T.O 12R2-2ART13-2

HANDBOOK

MAINTENANCE INSTRUCTIONS

RADIO TRANSMITTING SET AN/ART-13A

THIS PUBLICATION REPLACES T.O. 12R2-2ART13-2 (FORMERLY 16-30ART13-4) DATED 8 MARCH 1949

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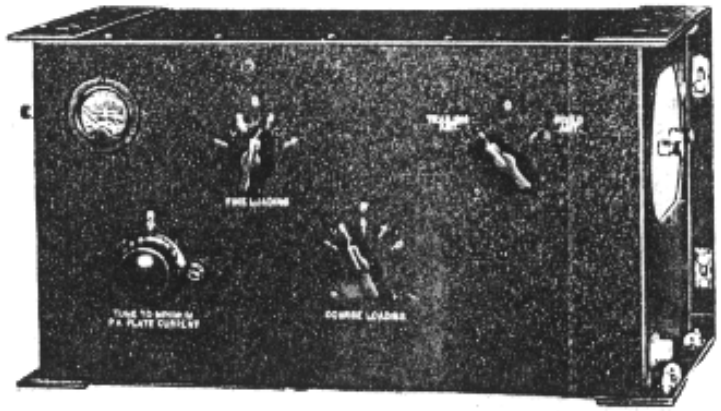

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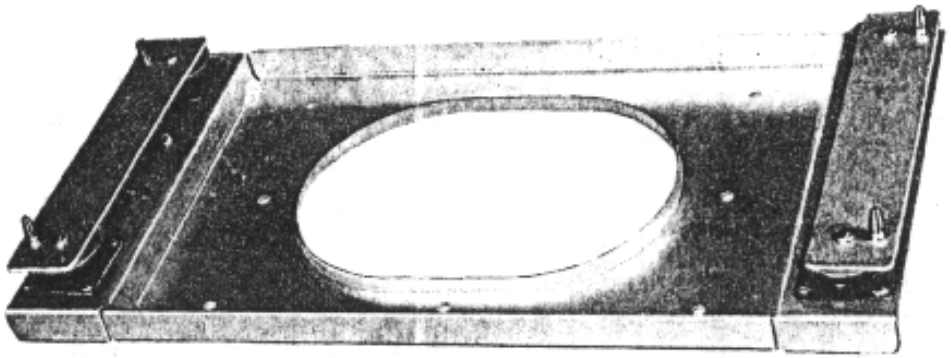

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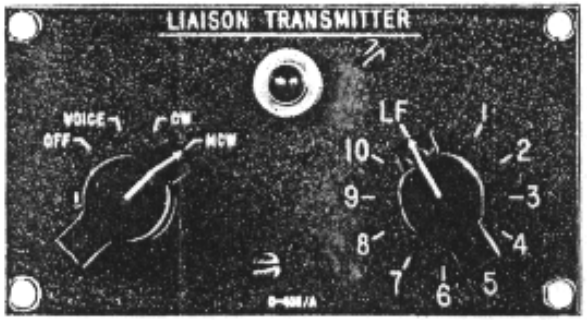

CONTROL PANEL C-405/A

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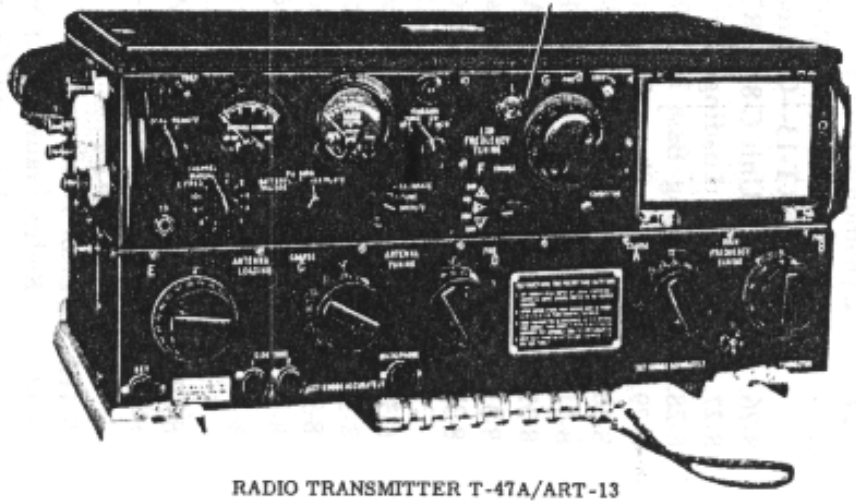
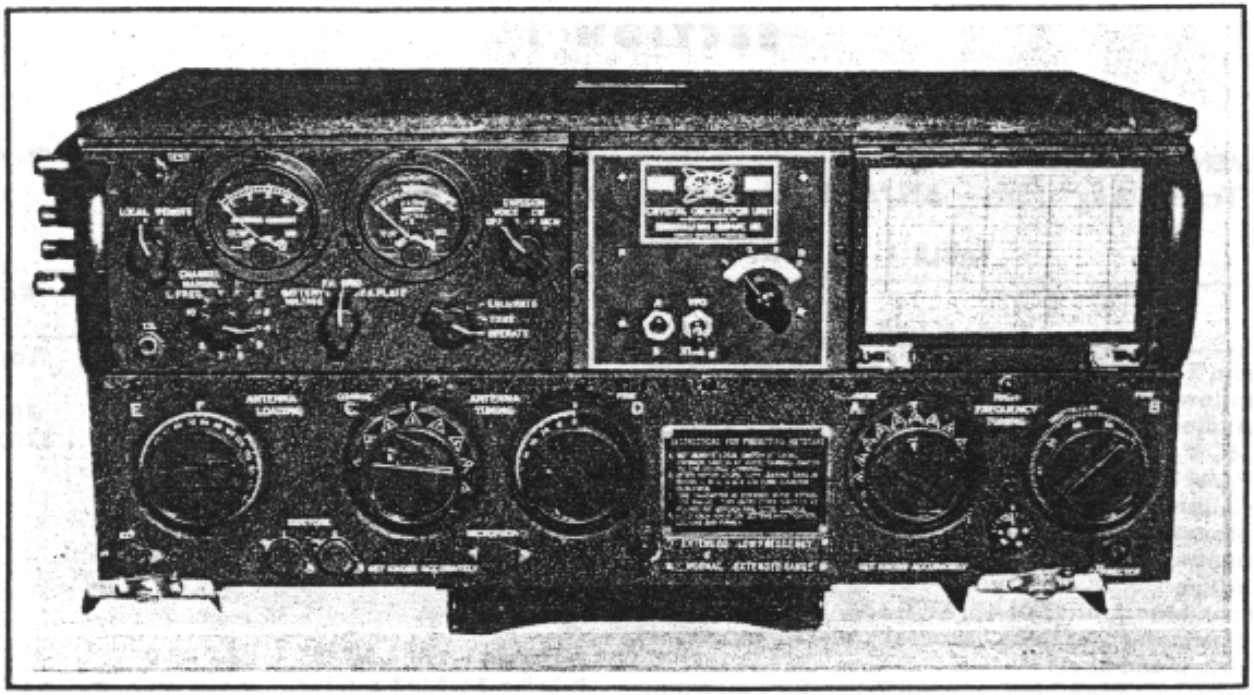


RADIO TRANSMITTER T-47A/ART-13
WITH
MOUNTING PLATE MT-283/ART-13

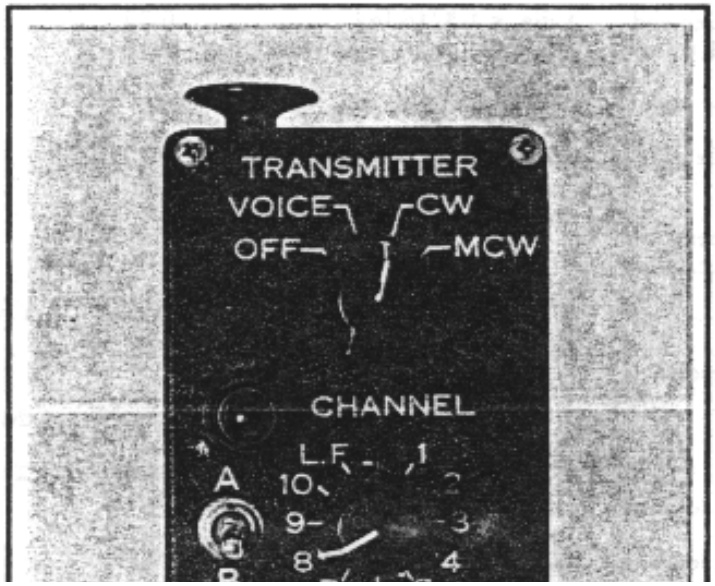
DYNAMOTOR UNIT DY-17/ART-13A
WITH
MOUNTING PLATE MT-164/ART-13

CONTROL UNIT C-87/ART-13
WITH
MOUNTING PLATE MT-163/ART-13

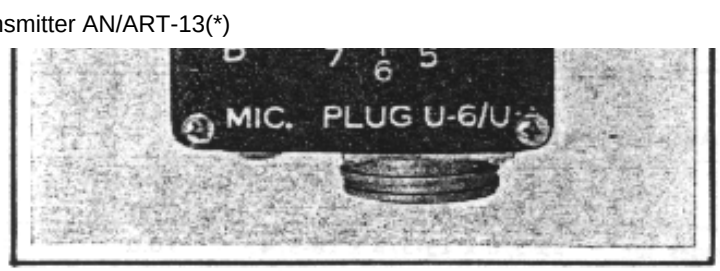
Figure 1-1. Radio Transmitting Set, AN/ART-13A -- Major Assemblies



RADIO TRANSMITTER T-412/ART-13B



NOTE: All components shown in Fig. 1-1 will apply to Radio Transmitting Set AN/ART-13B except the trans-



* CONTROL UNIT C-87/ART-13 (Modified)

mitter and control unit which are illustrated on this page.

Figure 1-1A. Radio Transmitting Set, AN/ART-13B -- Major Assemblies

SECTION I GENERAL DESCRIPTION

1. EQUIPMENT SUPPLIED.

Radio Transmitting Sets AN/ART-13A and AN/ART-13B, covered by these instructions, consist of units as listed in tables 1-1 and 1-1A.

TABLE 1-1. AN/ART-13A -- EQUIPMENT SUPPLIED

Quantity	Name of Unit	Overall Dimensions (Inches)	Weight (Pounds)	Reference Symbols
1	Radio Transmitter T-47A/ART-13 which includes the following items as issued:	23-5/8 x 13-5/8 x 10-3/4	70.0	101 to 199
	Audio Amplifier Unit			201 to 299
	MCW-CFI Unit			2201 to 2299
	Panel MX- 128/ART- 13			
	Calibration Book			
	Mounting Plate MT-283/ART-13			
1	Mounting Base MT-284/ART-13 for mounting transmitter	20-1/2 x 14-3/4 x 2-1/2	2.94	
1	Dynamotor Unit DY-I7/ART-I3A which includes dynamotor machine, control relays, barometric switch and filters	7-1/8 x 11-7/8 x 8-7/8	28.0	2701 to 2799
1	Mounting Plate MT-164/ART-13 for mounting dynamotor unit	7-1/8 x 11-5/32 x 1-1/4	1.13	
1	Control Unit C-87/ART-13	3-1/2 x 6-5/32 x 3-1/4	1.44	601 to 699

1	Mounting Plate MT-163/ART-13 for mounting control unit	3-5/8 x 5-1/4 x 1/4	0.11	
1	Control Panel C-405/A	2-1/2 x 5 x 2-5/8	Approx. 1.5	
1	Plug U-6/U female cable plug for remote control box, remote control end	1-5/8 dia. x 2-5/32 lng.	0.20	
1	Plug U-7/U female power cable plug, transmitter end	2 dia. x 2-5/16 lng.	0.25	
1	Plug U-8/U, male cable plug for remote control, trans mitter end	1-3/4 dia. x 1-31/32 lng.	0.19	
1	Plug U-9/U male power cable plug, dynamotor end	2-1/8 dia. x 1-7/8 lng. X 2-3/4 wide		
1	Plug U-10/U female primary power input cable plug, dynamotor end	1-5/6 dia. x 1-7/8 lng. X 1-7/8 wide		
1	Handbook of Operating Instructions	8-1/2 x 11		
	The following two items are required when operation is desired between 2000 Kc. and 3000 Kc. with fixed antennas less than 55 ft.			
1	Antenna Shunt Capacitor CU-24/ART-13	5 x 4-1/8 x 4	1.59	1101 to 1199
1	Switch SA-46/ART-13A	6-I/4 x 2 x 4		
	The following items are required when operation is desired in the range of 200 Kc. to 600 Kc.			
1	Oscillator O-17/ART-13A			2601 to 2699
1	Mounting Base MT-198/ART-13A	22-1/2 x 10-11/16 x 2		
1	Antenna Loading Unit CU-32/ART-13A	23-1/2 x 13 x 12	24.75	2501 to 2599
1	Plug U-11/U, male cable plug for antenna loading unit, transmitter end	1-1/8 dia. x 1-29/32 lng.	0.12	
1	Plug U-12/U, female cable plug for antenna loading unit, load unit end	1-1/8 dia. x 2 x 1-15/32	0.12	

TABLE 1-1A. AN/ART-13B -- EQUIPMENT SUPPLIED

Quantity	Name of Unit	Overall Dimensions (Inches)	Weight (Pounds)	Reference Symbols
1	Radio Transmitter T-412/ART-13B which includes the following items as issued:	23-5/8 x 13-5/8 x 10-3/4	70.0	101 to 199
	Audio Amplifier Unit			201 to 299
	MCW-CFI Unit			2201 to 2299
	Panel MX- 128/ART- 13			
	Calibration Book			
	Mounting Plate MT-283/ART-13			
1	Mounting Base MT-284/ART-13 for mounting transmitter	20-1/2 x 14-3/4 x 2-1/2	2.94	
1	Dynamotor Unit DY-I7/ART-I3A which includes dynamotor machine, control relays, barometric switch and filters	7-1/8 x 11-7/8 x 8-7/8	28.0	2701 to 2799
1	Mounting Plate MT-164/ART-13 for mounting dynamotor unit	7-1/8 x 11-5/32 x 1-1/4	1.13	
1	Control Unit C-87/ART-13 (modified)	3-1/2 x 6-5/32 x 3-1/4	1.44	601 to 699
1	Mounting Plate MT-163/ART-13 for mounting control unit	3-5/8 x 5-1/4 x 1/4	0.11	
1	Control Panel C-405/A	2-1/2 x 5 x 2-5/8	Approx. 1.5	
1	Plug U-6/U female cable plug for remote control box, remote control end	1-5/8 dia. x 2-5/32 lng.	0.20	
1	Plug U-7/U female power cable plug, transmitter end	2 dia. x 2-5/16 lng.	0.25	
1	Plug U-8/U, male cable plug for remote control, transmitter end	1-3/4 dia. x 1-31/32 lng.	0.19	

1	Plug U-9/U male power cable plug, dynamotor end	2-1/8 dia. x 1-7/8 lng. X 2-3/4 wide		
1	Plug U-10/U female primary power input cable plug, dynamotor end	1-5/6 dia. x 1-7/8 lng. X 1-7/8 wide		
1	Handbook of Operating Instructions	8-1/2 x 11		
	The following two items are required when operation is desired between 1670 Kc. and 3000 Kc. with fixed antennas less than 55 ft.			
1	Antenna Shunt Capacitor CU-24/ART-13	5 x 4-1/8 x 4	1.59	1101 to 1199
1	Switch SA-46/ART-13A	6-I/4 x 2 x 4		
1	Crystal Control Unit CDA-T	-3/8 x 9-1/2 x 6-1/2	3.88	801-899
	The following items are required when operation is desired in the range of 300 Kc. to 500 Kc.			
1	Mounting Base MT-198/ART-13A	22-1/2 x 10-11/16 x 2		
1	Antenna Loading Unit CU-32/ART-13A	23-1/2 x 13 x 12	24.75	2501 to 2599
1	Plug U-11/U, male cable plug for antenna loading unit, transmitter end	1-1/8 dia. x 1-29/32 lng.	0.12	
1	Plug U-12/U, female cable plug for antenna loading unit, load unit end	1-1/8 dia. x 2 x 1-15/32	0.12	

2. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

Items listed in table 1-2 are used to complete an installation but are not supplied with the equipment.

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

Quantity	*Name of Unit*	*Required Characteristics*
1	Microphone T-17 or T-30. (Microphone T-30 requires cord CD-318 or CD-508)	Carbon microphone with 40 to 100 ohms internal impedance
1	Key J-37	
1	Headset HS-33 or HS-38	300 ohm impedance

1	Antenna Equipment AN/ARA-4 or Antenna Assembly AS-315/A	Fixed and trailing wire type antennas
1	All Cables and Wiring	Open wiring. See fig. 8-43 all cable and wiring requirements
*20	Quartz Crystal Units	Type CR-7
*2	Quartz Crystal Units	Western Electric Type 5A
*1	Quartz Crystal Unit, dual type	Western Electric Type 5D

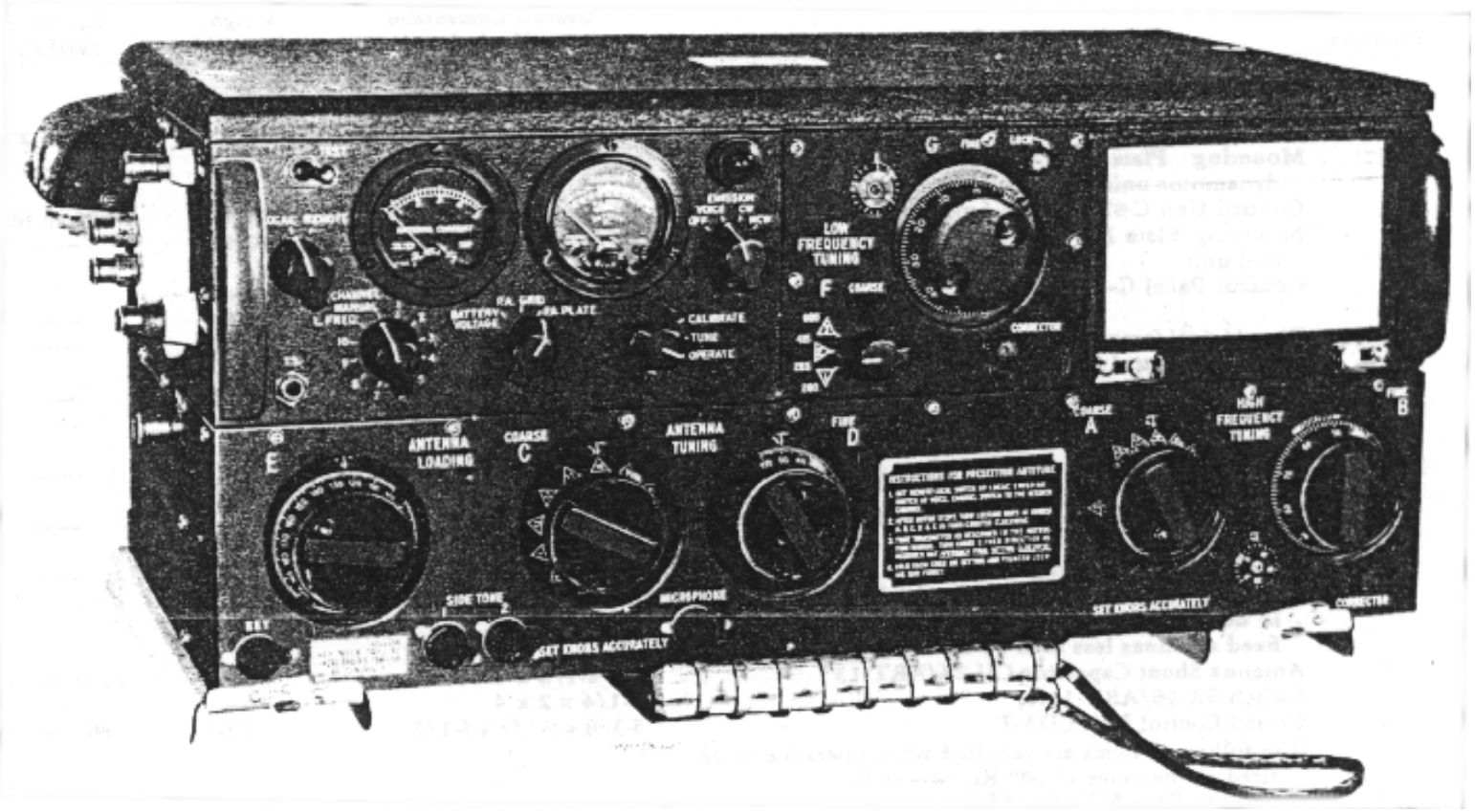


Figure 1-2. Radio Transmitter, T-47A/ART-13

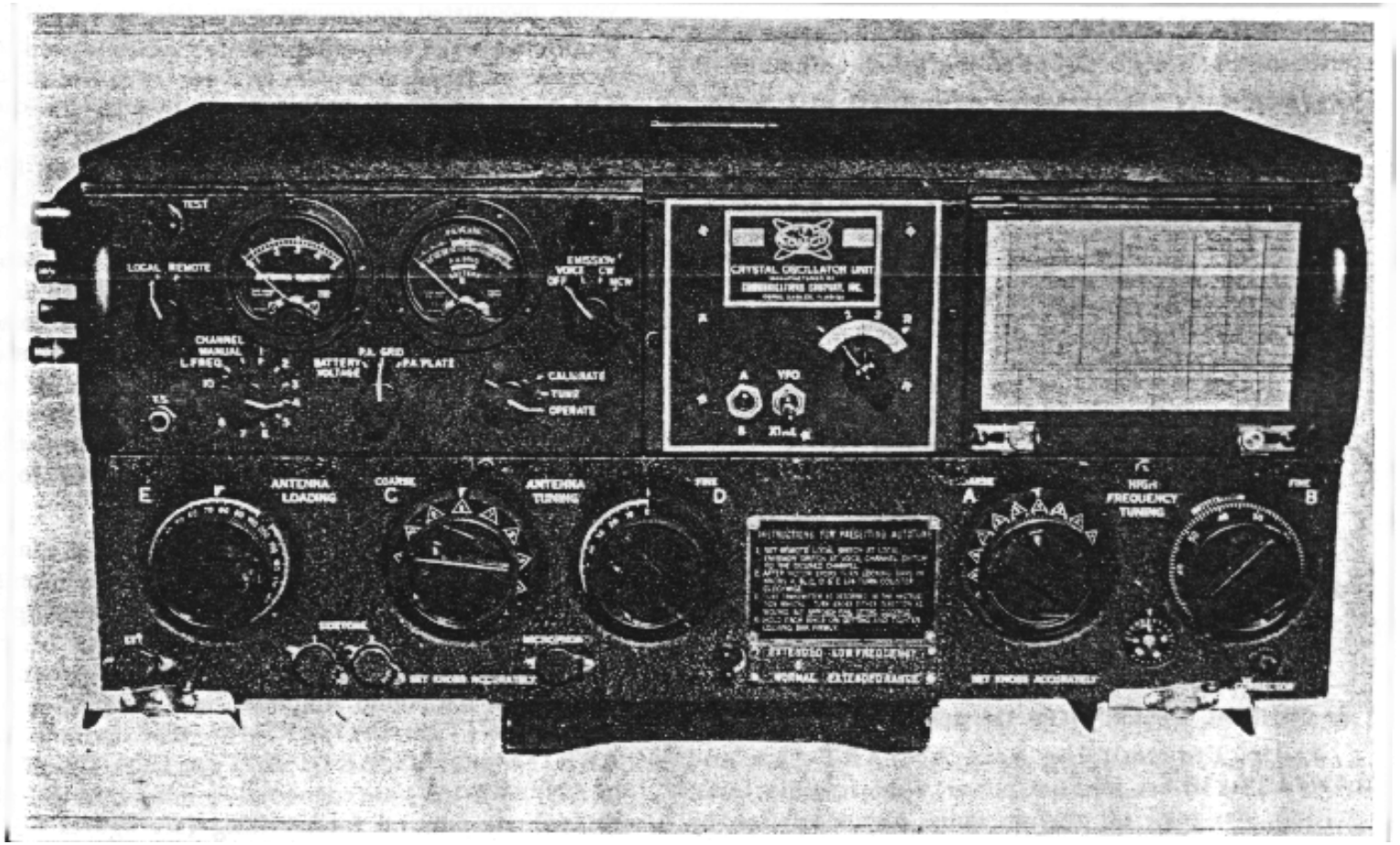


Figure 1-2A. Radio Transmitter, T-412/ART-13B

3. GENERAL DESCRIPTION OF EQUIPMENT.

Radio Transmitting Sets ANttART-13A and AN/ART-13B are medium power, aircraft radio transmitters, designed to provide radio communication by voice, modulated continuous wave telegraphy (MCW), or continuous wave telegraphy (CW). Either a carbon or dynamic microphone may be used for voice emission. The audio system is capable of modulating the carrier (100 watts nominal) at least 90 percent for MCW or Voice emission. When operating with CW or MCW emission, entirely satisfactory performance will be obtained .for keying speeds up to 30 words per minute. Transmission frequencies differ between the Models AN/ART-13A and. AN/ART-13B as outlined in the following paragraphs. Shifting from one transmission to another can be accomplished by the conventional method of 'hand-positioning' the controls or by using the built-in automatic shifting mechanism known as the "Autotune". This automatic mechanism is also utilized to provide remote control of functions required to shift transmission frequency.

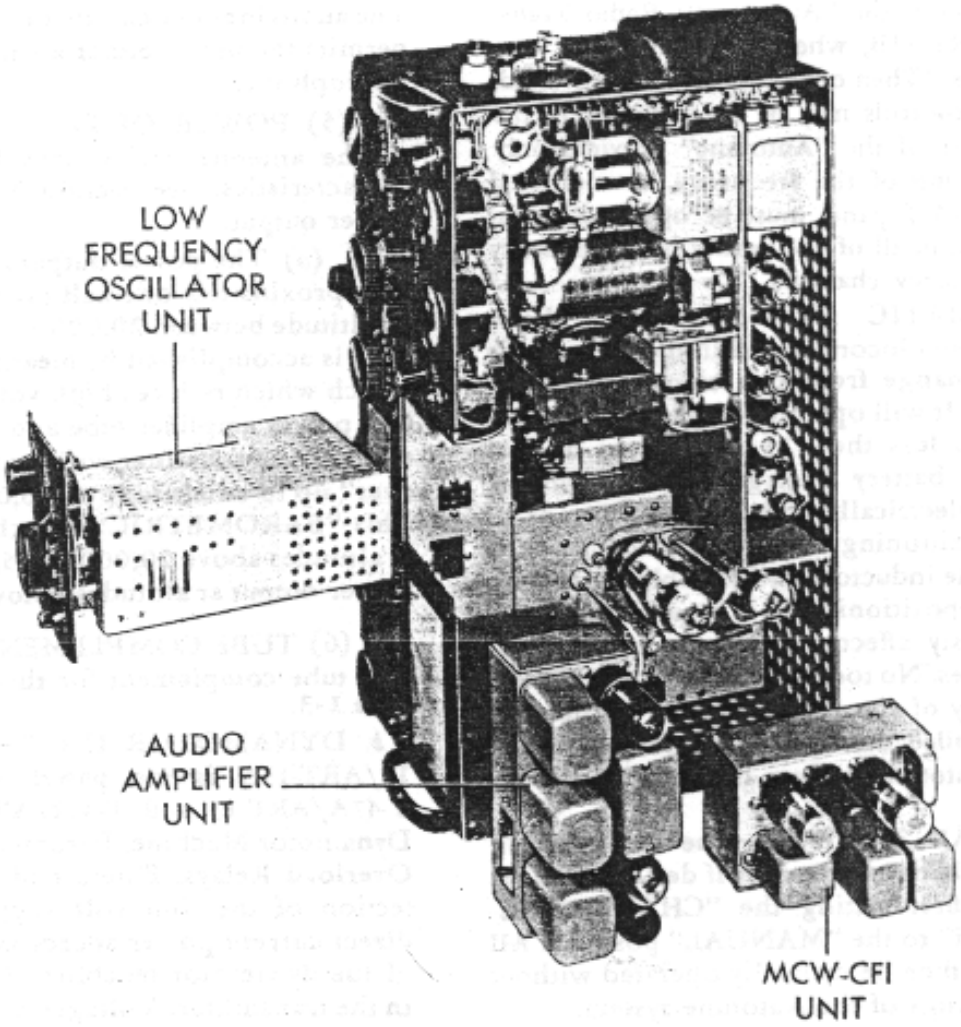


Figure 1-3. Radio Transmitter, T-47A/ART-13 -- Units Removed

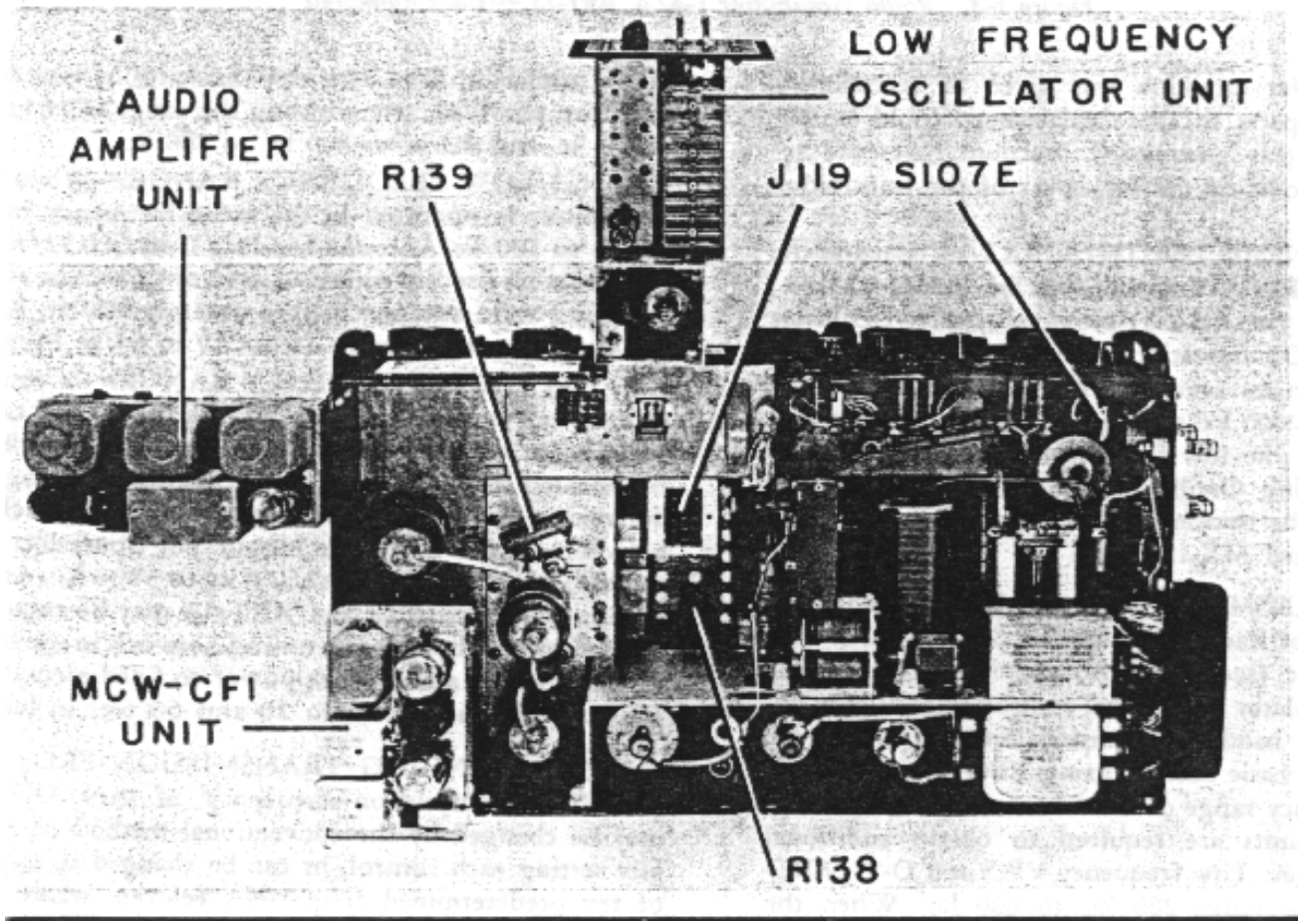


Figure 1-3A. Radio Transmitter, T-412/ART-13B and Removable Units

a. TRANSMITTERS.---Sub-assembly type of construction has been used extensively in Radio Transmitters T47A/ART-13 and T-412/ART-13B. This type of construction greatly simplifies the removal of component parts without major disassembly of the unit. The MCW-CFI, the Audio Amplifier, and the plug-in oscillator units (Type O-17/ART-13A used in both AN/ART-13A and AN/ART-13B; Type CDA-T used only in AN/ART-13B) are connected by multi-terminal plugs to facilitate removal for servicing (see figures 1-3 and 1-3A). Particular attention was given to accessibility of component parts so that replacement could be accomplished quickly and easily. Vacuum tubes are accessible by removal of the top cover of the transmitter case.

(1) TRANSMITTER T-47A/ART-13. Used as the basic unit of Radio Transmitting Set AN/ART-13A, this transmitter (see fig. 1-2) provides variable frequency oscillator (VFO) operation with two bands of transmission frequencies available. Normal frequency range of this unit is 2000 kc. through 18,100 kc. Output may be obtained in the low frequency range of 200 kc. to 600 kc. by using Oscillator O-17/ART-13A which is not a part of the transmitter but may be installed upon removal of Panel MX-128/ART-13.

(2) TRANSMITTER T-412/ART-13B.--Used as the basic unit of Radio Transmitting Set AN/ART-13B, this transmitter (see fig. 1-2A) provides both variable frequency oscillator and crystal-controlled oscillator operation. Four bands of transmission frequencies are available. The basic unit, utilizing VFO operation, covers the frequency range of 2000 kc. to 18,100 kc. Plug-in oscillator units are required to obtain additional frequency ranges. Low frequency VFO unit O-17/ART13A covers the range 200 kc. to 600 kc. When the CDA-T unit is utilized, two crystal-controlled frequency bands are provided, one covering the range 1670kc. to 18,000 kc. and the other 300 kc. to 500 kc.

(a) LOW FREQUENCY RANGE.--When the transmitter is operated in the radio frequency range 300 kc to 500 kc, Antenna Loading Unit CU-32/ART-13A must be used to tune and deliver power to either a trailing wire antenna (approximately 200 ft. long) or a fixed aircraft antenna (from 17 to 65 ft. long).

(b) HIGH FREQUENCY RANGE.--When the transmitter is operated in the radio frequency range 1670 kc to 18,100 kc the antenna tuning network, incorporated in the transmitter, is capable of tuning and. delivering power into fixed aircraft antennas which are between 17 and 65 feet in length. For operation over the radio-frequency range 1670 kc to 5000 kc, Antenna Shunt Capacitor CU-24/ART-13 may be required, in addition to the antenna tuning network in the transmitter, to tune and deliver power to

fixed aircraft antennas which are between 20 and 60 feet in length.

(3). CHANGING TRANSMISSION FREQUENCY.--The transmission frequency of AN/ART-13A may be changed by the conventional method of manually setting each control, or can be changed to any one of ten predetermined frequencies (eleven, when using the O-17/ART-13A unit) by means of the automatic tuning system known as the "Autotune". Radio Transmitting Set AN/ART-13B, when operating VFO, uses the above procedures. When operating crystal-controlled, the AN/ART-13B controls may be manually set in the usual manner but use of the "Autotune" provides only semi-automatic shifting of the frequency, as additional switches on the CDA-T panel must be operated manually to obtain output in all of the twenty high frequency and four low frequency channels.

(a) AUTOMATIC TUNING.--The "Autotune" system has been incorporated in the transmitter to permit rapid change from one transmission frequency to another. It will operate to change frequency of transmission in less than 25 seconds at normal temperatures and battery voltage. This automatic tuning system is electrically controlled by means of mechanically repositioning adjustable elements such as switches, variable inductors and variable capacitors. The accuracy of repositioning is of a very high order and is not seriously affected by wear, humidity or temperature changes. No tools are necessary to change the settings for any of the predetermined transmission frequencies. A detailed description of construction and operation of the Autotune is given in Section IV of this manual.

(b) MANUAL TUNING.--The transmission frequency may be changed manually if desired. This is accomplished by first setting the "CHANNEL SELECTOR SWITCH" to the "MANUAL" position. All control knobs can then be manually operated without disturbing the settings of the Autotune system.

(4) AUDIO INPUT FOR VOICE EMISSION.-The audio input circuit incorporated in this equipment permits the use of either a carbon or dynamic type of microphone.

(5) POWER OUTPUT.--The power delivered to the antenna varies with frequency and antenna characteristics. See section VI for typical values of power output.

(a) The power output is automatically reduced to approximately one-half the full power output when an altitude between 20,000 and 25,000 feet is reached. This is accomplished by means of a pressure-operated switch which reduces high voltage on the plate of the 813 power amplifier tube and the two 811 modulator tubes. The transmitter will then operate without "flashover" up to an altitude of 40,000 feet above sea level. This "BAROMETRIC" switch reduces power output at altitudes above 20,000 to 25,000 ft. and permits full power output at altitudes below this value.

(6) TUBE COMPLEMENT.--The complete vacuum tube complement for this equipment is given in table 1-3.

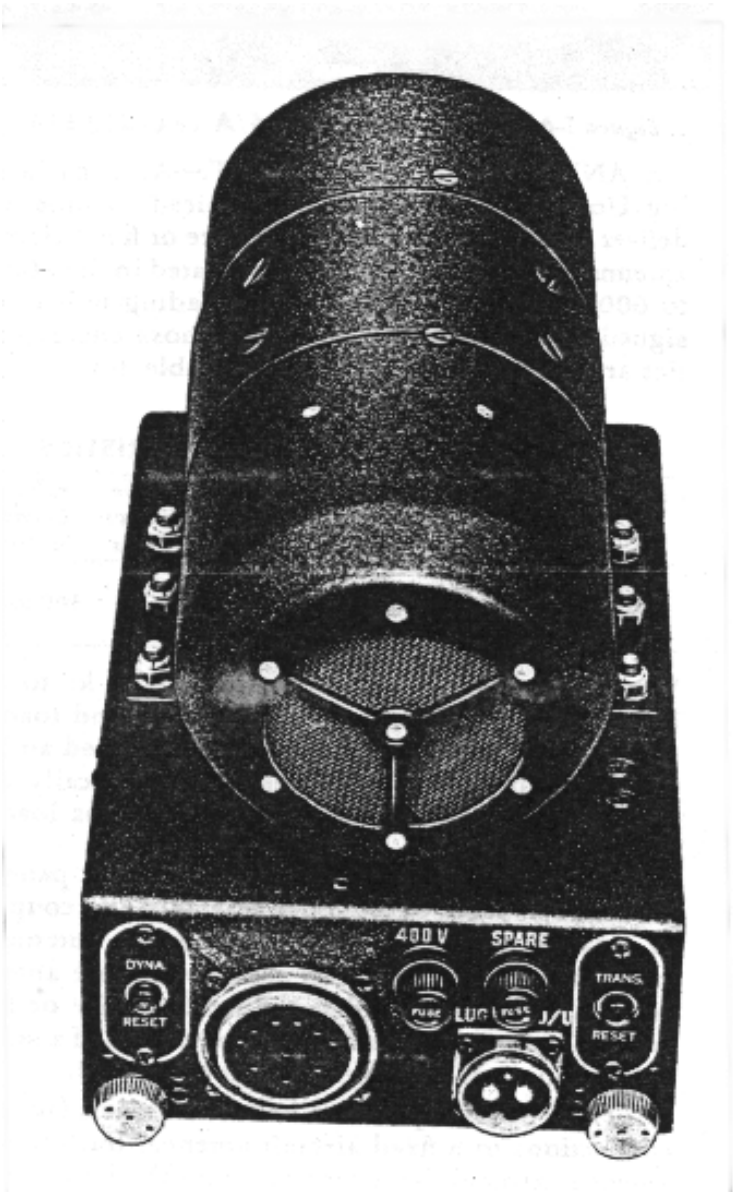


Figure 1-4. Dynamotor Unit DY-17/ART-13A

b. DYNAMOTOR UNIT.--Dynamotor Unit DY17/ART-13A is the power source for Transmitters T-47A/ART-13 and T-412/ART-13B. It contains the Dynamotor Machine, Barometric Switch, Control and Overload Relays, Filters and Fuse for overload protection of the 400 volt supply circuits. A 28 volt direct current power source Is required for operation of the dynamotor machine as well as for the circuits in the transmitter. Voltages as low as 24 volts d-c may be used but reduction in power output and increased time required for Autotune operation will result.

(1) The dynamotor machine employs an armature With dual windings and two commutators to give output voltages of 400 and 750 volts d-c. A barometric switch incorporated in the dynamotor unit chassis connects the two windings of the dynamotor in series at altitudes below 20,000 to 25,000 feet. At higher altitudes the series connection is broken. This arrangement provides either 1150 or 750 volts for the high voltage supply circuits of the transmitter, the voltage being automatically reduced from 1150 to 750 when equipment is operated at a high altitude.

TABLE 1-4. POWER INPUT REQUIREMENTS

Type of Emission Used	Frequency	Power Input (Watts)	
		Full Power	Reduced Power
CW	3.0 Mc.	780	700
CW (Stand By)	3.0 Mc.	560	560
MCW	3.0 Mc.	925	760
MCW (Stand By)	3.0 Mc.	560	560
Voice (90% Mod.)	3.0 Mc.	925	760
Voice (Stand By)	3.0 Mc.	250	250

(2) Table 1-4 shows typical power input requirements for a supply voltage of 28 volts d-c. Data is shown for different types of emission and for full or reduced power INPUT (reduced power INPUT being obtained by operation of barometric switch at altitudes above 20,000 to 25,000 feet). All measurements made with power amplifier loaded to rated P.A. plate current.

Figure 1-5. Control Unit C-87/ART-13

c. CONTROL UNITS.--Control Unit C-87/ART-13 (see fig. 1-5) used with Radio Transmitting Set AN/ART-13A and a modified version of this unit (see fig. 1-1A) used with Radio Transmitting Set AN/ART-13B, provide a means of operating the transmitter from a remote position. These two controls differ only by the addition of a toggle switch in the modified version, One knob on each unit permits the power supply to be turned on and off, and selects the type of emission (CW, MCW or VOICE). A second knob operates the Autotune and permits selection of any one of eleven preset frequency channels. The control unit used with AN/ART-13B utilizes a toggle switch which allows selection of two frequencies for each of the ten high frequency channels of the Autotune system, provided the remote transmitter is using crystal controlled operation.
(1) The pilot lamp on the control unit will operate when the emission selector switch is in any position other than the "OFF" position (providing Autotune System is at rest). The pilot lamp will light only when the remote position is in control. The pilot lamp on the transmitter performs the same function when the transmitter controls are being used. If Autotune is in process of changing the transmission frequency, the pilot lamp will remain off until the Autotune cycle is conpleted. Thus, the pilot lamp serves a dual purpose by indicating that the power supply has been connected to the equipment and to let the operator know when the Autotune has completed the change from one transmission frequency to another so that the carrier is again ready to be keyed or voice modulated.
(2) Both control units mount a key, used for keying the transmitter on "CW" or "MCW" and a jack for connection of a microphone for "VOICE" operation.

Figure 1-6. Control Panel C-405/A or C-405A/A

d. CONTROL PANEL--For installations having standardized control panels, Control Panel C-405/A replaces and performs all the functions (except key) of Control Unit C-87/ART-13. See figure 1-6.

Note

Control Panel C-405A/A may be supplied instead of C-405/A. Control Panel C-405A/A differs from the C-405/A model in that it has an edge-lighted lucite panel and two lamps. It is mechanically and electrically interchangeable with the C-405/A except that it has an additional wire to bring power to the lamps.

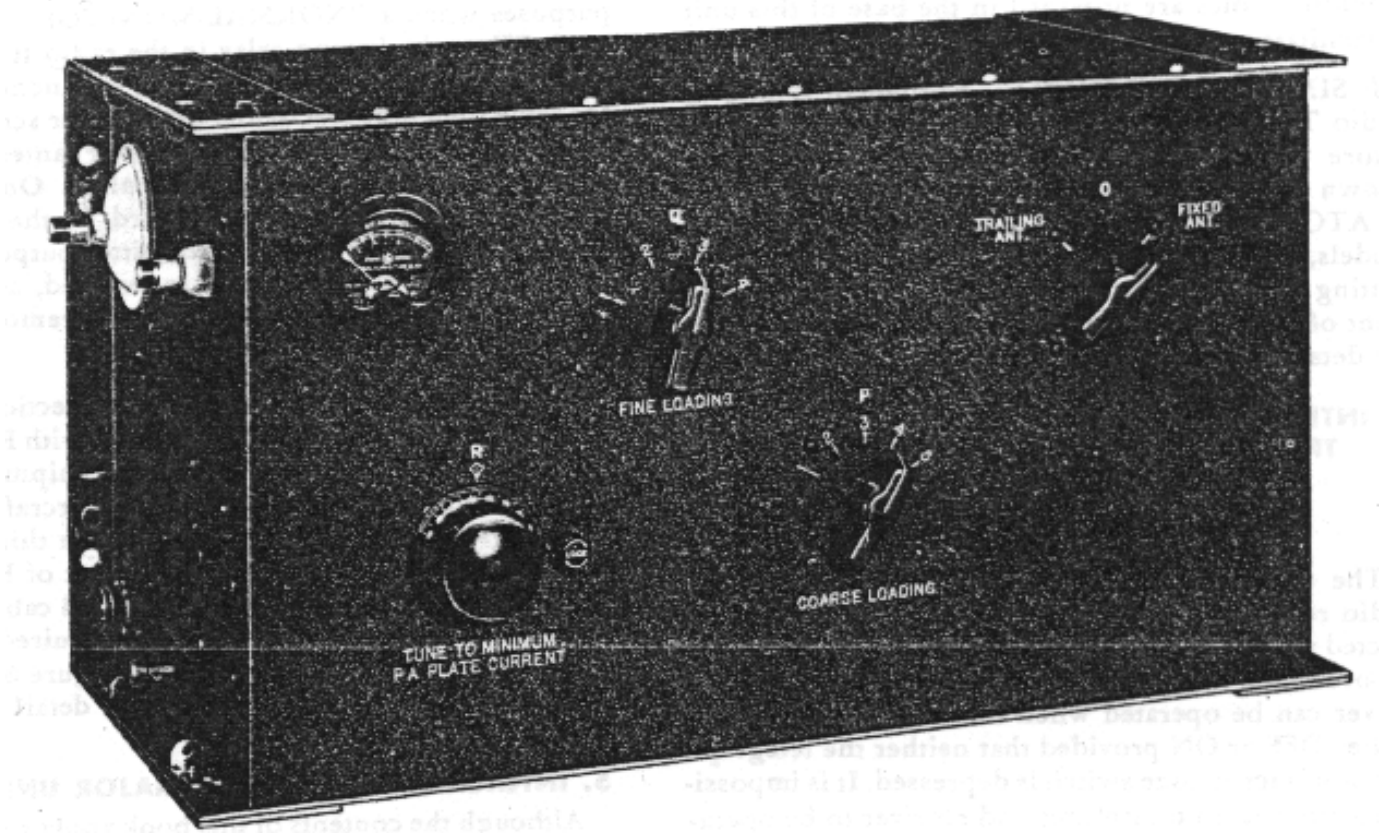


Figure 1-7. Antenna Loading Unit CU-32/ART-13A -- Front View

e. ANTENNA LOADING UNIT.--Antenna Loading Unit CU-32/ART-13A is required to tune and deliver power to either a trailing wire or fixed aircraft antenna when the transmitter is operated in the 200 kc to 600 kc frequency range. This loading unit is designed to accommodate antennas whose characteristics are within the range shown in table 1-5.

TABLE 1-5. REQUIRED ANTENNA CHARACTERISTICS

Freq. In KC.	Effective Resistance In Ohms	Effective Capacity In Mmfd.
200 to 600	3 to 10	85 to 175
200 to 600	3 to 15	300 to 450

When transmission frequencies in the 200 kc to 600 kc range are selected, the antenna tuning and loading circuits, built into the transmitter, are not used and the output of the power amplifier is automatically connected to the loading circuits in the antenna loading unit.
(1) Controls are provided on the front panel to permit adjustment of inductive reactance and coupling in order to tune and deliver power to the antenna. A radio frequency ammeter is used to indicate antenna current. Selection of either the trailing wire or fixed aircraft antenna is accomplished by means of a switch located on the front panel of the loading coil.
(2)Terminal posts on both side panels facilitate connections to a fixed aircraft antenna, trailing wire antenna, ground (structure of aircraft), the high frequency antenna terminal of the transmitter, the low frequency terminal of the transmitter, and to a 28 volt supply source which is controlled by the output circuit selecting relay (K105) in the

transmitter. The 28 volt d-c source, is "keyed" by microphone or telegraph key and actuates a relay in the loading unit. This relay either connects the aircraft antenna to the high frequency antenna terminal of the transmitter or connects aircraft antenna to the circuits of the loading unit. Thus, automatic selection of the correct antenna tuning and loading system is accomplished for either high or low frequency operation when the transmitter controls .are being set to the desired transmission frequency.
(3) When both the trailing wire antenna and the fixed antenna are connected to the loading unit, only one or the other is actually in use for any transmission frequency. The idle antenna is, at all times, automatically connected to a terminal post on the exterior of the unit. This terminal (labeled "PLUG PL-259") may be connected to a disassociated receiver.
(4) A mounting plate, type Mounting Base MT-198/ART-13A, is supplied for mounting the antenna loading unit to the aircraft structure.

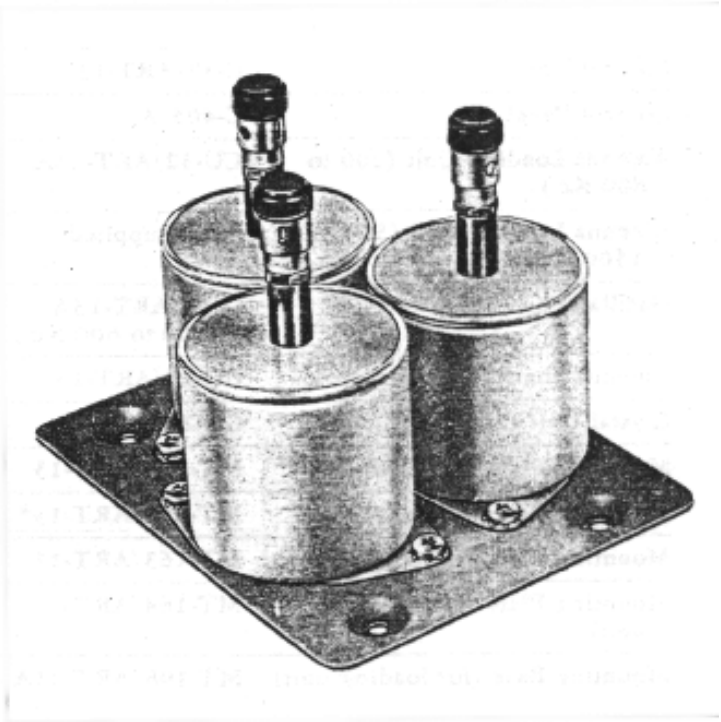


Figure 1-8. Antenna Shunt Capacitor CU-24/ART-13

f. ANTENNA SHUNT CAPACITOR.--Antenna Shunt Capacitor CU-24/ART-13 is supplied for use with the transmitter. It is used whenever required (see section II, paragraph 6b(2)(jj), to properly tune and deliver power to fixed aircraft antennas (20 to 60 feet long) operating in 2000 kc to 3000 kc range of transmission frequencies. The shunt capacitor unit consists of three individual 25 micromicrofarad capacitors, mounted on a plate which serves as a common connection to one terminal of each unit. The terminal at the top of each capacitor may be connected individually or collectively to the antenna system, thus providing capacitance values of 25, 50, or 75 micromicrofarads. Mounting holes are provided in the base of this unit to facilitate attachment to the aircraft structure.
g. SIMILAR EQUIPMENT.--Equipment similar to Radio Transmitting Set AN/ART-13 was purchased before procurement of the latter. This equipment, known as Radio Transmitting Set AN/ART-13, ATC, or ATC-1 Aircraft Radio Transmitter in its various models, is substantially the same as Radio Transmitting Set AN/ART-13A, especially after accomplishment of Technical Order modifications. See table 1-6 for details.

4. INTERCONNECTION OF RADIO TRANSMITTING SET AN/ART-13A WITH RADIO RECEIVING SET AN/ARR-11 TO FORM COMPLETE RADIO SET AN/ARC-8.

The complete Radio Set AN/ARC-8 includes the radio receiver. The receiving equipment is interconnected with the transmitting equipment so that they are coordinated for "break-in" operation. The radio receiver can be operated when the radio transmitter is either OFF or ON provided that neither the telegraph key nor microphone switch is depressed. It is impossible for the radio transmitter and receiver to be operative at the same time except for receiver calibration purposes when a "NORMAL-MONITOR" switch is used. When the keying relay in the radio transmitter is actuated, it causes the transmitter to function and at the same time it open-circuits that receiver screen voltage supply, disconnects the receiver antenna, and grounds the receiver antenna terminal. Only transmitter sidetone will then be heard in the headset. When keying relay opens, transmitter output ceases, receiver screen voltage supply is restored, antenna is reconnected and ground connection is removed. The receiver is then ready for operation.
Figure 8-43 illustrates the interconnection of the Radio Transmitting Set AN/ART-13A with Radio Receiving Set AN/ARR-11, Antenna Equipment AN/ARA-4, and terminal

panel for the Aircraft's Interphone system. The equipment shown in this illustration constitutes the complete equipment of Radio Set AN/ARC-8. A detailed description of all cables (wire sizes and points of connection) and required plugs is given in the tabulation at the side of figure 8-43. The required plugs are shown in greater detail in figure 8-33.

5. INTERCHANGEABILITY OF MAJOR UNITS.

Although the contents of this book apply specifically to Radio Transmitting Set AN/ART-13A, the same general type of equipment is also employed by the Navy Bureau of Aeronautics as Radio Transmitting Set AN/ART-13. Major units of both equipments are electrically and mechanically interchangeable. Table 1-6 indicates, by name and designation numbers, each of the major assemblies of equivalent equipments used by the different services or of succeeding models of the same equipment, interchangeability is indicated by the symbol X.

TABLE 1-6. INTERCHANGEABILITY OF MAJOR UNITS

Name of Unit	Type Designation of USAF Item	Type Designation of Navy Item	Interchangeability
Radio Transmitting Set	AN/ART-13A	Navy ATC- 1	See individual components.
Radio Transmitter	T-47A/ART-13	T-47/ART-13	Electrical and mechanical
Dynamotor Unit	DY-17/ART-13A	DY-11/ART-13 and DY-12/ART-13	Electrical and mechanical
Control Unit	C-87/ART-13	C-87/ART- 13	Identical
Control Panel	C-405/A	None	No Navy Equivalent
Antenna Loading Unit (200 to 600 Kc.)	CU-32/ART-13A	CU-25/ART-13 plus SA-22/ART-13	Electrical
Antenna Loading Coil (500 to 1500 kc)	None supplied	CU-26/ART-13	Item dropped by USAF
Oscillator (200 to 600 Kc.)	O-17/ART-13A	O-16/ART-13 (200.to 1500 Kc.)	Electrical and mechanical
Antenna Shunt Capacitor	CU-24/ART-13	CU-24/ART-13	Identical
Crystal Unit (200 Kc.)	CR-2B/U	CR-2B/U	Identical
Mounting Plate (on transmitter)	MT-283/ART-13	MT-283/ART-13	Identical
Mounting Base (on transmitter)	MT-284/ART-13*	MT-284/ART-13*	Identical
Mounting Plate (for control unit)	MT-163/ART-13	MT-163/ART-13	Identical

Mounting Plate (for dynamotor unit.)	MT-164/ART-13	MT-164/ART-13	Identical
Mounting Base (for loading unit)	MT-198/ART-13A	None for load unit; FT-142 for SA-22/ART-13	CU-25 and CU-26 mounted directly
Switch	SA-46/ART-13A	None supplied	SA-46 can be used with either
Plugs	U-6/U -- U-12/U	U-6/U -- U-12/U	Identical

* Denotes MT-284A/ART-13 is interchangeable.

6. ABBREVIATIONS.

Abbreviations of certain radio terms and phrases are used on the control panels of the equipment and in the following sections of this handbook. These terms and their definitions are itemized as follows.

Abbreviation	Term
A-F	Audio Frequency
CFI	Calibration Frequency Indicator
CW	Continuous-Wave Type of Emission
D.C. (or dc)	Direct Current
1st Multiplier	First Radio-Frequency Multiplier Stage
GND	Ground (Br. Earth)
H-F Oscillator	High Frequency Oscillator (1000 to 1510 Kc.)
L Frequency	Low Frequency Band (200-600 Kc.)
L-F Oscillator	Low Frequency Oscillator (200-600 Kc.)
Local	Using the Controls on the Transmitter; Not Controlled from a Remote Control Unit
MCW	Modulated Continuous-Wave Type of Emission
P.A.	Power Amplifier
R-F	Radio Frequency
Remote	Use of Remote Controls (on Control Unit) to Operate the Transmitter

2nd Multiplier	Second Radio-Frequency Multiplier Stage
VFO	Variable Frequency Oscillator
Voice	Voice Modulation of Radio-Frequency Carrier
XTAL	Crystal-controlled
T.S.	Throttle Switch

7. SYMBOL DESIGNATIONS.

All component parts of Radio Transmitting Sets AN/ART-13A and AN/ART-13B are identified in this manual by means of a symbol designation. These symbol designations appear in the text of the following sections, in illustrations, photographs, schematic circuit diagrams and in the parts list section. Thus a part shown in an illustration can be located in the parts list by means of the symbol designation. Complete descriptions of parts as well as the stock numbers and manufacturer's part numbers appear in the Table of Replaceable Parts (section VII) of this manual.

SECTION II INSTALLATION AND ADJUSTMENT

1. UNCRATING.

Open packing crates as outlined below. Use care to avoid damage and search all packing material to be sure that small packages are not overlooked. All crates are marked with arrows to indicate the upright position. Cut and remove banding around crates.

a. TRANSMITTER.--Keep in upright position and open the carton. Take off waterproof and foil bags. Lift the transmitter out.

b. DYNAMOTOR CRATE.--Keep in upright position and remove cover of crate. Remove waterproof and foil bags. Remove two clamps holding dynamotor to base and lift out the dynamotor. Remove Kimpak wrapper.

c. CONTROL UNIT.--Remove cover of crate. Lift out cardboard carton containing the unit. Remove unit from carton.

d. ANTENNA LOADING i3NIT.--Remove cover of crate. Remove foil and waterproof bags.

e. ANTENNA SHUNT CAPACITOR.--Remove cover of crate. Lift out cardboard carton containing the unit. Remove unit from carton.

2. PREPARATION FOR INSTALLATION.

The equipment should be checked before installation to make sure that all parts are operating properly and that no damage occurred during shipment which might cause early failure in service.

a. MECHANICAL INSPECTION.

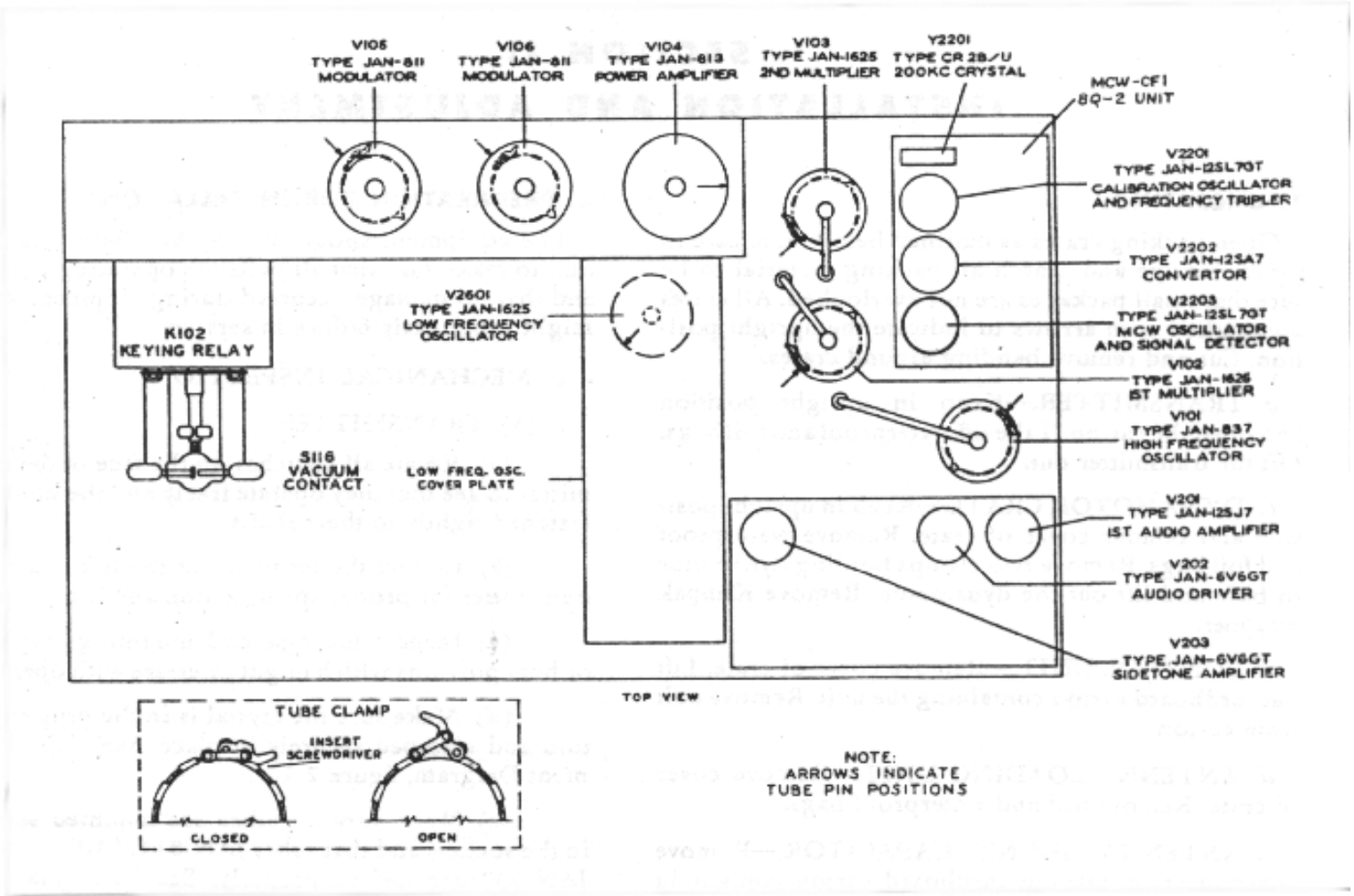


Figure 2-1. Tube Replacement Diagram

Figure 2-1A. Tube Replacement Diagram AN/ART-13B

(1) TRANSMITTER.
(a) Rotate all switches on the face of the transmitter to see that they operate freely and the knobs are fastened tightly to their shafts.
(b) Inspect the terminals at the left end of the transmitter for proper spring action and broken parts.
(c) Inspect the case and mountings for dents or bent portions which might interfere with operation.
(d) Make sure the crystal is in the proper position and clamped securely in place. See Tube Placement Diagram, figure 2-1.
(e) Make sure all tubes are mounted securely in the sockets and that tubes JAN-811, JAN-1625, and JAN-837 are locked properly. See Tube Placement Diagrams, figures 2-1 and 2-1A.
(f) Make sure the plate connector caps on all tubes employing them are in the proper position and firm.
(g) Remove the cover from the low frequency oscillator and Check the tube for proper seating in the socket and firm and proper connection of the plate cap. Replace the cover.
(h) Check the vacuum switch to be sure it is not broken.

(2) DYNAMOTOR UNIT.
(a) Check the fuse and spare fuse to see that they are not blown.
(b) Remove the bottom plate and check all relays and stand off insulators for broken parts.
(c) Check the relays by closing them by hand to see that they do not bind and are not bent.
(d) Make sure all circuit elements are mounted securely. Replace the bottom cover.
(e) Make sure the end cover mounting bolts are tight.
(3) CONTROL UNIT.
(a) Turn the switches to make sure they function properly and the knobs are not loose on the shafts.
(b) Press the key to check the spring action and make sure the mechanism does not bind and stick.
(c) Remove the back plate and inspect the switches for broken parts. Replace the plate.
(4) CONTROL PANEL.
(a) Turn the switches to make sure they function properly and the knobs are not loose on the shafts.
(b) Inspect the switches for broken parts.
(5) ANTENNA SHUNT CAPACITOR.
(a) Inspect to see that no parts are bent or broken.
(b) Check spring action of all terminals.
(6) ANTENNA LOADING UNIT.
(a) Turn the switches to make sure they function properly and the knobs are not loose on the shafts.
(b) Check all terminals for broken parts and spring action.
(c) Remove the cover plate and inspect all switches for broken parts.
(d) Rotate the variometer and make sure it does not bind.
(e) Make sure vacuum switch is not broken.
(f) Make sure micalex terminal boards are not broken.
(g) Check all standoff insulators to see that none are broken and replace the cover.
b. BENCH TEST.(1) GENERAL.--Check the complete equipment for proper operation before installation in the aircraft. When numerous installations are to be made, it is recommended that a test bench be set up.

Note

Adjustment procedures for the equipment must be thoroughly understood before making any of the following tests. (See par. 6, this section.)

(2) EQUIPMENT REQUIRED.(a) Complete mock-up including all necessary cables and plugs and one interphone jack box or panel with liaison position connected into the mock-up.(b) A 28-volt direct current power source with a capacity of 35 amperes per transmitter being tested.
(c) Suitable phantom antenna (Antenna A-58).
(d) Head Set HS-33.(e) Microphone T-17, or Microphone T-30 with Cord CD-318 or CD-508.(f) Means for checking continuity. This may be a continuity meter or just a battery and light bulb.
(g) Plug PL-55 with the terminals shorted.
(3) TEST PROCEDURE MODEL AN/ART-13A.(a) Connect the components in the beach mock-up with Antenna A-58 connected to the "FIXED ANTENNA" terminal on the antenna loading unit.
(b) Turn "EMISSION" switch to "VOICE" position and "CHANNEL" switch to position 1.
(c) Set the antenna change-over switch on the antenna loading unit on "FIXED ANT." position and the switch on Antenna A-58 on position 4. Set and lock the transmitter controls on 2400 kc (control A on 1) on channel 1 in accordance with the operating instructions for CW operation and using the crystal frequency indicator. Check P.A. GRID meter reading to make certain the grid drive to the final amplifier tube is within limits.
(d) Channel the autotune into channel I by moving "CHANNEL" switch to position 2 until the autotune motor starts and then back to position t. Close "TEST" switch after cycling is completed. The P.A. PLATE reading should be very close to that obtained when the channel was set up.
(e) Plug the shorted Plug PL-55 into T.S. jack and "KEY" jack in turn. Power should be delivered to the antenna in each case.

Figure 2-2. Microphone Selector Switch and Sidetone Output Switch

Figure 2-3. MCW-CFI -- Top View

(f) Lift the calibration chart on the face of the transmitter and make sure that microphone selector switch S201 is in "CARBON" position. (See fig. 2-2.) Turn "EMISSION" switch to "VOICE," plug the microphone into "MICROPHONE" jack, and press the button. Power should be delivered to the antenna and the plate current should be slightly above that for CW operation. Speak or whistle into the microphone. Plate current should rise near or higher than the MCW area on the meter with modulation.
(g) Place "EMISSION" switch on MCW position and close "TEST" switch. Power should be delivered to the antenna and the plate current meter should read 190 or higher. If this reading is not obtained, readjust the MCW control until a reading of 190 is secured. This adjustment, marked "R2201" in figure 2-3, is located inside the transmitter. See paragraph 7 in the MAINTENANCE section (V) which describes this adjustment.
(h) Listen in the "SIDETONE 1" circuit and key the transmitter on CW, MCW, and modulate on "VOICE" position. The proper sidetone signal should be heard on all emission positions. Repeat with headset connected to the interphone jack box, control box or control panel installed as a pa/t of the mock-up. Lift the calibration chart and set "OUTPUT" switch S202 on each position in turn. (See fig. 2-2.) The proper sidetone signal should be heard on each position, being louder the higher the number of the switch position.
(i) Set up and lock the other channels of the autotune by loading the transmitter into the phantom antenna, with controls A and B set as follows:

Channel	A	B
2	2	200
3	3	100
4	4	060
5	5	100
6	6	100
7	7	100
8	8	100
9	9	100
10	10	100

(j) Set up the "L.FREQ." channel on 400 kc using the internal CFI.(k) Place "CHANNEL" switch on "MANUAL," power level switch on "TUNE," meter switch on "P.A. GRID," control B on 100, control C on 13, control A on 11, and close "TEST" switch. The meter should read in or slightly above the lightly shaded area under "P.A. GRID." Repeat with control A on position 12.
(l) Connect all three sections of the antenna; shunt capacitor between the "COND" post and ground, and tune the transmitter near 2300 kc. Disconnect the capacitors.
(m) Turn "EMISSION" switch to "OFF."
(n) Change the phantom antenna lead from the "FIXED ANTENNA" terminal on antenna loading unit to the "TRAILING ANTENNA" terminal and set the switch to the "TRAILING ANT." position.
(o) Set "LOCAL-REMOTE" switch on "REMOTE" position, the emission switch on the remote control unit on "VOICE," and "CHANNEL" switch on position 1. Then place the emission switch on CW. Wait for the light on the control unit to come on.

Note

If a control panel is used in the mock-up, disregard the next two steps and check the operation from a microphone connected to the proper terminals for remote operation.

(p) Press the key on the control unit. Power should' be delivered to the antenna and the meter should read in the lightly shaded area marked CW. Meter readings should be very close to those obtained previously.
(q) Check "VOICE" and MCW operation from the control unit by means of its emission switch and the microphone jack on it.

(r) Select channels 2 to L.F. on the control unit in turn, closing the key each time the autotune completes cycling. Operation should be normal on each; meter readings, plate and antenna, should be very close to those obtained previously.
(s) Disconnect the wires from the "ANT." and "LOAD COIL" posts and check continuity between the "RECEIVER" post and ground. They should be open with the key up and closed with the key down. Remove the input plug from the dynamotor unit and then check continuity between the "ANT" and "RECEIVER" posts. They should he connected.
(4) TEST PROCEDURE--MODEL AN/ART-13B.

Note

For VFO operation, using Oscillator O-17/ ART-13A, follow instructions as outlined in the preceding paragraph (3) of this section. For crystal-controlled operation, using Oscillator CDA-T, the following instructions are applicable.

(a) Connect the components in the bench mock-up with Antenna A-58 connected to the "FIXED ANTENNA" terminal on the antenna loading unit.
(b) Turn "VFO-XTAL" switch to "XTAL" position, "A-B" switch to "A" position, "EMISSION" switch to "VOICE" position and "CHANNEL" switch to position 1. Set the antenna change-over switch on the antenna loading unit on "FIXED ANT." position and the switch on Antenna A-58 on position 4.
(e) Check control "A" to be sure it is set on channel 1. Unlock control **B", operate the test switch and observe the P.A. GRID meter for grid drive indication. Vary control "B" while observing this meter to obtain maximum reading. Lock control "B'. If two crystals are in use for channel 1, adjust control '*B' for maximum grid drive reading and note the control setting. Turn the 'A-B" switch to 'B" and again adjust control "B" for highest grid drive indication. Finally, set control 'B" midway between the two settings required to produce maximum grid drive for each crystal, and lock the control.
(d) With the 'A-B" switch in the 'A" position, channel the autotune into channel 1 by moving "CHANNEL" switch to position 2 until the autotune motor starts and then back to position 1. Close "TEST" switch after cycling is completed. The P.A. PLATE reading should be very close to that obtained when the channel was set up. Switch to crystal "B". It also should retain the reading previously obtained when the controls were set.
(e) Plug the shorted Plug PL-55 into T.S. jack and "KEY" jack in turn. Power should be delivered to the antenna in each case.
(f) Lift the calibration chart on the face of the transmitter and make sure that microphone selector switch S201 is in "CARBON" position. (See fig. 2-20 Turn "EMISSION" switch to "VOICE," plug the microphone into "MICROPHONE" jack, and press the button. Power should be delivered to the antenna and the plate current should be slightly above that for CW operation. Speak or whistle into the microphone. Plate current should rise near or higher than the MCW area on the meter with modulation.
(g) Place "EMISSION" switch on MCW position and close "TEST" switch. Power should be delivered to the antenna and the plate current meter should read 190 or higher. If this reading is not obtained, readjust the MCW control until a reading of 190 is secured. This adjustment, marked "R220t" in figure 2-3, is located inside the transmitter. See paragraph 7 in the MAINTENANCE section (V) which describes this adjustment.
(h) Listen in the "SIDETONE 1" circuit and key the transmitter on CW, MCW, and modulate on "VOICE" position. The proper sidetone signal should be heard on all emission positions. Repeat with headset connected to the interphone jack box, control box or control panel installed as a part of the mock-up. Lift the calibration chart and set "OUTPUT" switch S202 on each position in turn. (See fig. 2-2.) The proper sidetone signal should be heard on each position, being louder the higher the number of the switch position.
(i) Check channels 2 through 10, as outlined in paragraph (4) (a) through (e). It should be understood that "CHANNEL" switch positions will not necessarily correspond with the same position number of control "A". Control "A" has 12 settings available for the high frequency band, and any ten of these settings may be utilized for autotune operation, depending on the crystals in use and the frequency desired.
(j) Turn the "CHANNEL" switch to L.FREQ. When the autotune cycling is complete, control "A" should rest on position 13. Four crystal-controlled frequencies are available, depending on the setting of the 4-position low frequency switch, located on the CDA-T panel. With the four low frequency crystals in place (one holder is a dual crystal type), check for grid drive as previously outlined for the higher frequency ranges. Grid drive may be varied by means of the adjustable plate choke, L803, of the low frequency oscillator tube, V802. This adjustment is readily available from the top of the chassis, at the rear of the CDA-T unit. When more than one low frequency crystal is used, a setting should be selected that will provide sufficient grid drive to obtain normal transmitter output on each crystal frequency.
(k) Crystal operation is not possible using the "MANUAL" setting of the "CHANNEL" switch. This "MANUAL" setting applies only to VFO operation and should be checked as outlined in paragraph (3) (k).
(l) Connect all three sections of the antenna shunt capacitor between the "COND" post and ground. Channel the autotune to a crystal frequency setting near 2300 kc and tune the transmitter. Disconnect the capacitors.
(m) Turn "EMISSION" switch to "OFF."
(n) Change the phantom antenna lead from the "FIXED ANTENNA" terminal on antenna loading unit to the "TRAILING ANTENNA" terminal and set the switch to the "TRAILING ANT." position.
(o) Set "LOCAL-REMOTE" switch on REMOTE" position, the emission switch on the remote control unit on "VOICE", the "A-B' switch to "A" and the "CHANNEL" switch to position 1. Then place the emission switch on "CW". Wait for the light on the control unit to come on.

Note

If a control panel is used in the mock-up, disregard the next two steps and check the operation from a microphone connected to the proper terminals for remote operation.

(p) Press the key on the control unit. Power should be delivered to the antenna and the meter should read in the lightly shaded area marked CW. Meter readings should be

very close to those obtained previously.
(q) Check "VOICE" and MCW operation from the control unit by means of its emission switch and the microphone jack on it.
(r) Turn 'A-B" switch on remote control unit to "B". Check again as outlined in preceding paragraphs (4) (p) and (q). Operate the "CHANNEL" switch through positions 2 to L. FREQ., closing the key each time the autotune completes cycling. Operation should be normal on each; meter readings, plate and antenna, should be very close to those obtained previously. In the L.FREQ position, only one frequency check is possible from the remote position, as the l-position low frequency switch must be manually operated at the transmitter location.
(s) Disconnect the wires from the "ANT." sad "LOAD COIL" posts and check continuity between the "RECEIVER" post and ground. They should be 'open with the key up and dosed with the key down. Remove the input plug from the dynamotor unit and then check continuity between the "ANT" and "RECEIVER" posts. They should be connected.

3. INSTALLATION.

Figure 2-4. Transmitting and Mounting Plate MT-283/ART-13, shown

With Mounting Bases MT-284/ART-13 and MT-284A/ART-13

a. TRANSMITTER.
(1) Mount the transmitter at a height convenient for operation of the controls. See figure 8-25 Transmitter Outline Dimensions with Mounting Base MT284/ART- 13 for ventilation provisions, clearances required for operation and removal, bonding, and mounting hole size and placement. The unit may be slid into position from the front or may be lowered on the mounting two inches forward of the final position and slid backwards into position. When the unit has been placed, tighten the two locking knobs on the front edge of the mounting by rotating them clockwise. Tie wire the locking knobs in position.

Figure 2-5. Dynamotor Unit DY-17/ART-13A with Mounting Plate MT-164/ART-13

b. DYNAMOTOR UNIT.(1) Locate the dynamotor unit in such a position that it will be possible to reach the "RESET" buttons and the "FUSE" on the front of the unit while in flight. Both ends must be at least three inches from a flat surface to provide sufficient ventilation.
(2) See figure 8-31 Dynamotor Unit Outline Dimensions for plug clearances, bonding, and mounting hole positions and sizes.
(3) To install the dynamotor unit on Mounting Plate MT-164/ART-13, set it on the mounting and slide it backward until the holding pins are engaged; then tighten the two locking knobs on the front of the unit by turning them clockwise. Tie wire the locking knobs together.

Figure 2-6. Antenna Loading Unit CU-32/ART-13A with Mounting Plate MT-198/ART-13A

c. ANTENNA LOADING UNIT.
(1) Mount Antenna Loading Unit at a height convenient for operation of controls and within easy reach of the transmitter. A clearance of at least 6 inches should be provided between electrical terminals on each side of this unit and surrounding objects.
(2) See figure 8-27 for outline dimensions of Antenna Loading Unit CU-32/ART-l3A and figure 8-28 for outline dimensions of Mounting Base MT-198/ART-13A. Required clearances, mounting hole location and bonding instructions are also shown in these figures. The mounting base may be installed on top of, or hung upside down from, a flat surface. Shock mounts must be assembled differently when the loading unit is suspended from the mount. Instructions for proper assembly are shown in figure 8-28. The loading unit may be mounted on top of the mounting base on its top, bottom or back or it may be suspended from the mounting by its top, bottom or back.
(3) Mounting Base MT-198/ART-13A is mounted to the structure of the aircraft by means of four 1/4" screws (see fig. 8-28 for location of holes).
(4) After mounting base has been installed, place loading unit in position on mounting plate and secure by closing all four snap slides (one on each corner of the case). Tie wire the four snap slides.

Figure 2-7. Control Unit C-87/ART-13 with Mounting Plate MT-163/ART-13

d. CONTROL UNIT.--Locate the control unit so that the controls are easily accessible to the operator. Mount it with the key upward leaving sufficient space for operation of

the key.
(1) See figure 8-26 (Control Unit Outline Dimensions) for plug clearances and mounting hole positions and sizes.
(2) To mount the control unit on Mounting Plate MT-163/ART-13, place the unit on the mounting and tighten the four screws, one in each corner.
e. CONTROL PANEL.--Install the panel in the rack. In racks with threaded holes, mount the panel with screws. In racks with smooth holes and a wire across the center, the panel needs a small adapter plate equipped with quick-release fasteners on each side. A half turn clockwise is all that is necessary to fasten the panel.
f. ANTENNA SHUNT CAPACITOR AND SWITCH.
(1) Locate the unit as near the left end of the transmitter as possible. Place between the unit and the transmitter in such a position that vibration will not cause it to close. The total length of lead from the transmitter to the capacitor shall not exceed 12 inches.
(2) See figures 8-29 and 8-30 for bonding and position and size of mounting holes.
g. OSCILLATOR O-17/ART-13A AND PANEL MX-128/ART-13.--These units are mechanically interchangeable and electrically always maintain the continuity of the filament string. To remove panel bIX-128/ART-13 and install Oscillator O-17/ART-13A, proceed as follows:
(1) Remove the top cover and type 813 tube.
(2) Remove the two screws holding the rear of the installed unit to the fire wall assembly.
(3) Remove the seven screws around the front panel of the unit.
(4) Disconnect the lead to the multiplier section as required.
(5) Lift straight up to remove.
(6) Before any attempt is made to install new unit, make certain that the top screws of the autotune cover are loosened on each side of the oscillator panel.
(7) Tilt the low frequency oscillator forward 15 to 20 degrees and install the lower lip of the oscillator panel behind the autotune cover.
(8) Lower the oscillator from its tilted forward position to mate with the Jones plug. Force should not be used to mate these plugs.
(9) When the oscillator is in place, replace and tighten the seven screws that hold the low frequency oscillator panel in place.
(10) Tighten screws along top edge of autotune cover.
(11) Replace and tighten screws that hold the back of oscillator unit.
(12) Replace JAN-813 power amplifier tube and connect plate lead.
(13) Connect one end of wire from standoff insulator (Ref. E-109-B, Figure 8-2) to terminal on right side of oscillator unit.
(14) Replace cover on Transmitter.
h. OSCILLATOR CDA-T.--This unit, used only in Radio Transmitting Set AN/ART-13B, is mechanically interchangeable with Oscillator O-17/ART-13A and Panel MX-128/ART-13 but differs electrically from the latter units. To remove Oscillator O-17/ART-13A and install Oscillator CDA-T, proceed as follows:
(1) Remove the transmitter cover and the type 813 power amplifier tube.
(2) Remove the two screws holding the rear of the installed unit to the fire wall assembly. Replace the type 813 tube.
(3) Remove the seven screws around the front panel of the unit. Loosen the top screws of the autotune front cover on each side of the oscillator panel.
(4) Disconnect the lead from the insulated standoff terminal on the right side of the oscillator unit.
(5) Lift straight up to remove.
(6) Tilt the CDA-T unit forward 15 to 20 degrees and insert the lower lip of the oscillator panel behind the top of the autotune cover.
(7) Lower the oscillator from its tilted forward position to mate with the two Jones connectors. Force should not be used to mate these plugs and receptacles.
(8) When the unit is in place, replace and tighten the seven screws that hold the oscillator in place and tighten screws along top edge of autotune cover.
(9) Remove the low frequency oscillator tube (JAN-1625) in the CDA-T unit. Install screw that holds the back of the oscillator unit to the fire wall assembly. Replace the JAN-1625 tube and connect its plate lead.
(10) Connect the two leads to the standoff insulators on the right side of the CDA-T unit (see figure 8-2A).
(11) Replace cover on transmitter.

4. INTER-UNIT CONNECTIONS.

a. Make up the inter-unit connections when installing the equipment. A drawing of a typical wiring diagram is shown in figure 8-43. Cut the wires to the proper length for the installation involved. Allow enough additional length for each cable so that the radius of any bend in a cable is never less than 8 inches and the cable is not tight enough to interfere with the action of the shock mounts or to damage the connectors. Figure 8-33 shows the dimensions of the plugs and outlines the method of connecting wires to the terminals.
b. Tighten the locking rings on all plugs and tie wire them in place.

5. INSPECTION AND TEST AFTER INSTALLATION.

a. Inspect the inter-connections to check them for conformity to the mock-up of the particular installation. Check the knobs on the front of the transmitter and dynamotor unit, the microphone selector switch under the chart, and all connector plug locking rings for tie wire.
b. Set up the frequencies to be used in the flight test on the channels desired according to the procedure given in the "ADJUSTMENTS" section of this book.
c. Set up one frequency in the range 200 to 600 kc and check it for proper operation.
d. Follow the procedure outlined for DAILY INSPECTION in this Handbook of Maintenance Instructions.
e. Turn on the receiver, make sure the "NORMAL-MONITOR" switch is in the "NORMAL" position, and listen in the liaison position of the jack box. The receiver hiss should be heard with the key up; the proper transmitter sidetone signal should be heard with the key down. Set the output switch under the calibration chart on the position that

gives the proper volume of sidetone signal when the transmitter is being operated.
f. Tune the receiver for CW operation on one of the frequencies set up on the transmitter. Set "NORMALMONITOR" switch in "MONITOR" position and close the transmitter key. The transmitter should be on CW. It should be possible to hear a beat note and to tune the beat note to zero by rotating the receiver dial. Release the transmitter key and return "NORMAL-MONITOR" switch to "NORMAL" position.
g. Establish communication with the ground station on each frequency to be used in the flight test.

6. ADJUSTMENTS.

WARNING

Operation of this equipment involves use of high voltages which are dangerous to life. Operating personnel must observe all safety precautions. Whenever the dynamotor is running, there is a potential of 1150 volts applied to the plate caps on top of the tubes.

a. USE OF CALIBRATION TABLES.(1) In Radio Transmitting Set AN/ART-13A, the low frequency and high frequency oscillators are variable frequency master oscillators (VFO) with no provision made for crystal control of the frequency of either oscillator. Therefore, a crystal controlled frequency standard has been incorporated in the equipment to be used for the calibration of the variable frequency oscillators. Radio Transmitting Set AN/ART-I3B uses both crystal-controlled and variable frequency oscillators. These calibration tables are necessary for the VFO operation but are not required for crystal-controlled operation.
(2) Detailed oscillator calibration tables 6-9 and 6-10 are included in section VI, SUPPLEMENTARY DATA, of this book. Calibrating frequency "check points" have been indicated in the calibration tables by printing them in heavy black type. When checking the calibration, it is necessary to use the checkpoint which is numerically nearest to the transmission frequency that is to be used. Heavy ruled lines that appear at intervals in the calibration tables, serve to indicate the direction of the nearest check point. For example - for frequencies that appear above (or before) this dividing line, use first check point (heavy type) that is encountered by looking back to succeedingly lower frequencies. For frequencies that appear below (or after) the dividing line, use first check point (heavy type) that is encountered by looking ahead to succeedingly higher frequencies.
(3) The check points are frequencies at which audio beat notes between the output of the low-frequency oscillator or the output of the high-frequency oscillator and the harmonics of the crystal controlled50 kc output of CFI unit may be heard. These "beat notes" are used for setting the dial and the movable indicator mark is for adjusting the calibration of the oscillator. The frequency in the tables is given in kilocycles with the control positions in columns opposite the frequency. The numbers in column B or G may be considered as combination numbers. For control G, the hundreds figures (the one or two figures in the third and fourth positions to the left of the decimal point as underlined in the following example: 724.6 or 1536.4) are set on the revolution counter near the control and the rest of the number is set on the dial, estimating the figure to the right of the decimal and setting it between divisions on the dial. For control B, the hundreds figures are set the same as for control G, the two figures immediately to the left of the decimal point (724.6 or 1536.4) are set on the dial and the figure to the right of the decimal point (724.6 or 1546.4) is set by means of a vernier. To obtain the settings given in the columns under B and G (B and G represent both dial designations and calibration table column heading), rotate the control until the revolution counter indicates the proper number of full revolutions and the dial indicates the fraction of a revolution. For accuracy in setting control B, a vernier scale has been provided. To use the vernier, set that part of the number to the left of the decimal point opposite the zero line on the vernier scale. Then note the line on the vernier scale that corresponds to the figure to the right of the decimal point and rotate the dial slightly in a clockwise direction until that line on the vernier is lined up with the first line on the dial that approaches it. For example, opposite 3410 kc the reading under B in the table is 1114.1. To obtain this setting of control B, rotate the dial until the revolution counter indicates that the control has been rotated 11 full revolutions from the zero setting (see fig. 2-8); then continue to rotate the control until 14 on the dial appears opposite the zero indicating mark, note line 1 on the vernier scale and further rotate the dial until the first line (15) on the dial lines up with line 1 on the vernier.
(4) The transmitter can be set to frequencies between those given in the table by the following method:
(a) Find the two frequencies located on either side of the desired frequency.
(b) Find the difference between the dial settings of control B or G for these two frequencies.
(c) Multiply this difference by the decimal of a kilocycle in the desired frequency.
(d) Add this product to the dial setting for the lower frequency in (a).
(e) Example: It is desired to transmit on 3411.5 kilocycles.

	Freq.	A	B	
Desired Frequency 3411.5	3410	3	1114.1	
	3411	3	1116.6	Difference Between Dial Settings Is 2.4
	3412	3	1119.0	
	3413	3	1121.5	

Setting for desired frequency is obtained thus:

Difference in Dial Settings---	2.4
Decimal in the Desired Frequency---	x .5
Product--	1.20
Dial Setting for Lower Frequency---	1116.60
Dial Setting for Desired Frequency---	1117.80

Figure 2-8. Illustration Showing Setting of Control "B" to 1114.1 ***(Per Example in the Text)***

Figure 2-9. Radio Transmitter T-47A/ART-13

Figure 2-9A. Radio Transmitter T-412/ART-13B -- Front View

b. PROCEDURES FOR SETTING THE CONTROLS OF RADIO TRANSMITTER SET AN/ART-13A (MANUAL OR AUTOTUNE OPERATION)
(1) GENERAL.--The following procedures are for setting up the transmitter for "MANUAL" or autotune operation. If "MANUAL" operation is desired it is only necessary to set "CHANNEL" switch on "MANUAL" position and follow these instructions, except the locking bars should not be moved. "MANUAL" operation will not interfere with any of the channels set up for autotune operation if the locking bars are not loosened, nor will setting up any channel in accordance with the following procedure interfere with any other channel previously set up. Channeling the autotune with the locking bars loose will completely eliminate the settings previously set up for the channel that was cycled and may cause settings for some or all of the other channels to shift.
(2) "CW" OPERATION INTO FIXED ANTENNA (2000 to 18100 KC).--The following procedure is to be used for setting up the transmitter for autotune operation on a desired frequency on any one of the 10 high-frequency channels.
(a) Place the antenna selector switch on the antenna loading unit on "FIXED ANT." position.
(b) Make certain that the microphone, key, and throttle switch (T.S.) jack circuits are open.
(c) Place "LOCAL-REMOTE" switch in "LOCAL" position.
(d) Place "EMISSION" switch in "VOICE" position.
(e) Check primary voltage by moving the meter switch to "BATTERY-VOLTAGE" position. Usable primary voltage is indicated when the meter needle is within the light shaded area under "BATTERY." A primary voltage of 28 volts will cause the meter needle to read at the top edge of this shaded area. A primary voltage of 24 volts will cause the meter needle to read at the lower edge of this shaded area.
(f) Place "CHANNEL" switch in the position corresponding to the channel it is desired to set up. (If "MANUAL" operation is desired, place "CHANNEL" switch in "MANUAL" position.) If the autotune system begins to run, allow it to complete the cycle of operation before proceeding. The red pilot light on the front of the transmitter will light when the autotune cycle is completed, and the transmitter will be ready for tuning adjustments or operation.
(g) Unlock all five controls by holding the dial and turning the locking bar 1/4 turn in a counterclockwise direction. (If "MANUAL" operation is being used, the locking bars should not be loosened.)
(h) Set control "C" on position 1. Check the position of the control against the indicator mark on the transmitter panel. The setting of this control is critical The transmitter will not operate if control 'C" is not set properly.
(i) Find the desired frequency in the calibration table and note the nearest crystal checkpoint marked in heavy black type.
(j) Set control A to the position corresponding to the number in column A at this crystal checkpoint. Check the position of the control against the indicator mark on the transmitter panel. The setting of this control is critical The transmitter will not operate if control A is not set properly.
(k) Set control B to the position corresponding to the number in column B at this crystal checkpoint.

(l) Set the power level switch to "CALIBRATE" position and listen in the sidetone circuit for a beat note while rotating control B back and forth about the position given for the crystal check point. Set control B on the position that gives zero beat and turn the power level switch to "TUNE" position.
(m) Set the movable indicator mark by means of the "CORRECTOR" knob near control B to the reading of control B found in column B at this crystal checkpoint.
(n) Refer to the calibration table and obtain the correct setting of control "B" for the desired operating frequency.
(o) Set control B to the reading obtained above. (p) Lock control A by first noting its reading, rotating dial counterclockwise one-quarter turn, or against the stop if the stop is within one-quarter turn, and then rotating it clockwise to, but not past the reading on which it had been set. Hold the knob and turn the locking bar clockwise until it is tight with a firm but not heavy pressure. Repeat this procedure for control B. Further pressure on either control in a clockwise direction should not cause the dial to move beyond the original setting. If it does, unlock and repeat the locking procedure, making certain the original dial settings are used. (If "MANUAL" operation i$ being used, the locking bars should not be bothered.)
(q) Place "EMISSION" switch on "CW" position.
(r) Check the grid drive to the final amplifier by placing the meter switch on "P.A. GRID" position, closing "TEST" switch, and noting the reading on the meter. It should read in, or slightly above, the light shaded area marked "P.A. GRID." If it does not, operation is not normal. Control A may not have been positioned accurately or there may be something wrong with the transmitter. Check the trouble before proceeding. See "Note" in paragraph 6b(2)(hh), this section.
(s) Place the meter switch on "P.A. PLATE" position.
(t) Place control "D" on zero.
(u) Hold "TEST" switch closed and rotate control "E" throughout its range, seeking a plate current dip indicating resonance of the circuit.

CAUTION

Do not move control "E" across the space between 100 and 200 or between 0 and 100 while "TEST" switch, microphone button, or key is closed. An internal switch will be damaged if this precaution is not followed.

(v) If no resonance dip is found, set control C on the next higher position and rotate control E again, seeking a dip in plate current.(w) Repeat the instructions in paragraph (v), above, until the resonance dip i$ found or until control C is sec on position 8 and resonance has not been found.

Note

If frequency of operation is below 3000 kc, see instructions in paragraph 6b(2)(jj), this section.

(x) If resonance was found on position 1 to 7, inclusive, on control C, place the power level switch in "OPERATE" position.
(y) Load the power amplifier by increasing the reading on control D in steps, re-resonating with control E each time. When control D had been rotated throughout its range, set control C on the next higher position, control D on zero and repeat. Continue this process until the resonance dip falls in the light-shaded area marked "CW" on the plate meter. Correct loading of the final amplifier tube, when a 28-volt primary voltage is used, is 100 on the plate meter. It may not be possible in all cases to load the amplifier tube exactly to this value, but any value of loading which is in the light-shaded area marked "CW" will be satisfactory.

Note

If the resonance dip causes the plate current to fall to a very low value, control C may be set to the next higher position without moving control D, always re-resonating with control E each time as before. Fine adjustment must still be made by means of control D. On antennas less than 55 feet in length and on frequencies below 3000 kc, it may not be possible to load the final amplifier to the light-shaded area marked "CW" before control E reaches zero. If this happens, set control E on zero and resonate with control D. This will give the best operation obtainable under these conditions.

(z) If resonance was not found before control C was set on position 8, leave control C on position 8, set control E on zero, and seek the resonance dip in plate current by rotating control D throughout the range of 0 to 100.
(aa) If resonance is not found, set control C on the next higher position, rotate control D again, seeking the resonance dip.
(bb) Repeat paragraph (aa), above, until resonance is found or until control C has been tried on position 13 without finding a resonance dip.
(cc) If the resonance dip was not found with control C on position 13, leave that control on position 13, place control D on 100, and seek the resonance dip with control E.
(dd) When resonance, is found, place the power level switch on "OPERATE position.
(ee) Load the power amplifier by increasing the reading on control E in steps, re-resonating with control D each time until the resonance dip falls in the light-shaded area marked "CW" on the meter.
(ff) After proper loading of the final amplifier tube has been found using any of the above procedures, lock control C by noting its reading, rotating the dial counterclockwise about one-quarter turn, and then rotating it clockwise to, but not past the reading on which it had been set. Hold the knob and turn the locking bar clockwise, until tight, with a firm but not heavy pressure. Further pressure on the dial in a clockwise direction should not cause the dial to move beyond the original setting. If it does, unlock and repeat the locking procedure, making certain the original dial setting is used. Repeat this procedure with controls D and E. (If "MANUAL" operation is being used, the locking bars should not be bothered.)
(gg) Check tuning and locking by holding "TEST" switch closed while placing a small force on each dial in turn in the clockwise direction. If all dials ate locked properly, no detuning will result. (Do not use this test when in "MANUAL" position.)
(hh) Repeat the above procedure for each high-frequency autotune channel it is desired to set up on the transmitter.

Note

The "P.A. GRID" meter reading, with control A on position No. 7, is usually at the lower edge of the light-shaded area. It is permissible for the grid meter reading for this particular setting (control A on No. 7) to be 50 on the meter scale and still be satisfactory. A lower meter reading is not satisfactory, and the transmitter should be repaired or aligned according to the instructions in section V of this handbook. If control A is not set accurately it is possible for some of the multiplier switches to be between contact positions; this results in loss of grid drive to the final amplifier tube, and burning of contacts. Set control accurately.

(ii) When operating in the 2000-kc to 3000-kc range into a fixed antenna, care must be exercised to avoid operation on a harmonic of the desired frequency. This will be avoided in most cases by following the outlined procedure for tuning adjustment into a fixed antenna. However, for frequencies between 2000 kc and 3000 kc on antennas shorter than approximately 50 feet, the antenna may be too short for the tuning elements in the transmitter to resonate at the fundamental frequency. Therefore, the first resonance indicated by the tuning adjustment may be a harmonic of the desired frequency. To determine whether this is true, follow the tuning procedure outlined in paragraph (jj), below.

(jj) For operation into short antennas (less than 50 feet) at frequencies between 2000 kc and 3000 kc, it may be necessary to connect the antenna shunt capacitor to the "COND." post on the transmitter. This is accomplished by throwing the knife switch so the capacitors are connected to the transmitter. Table 2-1 may be used as a guide to determine whether or not use of the capacitor will be necessary and, if used, how many sections are required for various frequencies and lengths of antenna.

TABLE 2-1. USE OF ANTENNA SHUNT CAPACITOR WITH ANTENNAS OF DIFFERENT LENGTHS

Length of Antenna (in feet)	Frequency Range (in kilocycles)	Antenna Shunt Capacitor; No. of Sections Necessary
60 to 65	2000 to 18100	None
53 to 60	2000 to 2100	One
53 to 60	2100 to 18100	None
45 to 53	2000 to 2100	Two
45 to 53	2100 to 2200	One
45 to 53	2200 to 18100	None
36 to 45	2000 to 2100	Three
36 to 45	2100 to 2200	Two
36 to 45	2200 to 2400	One
36 to 45	2400 to 18100	None
27 to 36	2100 to 2200	Three
27 to 36	2200 to 2400	Two
27 to 36	2400 to 2700	One

27 to 36	2700 to 18100	None
20 to 27	2200 to 2400	Three
20 to 27	2400 to 2700	Two
20 to 27	2700 to 3000	One
20 to 27	3000 to 18100	None

To determine the length of the antenna, measure the total length of wire from the antenna terminal of the transmitter to the extreme end of the antenna (including the length of the lead inside the airplane). If the antenna is a "T," disregard the length of wire in the shorter branch at the top of the "T," or, if the two branches are equal, include the length of only one of them. The tuning procedure for the transmitter, when using the shunt capacitor, is identical to the procedure without shunt capacitors. The use of these antenna shunt capacitors reduces the power output from the transmitter when used on frequencies higher than those which require its use. For this reason, it should not be used unless necessary and only on those channels which require it. This obviously cannot be done if the transmitter is to be operated from a remote position, since no provisions have been made to automatically switch the shunt capacitor in or out. In this case the capacitor should be used only if it is desired to set a channel in the frequency range wherein the antenna cannot be resonated by the tuning elements in the transmitter itself, and it must be left in for all channels regardless of the reduction of power. Only the capacity necessary to tune the lowest frequency used should be connected. This can be done by connecting one, two, or three of the capacitors in parallel, according to the amount of capacity needed. Use the smallest number possible. To determine the lowest frequency that can be tuned with a given number for a particular antenna, proceed as follows:

1. Connect the circuit it is desired to check; that is, either no capacitor connected, one section connected, two sections connected, or three sections connected.
2. Place 'LOCAL-REMOTE" switch to "LOCAL" position.
3. Place "EMISSION" switch on "VOICE" position,
4. Place "CHANNEL" switch on "MANUAL" position.
5. Place the meter switch on "P.A. PLATE" position.
6. When the autotune motor stops and the pilot light comes on, set control A on position 2 and control B on 2000.
7. Tune and load the power amplifier according to instructions contained in paragraphs 6.b. (2)(q) thru (y).

Control A	Control B
2	1500
2	1000
2	500
1	1500
1	1000
1	500
1	100

8. Attempt to repeat the above tuning and loading procedure with each of the following combinations of setting in turn.The setting of control E for each successive trial will be lower than for the preceding trial. If one of the above combinations of controls A and B cannot be tuned without going to a "HIGHER" setting of control C than for the preceding combination, place control C on position 1, control D on zero, and control E on zero. Then rotate control B toward a higher reading, while holding "TEST" switch

closed, until the plate current shows a resonance dip. Turn the transmitter off and look up the frequency in the calibration table corresponding to the combination of controls A and B found by this process. This installation of the transmitter, with sections of the antenna shunt capacitor (if used), with this length of fixed antenna wire in this type of airplane, cannot be tuned to any frequency below that obtained by this process. It may appear that proper operation is obtained by continuing the tuning procedure to "HIGHER" positions of control C, but this results in operation on a harmonic of the desired frequency and will result in complete lack of communication.
(3) CW OPERATION INTO TRAILING ANTENNA (2000 KC TO 18,100 KC).
(a) Set controls A and B on the desired frequency by following instructions in paragraphs 6.b. (2) (b) through (s).
(b) Connect the "ANT." post on the transmitter to ground with a lead as short as possible.
(c) Place control D on zero.(d) Hold "TEST" switch closed and rotate control E throughout its range, seeking a plate current dip indicating resonance of the circuit.
(e) If no resonance dip is found, set control C on the next higher position and rotate control E again, seeking a dip in plate current.
(f) Repeat the instructions in paragraph (e), above, until the resonance dip is found or until control C is set on position 8.
(g) If resonance was not found before control C was set on position 8, leave control C on position 8, set control E on zero, and seek resonance dip in plate current by rotating control D throughout the range of 0 to 100.
(h) If resonance is not found, set control C on the next higher position, rotate D again, seeking the resonance dip.
(i) Repeat paragraph (h), above until resonance is found or until Control C has been tried on position 13 without finding a resonance dip.
(j) If the resonance dip was not found with control C on position 13, leave that control on position 13, place control D on 100, and seek the resonance dip with control E.

CAUTION

Do not attempt to load the transmitter.

Note

The above procedure may be accomplished on the ground and controls C, D, and E locked in the positions found for each frequency on which trailing wire operation is desired. Then, during flight, it will be necessary to channel the autotune into the channel on which it is desired to operate; unlock controls C, D, and E and continue with the procedure that follows. Be sure "EMISSION" switch is on CW, power level switch is on "TUNE," and meter switch is on "P.A. PLATE."

(k) When resonance is obtained, release the "TEST" key and remove the connection between the "ANT." post and ground and make certain the proper wire is fastened to that post.
(l) Let out the trailing wire to a counter reading 10 higher than that shown in the following table of approximate antenna lengths for the desired frequency.
(m) Hold the "TEST" switch closed and reel the wire in while watching the plate current meter for a resonance dip.
(n) If no dip is found, let the wire out to a reading 20 higher than that indicated in the following table and repeat the reeling-in procedure.

KC	Counter Reading		
	1/4 Wave	3/4 Wave	5/4 Wave
2000	101		
3000	61		
4000	46	150	
5000	38	118	
6000		90	
7000		70	
8000		60	

9000		48	93
10000		41	76
12000			55
14000			44
16000			37
18000			34

(o) When resonance is found, adjust the length of the wire to correspond to minimum plate current and set power level switch on "OPERATE" position.(p) If resonance was found with control C on positions 1 to 7 inclusive, load the power amplifier by increasing the reading on control D in steps, re-resonating with control E each time. When control D has been rotated throughout its range, set control C on the next higher position, control D on zero, and repeat. Continue this process until the resonance dip falls in the light-shaded area marked "CW" on the plate meter.

Note

If the resonance dip causes the plate current to fall to a very low value, control C may be set to the next higher position without moving control D, always re-resonating with control E each time as before. Fine adjustment must still be made by means of control D.

(q) If resonance was found with control C on positions 8 to 13 inclusive, load the power amplifier by increasing the reading on control E in steps, re-resonating with control D each time until the resonance dip falls in the light-shaded area marked "CW" on the meter.
(r) Lock controls C, D, and E. (If "MANUAL" operation is being used, the locking bars should not be loosened.)

Note

This channel may be used on trailing wire again without unlocking the dials by cycling the autotune into the channel, placing the power level switch on "TUNE" position, adjusting the antenna length to the position corresponding to minimum plate current if frequency is below 10,000 kc and to maximum antenna current if frequency is above 10,000 kc, and returning the power level switch to "OPERATE" position. Be sure to use the same number of quarter wave lengths as in tuning up.

(s) Trailing wire operation will increase the range of the equipment considerably in the frequency range 2000 to 6000 kc and somewhat in the frequency range above 6000 kc.
(4) CW OPERATION INTO FIXED OR TRAILING ANTENNA (200 KC TO 600 KC).
The following procedure is to he used for setting up the transmitter for autotune or manual operation on a desired frequency in 'the low frequency channel.
(a) Place the antenna selector switch on the antenna loading unit in the position which selects the desired antenna.
(b) Make certain that the microphone, key and throttle switch (T.S.) jack circuits are open.
(c) Place "LOCAL-REMOTE" switch in "LOCAL" position.
(d) Place "EMISSION" switch in "VOICE" position.
(e) Place "CHANNEL" switch in 'L. FREQ." position and wait until the autotune stops.
(./) Unlock controls A and C, place control A on position 13 and control C on position 8, and lock them in place. (If "MANUAL" operation is being used, place control A on position 13 and control C on position 8 without unlocking them.)

Note

If the low frequency autotune mechanism should fail, it is only necessary to switch to "MANUAL" and set control A to position 13 and control C to position 8, since low frequency operation is only a switching procedure. It is possible to set the low frequency position on any of the 1 ! channels. It is only necessary to lock control A on position 13 and control C on position 8, on the channel it is desired to use as a substitute for the "L FREQ." position.

(g) Find the desired frequency in the calibration table and note the nearest crystal checkpoint marked in heavy black type.
(h) Set control F to the position corresponding to the number in column F at the crystal checkpoint.
(i) Unlock control G by turning the "LOCK" knob counterclockwise until loose. Then set control G to the position corresponding to the number in column G at the crystal

checkpoint.
(j) Set the power level switch to "CALIBRATE" position and listen in the sidetone circuit for a beat note while rotating control G back and forth about the position given for the crystal check point. Set control G on the position that gives zero beat and turn the power level switch to "TUNE" position.
(k) Set the movable indicating mark by means of the "CORRECTOR" knob near control G to the reading of control G found in column G at the crystal checkpoint.
(/) Refer to the calibration table and obtain the correct setting of control G for the desired operating frequency and set control G to that reading. Lock the dial.
(m) Place "EMISSION" switch on "CW" position.
(n) Check the grid drive to the final amplifier by placing the meter switch on "P.A. GRID" position, closing "TEST" switch, and noting the reading on the meter. It should read in, or slightly above, the light-shaded area marked "P.A. GRID" on the meter. If it does not, check the position of controls A and C.
(o) Place the meter switch on "P.A. PLATE" position.

Note

In certain aircraft an auxiliary plate current meter is located adjacent to the antenna loading unit for convenience in tuning.

(p) Place control P on the antenna loading unit on position 1.(q) Place control Q on position 1.(r) Unlock control R and place it on zero.(s) Hold "TEST" switch closed and rotate control R throughout its range, seeking a plate current dip indicating resonance of the circuit.
(t) If no resonance was found, place control Q on the next higher position, hold "TEST" switch closed, and rotate control R again, seeking the dip in plate current.
(u) Repeat paragraph (t) above until resonance is found or until control Q has been tried on all its positions.
(v) If no resonance was found in paragraph (u) above, set control P on the next higher position, control Q on position 1 and repeat paragraphs (s), (t), and (u) above.
(w) Repeat paragraph (v) above until resonance is found.
(x) When resonance is found, lock control R in the position giving minimum plate current.
(y) This completes the tuning procedure, as there is no provision for exact loading of the transmitter in the frequency range 200 to 600 kc. The plate current may read anywhere between 10 and 120 for normal operation.
(5) VOICE OPERATION.

Note

Voice and MCW operation on fixed wire antennas in the 200 kc to 600 kc range is prohibited because the loading unit is not designed to withstand the high voltages generated with modulation under these conditions. Use CW only on "FIXED ANT." in the 200 kc to 600 kc range.

(a) Adjust the transmitter for "CW" operation and place "EMISSION" switch on "VOICE" position. No further tuning adjustments are necessary.
(b) Be sure the microphone selector switch under the tuning chart on the front panel of the transmitter is in the position corresponding to the type of microphone being used.
(c) Press the button on the microphone or in its cord and hold it depressed while speaking. Release it to listen.

Note

When the meter switch is in "P.A. PLATE" position, the meter indicates the sum of the power amplifier and modulator plate currents and will, therefore, read slightly higher on "VOICE" than on "CW." With normal modulation the plate current meter will read in the red area above the "CW" portion and may hit the meter peg with heavy modulation during normal operation.

(6) "MCW" OPERATION.

Note

Voice and MCW operation on fixed wire antennas in the 200 kc to 600 kc range is prohibited because the loading unit is not designed to withstand the high voltages generated with modulation under these conditions. Use CW only on "FIXED ANT." in the 200 kc to 600 kc range.

(a) Adjust the transmitter for "CW" operation and place "EMISSION" switch on "MCW" position. No further adjustments are necessary.
(b) Key the transmitter for normal operation.

Note

The normal meter reading on "MCW" when the meter switch is in "P.A. PLATE" position, key down, will be in or slightly above the light-shaded area marked "MCW."

(7) ADJUSTMENT OF SIDETONE LEVEL.(a) Lift the chart on the front panel of the transmitter.(b) Listen in the headphones while holding the "TEST" switch closed and adjust the "OUTPUT" control for proper volume of signal. Check the volume on each type of emission; "MCW," "CW," and "VOICE."
(8) USE OF CHART ON FACE OF TRANSMITTER.--After the transmitter has been set on the desired channels, enter the readings of controls A, B, C, D, and E, on the chart on the transmitter. Make these entries after the autotune has been channeled into each channel set up and after the operation has been checked. Set the indicating mark for control B with the zero line of the vernier directly above the dial and record the reading of the dial with the indicating mark in that position. This will enable the operator to check the settings even after the movable indicating mark has been adjusted to set up another channel. If the shunt capacitor is necessary on any of the

frequencies set up, write the number of sections required following the number of channel in the left hand column. Record the settings of controls F, G, P, Q, and R on the lower line. Set the movable indicating mark on control G directly above the dial to obtain its reading, then record whether P, Q, and R are settings for fixed or trailing antenna in the left hand column in the same position used for indicating sections of the shunt capacitor in the upper lines. To minimize tuning in the air, leave controls P, Q, and R on the positions for fixed antenna operation and record the positions for trailing antenna on the chart or reverse the order if desired. If two frequencies in the range 200 to 600 kc are to be used, one may be set on the controls (F, G, P, Q, and R) and the other recorded on the chart. Which of the above methods is chosen for use of the chart for low frequency operation will depend on tactical considerations.

(9) PREPARATION FOR OPERATION.--This transmitter uses tubes which require at least 30 seconds to warm up before operation. If conditions permit, have the transmitter in readiness for operation by leaving the "EMISSION" switch in "VOICE" position during the entire flight. This is a "standby" condition and eliminates the 30 second delay waiting for the tubes to warm up.

TABLE 2-2. CDA-T CRYSTAL-CONTROLLED OSCILLATOR/MULTIPLIER OPERATION

"A" Dial Position	V-801 -- High Freq. Osc.		V-102 -- 1st. Mult.		V-103 -- 2nd. Mult.		Output Frequency Range (Kc)
	"A-B" Switch Position	Xtal Frequency Range (Kc)	Xtal Freq.	Frequency Range (Kc)	Xtal Freq.	Frequency Range (Kc)	
1	A or B	1670-2400	X 1	1670-2400			1670-2400
2	A or B	2400-3000	X 1	2400-3000			2400-3000
3	A or B	3000-3600	X 1	3000-3600			3000-3600
4	A or B	1800-2000	X 2	3600-4000			3600-4000
5	A or B	2000-2400	X 2	4000-4800			4000-4800
6	A or B	2400-3000	X 2	4800-6000			4800-6000
7	A or B	2000-2400	X 1	2000-2400	X 3	6000-7200	6000-7200
8	A or B	2400-3000	X 1	2400-3000	X 3	7200-9000	7200-9000
9	A or B	3000-3600	X 1	3000-3600	X 3	9000-10800	9000-10800
10	A or B	3600-4000	X 2	3600-4000	X 3	10800-12000	10800-12000
11	A or B	2000-2400	X 2	4000-4800	X 3	12000-14400	12000-14400
12	A or B	2400-3000	X 2	4800-6000	X 3	14400-18100	14400-18100

TABLE 2-3. VFO OSCILLATOR/MULTIPLIER OPERATION

"A" Dial Position	V-101 -- High Freq. Osc.	V-102 -- 1st. Mult.	V-103 -- 2nd. Mult.	Output Frequency

	S-101	C-101 C-135 Switched	Frequency Range (Kc)	M.O. Freq.	Frequency Range (Kc)	M.O.Freq.	Frequency Range (Kc)	Range (Kc)
1	Closed	In	1000-1200	X 2	2000-2400			1670-2400
2	Open	Out	1200-1510	X 2	2400-3000			2400-3000
3	Closed	In	1000-1200	X 3	3000-3600			3000-3600
4	Open	Out	1200-1510	X 3	3600-4000			3600-4000
5	Closed	In	1000-1200	X 4	4000-4800			4000-4800
6	Open	Out	1200-1510	X 4	4800-6000			4800-6000
7	Closed	In	1000-1200	X 2	2000-2400	X 3	6000-7200	6000-7200
8	Open	Out	1200-1510	X 2	2400-3000	X 3	7200-9000	7200-9000
9	Closed	In	1000-1200	X 3	3000-3600	X 3	9000-10800	9000-10800
10	Open	Out	1200-1510	X 3	3600-4000	X 3	10800-12000	10800-12000
11	Closed	In	1000-1200	X 4	4000-4800	X 3	12000-14400	12000-14400
12	Open	Out	1200-1510	X 4	4800-6000	X 3	14400-18100	14400-18100

c. SIMPLIFIED PROCEDURE FOR SETTING THE CONTROLS.
(1) GENERAL.--The following procedures are for setting the controls using the approximate dial settings following the calibration tables.
(2) "CW" OPERATION INTO FIXED ANTENNA (2000 KC TO 18,100 KC).
(a) Follow instructions in paragraphs 6b(2) (a) through (s), this section.
(b) Set controls C, D, and E to the positions indicated in the table of approximate dial settings for the desired frequency. (Table 6-11 in this manual.)
(c) If control C is on position 7 or below:
1. Hold "TEST" switch closed and adjust control E to the position at resonance indicated by the dip in plate current.
2. Place the power level switch on "OPERATE" position.
3. If the plate current meter reading is above the area marked "CW," move control D a few divisions lower and readjust control E for minimum plate current. Repeat until the plate current reading is in the area marked "CW." If the plate current meter reading is below the area marked "CW," move control D a few divisions higher and readjust control E for minimum plate current. Repeat until the plate current reading is in the area marked "CW." Do not leave the controls on an) position other than that at the resonance dip. Lock controls C, D, and E.
(d) If control C is on position 8 or above:
1. Hold "TEST" switch closed and adjust control D to the position at resonance indicated by the dip in plate current.
2. Place the power level switch on "OPERATE" position.
3. If the plate current meter reading is above the area marked "CW," move control E a few divisions lower and readjust control D for minimum plate current. Repeat until the plate current reading is in the area marked "CW." If the plate current meter reading is below the area marked "CW," move control E a few divisions higher and readjust

control D for minimum plate current. Repeat until the plate current reading is in the area marked "CW." Do not leave the controls on any position other than that at the resonance dip. Lock controls C, D, and E.

Figure 2-10. Antenna Loading Unit CU-32/ART-13A -- Front View

(3) "CW" OPERATION INTO FIXED OR TRAILING ANTENNA (200 KC TO 600 KC).
(a) Follow instructions in paragraphs 6b(4), steps (a) through (0).
(b) Set controls P and Q on the positions indicated in the table of approximate dial settings for the frequency below the desired frequency. Be sure to use the column under the correct length of antenna.
(c) Follow the instructions in the regular procedure starting with paragraphs 6b(4) (s), this section.
d. PROCEDURES FOR SETTING THE CONTROLS OF RADIO TRANSMITTING SET AN/ART-13B (MANUAL OR AUTOTUNE OPERATION)
(1) GENERAL--Radio Transmitting Set AN/ ART-13B employs both variable frequency oscillator (VFO) operation and crystal-controlled (XTAL) operation. When operated as a VFO transmitter, utilizing Oscillator O-17/ART-13A, procedures for setting all controls are exactly as outlined for Radio Transmitting Set AN/ART-13A in paragraph b. of this section. For VFO operation on the high frequency range, with the CDA-T Oscillator in use, the transmitter controls are set as outlined for the AN/ART-13A, with the addition of one operation; that is the setting of the "VFO-XTAL" switch, on the CDA-T panel, to "VFO".
Crystal-controlled operation is obtainable only with use of the CDA-T Oscillator unit, and its "VFO-XTAL' switch turned to "XTAL". "MANUAL" operation is not possible with crystal-controlled operation. All transmitter and loading coil adjustments for crystal-controlled operation (excepting the frequency controls "A" and "B") are performed the same as described in paragraph b. of this section. Crystal-controlled frequency adjustment procedures are as follows.

Figure 2-11. Crystal Controlled Oscillator Unit (CDA-T) -- Front Side View

(2) FREQUENCY ADJUSTMENTS---CRYSTAL CONTROLLED OPERATION.--Since manual control is inoperative with crystal-controlled operation, ten high frequency and one low frequency channels are available with autotune selection. Through use of an "A-B" switch on the CDA-T panel, two frequencies are available on each of the ten high frequency "CHANNEL" switch positions. A 4-position switch, also on the CDA-T panel, permits selection of four low frequencies with the "CHANNEL" switch in the "L.FREQ." position.
(3) HIGH FREQUENCY RANGE.--Utilizing the "A-B" switch, two frequency channels are available on each of the autotune "CHANNEL" switch positions, 1 through 10. Selection of frequencies with the 1670 to 18,000 Kc. range are limited only by the available crystals and the individual range of each setting of the transmitters "A" control. "CHANNEL" switch positions of the autotune mechanism are not restricted to any particular setting of the "A" control and several frequency outputs within a narrow frequency range are possible, providing crystals are available for each channel desired. The crystal frequency used, however, must be suitable for the frequency range of the chosen "A" control setting. Table 2-2 lists the frequency range of each position of control "A" and the crystal frequency required for each of these output ranges.
(a) Place the antenna selector switch on the antenna loading unit on "FIXED ANT." position. Make certain that the microphone, key and throttle switch (T.S.) jack circuits are open.
(b) Place "LOCAL-REMOTE" switch in "LOCAL" position, the "VFO-XTAL" switch in "XTAL" position and the "A-B" switch in the "A" position. Turn the "EMISSION" switch to "VOICE".
(c) Check crystals for proper seating and frequency. Channel the autotune to position 1. When cycling has stopped, check the frequency range of the control "A" setting, to be sure it is suitable for the crystal employed. If not suitable, change either the crystal or retune control "A" to the proper frequency range setting. Lock this control. Unlock the other transmitter controls; set control "C" to position 1.
(d) Place "EMISSION" switch on "CW" position. Check the grid drive to the final amplifier by placing the meter switch on "P.A.GRID" position, closing the "TEST" switch, and noting the reading on the meter. If no reading, or a very low reading is observed, close the "TEST" switch, at the same time varying the "B" control setting. The grid drive indication will vary as the 'B" control setting is changed. Adjust this setting for maximum grid drive reading.
(e) Set the remaining transmitter loading controls, as described in paragraph b. to obtain proper P.A. Plate dip indication, and maximum antenna current reading.
(f) Channel the autotune to channel 2, and when cycling starts, turn the "CHANNEL" switch back to position 1. Again check the grid drive and P.A. Plate readings, which should be approximately the same as previously obtained.
(g) Channel the autotune to each of the remaining nine high frequency channels and tune as outlined for channel 1.
(h) If two frequency outputs are desired for any one position of the "CHANNEL" switch, their frequencies should not be separated by more than 3%. The exact amount of separation possible will be determined by the output frequency and the antenna characteristics into which the transmitter operates. Adjust the setting of control "B" as outlined with the "A-B" switch on "A". Record the setting of this control for maximum grid drive reading. Throw the "A-B" switch to "B" and determine the setting of control "B" for maximum grid drive indication. Finally, set control "B" midway between the two settings obtained with maximum grid drive for the "A" and "B" crystals. Repeat this procedure for all channel switch positions for which two crystals are in use.
(4) LOW' FREQUENCY RANGE.--Utilizing the 4-position selector switch, located on the CDA-T panel, four low frequency outputs within the range of 300 to 500 Kc. are possible. It will be noted that only three low frequency crystal sockets are provided, requiring the use of a dual crystal holder in one socket. Due to the physical limitations of this holder, its two crystals must be within the range of 400 to 500 Kc. Remote control of low frequency operation is possible, only on one frequency, as the 4-position switch must be operated manually and its setting will determine the frequency obtained by the remote control operator.
(a) Place the antenna selector switch on the antenna loading unit in the fixed antenna position. Make certain that the microphone, key and throttle switch (T.S.) jack circuits are open. Place "LOCAL-REMOTE" switch in "LOCAL" position, the "EMISSION" switch in "VOICE" position, the "VFO-XTAL" switch in "XTAL" position, and the 4-position low frequency selector switch in position 1.
(b) Place "CHANNEL" switch in "L.FREQ." position and wait until the autotune stops. Control "A" should stop on position 13. If not in this position when cycling is complete, unlock control and set to 13. Set control "C' to position 8. (Control "B" is not required for low frequency crystal operation.)
(c) Place the meter switch on "P.A. GRID"; the "EMISSION" switch on "CW", and check for grid drive by closing the "TEST" switch and noting the meter reading. P.A.GRID meter readings will be lower than those obtained for the high frequency ranges.
(d) Adjust the variable choke, L-803, located at the top rear corner of the CDA-T unit, to obtain maximum grid drive indication.
(e) Turn the 4-position switch to the remaining three positions, and check for grid drive. Adjust the variable choke, as required, to obtain maximum grid drive reading for each switch position. This choke setting will vary slightly for each of the low frequency output frequencies, and should finally be set to obtain sufficient grid drive with all crystals employed.
(/) Set all other transmitter and loading coil adjustments as outlined in paragraph b. (4) (a) through (y) of this section, to obtain proper P.A. Plate dip indication and maximum antenna current reading. When more than one low frequency crystal is employed, optimum transmitter performance on any one frequency requires readjustment of the variable choke (for grid drive peaking) and the transmitter loading controls, with a resultant lowering of output at the remaining low frequency channels.

SECTION III OPERATION

CAUTION

No transmissions mill be made on emergency (distress) H.F. channels except for emergency purposes. For testing, demonstration or drill purposes, radio equipment will be operated into a non-radiating dummy load instead of an antenna to prevent transmission of false distress signals.

WARNING

This equipment utilizes high voltages which are dangerous to life. Operating personnel must observe all safety regulations. Be sure to turn off the entire equipment before opening top cover of transmitter. High voltage (1150 volts) connections are made to the caps at the tops of some tubes.

1. STARTING AND STOPPING THE EQUIPMENT.

a. TO START.--Turn "EMISSION" switch to "VOICE" position.
b. TO STOP.--Turn "EMISSION" switch to "OFF" position.

2. OPERATION DURING NORMAL USE.

a. Check "LOCAL-REMOTE" switch to make sure it is in the proper position according to whether operation is from the transmitter panel or from the remote control unit.
b. Place the emission switch on "VOICE" and "CHANNEL" switch on the position corresponding to the frequency on which transmission is desired. This may be found on the chart on the front panel of the transmitter.
c. When the red pilot light comes on (it will take about 25 seconds for the Autotune to seek the proper position), place the emission switch on the position corresponding to the type of emission desired, either "VOICE," "CW," or "MCW."

Note

Voice and MCW operation on fixed wire antennas in the 200 kc to 600 kc range is prohibited because the loading unit is not designed to withstand the high voltage generated with modulation under these conditions. Use CW only on "FIXED ANT." in the 200 kc to 600 kc range.

d. The transmitter is now ready for operation. Use either a key or a standard microphone as required by the type of emission chosen.

CAUTION

Under no circumstances should the transmitter be actually operating (key down or microphone pushbutton closed) when "EMISSION" switch is being operated. Such operation, especially at high altitudes, can cause an arc to occur and damage the contacts of relays.

3. CORRECTIVE MEASURES IF NORMAL OPERATION IS NOT OBTAINED.

a. FUSE OR CIRCUIT BREAKER FAILURE.
(1) If Autotune does not run and tubes do not light, press the "TRANS. RESET" button on the front of the dynamotor unit.
(2) If Autotune runs and tubes light but dynamotor does not start, press the "DYNA. RESET" button on the front of the dynamotor unit.
(3) If Autotune runs, tubes light, and dynamotor starts but no transmission is obtained, first check the position of control C by unlocking the dial and rotating it back and forth through a small range while holding "TEST" switch closed. If this results in normal operation, lock control C near the proper number but in such a position that the transmitter will operate even if not exactly on the indicated position. If rotating control C does not result in normal operation, check the fuse on the front panel of the dynamotor unit and if it is blown, replace it with the SPARE fuse.
b. REMOTE CONTROL UNIT OR CABLE FAILURE.
(1) Place "LOCAL-REMOTE" switch on the transmitter panel in "LOCAL" position and operate transmitter from its panel.
c. TUBE FAILURES.
(1) LOW FREQUENCY OSCILLATOR.--Replace with one of the multiplier tubes. This will provide low frequency operation only.
(2) ONE MULTIPLIER TUBE.--Interchange with the low frequency oscillator tube. A tube with a good filament must be in the low frequency oscillator socket at all times. This will provide high frequency operation only.
(3) TWO MULTIPLIER TUBES OR ONE MULTIPLIER TUBE AND THE LOW FREQUENCY OSCILLATOR TUBE.--Put the good tube in the first multiplier socket. Tubes with good filaments must be in the low frequency oscillator and the second multiplier sockets. This will provide operation in the frequency range 2000 to 6000 kc.
(4) SPEECH AMPLIFIER.--Use "CW" operation. No sidetone signal will be available.
(5) AUDIO DRIVER.--Interchange it with the sidetone amplifier. There must be a tube with a good filament in the sidetone socket. This will provide normal operation with the exception of a sidetone signal.
(6) MODULATOR.--Use "CW" operation. The modulator tubes must have good filaments.
(7) DETECTOR AND MCW AUDIO OSCILLATOR.--Interchange it with the crystal oscillator tube. If there is a tube with a good filament in the crystal oscillator socket, all operation will be normal except
the "CFI" will be inoperative. If the tube in the crystal oscillator socket does not have a good filament, only "VOICE" and "CW" operation are possible.
(8) ANY COMBINATION (INCLUDING ALL) OF CRYSTAL OSCILLATOR, MIXER, DETECTOR AND "MCW' AUDIO OSCILLATOR, SIDETONE AMPLIFIER.--There must be a tube with a good filament in the sidetone amplifier socket. "VOICE" and CW operation are available.
(9) ANY COMBINATION (INCLUDING ALL) OF CRYSTAL OSCILLATOR, MIXER, DETECTOR AND MCW AUDIO OSCILLATOR, SPEECH AMPLIFIER, DRIVER, SIDETONE AMPLIFIER, MODULATORS.--There must be tubes with good filaments in the modulator sockets. CW operation is available.

(10) HIGH FREQUENCY OSCILLATOR.--Interchange with the low frequency oscillator. The robe in the low frequency oscillator socket must have a good filament. It may be necessary to reset the frequency of operation since this interchange will cause the oscillator to shift from the original frequency. The tube must be replaced with the proper type as soon as possible. This interchange will provide high frequency operation only.

d. AUTOTUNE FAILURE.--If the Autotune fails to position all dials properly, proceed as follows until proper positioning is obtained.

(1) First turn all controls, that did not position properly, in the extreme counterclockwise direction by hand and then turn them clockwise until they stop.

(2) If that fails, turn "CHANNEL" switch to "MANUAL" and set the controls on the proper position as indicated by the chart on the transmitter and re-resonate by adjusting the tuning control (either D or E) to the plate current dip.

(3) If controls are tight and above procedure fails, loosen the locking bars and set the controls as for "MANUAL" position.

e. ANTENNA LOADING UNIT FAILURE.--Connect the "ANT." post on the transmitter directly to the antenna lead-in. This will provide high frequency operation only.

f. VACUUM SWITCH FAILURE.--Remove the wire from the "ANT." post and connect it to the "COND." post. Add a wire from the "RECEIVER" post on the transmitter to the antenna (either fixed or trailing) not being used for transmission. Be sure the trailing wire is reeled out. This operation may result in damage to the receiver especially if the same frequency is being used for transmission and reception. As a precaution, the wire may be disconnected from the antenna (A) post on the receiver during each transmission period.

g. COLD WEATHER FAILURE:---On certain frequencies where Dial D tunes very sharply, difficulty may be experienced if those frequencies are set up in moderate ambient temperatures and subsequently operated at extremely cold temperatures, or vice versa. This is due to change of inductance with temperature. The condition will occur only in extremes of temperature and can be corrected by resetting Dial D.

SECTION IV THEORY OF OPERATION

Figure 4-1. Radio Transmitting Set AN/ART-13A -- Block Diagram

Figure 4-1A. Radio Transmitting Set AN/ART-13B -- Block Diagram

1. DESCRIPTION OF OPERATION.

a. GENERAL.--A detailed analysis of the theory and function of all parts of Radio Transmitting Sets AN/ART-13A and AN/ART-13B is presented in this section. Model AN/ART-13B duplicates all functions of Model AN/ART-13A, differing from the latter model by the addition of a crystal-controlled oscillator unit, known as the CDA-T. Any reference to the Model AN/ART-13B or crystal-controlled operation, which does not apply to the AN/ART-13A, will be indicated by a separate paragraph with an appropriate sub-title.

Both equipments are designed to provide radio communication by voice, modulated continuous wave telegraphy, or continuous wave telegraphy employing VFO operation over the frequency ranges 200 kc to 600 kc and 2000 kc to. 18,100 kc. In addition to the VFO operation, Model AN/ART-13B provides crystal- controlled operation over the frequency ranges 300 to 500 kc and 1670kc to 18,000 kc. These equipments function as medium power transmitters intended primarily for aircraft use. A distinguishing feature of this equipment is the automatic tuning system known as the "Autotune". By means of the Autotune, the manual functions that are performed to change transmission frequency, can be made automatic and any one of eleven preset transmission channels may be selected. Approximately 25 seconds is required for the Autotune to reset transmitter controls for operation on a new transmission frequency. Remote control of operations required to change the transmission frequency is also made possible with the aid of the Autotune system.

An understanding of the theory and performance of the circuits can be more easily obtained by first examining the contribution made by each major circuit and by following the signal path from origin to the antenna. This can be accomplished by a study of the block diagrams, figures 4-1 and 4-1A; and with the aid of the explanation in the following paragraphs.

b. ORIGIN OF CARRIER FREQUENCY.--The Carrier frequency of both transmitters, for VFO operation, is generated in either of two variable frequency oscillators, depending on the transmission frequency that is selected. One oscillator, which covers the range 200 kc to 600 kc is known as the low frequency oscillator, or "LFO Unit". The second VFO oscillator, covering the range of 1000 kc to 1510 kc, utilizes one or more frequency multiplier stages to produce the high frequency range of 2000 kc to 18,100 kc. For crystal controlled operation (Model AN/ART-13B only), a plug-in crystal unit known as the CDA-T, provides a low frequency output of 300 kc to 500 kc, coupled direct to the Power Amplifier stage and a high frequency output which utilizes one or more of the transmitters frequency multiplier stages to cover a frequency range of 1670kc to 18,000 kc. Tables 2-2 and 2-3 indicate the basic oscillator frequencies for each of the twelve high frequency dial positions, along with the multiplication factors, the frequency multiplier stages used and their frequency output.

(1) VFO OPERATION--MODELS AN/ART- 13A AND AN/ART-13B

(a) HIGH FREQUENCY OSCILLATOR AND MULTIPLIER STAGES.--When transmission frequencies in 2000 kc to 18,100 kc range are required, the V1O1 High Frequency Oscillator is used. Output of this oscillator is fed into the First Frequency Multiplier stage where the frequency is doubled, tripled, or quadrupled as required. Further frequency multiplication is required to obtain frequencies above 6.0 megacycles and a Second Frequency Multiplier stage is provided for that purpose. The second

multiplier acts only as a frequency tripler and is not used for generation of transmission frequencies below 6.0 megacycles. Thus, for transmission frequencies in the range 2.0 to 6.0 megacycles, the Second Frequency Multiplier is disconnected and the output of the First Frequency Multiplier is fed directly to the Power Amplifier stage. For transmission frequencies in the range 6.0 to 18.1 megacycles, the Second Frequency Multiplier is connected into the system and the output of the First Frequency Multiplier is fed to the Second Frequency Multiplier. Output of the Second Frequency Multiplier is then coupled to the Power Amplifier stage.

(b) LOW FREQUENCY OSCILLATOR.--When transmission frequencies in the 200 kc to 600 kc range are required, the Low Frequency Oscillator is used. Output of this oscillator is fed directly to the Power Amplifier Stage. The High Frequency Oscillator and both multiplier stages are not used.

c. MODULATION.--The carrier frequency may be "keyed" for Continuous Wave (CW) or Tone Modulated Continuous Wave (MCW) emission. Voice modulation may also be accomplished. The three types of emission, CW, MCW, or VOICE are selected by means of a manually operated switch knob on the control panel of the transmitter or the control panel of the Control Unit.

d. FIRST AUDIO AMPLIFIER, AUDIO DRIVER, AND MODULATOR.--When voice is used, the input from either a carbon or dynamic microphone is coupled to the First Audio Amplifier Stage. Output of the amplifier is fed to the Audio Driver Stage which develops sufficient audio power to "drive" the Modulator Stage. The Modulator Stage is then coupled to the Power Amplifier to accomplish Voice modulation of the carrier.

e. MCW OSCILLATOR.--A separate audio oscillator, known as the MCW Oscillator, is provided to generate approximately a 1000 cycle tone that is used for modulation of the carrier frequency when MCW emission is selected. The output of the MCW oscillator is coupled to the input of the First Audio Amplifier when transmitter is used for CW or MCW emission. This audible tone then passes through Audio Driver Stage, Modulator Stage, and to Power Amplifier to modulate the carrier. (NOTE: When using CW emission, modulator stage is not in operation thus preventing this audible tone from modulating the carrier.) Operation of the telegraph key will "key" the MCW Oscillator as well as the Carrier Oscillator (High or Iow Frequency Oscillator) and the Power Amplifier Stage.

f. POWER AMPLIFICATION AND ANTENNA COUPLING.--The Power Amplifier Stage provides for power amplification of the modulated carrier. Output of this stage is connected to an antenna loading circuit where power is delivered to the antenna. Two separate antenna loading circuits are provided. The loading circuits in Radio Transmitters T-47A/ART-13 (AN/ART-13A) and T-412/ART-13B(AN/ART-13B) are used for transmission frequencies in the range 1670 kc to 18,100 kc. A separate unit known as Antenna Loading Unit CU-32/ART-13A is equipped with the loading circuits for transmission frequencies in the range 200 kc to 600 kc. Separate output terminals on the transmitter are used to connect both the low frequency and high frequency output to two separate terminals on Antenna Loading Unit CU-32/ART-13A. The low frequency input connects to the loading circuits within the loading unit. Output from these circuits passes to a "break-in" relay also incorporated in the loading unit. This relay also handles the high frequency output of the transmitter. When transmitter is operated in the 1670 kc to 18,100 kc frequency range, the "break-in" relay in Antenna Loading Unit CU-32/ART-13A is not operated and its contacts provide a closed path for connection of high frequency terminal to the antenna directly. When transmitter is operated in 200 kc to 600 kc frequency range, the relay in Antenna Loading Unit CU-32/ART-13A is operated by the telegraph key or microphone switch. The antenna is then connected to the output of the low frequency loading circuits in the unit; thus permitting power to be delivered to antenna whenever the telegraph key or microphone switch is depressed. When the telegraph key or microphone switch is released, the relay reconnects the antenna to the high frequency antenna terminal of the transmitter. The high frequency antenna terminal of the transmitter is connected to the receiver antenna terminal whenever the telegraph key or microphone switch is released thus providing for "break-in" operation of an associated radio receiving set.

g. ANTENNAS.--The output of the Antenna Loading Unit may be connected to either a Trailing Wire or a Fixed Aircraft Antenna. Two separate antenna terminals are provided. A manually operated switch on the Loading Unit is used to select either antenna.

h. SIDETONE AMPLIFIER.--A portion of the output from the Audio Driver Stage is coupled to a separate audio amplifier known as the Sidetone Amplifier. Output from this amplifier is used to operate the headset or a speaker. The Sidetone Amplifier provides for monitoring the code or voice that modulates the carrier. It also provides a means of listening to the output of the CFI Unit that is used in checking calibration of the high or low frequency oscillators. This action is described more fully in the following paragraph.

i. CALIBRATION FREQUENCY INDICATOR ("CFI") UNIT.--This unit, used only with VFO operation, consists of four major circuits which operate to provide a constant 50 kc signal (rich in harmonics) that is then mixed with output of either the high or low frequency oscillator to produce an audible beat note. Calibration of the carrier frequency oscillator can then be checked at numerous points by "zero beating" the 50 kc standard against the carrier frequency oscillator. A beat note will be heard when the carrier frequency or its harmonics are approximately equal to some harmonic of the 50 kc standard.

j. GENERATION.--Generation of the 50 kc signal in the CFI Unit is accomplished by using a circuit known as a regenerative frequency divider. The circuit produces a 50 kc fundamental frequency and harmonic output voltages while using a 200 kc crystal as the controlling standard. The output of the 200 kc Crystal Controlled Oscillator and the 150 kc output of a Frequency Triplet Stage are both fed to a Mixer Stage. The difference frequency (50 kc) is present in the output of the Mixer Stage. A portion of this 50 kc signal is fed back to the Frequency Tripler Stage to provide the 150 kc output of that stage. It is the 50 kc signal that is obtained from' the Mixer Stage that i$ used to "beat against" (or mix with) the carrier frequency oscillator of the transmitter and is introduced into the Signal Detector Stage in the CFI Unit to produce an audible beat note.

k. OUTPUT.--Output from the Signal Detector in the CFI Unit is coupled to the First Audio Amplifier. The audible beat note is further amplified in passing through the Audio Driver Stage and the Sidetone Amplifier to the headset.(2) CRYSTAL-CONTROLLED OPERATION-MODEL AN/ART-13B

(a) HIGH FREQUENCY OSCILLATOR AND MULTIPLIER STAGES.--The high frequency oscillator of the CDA-T unit covers a frequency range of 1670 kc to 3600 kc, and its output is fed to the First Frequency Multiplier stage. The First Frequency Multiplier stage functions as a straight through amplifier or as a doubler, for transmission frequencies in the range of 1.67to 6.0 megacycles, the output of this First Frequency Multiplier stage couples directly to the Power Amplifier. If frequencies between 6.0 and 18.0 megacycles are desired, the output of the First Frequency Multiplier stage is fed to the Second Frequency Multiplier stage which functions as a frequency tripler, whose output couples to the final amplifier.

(b) LOW FREQUENCV OSCIllLATOR.--When transmission frequencies in the 300 kc to 500 kc range are required, the low frequency oscillator of the CDA-T unit is utilized.

Output of this oscillator ii fed directly to the Power Amplifier stage. The high frequency oscillators and the multiplier stages are not used.
(3) CRYSTAL-CONTROLLED OPERATION-HIGH FREQUENCY.--The high frequency oscillator of the CDA-T unit, in conjunction with the frequency multiplier stages of the basic transmitter provide twenty crystal-controlled output frequencies in the range 1670 kc to 18,000 kc. Utilizing the autotune selection system and manually operated controls on the CDA-T panel, any one of these 20 preset frequencies may be selected without circuit readjustments.
(a) Utilizing a modified Pierce crystal oscillator circuit, this high frequency oscillator employs a Type JAN-6AQ5 tube (V801) and operates over the range of 1670 kc to 4000 kc. The output frequency of the oscillator will always be the frequency of the crystal in the circuit. The twenty crystals utilized to cover the above range are divided into two groups, "A" and "B", with ten crystals in each group. Group selection is accomplished by manually operating the "A-B" switch, S801, located on the CDA-T panel. This switch actuates the "A-B" relay (K811) which selects one group of crystals, shorting out the other group. Individual selection of crystals within a group functions through the autotune system, using positions I through 10 of the "CHANNEL" switch. When the autotune has cycled control "A" to the desired position, switch S109 which is mechanically, coupled to the "A" control autotune motor, supplies relay operating voltage to one of the ten crystal relays (KS01 through KS10) which connects the selected crystal to the grid circuit of oscillator tube, V801. Oscillator operation is controlled by opening the cathode lead of V801 as previously described in this section, paragraph 2.d.(2a). Oscillator frequency range for each of the 12 positions of the "A" control are outlined in table 2-2.
(b) The output Of the crystal oscillator is coupled through capacitor C150 and resistor R139 to the input of the First Frequency Multiplier stage. For transmitter output frequencies between 1.67and 6.0 megacycles, this frequency multiplier stage couples directly to the Power Amplifier stage. For frequencies between 6.0 and 18.0 megacycles, the output of the First Frequency Multiplier stage is fed to the Second Frequency Multiplier. The First Frequency Multiplier operates as a straight through amplifier or as a frequency doubler, depending on the transmitter output frequency range desired. For positions 1 through 3 and 7 through 10 of the :"A" control, it is an amplifier with its frequency output the same as the crystal. In positions 4 through 6, 11 and 12 of the "A' control, it .is a frequency doubler, with its output frequency twice that of the crystal.
(c) The .Second Frequency Multiplier stage always operates as a frequency tripler and is used for positions 7 thiough 12 of the "A" control. Its output couples to the Power Amplifier.
(d) All Power Amplifier and Output circuits operate exactly as outlined previously in paragraph 2.g.(6) of this section.
(4) CRYSTAL-CONTROLLED--LOW FREQUENCY.--The low frequency oscillator of the CDA-T unit employs a Type JAN-1625 beam pentode tube V802 in a modified Pierce oscillator circuit to cover the frequency range of 300 to 500 kc. Three crystal sockets, one of which accommodates a dual type crystal holder, permit four channel low frequency operation. Switching from one frequency to another is accomplished through the 4-position rotary switch (S802) which shunts out all crystals not in use. An iron core plate choke (L803) may be varied to obtain resonance and provide maximum oscillator output. Screen and plate voltage for V802 is obtained from a tap on the dynamotor low voltage bleeder. Oscillator operation is controlled by opening the cathode lead of V802 as indicated in figure 4-5A. This cathode returns to ground through switch S114 (which is mechanically operated by the "A" control); through relay K106 (controlled by the "VFO-XTAL" switch S802), and finally through the keying relay contacts K102E. For low frequency operation, control "A" must be in position 13, which couples the oscillator output through the Second Multiplier range switch S103, to the grid of the Power Amplifier tube, V104. Frequency output of this oscillator is always the frequency of the crystal in the circuit.

2. DETAILED ANALYSIS OF MAJOR CIRCUITS.

Simplified schematic diagrams of the basic circuits are presented to complement the discussion. Where Eicor Dynamotor Unit DY-17A/ART-13A is used, basic theory and function apply, but there are differences in reference symbols and circuitry. Referring to Figure 8-41A schematic diagram, note that S2701, S2702 and S2703 correspond to K2705, K2706 and K2704 respectively; also, the filters are sealed assemblies.

Figure 4-2. Power Control Circuits

a. POWER CONTROL CIRCUITS.--Primary power to the dynamotor is controlled by contactors located in Dynamotor DY-17/ART-13A. All relays and contactors which require energizing operate from the 28 V d-c power source. Relays K2705 and K2706 are thermal-operated, overload relays which protect the equipment from damage due to overloads. Relay K2704 is a pressure-operated switch which requires no power; it operates when the atmospheric pressure is reduced to that corresponding to altitudes between 20,000 and 25,000 feet above sea level. Complete control of all power contactors is possible from either the transmitter or the remote position.
(1) Figure 4-2 shows a simplified schematic of the power control circuits.
(2) Relays K2705 and K2706 are normally closed and operate to break the primary circuits when an overload occurs. These relays may be returned to the normal position by pressing the "RESET" buttons located on the Dynamotor Unit. Primary overload relay K2705 is designated as TRANSMITTER RESET and dynamotor overload relay K2706 as DYNAMOTOR RESET. With the overload relays K2705 and K2706 in normally closed positions and the "LOCAL-REMOTE" switch, S107, in the "LOCAL" position, placing the "EMISSION" selector switch, S110, in the "VOICE" position will complete the circuit necessary for the operation of the primary power contactor, K2702. The primary power contactor coil, K2702A, is energized by the circuit through LOCAL-REMOTE switch S107, EMISSION selector switch S110, primary power contactor coil K2702A and the contacts of primary overload relay K2705. When the power control relay, K2702, has operated, the circuit necessary for the operation of the "voice" relay, K104, is completed through the contacts of primary overload relay K2705, primary power contactor contacts K2702B, "voice" relay coil K104A, the contacts of EMISSION selector switch S110, and the contacts of LOCAL-REMOTE switch S107. If the power level switch, S106, is in either the "TUNE" or "OPERATE" position, it is necessary to operate the TEST switch, S104, or to complete the circuit through the throttle switch jack, J 101, MICROPHONE jack J 102, or KEY jack J103, before the dynamotor input relay, K2703A, will operate.

(3) Operating the EMISSION selector switch, SI 10, to the CW position completes the circuit necessary for the operation of CW relay K103, through the contacts of LOCAL-REMOTE switch S107, EMISSION selector switch SILO, and CW relay coil K103A. When the CW relay, K103, has operated, the coil of dynamotor input relay K2703 is energized through the contacts of CW relay K103B, dynamotor input relay coil K2703A, the contacts of safety interlock switch Sl17, the contacts of Autotune limit switch section Sill, motor control relay contacts KIO1B, primary power contactor contacts K2702B, and the normally closed contacts of overload relay K2705.
(4) If the EMISSION selector switch, SI10, is operated to the MCW position, the primary power contactor K2702, is operated by the circuit through the normally closed contacts of overload relay K2705, the coil of primary power contactor K2702, the contacts of EMISSION selector switch SI 10, and the contacts of LOCAL-REMOTE switch SI07. Dynamotor input relay K2703 is energized by the circuit through the normally closed contacts of primary overload relay K2705, motor control relay contacts KIOIB, the contacts of Autotune limit switch section S1 l l, the contacts of safety interlock switch SI 17, dynamotor input relay coil K2703A, the contacts of EMISSION selector switch SI10, and the contacts of LOCAL-REMOTE switch S107. The operation of dynamotor input relay K2703 closes the contacts of this relay and applies power to the motor section of dynamotor D2701 through the normally closed contacts of dynamotor overload relay K2706.
(5) If the power level switch S106 is operated to the "CALIBRATE" position, CW relay K103 is operated through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, CW relay coil K103A and the contacts of power level switch S106. The dynamotor input relay, K2703, is operated by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts K101B, the contacts of Autotune limit switch section S111, the contacts of safety interlock switch S117, dynamotor input relay coil K2703A, and CW relay contacts K103B.
(6) With LOCAL-REMOTE switch S107 in the local position the primary power contactor, KI70I, and the transmitter panel pilot lamp, I101, will be energized when the EMISSION selector switch, SI 10, is in any position other than the "OFF' position. Primal, power contactor K2702 will be operated by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor coil K2702A, the contacts of EMISSION se. lector switch Sll0, and the contacts Of LOCAL-REMOTE switch S107. The pilot lamp, Il01, will be energized through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts K101B, the contacts of Autotune limit switch section SI 11, the contacts of safety interlock switch SI 17, the pilot lamp series resistor, R136, the contacts of LOCAL-REMOTE switch S107 and the contacts of EMISSION selector switch SI 10.
(7) When the LOCAL-REMOTE switch, S107, is placed in the "REMOTE" position, control of all power circuits is transferred from the transmitter panel controls to the controls located on the remote control unit.

Note

Operation of the control panel is identified to that of the control box described below except that there is no key or microphone jack on the panel.

(8) If the EMISSION selector switch, S602, is placed in the "VOICE" position, the primary power contactor, K2702, is energized by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor coil K2702A, the contacts of EMISSION selector switch S602, and the contacts of LOCAL-REMOTE switch S107. To complete the circuit necessary for the operation of the dynamotor input relay, K2703, the telegraph key, S603, must be operated or the microphone jack, J602, circuit must be completed. The "voice" relay, K104, is operated by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, "voice" relay coil K104A, the contacts of EMISSION selector switch S602, and the contacts of LOCAL-REMOTE switch S107. The dynamotor input relay, K2703, is operated by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts K10IB, the contacts of Autotune limit switch section Sill, the contacts of safety interlock switch S117, dynamotor input relay coil K2703, "voice" relay contacts KI04C and telegraph key S602 or microphone jack J602.
(9) When the EMISSION selector switch, S602, is operated to the CW position, the CW relay, Kl03, is operated by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, CW relay coil KIO3A, the contacts of EMISSION selector switch S602 and the contacts of LOCAL-REMOTE switch S107. The operation of CW relay KI03 completes the circuit necessary for the operation of dynamotor input relay K2703. Dynamotor input relay K2703 is operated by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts KIO1B, the contacts of Autotune limit switch section S111, the contacts of safety interlock switch S117, dynamotor input relay coil K2703A and CW relay contacts K103B. The operation of the dynamotor input relay, K2703, applies power to the motor section of dynamotor D2701 through the normally dosed contacts of dynamotor overload relay K2705 and dynamotor input relay contacts K2703B.
(10) If the EMISSION selector switch, S602, is operated to the MCW position, primary power contactor K2702 is held operated and dynamotor input relay K2703 is energized through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts K101B, the contacts of Autotune limit switch section S111, the contacts of safety interlock switch S117, dynamotor input relay coil K2703A, the contacts of EMISSION selector switch S602 and the contacts of LOCAL-REMOTE switch S107.
(11) LOCAL-REMOTE CIRCUITS
(a) AN/ART-13A
With LOCAL-REMOTE switch S107 in the "REMOTE" position the primary power contactor, K2702, and the pilot lamp, I601, are energized when EMISSION selector switch S602 is in any position other than the "OFF" position. Primary power contactor K2702 is energized through the normally dosed contacts of primary overload relay K2705, primary power contactor coil K2702A, the contacts of EMISSION selector switch S602, and the contacts of LOCAL-REMOTE switch S107. The pilot lamp, I601, is energized by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts K101B, the contacts of Autotune limit switch section S111, the contacts of safety interlock switch S117, pilot lamp series resistor R136, the contacts of LOCAL-REMOTE switch S 107 and the contacts of EMISSION selector switch S602.
(b) AN/ART-13B

Supplementing the LOCAL-REMOTE circuits as outlined in the preceding paragraph, the AN/ART-13B utilizes an additional single pole, double throw wafer on "LOCAL-REMOTE" switch S107. For crystal-controlled operation, this wafer connects to an "A-B" toggle switch on the remote control unit and to the "A-B" relay (K811) and "A-B" switch (S801) of the CDA-T unit. With the "LOCAL-REMOTE" switch in the "LOCAL" position, S801 controls operation of the "A-B" relay, changing the group of crystals as desired. With the "LOCAL-REMOTE" switch in the "REMOTE" position, the "A-B" toggle switch of the remote unit controls the crystal group switching.

(12) The power change relay, K2701, operates when the pressure is reduced to a pressure corresponding to altitudes between 20,000 and 25,000 feet above sea level by the operation of the pressure operated relay, K2704. If the transmitter is operating with VOICE emission, power change relay coil K2701A is energized by the circuit through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts K101B, the contacts of Autotune limit switch section S111, the contacts of safety interlock switch Sl17, power change relay coil K2701A, the contacts of pressure operated relay K2704, the contacts of "voice" relay KI04 and the closed circuit of MICROPHONE jack J102. If the transmitter is operating with CW emission and pressure operated relay K2704 has operated, the operating circuit for power change relay IC2701 is through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts K10IB, the contacts of Autotune limit switch section Sill, the contacts of safety interlock switch S117, power change relay coil K2701A, the contacts of pressure operated relay K2704 and CW relay contacts K103B. If the transmitter is operating with MCW emission, the energizing circuit for power change relay K2701 is through the normally closed contacts of primary overload relay K2705, primary power contactor contacts K2702B, Autotune motor control relay contacts KIO1B, the contacts of Autotune limit switch section S111, the contacts of safety interlock switch S117, power change relay coil K2701A, the contacts of pressure operated relay K2704, the contacts of EMISSION selector switch SIIO or S602 and the contacts of LOCAL-REMOTE switch S107.

Figure 4-3. Filament Circuits

Figure 4-3A. Filament Circuits -- AN/ART-13B

b. FILAMENT CIRCUITS.--The filament power circuits of the transmitter are a combination of series and parallel connections. The filaments are supplied with power from the 28 volt d-c source. Figure 4-3, covering Model AN/ART-13A and Figure 4-3A covering Model AN/ART-13B, show the filament circuits in simplified form. All filament power is controlled by primary Power contactor contacts K2702. The primary overload relay, K2705, operates to break the filament circuit when an overload occurs in the filament or associated circuits.

Figure 4-4. High Voltage Circuits

c. HIGH VOLTAGE CIRCUITS.--Figure 4-4 shows, in simplified form, the high voltage circuits employed in the equipment.(1) The dynamotor employs an armature with dual windings and two commutators to give output voltages of 400 volts d.c and 750 volts d-c. (The unit has slightly higher output voltages of 410 ans 780.) To obtain the high voltage necessary for application to the power amplifier and modulator tubes, the 400 volt .output is connected in' series with the 750 volt output of the dynamotor. On the diagrams, figure 4-4 and figure 8-42 the low voltage section of the dynamotor is designated as G1 and the h{gh Voltage section is designated as G2. When the power change relay, K2701, is in the normal position the positive lead from low voltage dynamotor section G1 is connected to the negative lead of high voltage dynamotor section G2 through the contacts of power change relay K2701, and milliammeter multiple resistor R2701B. The circuit necessary to energize the coil of power change relay K2701 is completed by the operation of the pressure-operated relay, K2704. When power change relay K2701 operates, the negative lead of high voltage dynamotor section 02 is disconnected from the positive lead of low voltage dynamotor section G1 and is grounded through milliammeter multiplier resistor R2701A and B and the contacts of power change relay K2701. Spark suppressing circuits have been incorporated in the output circuits of the dynamotor to suppress the sparks generated at the motor and generator brushes.

d. EMISSION SELECTION AND CARRIER CONTROL.(1) The "EMISSION" selector switch SI10 is a combination transmitter "ON-OFF" switch and "EMISSION" selector switch. Operating "EMISSION" selector switch S110 to the "VOICE," "CW" or "MCW" position will operate the primary contactor K2702 (see fig. 4-5). (Note: Refer to paragraph 3a, this section for detailed explanation of the operation of primary power cootactor K2702.) Selecting "VOICE" emission by the operation of "EMISSION" selector switch S110 operates "VOICE" relay K104. "VOICE" relay contacts K104B disconnect the output of the "MCW" oscillator tube, V2203, from the input to the speech amplifier. "VOICE" relay contacts KI04C connect the coil of dynamotor input relay K2703 to the emission control circuits of throttle switch jack J101, "MICROPHONE" jack J102, "KEY" jack J103 and the "TEST" switch, S104. Selecting "CW" emission completes the circuit necessary for the operation of "CW" relay KI03. "CW" relay contacts K103D complete the circuit necessary for the operaiion of dynamotor input relay K2703 which, in turn, applies primary power to the dynamotor, D2701. Selecting "MEW" emission operates dynamotor input relay K2703 directly.

Figure 4-5. Emission Selection and Carrier Control Circuits AN/ART-13A

(2)MODEL AN/ART-13A (Fig. 4-5).--The r-f carrier is keyed by opening the cathode circuit of the oscillator and removing the screen voltage from the power amplifier. The keying relay, gl02, has six sets of contacts. The contacts K102E complete the oscillator cathode circuit by grounding resistor RI31. Keying relay contacts KIO2E and resistor R131 serve as a cathode return for both the h-f oscillator tube, V101, and the l-f oscillator tube, V2601. The desired oscillator circuit is selected by the operation of oscillator selecting switch 5114 which operates in conjunction with Control A.

Figure 4-5A. Emission Selection and Carrier Control Circuits AN/ART-13B

(3A) MODEL AN/ART-13B (Fig. 4-5A).--The r-f carrier is keyed by opening the cathode circuit of the oscillator and removing the screen voltage from the power amplifier. Selection of the channel and method of operation (VFO or XTAL) is accomplished by switching the cathode ground return lead to the desired oscillator. Switch SI14, mechanically controlled by the "A" control dial, selects the frequency band. Positions 1 through 12 of control "A" permit operation in the high frequency band; position 13 the low frequency band. Choice of operation, XTAL or VFO, is controlled by switch S802 and relay K106. With switch 5802 turned to "XTAL", relay K106 is energized. This relay shorts out RI31, and depending on the setting of the "A" control, grounds the crystal oscillator cathode (V801 or V802) through S114 and keying relay contacts K102E. With switch S802 turned to "VFO", the cathode of the high frequency oscillator V101 is grounded through K106A, S1l14, R131 and K102E.
(4) The "MCW" oscillator tube, V2203, is in operation whenever keying relay K102 is in the operated position. The voltage developed across the resistor, R2201, is applied to the input of the 1st Audio Amplifier through "VOICE" relay contacts K104B, the contacts of power level switch: S106 and the input transformer, T201. Keying relay contacts K102F apply plate voltage to MCW oscillator tube V2203. During periods of "CW" transmission the output of the "MCW" oscillator is fed through the First Audio Amplifier and Audio Driver to the sidetone amplifier and the keying may be monitored by listening to the output of the sidetone amplifier. When power level switch S106 is in the "CALIBRATE" position, the circuit from the output of the "MCW" oscillator to the input of the First Audio Amplifier is broken. Also, with the power level switch S106 in the "CALIBRATE" position, voltage is removed from the screen grid of power amplifier tube V104 and this grid is connected back to the control grid of the same tube through a pair of contacts on switch St06. This connection permits negative voltage on control grid to be applied to screen grid and thereby cuts off output from power amplifier stage. The keying relay, K102, may be operated by closing the circuits of the Throttle Switch jack, J101, the "MICROPHONE" jack, J102, or the "KEY" jack, J103, or by operating the "TEST" switch, S104. Keying interlock switch S 113D is operated in conjunction with output network switch S113, and breaks the energizing circuit to the coil of keying relay K102 when output network switch S113 is operated, thus removing excitation from the R-F circuits to prevent arcing at the switch contacts. The Autotune limit switch section, S111l, and Autotune motor control relay contacts K101C are also connected in series with keying relay coil K102A so that when Autotune limit switch section S111 or Autotune motor control relay K101 operates, the holding circuit for keying relay K102 will be broken arid arcing at all switch contacts will be prevented.

Figure 4-6. Speech Amplifier Circuits

e. AUDIO CIRCUITS.--The audio system consists of a two stage speech amplifier, push-pull modulators, a sidetone amplifier, and an "MCW" audio tone oscillator, See simplified circuit in figure 4-6. (1) SPEECH AMPLIFIER.--Either of two types of microphones may be used with the equipment. The input to the speech amplifier has been designed so that by operating a switch, proper connections are made to the "MICROPHONE" jack J102, to match the output of either a carbon or dynamic type of microphone. The microphone circuit selector switch, S201, is located beneath the tuning chart on the front panel of the transmitter (see fig. 2-2). If microphone circuit selector switch S201 is placed in the "CARBON" position, the bleeder composed of R201, R202, R203, and R204 connected between the positive terminal of the 28-v d-c power source and ground (Br. earth) provides the voltage necessary for the operation of the carbon type of microphone. The operation of microphone circuit selector switch S201 also connects limiting resistor R203 between "MICROPHONE" jack J102 and the input circuit of the speech amplifier to reduce the level of the output of the carbon microphone to the level of the output of a dynamic microphone. Thus, no audio gain control has been provided because the level of the input to the speech amplifier is the same when using a dynamic microphone as it is when using a carbon microphone. If microphone circuit selector switch S201 is placed in the 'DYNAMIC' position, the voltage is removed from the input circuit and the "MICROPHONE" Jack, J 102, is connected in series with limiting resistor R216 and the primary of the input transformer T201. The two stage speech amplifier employs a Type JAN-12SJ7 1st Audio Amplifier tube, V201, and a Type JAN-6V6GT audio driver tube, V202. The output of the microphone is coupled by the input transformer, T2015 to the grid of 1st Audio Amplifier tube V201. The output nit 1st Audio Amplifier tube V201 is coupled to the grid of audio driver tube V202 by the capacitor C204. The output of audio driver tube V202 is coupled to the grids of the modulator tubes, V105 and • 106, by driver transformer T202.

Figure 4-7. Modulator Circuit

(2) MODULATOR.--The modulator employs two Type JAN-811 high-mu triodes connected in push-pull, and operating Class B. The modulators are capable of modulating the carrier (100 watts nominal) at least 90% with full voltage applied to the power amplifier. While the JAN-811 is essentially a zero bias tube when used with plate voltages as high as 1150 volts d-c, it becomes necessary to apply some bias to the grid of the tube to keep the static plate current as low as practicable. In this application the bias is obtained from the 28-volt d-c supply by utilizing the average voltage drop through the filaments of the tubes to obtain equal voltage for application to the grids of both modulator tubes. The output of the modulators is coupled to the r-f circuit by modulation transformer T101 (see fig. 4-7). Both the screen and plate of the final amplifier tube, V104, are modulated. The full output voltage of the dynamotor 1150 volts d-c, is applied to the plates of the modulator tubes, V105 and V106. "CW" relay contacts K103B remove plate voltage from the modulators when 'CW" emission is selected.

Figure 4-8. Sidetone Amplifier Circuit

(3) SIDETONE AMPLIFIER.--A sidetone amplifier is incorporated in the same unit as the two stage speech amplifier.
The amplifier employs a Type JAN-6V6GT beam pentode tube, V203. The output of the audio driver tube, V202, in addition to being applied to the primary of driver transformer T202, is applied to a voltage dividing system consisting of C206, R211 and R212. (See fig. 4-8). The grid of the sidetone amplifier tube, V203, is coupled to the junction of R211 and R212 and the voltage developed across resistor R211 drives the grid of V203 to provide sufficient output from the sidetone amplifier to operate headphones or speaker. The output of sidetone amplifier tube V203 is coupled to the "SIDETONE" jack, J104, by "SIDETONE" impedance matching transformer T203 through sidetone "OUTPUT" switch S202 and keying relay contacts K102C. The turns-ratio of "SIDETONE" impedance matching transformer T203 may be varied by operating the sidetone "OUTPUT" switch S202. The output of the sidetone amplifier is keyed by the operation of keying relay K102. The "SIDETONE" jack, J 104, may be connected in parallel with auxiliary jack J105 by connecting a jumper between terminals 26 and 27 of cable connector Jl06. The necessary plate and screen voltages for the sidetone amplifier are obtained by tapping the bleeder system of the low voltage output of the dynamotor.

Figure 4-9. MCW Oscillator Circuit

(4) "MCW" OSCILLATOR.--The "MCW" audio tone oscillator utilizes a Type JAN-12SLTGT dual triode tube, V2203. One triode section of this tube is used for the "MCW" audio oscillator and the other triode section is used in conjunction with the CFI Unit which is described in the next paragraph. The "MCW' oscillator is in operation whenever keying relay contacts K102F apply voltage to the plate of "MCW"' oscillator tube, V2203, when keying relay K102 is operated (see fig. 4-9). The audio frequency output of the "MCW" oscillator is controlled by varying "MCW" output control resistor R2201. A screwdriver slot for varying resistor R2201 is accessible through ú hole at the rear of the "MCW-CFI" Unit. The voltage developed across MCW output control resistor R2201is coupled to the input of the speech amplifier through "VOICE" relay contacts K104B and the contacts of power level switch, S106. When "VOICE" emission has been selected, "VOICE" relay contacts K104B disconnect the output of the "MCW" oscillator tube., V2205, from the input circuit of the speech amplifier. During periods of "CW" transmission the "MCW" oscillator is keyed and the output is fed to the input of the speech amplifier. The output of the sidetone amplifier provides a means of monitoring the keying.

Figure 4-107. CFI Oscillator Circuit

/. "CFI" CALIBRATION OSCILLATOR UNIT.--A regenerative frequency divider circuit is employed in the "CFI" Unit to obtain a stable 50-kc fundamental frequency and harmonics that are used to check the frequency of the carrier oscillator of the transmitter. The circuit utilizes a 200-kc crystal as the controlling standard. A simplified schematic diagram of this oscillator is shown in figure 4-10. Both triode sections of a JAN-12SL7GT tube, V2201, a JAN-12SA7 pentagrid converter tube, V2202, and one section of another JAN-12SL7GT tube, V2203, are used in the calibration oscillator. Plate voltage is supplied to these tubes from the low voltage output section of the dynamotor and is applied when the power level switch S106 is operated to the "CALIBRATE" position. Operating power level switch S106 to "TUNE" or "OPERATE" positions removes the plate voltage from the "CFI" tubes and disables the circuit.
(1) The application of plate voltage to the oscillator section of JAN-12SL7GT tube V2201, starts the 200-kc crystal oscillator. This produces a frequency of 200 kc, plus random tube and circuit noises, to appear on the injector grid of JAN-12SA7 mixer tube V2202. The random noises appearing on the plate of JAN 12SA7 excites frequency

tripler section of JAN 12SLTGT tube V2201. Since the plate circuit of this section of JAN-12SL7GT tube V2201 is tuned to 150 kc, only the 150-kc components of the random noises are amplified. This 150-kc component of random noise is then impressed on control grid of JAN-12SA7 mixer tube. Since the plate circuit of the JAN-12SA7 is tuned to 50 kc, the 50-kc difference frequency produced by the combination of a 200-kc voltage and a 150-kc voltage appearing in the JAN-12SA7 tube, is the frequency amplified. This 50-kc voltage continues to excite the second triode section of V2201, which because of its tuned 150-kc plate circuit, triples the frequency and sustains the 150-kc voltage on the JAN 12SA7 grid. The 50-kc voltage appearing on the JAN12SA7 plate becomes the calibration frequency.

(2) One triode section of the second JAN 12SL7GT tube, V2203, is employed as a signal detector. A portion of the 50-kc voltage appearing on the plate of JAN-12SA7 tube, V2202, is coupled to the grid of V2203 by capacitor C2204. Depending upon the transmission frequency selected, a portion of the output of the low frequency oscillator or the high frequency oscillator is coupled to the grid of V2203 by capacitor C2206 or C2205. The beat note that is generated in the signal detector is coupled to the input of the first amplifier by capacitor C2209.

(3) When power level switch S106 is operated to the "CALIBRATE" position, the circuit from capacitor C2209 to the input of the first audio amplifier is completed and the output of the signal detector will be heard through the sidetone circuits of the transmitter.

(4) The second triode section of V2203 is utilized as the "MCW" audio oscillator. A description of this circuit is given in paragraph 2e(4) entitled "MCW OSCILLATOR."

(5) The inductor tuning screws that protrude through the sides of the shield cans containing tank circuits Z2201A, Z2201B, Z2202A and Z2202B should not be disturbed for any reason unless the alignment procedure is thoroughly understood. The alignment of these circuits is described in the Maintenance section of this manual.

g. RADIO FREQUENCY CIRCUITS RADIO TRANSMITTING SET AN/ART-13A.--Radio Transmitter T-47A/ART-13 employs two r-f systems. One system covers the frequency range 200 kc to 600 kc and the other system the frequency range 2000 kc to 18,100 kc. Separate oscillator tubes are employed for each frequency range. The same power amplifier tube serves both systems.

Figure 4-11. VFO Low Frequency R-F Circuits AN/ART-13A

(1) LOW FREQUENCY R-F CIRCUITS.--The l-f oscillator employs a Type JAN-1625 beam pentode tube, V2601. This oscillator operates in the frequency range 200 kc to 600 kc. Frequency range is covered in three bands which have the following individual ranges:

200 kc to 285 kc

285 kc to 415 kc

415 kc to 600 kc

A combination of capacitive and inductive grid tuning is employed. The l-f oscillator "COARSE" tuning switch, S2601 (control "E"), varies the grid circuit capacity, by increasing the number of padding capacitors connected in the circuit as the switch is rotated toward the lowest frequency position (see fig. 4-11). Trimmer capacitors have been connected in parallel with the padding capacitors to provide means of fine adjustment of grid circuit capacity. These trimming capacitors are of the ceramic type and the capacity of each may be varied by rotating one plate with respect to the other. In spite of the small physical size, this type of capacitor provides a means of varying the capacity over a wide range. With the end points of the frequency band set and the trimmer capacitors adjusted to give some overlap in each position of l-f oscillator "COARSE" tuning switch S2601, all fine frequency adjustments within the frequency range of each switch position are made by varying the inductance of the inductor L2602. The inductance of L2602 is altered by adjusting the position of the core, which is actuated by a tuning screw. The position of the tuning core within the inductor is determined by control G. When l-f operation is desired and the l-f (13) position of control A has been selected, the cathode circuit of the l-f oscillator tube, V2601 is coupled through the contacts of oscillator selecting switch S114 and bias resistor R131 to keying relay contacts KI02E of keying relay K102. Operation of keying relay K102 completes the cathode circuit to ground. Screen voltage for l-f oscillator tube V2601 is obtained by tapping the dynamotor low voltage output bleeder. The output of l-f oscillator tube V2601 is coupled to the grid of the final amplifier tube, V104, by second multiplier range switch S103 when control A is operated in the l-f position. Selecting l-f operation operates output circuit selecting relay K105 which connects the plate circuit of final amplifier tube V104 to the external loading circuits in Antenna Loading Unit CU-32/ART13A. The h-f output network is completely removed from the circuit by the operation of output circuit selecting relay K105. Output circuit selecting relay contacts K105D remove the shorting connection across the plate choke, L109. Screen voltage for final amplifier tube V104 is obtained from the low voltage output of the dynamotor. The full voltage of the high voltage section of the dynamotor is applied to the plate of final amplifier tube V104. The external loading coil in addition to being an antenna loading coil is also the power amplifier plate tank circuit. A tapped inductor and variometer provides means of adjusting the power amplifier plate tank tuning.

(2) HIGH FREQUENCY R-F CIRCUITS.--The h-f oscillator employs a pentode Type JAN-837 tube, VI01, in a variable frequency oscillator circuit. The oscillator operates within the frequency range 1000 kc to 1510 kc. This frequency range is covered in two bands, 1000 kc to 1200 kc, and 1200 kc to 1510 kc. The band of frequencies within which output is obtained, is dependent on the position of h-f oscillator range switch S101. Capacitors C101 and C135, (see fig. 4-12) are connected in the grid circuit of the h-f oscillator tube V101, by h-f oscillator range switch S101 which is operated by control A. Alternate positions of control A add or remove the padding capacitors C101 and C135. With control A in the 2.0-mc to 2.4-mc position h-f oscillator range switch S101 is closed, giving the maximum grid circuit capacitance