactory. This switch S-108 is behind the channel selector cam S-109 on the channel motor drive assembly.

7-2-11. No Current Is Indicated on the PA Grid Milliammeter with the Dynamotor Running and the Test Key Closed.

(*a*) No tuning unit is in the active channel. The letter corresponding to the active channel is indicated by the transmitter channel indicator disc.

(*b*) The oscillator plate control B on the active tuning unit is not adjusted for maximum PA grid current.

(*c*) The oscillator grid switch G and plate switch H are not set on the same band. These switches are inside the tuning unit.

(*d*) No plate voltage is available for the oscillator. Remove a tuning unit and measure this voltage to ground from the platejack in the rear of the channel to ground. It should be 300 to 400 volts, depending on battery voltage. If this voltage is low, see Section 7-2-12.

(*e*) The oscillator tube or the PA tube has an open filament or low emission.

(*f*) The oscillator blades of the channel switch are making poor contact. Clean the fixed contacts and the contacts on the blades with fine sandpaper and bend them *slightly* to increase their contact pressure.

(*g*) The oscillator screen voltage is low. Measure this voltage at the tube socket. It should be 140 to 155 volts to ground. If the oscillator plate voltage is normal (300 to 400 volts) and the screen voltage is low, the oscillator screen resistors R-117 to R-120 are open or the regulator tube V-103 is defective. If screen voltage is normal and this tube does not glow, it is defective and should be replaced.

7-2-12. No Plate Voltage Is Applied to the Oscillator when the Dynamotor Is Running and the Test Key Is Closed.

(*a*) This fault will usually be indicated by a zero reading of the PA grid meter.

(*b*) Measure this voltage at the oscillator-plate jack J-109 to J-112 to ground. Remove a tuning unit. The plate jack is at the rear of the channel. This voltage should be 300 to 380 volts depending on battery voltage.

(*c*) The low voltage fuse in the dynamotor is open. Try a new fuse. If it fails, a short circuit exists on the 380-volt circuit. Find the short circuit before inserting any more fuses. See Section 7-2-13.

(*d*) Keying relay contact K-103E is open or making poor contact.

(*e*) Oscillator plate resistor R-121 is open.

(*f*) The cable is defective between dynamotor and transmitter unit.

7-2-13. Dynamotor Low Voltage Fuse Open Due to a Short Circuit on 380-Volt Circuit.

(*a*) The dynamotor low voltage filter capacitor C-202 is shorted. REMOVE THE BATTERY AND TRANSMITTER CABLE PLUGS FROM THE DYNAMOTOR. Remove the low voltage fuse from the

dynamotor. Measure the resistance across the terminals of this capacitor. It should be 100,000 ohms, the resistance of the bleeder resistor R-201.

(*b*) The cable from the dynamotor unit to the transmitter is defective. Remove the plugs of this cable from the dynamotor and transmitter. The resistance from 380-volt terminal 5 on the plug to the ground terminal 2 should be over five megohms. Check the cable with a 500-volt megger, if available.

(*c*) A short circuit exists in the transmitter. With all power off the transmitter and the dynamotor-transmitter cable plug removed from the transmitter, the resistance to ground from the 380-volt terminal 5 on receptacle J-101 of the transmitter unit should be approximately as shown:

Operating Condition	*Resistance Terminal 5 to Ground*	*TUNE-OPERATE Switch Position*	*Key Relay Contacts*	*CW-MCW Switch Position*
1	9 megohms	TUNE	OPEN	CW or MCW
2	7 megohms	TUNE	CLOSED	CW or MCW
3	9 megohms	OPERATE	OPEN	CW
4	25,000 ohms	OPERATE	OPEN	MCW
5	25,000 ohms	OPERATE	CLOSED	CW
6	13,000 ohms	OPERATE	CLOSED	MCW

Start with the TUNE-OPERATE and CW-MCW switches and the keying relay in positions shown in condition 1 of the above table and measure the resistance from the 380-volt buss to ground. Then go to condition 2, 3, 4, etc. and repeat the resistance measurement. A very low resistance measurement will occur on some of these operating conditions. A study of the schematic diagram, Figure 29, will then indicate in which part of the circuit the fault lies and it can then be definitely located in some component or faulty wire.

(*d*) Some tube is gassy. Remove tubes from their socket until resistance increases suddenly from the 380-volt buss to ground.

7-2-14. No Screen Voltage Available for PA Tube.

(*a*) This fault will usually be indicated by a low PA plate current.

(*b*) No low plate voltage is available. Measure this voltage from the oscillator plate jack inside the channel to ground with dynamotor running and keying relay closed. If no voltage is available, see Sections 7-2-12 and 7-2-13.

(*c*) Keying relay is open or its E contact is dirty.

(*d*) Modulation transformer screen secondary, terminal 6 to 7, is open.

(*e*) PA screen resistors R-125 to R-132 are open.

7-2-15. No Plate Voltage Available for PA Tube when the Dynamotor Is Running and the TUNE-OPERATE Switch Is in Operate Position.

(*a*) This fault will usually be indicated by a very low plate current on CW operation.

(*b*) The flexible lead to the PA plate cap is off.

(*c*) The dynamotor high voltage fuse is open. Try a new fuse. If it fails, a short circuit exists on the 1000-volt circuit. Find the short circuit before inserting any more fuses. See Section 7-2-16.

(*d*) The cable is defective between the dynamotor and the transmitter.

(*e*) The TUNE-OPERATE switch is making poor contact.

(*f*) The plate milliammeter is open.

(*g*) The plate secondary winding, terminal 4 to 5, is open on the modulation transformer.

(*h*) The PA plate reactors L105, L106 are open.

7-2-16. Dynamotor High Voltage Fuse Opens Due to a Short Circuit on the 1000-Volt Circuit.

(*a*) The dynamotor high voltage filter capacitor C-203 is shorted. REMOVE THE BATTERY AND THE TRANSMITTER CABLE PLUGS FROM THE DYNAMOTOR. Remove the high voltage fuse and measure the resistance across the terminals of this capacitor. It should be 300,000 ohms, the resistance of the bleeder resistors R-202, R-203, and R-204.

(*b*) The cable from the dynamotor to the transmitter is defective. Remove the plugs of this cable from the dynamotor and the transmitter. The resistance from the 1000-volt terminal 8 on the plug to the ground terminal 2 should be over five megohms. Check the cable with a 1000-volt megger, if available.

(*c*) A short circuit is present in the transmitter. With all power off the transmitter and the dynamotor-transmitter cable plug removed from the transmitter, the resistance to ground from the 1000-volt terminal 8

on the receptacle J-101 of the transmitter should be over five megohms.

7-2-17. The PA Plate Current Is Zero with the Dynamotor Running and the Test Key Closed.

(*a*) TUNE-OPERATE switch must be in OPERATE position to secure PA plate current.

(*b*) Flexible lead is not on PA plate cap.

(*c*) No PA plate voltage available. Dynamotor high voltage fuse F-204 open. See Section 7-2-15.

(*d*) High voltage tune-operate switch S-114 is making poor contact.

(*e*) PA tube is defective. It has an open filament or low emission.

7-3. AUDIO FREQUENCY CIRCUIT FAULTS.

7-3-1. General Cause of Fault.

Audio frequency circuit faults are caused by defective cables, poor contact on jacks, switches, or relays, failure of audio tubes or supply voltage, open resistors, and defective transformers or capacitors.

7-3-2. No Code Sidetone Signal Is Available in the Operator's or Pilot's Phones with the Dynamotor Running and the Test Key Closed and TUNE-OPERATE Switch in OPERATE Position.

(*a*) A fault exists in other equipment connected to the transmitter sidetone jacks. Remove plugs from both transmitter sidetone jacks and insert a phone plug into one jack. Test sidetone again.

(*b*) The sidetone switch S-111 is defective. Remove the tuning unit from D channel and rotate the sidetone switch shaft to a new position.

(*c*) The driver tube V-106 is defective.

(*d*) The PA tube filament is open and no filament voltage is available for the remaining tubes.

(*e*) 380 volts not available for plate supply. Low voltage fuse is open in dynamotor. Cable is defective between dynamotor and transmitter.

(*f*) No screen voltage available for driver tube. TUNE-OPERATE switch MUST be in OPERATE position. Keying relay is open. Driver screen resistors R-107, R-108, or R-139 to R-141 are open.

(*g*) Poor contact on phone relay K-101D.

(*h*) Driver feedback circuit is open. Capacitor C-125, resistors R-114 or R-115 are defective.

7-3-3. No Voice Sidetone Signal Is Available in the Operator's or Pilot's Phones when the Pilot or Operator Speaks into his Microphone.

(*a*) The dynamotor is not running.

(*b*) The TUNE-OPERATE switch is not in OPERATE position.

(*c*) A fault exists in other equipment connected to the transmitter sidetone jacks. Remove plugs from both sidetone jacks and insert a phone plug into one jack. Test sidetone signal.

(*d*) See Section 7-3-2(*d*) to (*f*) for possible faults.

(*e*) Microphone switch S-115 is in wrong position or is making poor contact. Switch should be in *magnetic* position for magnetic microphone and *carbon* position for carbon microphone. Upper edge of slot in switch shaft points to switch position designation. Remove tuning unit from D channel to see switch.

(*f*) Microphone amplifier tube V-107 is defective.

(*g*) Poor contact on phone relay K-101C or K-101D.

(*h*) When a carbon microphone is used, microphone filter reactor L-101 is open or motor relay contact K-104B is open.

7-3-4. Antenna Current Does Not Increase Five to Ten Per Cent with Modulation.

(*a*) No audio voltage available on modulator grids. In this case, there will be no sidetone signal available in the operator's phones. See Section 7-3-2 or 7-3-3 for possible faults. The modulator audio grid voltage measured from grid terminal to ground should be 25 to 30 volts RMS for MCW or phone modulation conditions. Use a rectifier type voltmeter to measure this voltage.

(*b*) No modulator plate or screen voltage available for MCW operation. The CW-MCW switch should be in MCW position. The TUNE-OPERATE switch should be in OPERATE position. The modulator screen resistors R-109 to R-113 are open.

(*c*) No modulator plate or screen voltage available for phone operation. The TUNE-OPERATE switch should be in the OPERATE position. The phone relay K-101 should be closed. See Section 7-2-5 for possible faults. The modulator screen resistors R-109 to R-113 are open.

(*d*) The modulator tubes have open filaments or low emission.

(*e*) The modulation transformer is open or shorted. 1000 VOLTS IS APPLIED TO TERMINALS 4 AND 5 OF THIS TRANSFORMER. USE CARE IN MAKING MEASUREMENTS. The audio voltage across modulation transformer terminals 4 and 5 should be

dynamotor. Measure the resistance across the terminals of this capacitor. It should be 100,000 ohms, the resistance of the bleeder resistor R-201.

(*b*) The cable from the dynamotor unit to the transmitter is defective. Remove the plugs of this cable from the dynamotor and transmitter. The resistance from 380-volt terminal 5 on the plug to the ground terminal 2 should be over five megohms. Check the cable with a 500-volt megger, if available.

(*c*) A short circuit exists in the transmitter. With all power off the transmitter and the dynamotor-transmitter cable plug removed from the transmitter, the resistance to ground from the 380-volt terminal 5 on receptacle J-101 of the transmitter unit should be approximately as shown:

Operating Condition	*Resistance Terminal 5 to Ground*	*TUNE-OPERATE Switch Position*	*Key Relay Contacts*	*CW-MCW Switch Position*
1	9 megohms	TUNE	OPEN	CW or MCW
2	7 megohms	TUNE	CLOSED	CW or MCW
3	9 megohms	OPERATE	OPEN	CW
4	25,000 ohms	OPERATE	OPEN	MCW
5	25,000 ohms	OPERATE	CLOSED	CW
6	13,000 ohms	OPERATE	CLOSED	MCW

Start with the TUNE-OPERATE and CW-MCW switches and the keying relay in positions shown in condition 1 of the above table and measure the resistance from the 380-volt buss to ground. Then go to condition 2, 3, 4, etc. and repeat the resistance measurement. A very low resistance measurement will occur on some of these operating conditions. A study of the schematic diagram, Figure 29, will then indicate in which part of the circuit the fault lies and it can then be definitely located in some component or faulty wire.

(*d*) Some tube is gassy. Remove tubes from their socket until resistance increases suddenly from the 380-volt buss to ground.

7-2-14. No Screen Voltage Available for PA Tube.

(*a*) This fault will usually be indicated by a low PA plate current.

(*b*) No low plate voltage is available. Measure this voltage from the oscillator plate jack inside the channel to ground with dynamotor running and keying relay closed. If no voltage is available, see Sections 7-2-12 and 7-2-13.

(*c*) Keying relay is open or its E contact is dirty.

(*d*) Modulation transformer screen secondary, terminal 6 to 7, is open.

(*e*) PA screen resistors R-125 to R-132 are open.

7-2-15. No Plate Voltage Available for PA Tube when the Dynamotor Is Running and the TUNE-OPERATE Switch Is in Operate Position.

(*a*) This fault will usually be indicated by a very low plate current on CW operation.

(*b*) The flexible lead to the PA plate cap is off.

(*c*) The dynamotor high voltage fuse is open. Try a new fuse. If it fails, a short circuit exists on the 1000-volt circuit. Find the short circuit before inserting any more fuses. See Section 7-2-16.

(*d*) The cable is defective between the dynamotor and the transmitter.

(*e*) The TUNE-OPERATE switch is making poor contact.

(*f*) The plate milliammeter is open.

(*g*) The plate secondary winding, terminal 4 to 5, is open on the modulation transformer.

(*h*) The PA plate reactors L105, L106 are open.

7-2-16. Dynamotor High Voltage Fuse Opens Due to a Short Circuit on the 1000-Volt Circuit.

(*a*) The dynamotor high voltage filter capacitor C-203 is shorted. REMOVE THE BATTERY AND THE TRANSMITTER CABLE PLUGS FROM THE DYNAMOTOR. Remove the high voltage fuse and measure the resistance across the terminals of this capacitor. It should be 300,000 ohms, the resistance of the bleeder resistors R-202, R-203, and R-204.

(*b*) The cable from the dynamotor to the transmitter is defective. Remove the plugs of this cable from the dynamotor and the transmitter. The resistance from the 1000-volt terminal 8 on the plug to the ground terminal 2 should be over five megohms. Check the cable with a 1000-volt megger, if available.

(*c*) A short circuit is present in the transmitter. With all power off the transmitter and the dynamotor-transmitter cable plug removed from the transmitter, the resistance to ground from the 1000-volt terminal 8

on the receptacle J-101 of the transmitter should be over five megohms.

7-2-17. The PA Plate Current Is Zero with the Dynamotor Running and the Test Key Closed.

(*a*) TUNE-OPERATE switch must be in OPERATE position to secure PA plate current.

(*b*) Flexible lead is not on PA plate cap..

(*c*) No PA plate voltage available. Dynamotor high voltage fuse F-204 open. See Section 7-2-15.

(*d*) High voltage tune-operate switch S-114 is making poor contact.

(*e*) PA tube is defective. It has an open filament or low emission.

7-3. AUDIO FREQUENCY CIRCUIT FAULTS.

7-3-1. General Cause of Fault.

Audio frequency circuit faults are caused by defective cables, poor contact on jacks, switches, or relays, failure of audio tubes or supply voltage, open resistors, and defective transformers or capacitors.

7-3-2. No Code Sidetone Signal Is Available in the Operator's or Pilot's Phones with the Dynamotor Running and the Test Key Closed and TUNE-OPERATE Switch in OPERATE Position.

(*a*) A fault exists in other equipment connected to the transmitter sidetone jacks. Remove plugs from both transmitter sidetone jacks and insert a phone plug into one jack. Test sidetone again.

(*b*) The sidetone switch S-111 is defective. Remove the tuning unit from D channel and rotate the sidetone switch shaft to a new position.

(*c*) The driver tube V-106 is defective.

(*d*) The PA tube filament is open and no filament voltage is available for the remaining tubes.

(*e*) 380 volts not available for plate supply. Low voltage fuse is open in dynamotor. Cable is defective between dynamotor and transmitter.

(*f*) No screen voltage available for driver tube. TUNE-OPERATE switch MUST be in OPERATE position. Keying relay is open. Driver screen resistors R-107, R-108, or R-139 to R-141 are open.

(*g*) Poor contact on phone relay K-101D.

(*h*) Driver feedback circuit is open. Capacitor C-125, resistors R-114 or R-115 are defective.

7-3-3. No Voice Sidetone Signal Is Available in the Operator's or Pilot's Phones when the Pilot or Operator Speaks into his Microphone.

(*a*) The dynamotor is not running.

(*b*) The TUNE-OPERATE switch is not in OPERATE position.

(*c*) A fault exists in other equipment connected to the transmitter sidetone jacks. Remove plugs from both sidetone jacks and insert a phone plug into one jack. Test sidetone signal.

(*d*) See Section 7-3-2(*d*) to (*f*) for possible faults.

(*e*) Microphone switch S-115 is in wrong position or is making poor contact. Switch should be in *magnetic* position for magnetic microphone and *carbon* position for carbon microphone. Upper edge of slot in switch shaft points to switch position designation. Remove tuning unit from D channel to see switch.

(*f*) Microphone amplifier tube V-107 is defective.

(*g*) Poor contact on phone relay K-101C or K-101D.

(*h*) When a carbon microphone is used, microphone filter reactor L-101 is open or motor relay contact K-104B is open.

7-3-4. Antenna Current Does Not Increase Five to Ten Per Cent with Modulation.

(*a*) No audio voltage available on modulator grids. In this case, there will be no sidetone signal available in the operator's phones. See Section 7-3-2 or 7-3-3 for possible faults. The modulator audio grid voltage measured from grid terminal to ground should be 25 to 30 volts RMS for MCW or phone modulation conditions. Use a rectifier type voltmeter to measure this voltage.

(*b*) No modulator plate or screen voltage available for MCW operation. The CW-MCW switch should be in MCW position. The TUNE-OPERATE switch should be in OPERATE position. The modulator screen resistors R-109 to R-113 are open.

(c) No modulator plate or screen voltage available for phone operation. The TUNE-OPERATE switch should be in the OPERATE position. The phone relay K-101 should be closed. See Section 7-2-5 for possible faults. The modulator screen resistors R-109 to R-113 are open.

(*d*) The modulator tubes have open filaments or low emission.

(*e*) The modulation transformer is open or shorted. 1000 VOLTS IS APPLIED TO TERMINALS 4 AND 5 OF THIS TRANSFORMER. USE CARE IN MAKING MEASUREMENTS. The audio voltage across modulation transformer terminals 4 and 5 should be

450 to 530 volts RMS for MCW or phone modulated conditions.

(*f*) The dynamotor low voltage filter capacitor C-202 or the dynamotor high voltage filter capacitor C-203 are open.

(*g*) The PA screen voltage is low. See Section 7-2-14.

(*h*) The PA tube has low emission.

7-3-5. Faulty Vacuum Tubes.

Should all indications point to faulty vacuum tube operation, consult Figure 77 for proper vacuum tube voltages and currents.

7-4. RADIO FREQUENCY CIRCUIT FAULTS.

7-4-1. General Cause of Fault.

Radio frequency circuit faults are caused by improper operation, poor contact on switches or tube sockets, failure of the oscillator or PA tube, shorted inductors or capacitors, open resistors, or operation with an abnormal antenna.

7-4-2. PA Grid Current Is Below Normal Value of 7 to 15 MA.

(*a*) Adjust the oscillator plate control B for maximum PA grid current.

(*b*) Battery voltage is less than 28 volts.

(*c*) Oscillator grid and plate band switches, controls G and H inside tuning unit, are not set on the same band position.

(*d*) The tuning unit which is being tuned is idle. If the unit being tuned is active, its channel letter will be indicated by the transmitter channel indicator disc.

(*e*) Oscillator plate voltage is below 380 volts. See Section 7-2-12 if voltage is zero. Oscillator screen voltage is below 150 volts.

(*f*) The channel switch blades are making poor contact. Clean the contacts with fine sandpaper and bend the blades *slightly* to increase contact pressure.

(*g*) The oscillator tube is defective.

(*h*) The oscillator plate inductor has a shorted turn.

(*i*) The PA grid relay K-102 is defective. Its contacts should open when the key is closed.

7-4-3. When the Key Is Closed, No Signal Can Be Heard in the Phones Connected to the Crystal Frequency Indicator Unit although PA Grid Current Is Normal.

(*a*) The oscillator band switches, controls G and H, inside the tuning unit are set on the wrong positions. Check these settings with the tuning chart on top of the transmitter. Check the oscillator grid dial A setting with this chart. Vary this dial A on the active channel.

(*b*) The crystal frequency indicator unit is improperly tuned.

(*c*) No connection has been made from the transmitter CFI post to the RF input post on the CFI unit. No ground connection has been made between the transmitter and CFI units.

7-4-4. Oscillator Frequency Varies as Transmitter Is Vibrated.

(*a*) Tighten both main locking screws on all tuning units. These screws are wing-headed. Tighten all dial-locking screws on all tuning units.

(*b*) The active tuning unit channel switch is making poor contact, particularly on the three bottom oscillator blades. Clean these blades and bend them *slightly* to increase the contact pressure.

(*c*) The top or bottom face of the tuning unit, the transmitter tracks, or leaf springs which contact these faces need cleaning with carbon tetrachloride or similar mild solvent.

(*d*) Oscillator, PA, or voltage regulator tube is making poor contact in its socket.

(*e*) There is a loose connection or loose shield in the oscillator compartment.

(*f*) The oscillator shaft setscrews are loose. USE CARE IN TIGHTENING THESE SCREWS TO AVOID DAMAGE TO THE SHAFT.

7-4-5. Oscillator Frequency Shifts when a Tuning Control Is Varied on an Idle Tuning Unit.

(*a*) The channel switch blades on the idle tuning unit are making poor contact on their back or shorting contacts.

(*b*) The push-rod of the idle unit is jammed so that it does not spring up when its cam is rotated to the idle position.

7-4-6. PA Plate Current Is Below Normal.

(*a*) With the dynamotor running and the test key closed, this current should be 80 to 120 MA, depending on frequency and battery voltage.

(*b*) Battery voltage is below 26 to 28 volts.

(*c*) PA grid current is below 7 MA. See Section 7-4-2.

(*d*) Antenna circuit is detuned or decoupled. Readjust antenna tuning control F, antenna load switch E, and antenna coupling control D, if necessary, for maximum PA plate current and antenna current.

(*e*) PA plate voltage is below 900 to 1000 volts. Dynamotor high voltage fuse may be open. See Section 7-2-15.

(*f*) PA screen voltage is low. It should be 220 to 250 volts DC with the key closed and the TUNE-OPERATE switch in OPERATE position. See Section 7-2-14.

(*g*) The keying relay is making poor contact. STOP THE DYNAMOTOR BY CHANGING TO PHONE STANDBY OPERATION. Close the TEST KEY and thus close the keying relay. Remove a tuning unit and use an ohmmeter to check the circuit between the antenna buss and the ANTENNA post on the left side of the transmitter unit. This buss is the top RF buss behind the channel switch assembly. (See Figure 10.)

(*h*) Antenna resistance is higher than normal. See Section 7-4-9 (*e*).

7-4-7. PA Plate Current Is Above Normal.

(*a*) Retune the PA tuning dial, control C, for *minimum* PA plate current.

(*b*) The antenna coupling is excessive. Decrease setting of antenna coupling control D, and retune PA dial, control C, for minimum PA plate current.

(*c*) The band switches G, H, and J inside the tuning unit are not properly set on the same band positions.

(*d*) The PA band switch blade, control J, is not set squarely on its contact.

(*e*) The PA tube is gassy.

(*f*) The PA tank inductor has a shorted turn or the tank capacitor is shorted.

7-4-8. The PA Plate Current Does Not Dip to a Minimum as the PA Tuning Dial C Is Varied.

(*a*) The PA tuning dial C is being varied on an *idle* channel. Tune the active tuning unit.

(*b*) The antenna coupling is too tight. Decrease coupling dial D.

(*c*) The band switches, controls G, H, and J, inside the tuning unit are set on different bands. They should all be set on the same band.

(*d*) The PA band switch, control J, is not set squarely on its contact.

(*e*) The PA tank inductor has a shorted turn or the PA band capacitors are open or shorted.

(*f*) The PA blade of the channel switch is making poor contact.

(*g*) The PA tube is gassy.

7-4-9. Antenna Ammeter Does Not Indicate Current, although PA Tuning Is Normal.

(*a*) The antenna circuit is not tuned. Vary the antenna load switch, control E, and the antenna tuning dial F until the PA plate current rises; then retune the PA circuit with the PA tuning dial, control C.

(*b*) Increase the coupling dial D and repeat (*a*) above.

(*c*) Change the setting of the antenna variometer or series capacitor switch, control K, inside the tuning unit, and repeat (*a*) and (*b*) above.

(*d*) The keying relay is making poor contact or the antenna ammeter is open. SHUT DOWN THE DYNAMOTOR. Close the relay by hand. Use an ohmmeter to check the circuit from the antenna buss behind the channel switch (top buss) to the antenna post at the left end of the transmitter.

(*e*) The antenna resistance is abnormally high. This may be caused by poor contact in the antenna circuit external to the transmitter. It may be the result of using an antenna whose electrical or physical length is much longer than specified. This condition may occur, particularly when a trailing wire antenna is used.

(*f*) The antenna loading switch or band switch is making poor contact.

(*g*) The antenna tuning inductor is shorted.

(*h*) If a 9,050–15,800 Kcs tuning unit is used, the antenna ammeter reading may be zero even when the antenna power is considerable. This is a normal condition above 12,000 Kcs due to the high antenna resistance at these frequencies. If the PA plate current is 80 to 120 milliamperes when the PA circuit is tuned to a plate current minimum, disregard the low reading of the antenna ammeter.

7-4-10. Antenna Circuit Voltage Breakdown Occurs at High Altitudes.

(*a*) Do not use a fixed antenna with the 540-1500 Kcs tuning unit. Use a trailing wire antenna.

(*b*) This fault will usually be indicated by a zero indication on the antenna ammeter when the PA plate current gives some indication. A breakdown of the safety gap at the antenna post will usually occur. This gap breakdown may occur in normal operation, particularly at 540 Kcs when using a trailing wire antenna or at 1500 or 3000 Kcs when using a fixed antenna, as the antenna voltage is unusually high at these frequencies. DO NOT REMOVE THIS SAFETY GAP.

(*c*) Breakdown may also occur across the safety gap at the rear of the 3000-9050 Kcs tuning unit. This gap may break down at 5800 to 6200 Kcs. DO NOT REMOVE THIS SAFETY GAP.

(*d*) Decrease the antenna coupling control D.

7-4-11. PA Plate Current Is Excessive with Antenna Lead off.

(*a*) The antenna load switch position is too low for normal operation with the antenna. Increase this switch position and retune the PA until the PA plate current drops down to approximately 30 milliamperes with the antenna off.

(*b*) This fault may occur on the 3000-9050 Kcs tuning unit and possibly on other tuning units as well. It usually occurs at the higher frequency end of a tuning unit when excessive antenna loading inductance is used. In this case, this inductance resonates with the distributed capacitance of the antenna circuit and loads the PA circuit.

7-4-12. Faulty Vacuum Tubes.

Should all indications point to faulty vacuum tube operation, consult Figure 77 for proper vacuum tube voltages and currents.

7-4-13. Typical CW Antenna Power.

Figure 76 shows a typical set of data for CW output over the entire frequency range.

7-4-14. Tuning Idle Channel Antenna Circuit Lowers Antenna Current of an Adjacent Active Channel.

(*a*) This effect may occur when a 1500/3000 Kcs tuning unit is operated in B channel at about 1500 Kcs and a 3000/9050 Kcs tuning unit is operated in C channel at about 9000 Kcs. When the 9000 Kcs tuning unit is active, and the antenna circuit of the idle 1500 Kcs unit is tuned, the 9000 Kcs antenna current will decrease about 20 per cent. This is due to the coupling existing between the 1500 Kcs and the 9000 Kcs antenna circuits, which causes the idle 1500 Kcs antenna circuit to draw power from the active 9000 Kcs antenna circuit.

(*b*) This effect may be remedied by operating the D channel tuning unit on 9000 Kcs and the C channel tuning unit on a lower frequency.

(*c*) If the method (*b*) is not feasible, the following method may be used. Assume that the antenna circuit of the 1500 Kcs tuning unit in channel B is resonant when this unit is active, and its antenna switch, control E, is set at position 2 and that the above undesirable coupling exists. Set this control E on position 1 or 3 and retune the antenna tuning control F for maximum antenna current. When the 1500 Kcs unit is active, note the setting of this control F. Now make the 9000 Kcs unit, channel C, active and resonate its antenna circuit. It will now be found that the 9000 Kcs antenna current may still be varied as the idle 1500 Kcs antenna circuit is tuned. However, this undesirable condition does not exist at the same setting of the 1500 Kcs antenna control F which is required for resonance at 1500 Kcs.

7-5. ORDERING REPLACEMENT PARTS.

Identify the part by the circuit symbol number marked near it on the transmitter or on the wiring diagrams or in this book. Each part is listed by symbol number in a material list at the rear of this book. This list gives complete ordering information for each part. When ordering a replacement part, specify the part as completely as it is listed in the material list if possible. The minimum ordering information should include the symbol number, function, and Bendix drawing number of the part and the Navy type number of the part if this is available. Ordering information should also include the following, relative to the transmitter or other major unit for which the part is desired: Name of unit, such as transmitter, Navy type number, serial number and destination and person to whom replacement part should be shipped.

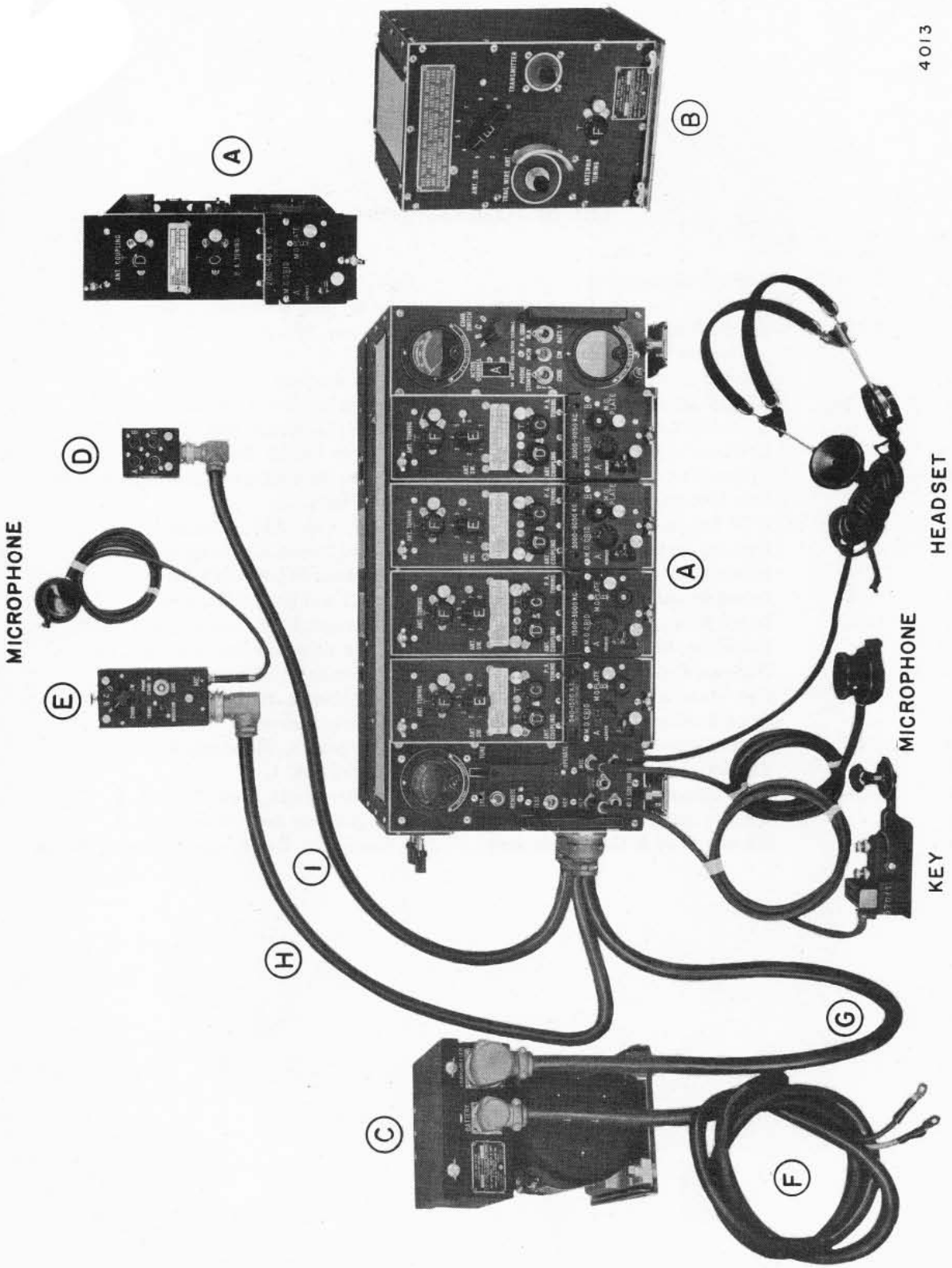
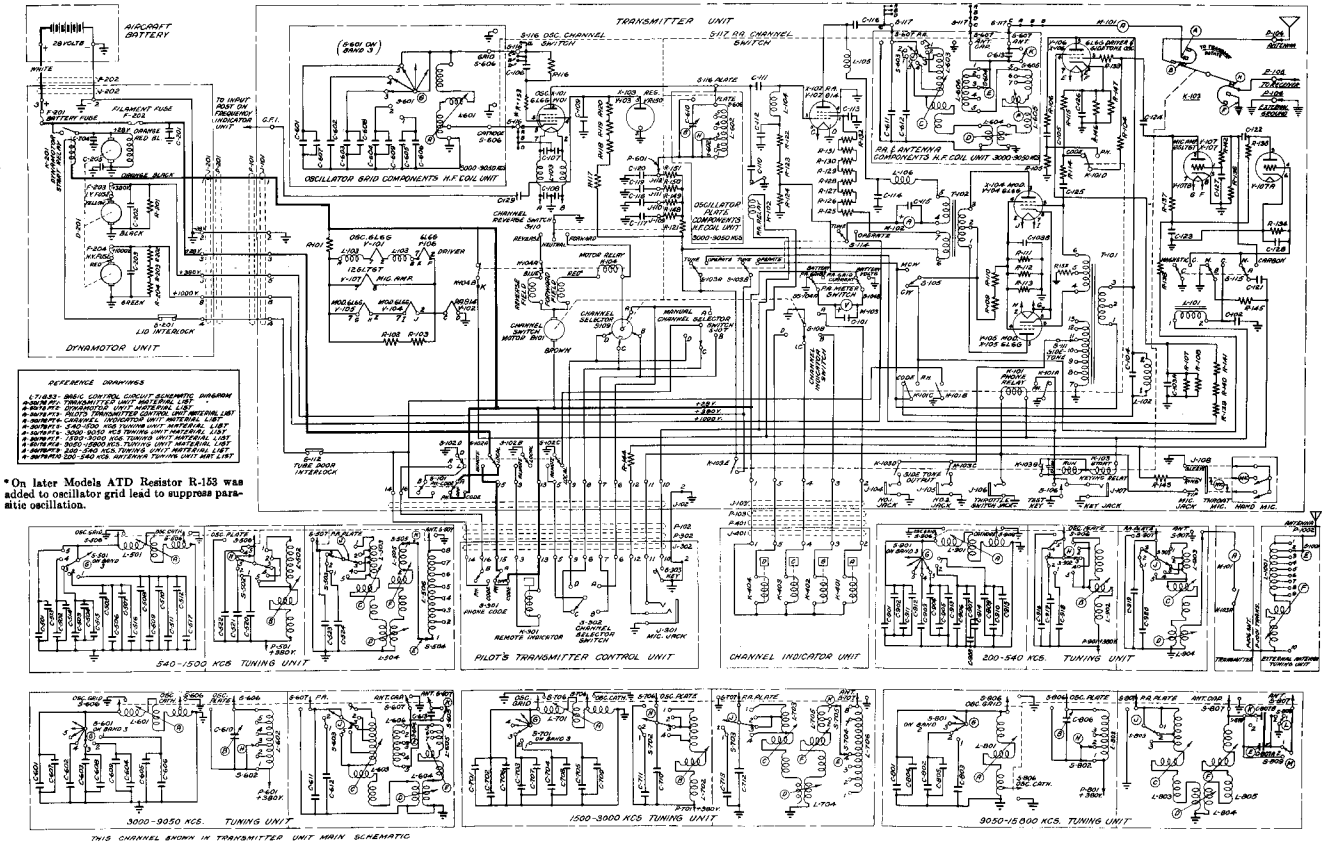


Figure 1. Composite View, Model ATD Aircraft Radio Transmitting Equipment



* On later Models ATD Resistor R-153 was added to oscillator grid lead to suppress parasitic oscillation.

VALUES OF COMPONENTS

Symbol No.		Symbol No.		Symbol No.	
C-101	.01 Mfd	C-707	80 Mmf	L-705	50/23.5 μHy
C-102	25 Mfd	C-708	Same as C-515	L-706	74 μHy
C-103A	.5 Mfd Dual	C-709	Same as C-515	L-801	4.6/2.36 μHy
C-103B	.5 Mfd Unit	C-710	100 Mmf	L-802	2.9 μHy
C-104	.04 Mfd	C-711	Same as C-710	L-803	10/4.2 μHy
C-105	.1/1 Mfd	C-712	100 Mmf	L-804	Pri. 25 μHy
C-106	700 Mmf	C-713	Same as C-712		Sec. .32 μHy
C-107	Same as C-105	C-801	Same as C-802		Mutual .197 μHy
C-108	Same as C-102	C-802	Same as C-802	L-805	5.5/2.5 μHy
C-109	Same as C-101	C-803	Same as C-802	L-901	100/76 μHy
C-110	.003 Mfd	C-804	30 Mmf	L-902	112/48 μHy
C-111	Same as C-110	C-805	Same as C-806	L-903	260/152 μHy
C-112	Same as C-101	C-806	Same as C-610	L-904	Pri. 18 μHy
C-113	Same as C-101	C-807	12/35 Mmf Dual		Sec. 56 μHy
C-114	.003 Mfd	C-807A	12/35 Mmf Unit		Mutual 35 μHy
C-115	Same as C-101	C-807B	18 Mmf	L-1001	2400/1770 μHy
C-116	Same as C-114	C-901	Same as C-501	M-101	0-5A
C-117	Same as C-101	C-902	Same as C-501	M-102	0-300 MA DC
C-118	Same as C-101	C-903	Same as C-501	M-103	0-30V DC
C-119	Same as C-101	C-904	Same as C-501	R-101	.5 ohms
C-120	Same as C-101	C-905	Same as C-502	R-102	4.8 ohms
C-121	Same as C-101	C-906	Same as C-501	R-103	Same as R-102
C-122	Same as C-101	C-907	Same as C-501	R-104	300,000 ohms
C-123	Same as C-105	C-908	1000 Mmf	R-105	2000 ohms
C-124	Same as C-101	C-909	Same as C-501	R-106	60,000 ohms
C-125	Same as C-101	C-910	Same as C-502	R-107	30,000 ohms
C-126	Same as C-102	C-911	Same as C-515	R-108	Same as R-107
C-127	15 Mmf	C-912	Same as C-707	R-109	2500 ohms
C-128	Same as C-106	C-913	Same as C-707	R-110	2500 ohms
C-129	Same as C-101	C-914	Same as C-516	R-111	60,000 ohms
C-130	Same as C-105	C-915	Same as C-517	R-113	60,000 ohms
C-201	Same as C-105	C-916	.0023 Mfd	R-113	60,000 ohms
C-202	2 Mfd	C-917	.058 Mfd	R-114	5000 ohms
C-203	1 Mfd	C-918	.006 Mfd	R-115	100,000 ohms
C-204	Same as C-101	C-919	.001 Mfd	R-116	20,000 ohms
C-205	Same as C-101	C-920	Same as C-919	R-117	Same as R-109
C-501	.001 Mfd	F-201	75A, 125V	R-118	Same as R-109
C-502	500 Mmf	F-202	10A, 28V	R-119	Same as R-109
C-503	Same as C-501	F-203	1A, 250V	R-120	Same as R-109
C-504	Same as C-502	F-204	.5A, 1000V	R-121	1000 ohms
C-505	Same as C-501	H-101	250 Ohms	R-122	5000 ohms
C-506	Same as C-501	K-102	175 ohms	R-123	5000 ohms
C-507	Same as C-502	K-103	Start Coil 7.5 ohms Running Coil 280 ohms	R-124	Same as R-121
C-508	Same as C-501			R-125	750 ohms
C-509	Same as C-501	K-104	3.5 ohms	R-126	750 ohms
C-510	Same as C-501	K-201	160 ohms	R-127	750 ohms
C-511	Same as C-501	K-301	260 ohms	R-128	750 ohms
C-512	Same as C-501	K-401	300 ohms	R-129	750 ohms
C-513	80 Mmf	K-402	Same as K-401	R-130	750 ohms
C-514	80 Mmf	K-403	Same as K-401	R-131	750 ohms
C-515	100 Mmf	K-404	Same as K-401	R-132	750 ohms
C-516	180 Mmf	L-101	.4 Hy	R-133	5000 ohms
C-517	350 Mmf	L-102	.51 Hy	R-134	500,000 ohms
C-518	350 Mmf	L-103	42 μHy	R-135	Same as R-115
C-521	450 Mmf	L-104	2.5 MHy	R-136	Same as R-134
C-522	250 Mmf	L-105	7.1 MHy	R-137	Same as R-115
C-523	450 Mmf	L-106	2.5 MHy	R-138	500,000 ohms
C-524	Same as C-523	L-501	86/40 μHy	R-139	Same as R-122
C-601	200 Mmf	L-502	112/48 μHy	R-140	Same as R-122
C-602	100 Mmf	L-503	190/70 μHy	R-141	Same as R-122
C-603	Same as C-601	L-504	Pri. 3.3 μHy Sec. 17.1 μHy, Mutual 3.7 μHy	R-142	Same as R-116
C-604	400 Mmf	L-505	93/40 μHy	R-143	400 ohms
C-605	Same as C-604	L-506	300 μHy	R-144	400 ohms
C-606	Same as C-501	L-601	9.4/3.8 μHy	R-145	300 ohms
C-607	40 Mmf	L-602	23.2 μHy	R-146	Same as R-121
C-608	10 Mmf	L-603	23.5/10.1 μHy	R-147	Same as R-121
C-609	Same as C-608	L-604	Pri. 1.28 μHy Sec. 2.0 μHy, Mutual .7 μHy	R-148	Same as R-145
C-610	5/52 Mmf	L-605	15/7.0 μHy	R-149	Same as R-145
C-611	25 Mmf	L-606	21.5 μHy	R-150	Same as R-145
C-612	75 Mmf	L-701	17/6.4 μHy	R-151	Same as R-145
C-613	40 Mmf	L-702	54/24 μHy	R-152	300 ohms
C-701	Same as C-501	L-703	61/25 μHy	R-201	100,000 ohms
C-702	250 Mmf	L-704	Pri. 27 μHy Sec. 9.0 μHy, Mutual 2.02 μHy	R-202	Same as R-201
C-703	Same as C-502			R-203	Same as R-201
C-704	Same as C-501			R-204	Same as R-201
C-705	Same as C-501				
C-706	Same as C-515				

On all ATD Transmitters between serial numbers 507 to 1351 and 1629 to 3039 capacitor C128 connection was changed from Choke L108 to screen of Oscillator V101.

Figure 29. Schematic Diagram, Model ATD Aircraft Radio Transmitting Unit