LAFAYETTE®

Model HA-410

(Stock No. 99-2575WX)

10-METER AMATEUR TRANSCEIVER

LRE

LAFAYETTE RADIO ELECTRONICS CORPORATION

INSTALLATION and OPERATING MANUAL

TABLE OF CONTENTS

SPECIFICATIONS

RECEIVER

SENSITIVITY	Less than 1 mv. for 10 db $\frac{s+n}{n}$
SELECTIVITY	±3 Kc at 6 db down, less than ±12 Kc at 50 db down.
INPUT IMPEDANCE	50 ohms (unbalanced).
OUTPUT IMPEDANCE	8 ohms.
TUNING RANGE	28.0 Mc to 29.7 Mc.
IF FREQUENCIES	1st: 5745 Kc; 2nd: 455 Kc.
AUDIO OUTPUT	4 watts.

TRANSMITTER

POWER INPUT	20 watts.
TUNING RANGE	28.0 Mc to 29.7 Mc.
CRYSTAL FREQUENCIES	7.0 Mc to 7.425 Mc.
MICROPHONE	High impedance ceramic with push-to-talk switch.
OUTPUT IMPEDANCE	50 ohms (unbalanced).
TRANSMISSION MODE	Type A3 emission (AM).

GENERAL

AC POWER REQUIREMENTS	117 volts, 60 cps, 160 watts (maximum).
DC POWER REQUIREMENTS	12 volts DC at 14 amperes (maximum).
DIMENSIONS	12-1/8" W. x 5-1/8" H. x 9-1/4" D.
WEIGHT	19 lbs.

GENERAL DESCRIPTION

INTRODUCTION

The Lafayette Model HA-410 is a compact, self-contained 10-meter radio station. Its compact size, ease of mounting, and universal power supply make this unit ideally suitable for operation as a 12 volt DC mobile unit or fixed station operation from a 117 volt, 60 cycle AC power source. The HA-410 covers the entire 10 meter band (28.0 Mc to 29.7 Mc). It is supplied complete with a push-to-talk microphone, power cables for AC and DC operation, and a mobile mounting bracket.

NOTE

AN FCC AMATEUR LICENSE IS REQUIRED BY ANYONE OPERATING THIS EQUIPMENT.

FEATURES

Built-in solid-state universal power supply. Operates from 117 volts AC or 12 volts DC.
Crystal-controlled or VFO transmitter operation.
Built-in TVI filter.
Spot switch.
S-Meter/Relative power indicator.
6CW4 Low-Noise RF amplifier; Crystal-controlled dual conversion IF system.
Built-in speaker.

TUBE AND TRANSISTOR COMPLEMENT

V1	RF amplifier
V2	1st mixer and local oscillator 1
V3	2nd mixer and local oscillator 2
V4	1st IF amplifier and microphone amplifier
V5	2nd IF amplifier
V6	2nd preamplifier and audio power amplifier/modulator
V7	Phase inverter and audio power amplifier/modulator
V8	Frequency doubler driver
V9	RF power amplifier
V10	VFO/Crystal oscillator and buffer amplifier
2SB425 (4)	DC power supply transistor

DIODE COMPLEMENT

1N60	Audio detector
1S72	Noise limiter
1S93 (3)	Rectifier
1S34 (2)	Meter rectifier
5F10	Power supply polarity reversal protection

INSTALLATION

LOCATION

The HA-410 may be placed in any location that will permit free air circulation through the ventilation holes and openings in the cabinet.

In fixed station use, avoid excessively warm locations such as those near radiators and heating vents. Also, avoid direct blasts of air from circulating fans, etc. Do not place any object on the cabinet cover that will impair natural ventilation.

In mobile installations, avoid direct air blasts from heaters or air conditioning units. See Figure 1 for mounting procedure.

CONNECTION TO POWER SOURCE

The HA-410 may be used for 117 volt, 60 cycle AC operation or 12 volt DC operation by selecting th correct power cord and plug assembly.

In fixed installations where a 117 volt AC source will be used, the power cord with the standard two-contact plug on one end is used.

In mobile installations the power lead with the "in-line" fuseholder is used. It is recommended that the bare end of this wire be connected directly to the battery terminal. Connection of this lead to other points may cause reduced voltage, increased ignition interference, etc. If additional length is required, wire no smaller than No. 14 AWG should be used.

The DC power cable must be connected in the following manner. The red (fused) lead should always be connected to the battery terminal which serves as the "hot" side of the system. This means that in a negative ground vehicle, the red fused lead must be connected to the positive battery terminal. In a positive ground vehicle, the red fused lead must be connected to the negative battery terminal. In each case the battery ground switch on the transceiver must be set for the type of ground employed in the vehicle.

NOTE: Make sure the BATTERY GROUND switch is set for the ground polarity of the vehicle in which the HA-410 is to be installed. The HA-410 will not operate unless this switch is in the proper position.

ANTENNAS

The HA-410 is designed for 50-ohm termination; therefore, any 10-meter antenna providing 50-ohm termination may be used. Antenna polarization is very important at these frequencies and should be considered when choosing an antenna. Generally speaking, the antenna polarization should be compatible with that of the stations you will normally be in contact with.

The antenna should be connected to the antenna receptacle on the back of the unit using RG-58/U (RG-8/U is recommended for lengths in excess of 100 feet).

It is important that the antenna be adjusted for the lowest possible VSWR at your normal operating frequency. Additional information on antennas may be found in the ARRL Handbook or in the ARRL Antenna Manual.

HEADPHONES

The headphone jack, located lower right corner, is wired so that the internal speaker is automatically disabled when the headphone plug is inserted.

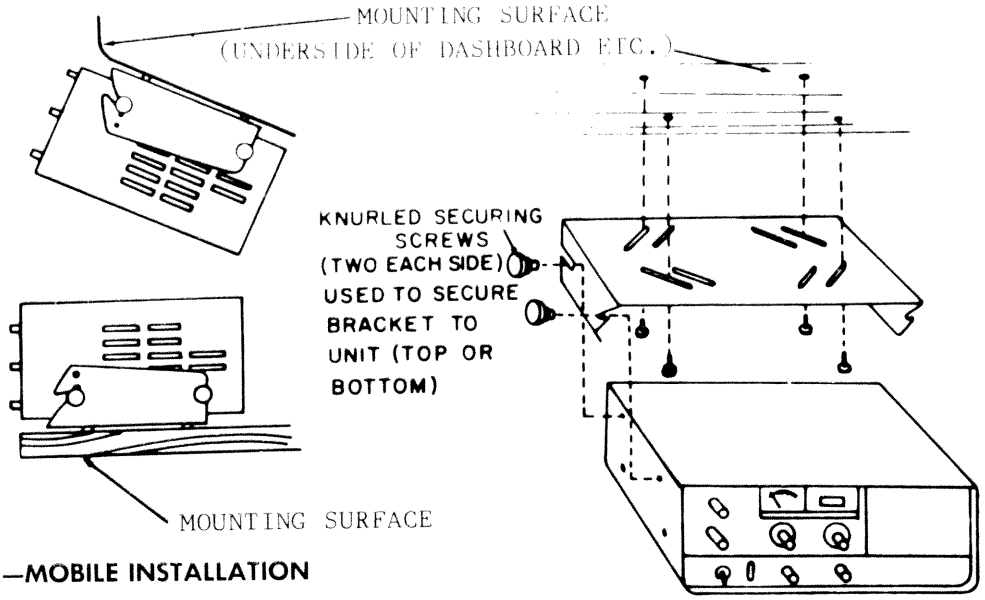

FIGURE 1—MOBILE INSTALLATION

OPERATION

CONTROLS, INDICATORS AND CONNECTORS

The controls, indicators and connectors necessary for the operation of the HA-410 are listed in Table 1.

TABLE 1 CONTROLS, INDICATORS AND CONNECTORS

	Control, Indicator or Connector	Function
(1)	PLATE TUNE Control	Tunes transmitter power amplifier plate circuit for maximum power output.
(2)	S-METER/RELATIVE POWER METER	Receive Mode: Indicates strength of received signal on S-Meter calibrated in S-Units from 1 to 9 and from 10 to 30 db above S9. Transmit Mode: Indicates relative power output of transmitter from 1 to 10 watts.
(3)	SPOT Switch	In the ON position, plate voltage is applied to the transmitter oscillator when in the receive mode. This permits generation of an unmodulated signal which may be tuned in on the receiver to determine the frequency of transmission.
(4)	PHONES Jack	Permits connection of headphones or external speaker (4 - 8 ohms). Insertion of plug into jack automatically silences internal speaker.

(5)	RCVR Tuning Control	Permits receiver tuning over the entire 10-meter band.
(6)	MIC Jack	Permits connection of microphone.
(7)	VOL Control	Adjusts the level of the audio output.
(8)	VFO Tuning Control	Permits transmitter tuning over the entire 10-meter band when in VFO mode.
(9)	XTAL-VFO Switch	Permits selection of either crystal or VFO operation of the transmitter oscillator.
(10)	Crystal Socket	Crystal is inserted in socket when transmitter is operated in XTAL mode.
(11)	POWER Switch	Turns transceiver ON or OFF.
(12)	ANT. LOAD Control	Tunes output portion of pi network for maximum power transfer into antenna load.
(13)	BATTERY GROUND Switch	Selects positive or negative ground for mobile operation.
(14)	BATTERY REVERSAL DIODE	Provides protection against incorrect DC power connection.
(15)	METER ADJ. Control	Provides an electrical zero adjustment for the S-Meter/Relative Power Meter.
(16)	POWER Connector	This eleven pin connector accepts plug connectors (supplied) for direct connection to 115 volt, 60 cps power supply, or to 12 volt DC power supply.
(17)	ANT. Connector	Provides connection for antenna transmission line.

RECEIVER OPERATION

To operate the receiver portion of the HA-410 Transceiver, proceed as follows:

(a) Connect a 10-meter 50-ohm antenna to the ANT receptacle located on the rear of the chassis.

(b) Connect either the AC or DC power cord supplied with the unit to the eleven pin POWER connector located on the rear of the chassis, and an appropriate power source.

(c) Set the POWER switch to ON. The dial window should become illuminated indicating power is applied to the transceiver.

(d) Adjust the VOL control for the desired audio level.

(e) Rotate the RCVR tuning control to the desired frequency.

NOTE: If desired, headphones may be used in place of the internal speaker. To use headphones, simply plug them into the PHONES jack on the front panel. This will automatically silence the internal speaker.

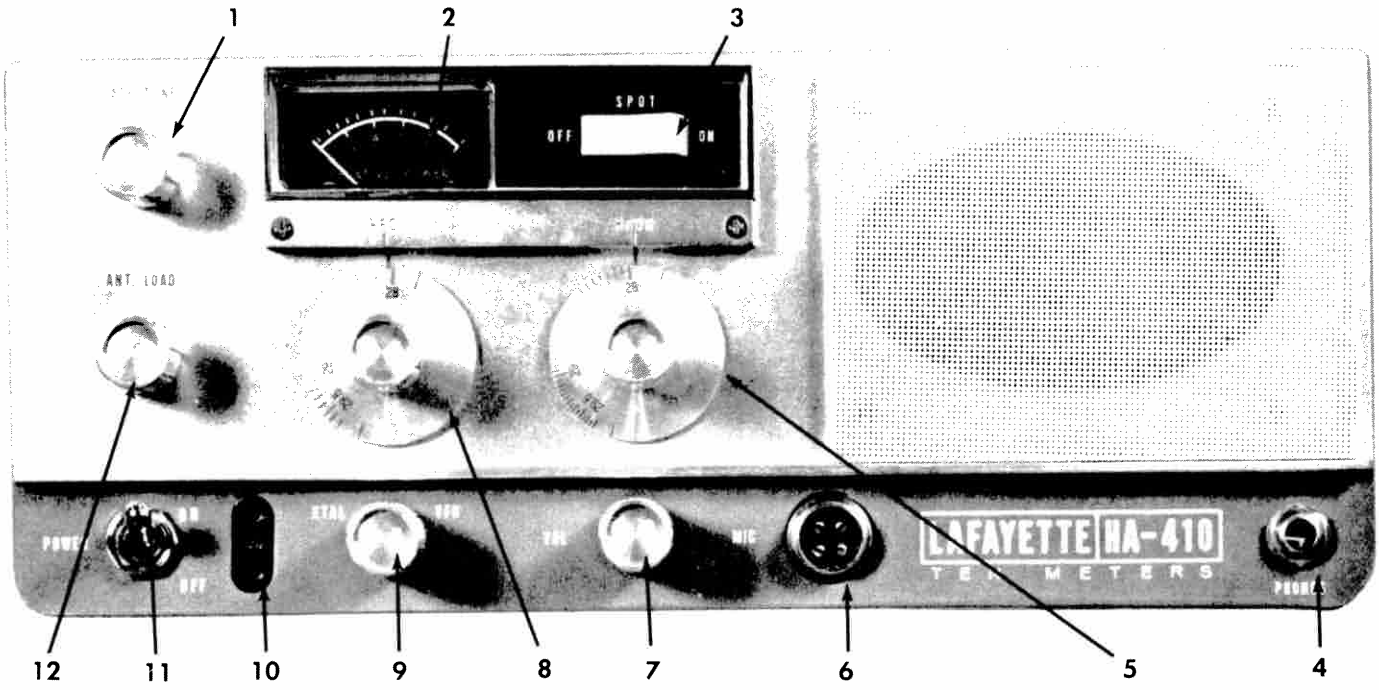

FIGURE 2—OPERATING CONTROLS, INDICATORS AND CONNECTORS (FRONT VIEW)

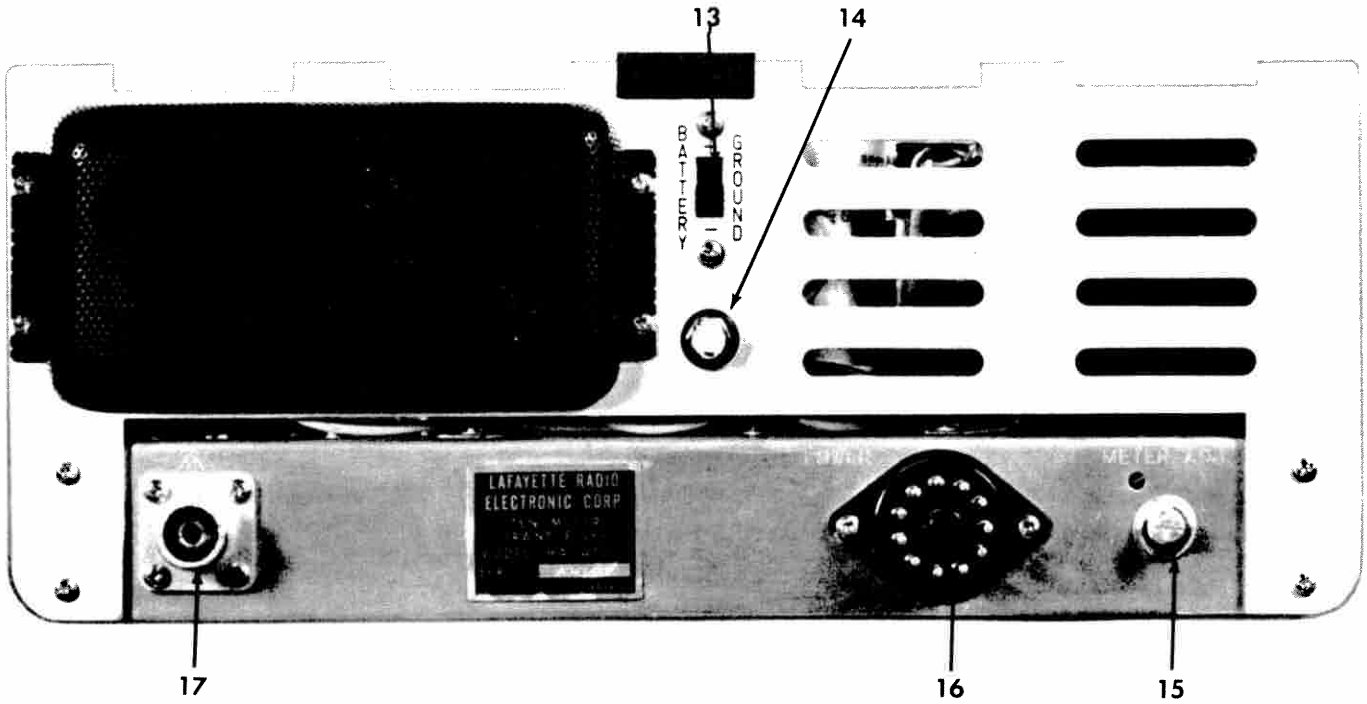

FIGURE 3—OPERATING CONTROLS, INDICATORS AND CONNECTORS (REAR VIEW)

TRANSMITTER OPERATION

To operate the transmitter portion of the HA-410 Transceiver, proceed as follows:

(a) Connect antenna and power source.

(b) Connect microphone to MIC receptacle on front panel.

(c) Set XTAL-VFO switch to the desired mode of operation.

NOTE: If the XTAL mode of operation is chosen, a crystal must be inserted in the socket provided on the front panel. When using this mode of operation, the frequency of transmission is four times the crystal frequency.

(d) If the VFO mode of operation is chosen, tune the VFO tuning control to the desired frequency.

(e) Preset the PLATE TUNE and ANT LOAD controls to mid rotation (black line up).

(f) Set POWER switch to ON. The dial window should become illuminated indicating power is applied to the transceiver.

(g) With microphone push-to-talk button depressed, adjust PLATE TUNING and ANT LOAD controls for maximum meter indication. Repeat adjustments until no further increase in meter reading is obtainable.

NOTE: Any time the operating frequency is changed, the PLATE TUNE and ANT LOAD controls must be readjusted for maximum output.

(h) The transmitter is now ready for transmission. To transmit, press the push-to-talk switch on the microphone and talk into the microphone.

(i) To locate the frequency of transmission on the receiver dial, set the SPOT switch to ON and tune the receiver until a strong unmodulated signal is heard. Then, return the SPOT switch to OFF and proceed with operation of transceiver.

NOTE: Transmitter will not operate with the spot switch in the ON position.

TRANSMITTER CRYSTALS

Crystals are available from Lafayette Radio or any of the well-known crystal manufacturers. To order crystals proceed as follows:

1. Divide the desired operating frequency by 4 to determine the crystal frequency. Example: The desired operating frequency is 29.0 Mc.

$$\frac{29.0}{4} = 7.250 \text{ Mc (crystal frequency)}$$

2. The crystal order to the manufacturer should contain the following information:

Crystal Type ..... FT 243

Crystal Frequency ..... Determined by formula in step 1.

THEORY OF OPERATION

INTRODUCTION

The following presentation of the theory of operation for the HA-410 Transceiver is divided into four parts. The first part deals with the operation of the receiver portion of the transceiver. The second part discusses the theory of operation for the transmitter portion of the transceiver The third part outlines the power supply and the fourth part deals with the S-Meter/Relative power indicator.

RECEIVER

Refer to the receiver block diagram (Fig. 4) while reading the following. If greater detail is desired, refer to the schematic diagram.

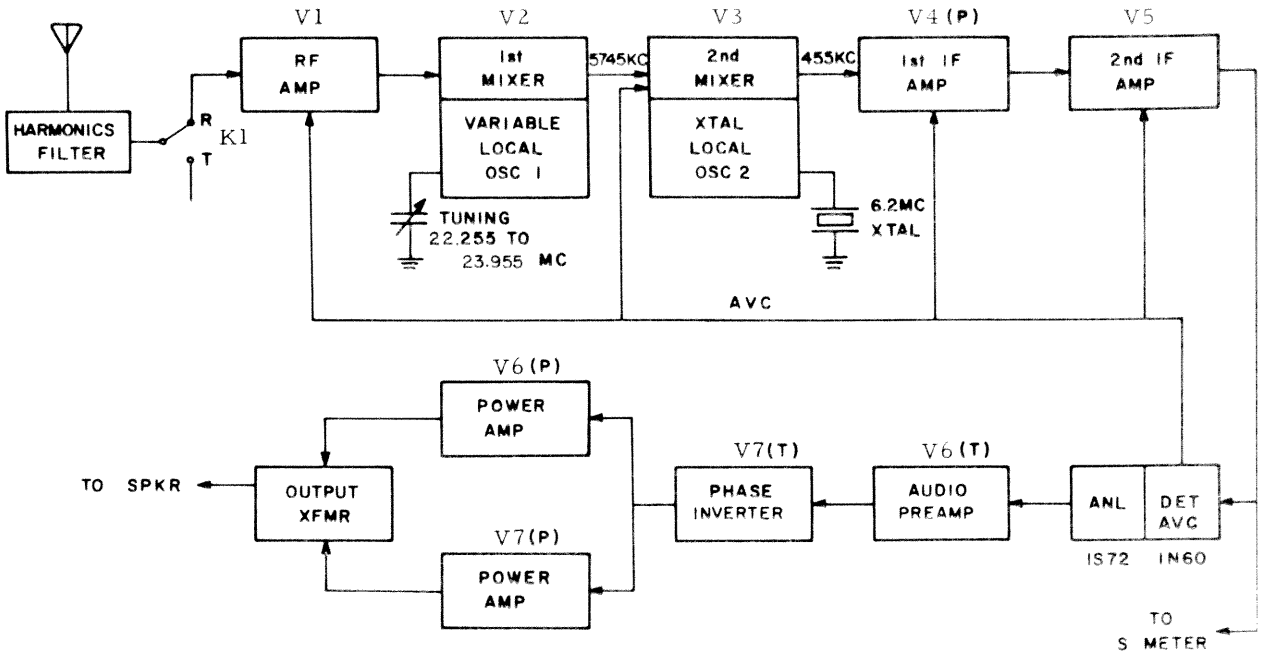

FIGURE 4—RECEIVER BLOCK DIAGRAM

NOTE: (P) = PENTODE SECTION
(T) = TRIODE SECTION

When an RF signal is applied to the antenna of the transceiver, it is fed through the harmonics filter and the change-over relay K1 to the input of the RF amplifier (V1). The RF amplifier (V1) is a low-noise Nuvistor stage.

After amplification by the RF amplifier stage (V1) the RF Signal is fed to the grid of the 1st Mixer stage (V2). The 1st Mixer stage (V2) is the pentode portion of tube V2. The triode section of this tube is variable local oscillator 1. The frequency of the local oscillator is determined by the setting of the RCVR TUNING control and it can be varied from 22.255 to 23.955 Mc. The output of local oscillator 1 is fed to the grid of the pentode portion of V2 where it mixes with the incoming RF signal. The output of the 1st mixer stage is tuned to the first intermediate frequency which is the frequency difference between the two signals applied to its input.

The output of the first mixer V2 is fed to the grid of the pentode portion of the 2nd mixer (V3). The triode portion of V3 is a 6.2 Mc crystal oscillator. The output of the 6.2 Mc crystal oscillator is fed to the grid of the pentode portion of the 2nd mixer V3 where it combines with the 5745 Kc signal fed from the 1st mixer V2. The output of the 2nd mixer V3 is tuned to 455 Kc which is the second intermediate frequency.

The output of the 2nd mixer stage V3 is fed through two stages of IF amplification (V4 and V5) and then to a 1N60 diode detector. The 1N60 diode detector rectifies the IF signal to produce the audio signal and the AVC voltage.

After filtering the AVC voltage is applied to both 455 Kc IF amplifiers, the second mixer, and the Nuvistor RF amplifier to provide automatic volume control.

After filtering the audio signal is fed through a self-adjusting automatic noise limiter to the VOL control. From the volume control the signal is fed to the input of the first audio amplifier V7. After amplification the audio signal is fed to the grid of the triode section of the phase inverter (V6). The phase inverter processes the audio signal and feeds it to the grids of the pentode sections of two tubes (V6 and V7) which operate as push-pull power amplifiers. The output of the push-pull power amplifier is fed to the primary of the output transformer (T5).

The secondary of the output transformer (T5) has two windings. One winding is used to drive the receiver speaker. The second winding is used to modulate the transmitter when relay K3 is in the proper position.

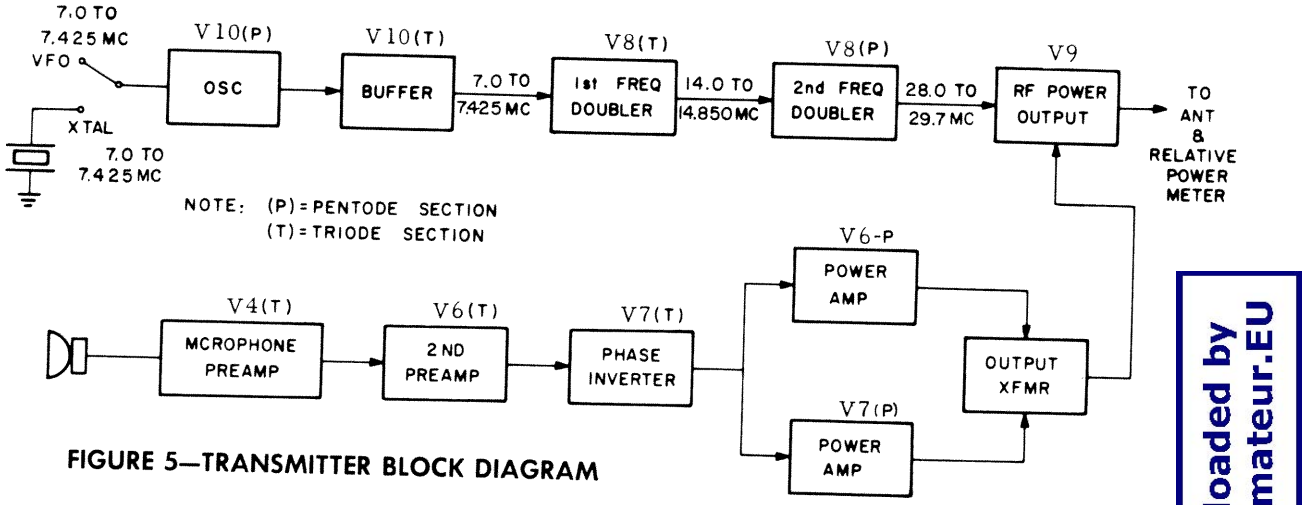

FIGURE 5—TRANSMITTER BLOCK DIAGRAM

TRANSMITTER

Refer to the transmitter block diagram Figure 5 while reading the following. If greater detail is desired at any point, refer to the schematic diagram.

The transmitter signal is generated in the pentode section of the oscillator/buffer stage V10. The oscillator may be either crystal-controlled or used as a VFO. The triode section of the oscillator/buffer stage V10 is a buffer amplifier used to isolate the oscillator from undesirable effects which might be caused by the loading of the following circuitry. The output of the buffer amplifier V10 is fed to the input of the first frequency doubler stage V8.

The first frequency doubler stage is the triode section of tube V8. The first frequency doubler stage doubles the fundamental oscillator frequency and feeds the doubled frequency to the input of the second frequency doubler stage.

The second frequency doubler stage is the pentode section of tube V8 and it doubles the frequency again. The frequency produced at the output of the second frequency doubler stage V8 is four times the fundamental oscillator frequency. The output of the second frequency doubler is fed to the grid of the RF power output stage V9.

The RF power output stage V9 amplifies the signal further and supplies RF power to the antenna through a pi matching network and a harmonic filter.

To modulate the transmitter, an audio signal must be introduced into the microphone. When an audio signal is introduced into the microphone, it is amplified by the triode section of the microphone preamplifier V4. The output of the microphone preamplifier is fed to the triode section of the second preamplifier V6 where it is further amplified. The output of the second preamplifier is fed to the triode section of the phase inverter V7 where two 180^{o} out-of-phase signals are produced to feed the push-pull power output tubes (V6 and V7). The output of the phase inverter is fed to the grids of the pentode sections of the power amplifiers (V6 and V7) which provides the power necessary for high level plate modulation.

The output of the push-pull power amplifiers is used to modulate the RF power output stage V9.

POWER SUPPLY

The power supply of the HA-410 is a universal type capable of operating from 117 volts AC or 12 volts DC power sources.

When operating from 117 volts AC power source, the power supply functions in the usual manner with the AC being applied to the power transformer and rectified by a full wave rectifier and its associated filter network (see schematic diagram).

When operating from a 12 volt DC source, four 2SB425 transistors are used to convert the DC to AC. The AC is then stepped up by the power transformer and rectified to produce the B+ voltage. A polarity reversing switch S1 (See schematic diagram) is furnished so that the power supply may be used on vehicles having either a positive or negative ground.

S-METER/RELATIVE POWER INDICATOR

A unique meter circuit is used to provide indication of operation in both the receive and transmit models. In the receive mode, the screen current of the AVC controlled IF amplifier (V5) is measured by the meter. The indication is proportional to the AVC voltage (or incoming signal strength). The meter is calibrated in "S" units to 9 and in decibels above S-9.

In transmit, a small portion of the RF output signal is rectified and filtered. This rectified voltage is measured by the meter and gives an indication of the relative output of the transmitter.

TROUBLE SHOOTING HINTS

INTRODUCTION

In case a malfunction should develop in the HA-410, the trouble-shooting hints given in Table 2 can be used as a general procedure for locating the defective section of the transceiver. Once the defective section has been located, the voltage measurements given in Table 3 can be used as a reference to further localize the malfunction.

TABLE 2 - TROUBLE SHOOTING HINTS

TROUBLE	WHAT TO LOOK FOR	WHAT TO DO
Unit inoperative Dial light not on	Power source not connected	Connect power source
	Open fuse in 12 volt DC power cord	Check for short and replace fuse
	Defective power cord	Replace or repair power cord
Unit inoperative -- Dial light and tubes are lit	Open fuse in B+ power supply	Check for B+ short and replace fuse
	Defect in B+ power supply	Check out B+ power supply and repair
Transmitter inoperative Receiver operating normally	Defective tube in transmitter section	Check tubes and replace any found to be defective
	Defective microphone push-to-talk switch	Check switch. Repair or replace as necessary
	Defective change-over relay	Check relay and replace if necessary
	Defect in transmitter section	Check voltages in transmitter section using Table 3 as a reference
Receiver inoperative Transmitter operating normally	Defective tube or diode in receiver section	Check tubes and diodes and replace any found to be defective
	Defect in receiver section	Check voltages in receiver section using Table 3 as a reference

TABLE 3 - VOLTAGE MEASUREMENTS

Tube	Operation	PIN NUMBERS											
		1	2	3	4	5	6	7	8	9	10	11	12
V1	RCV	--	80	--	NDV	--	--	--	0	--	H	--	H
	XMT												
V2	RCV	92	NDV	85	H	H	110	1.9	NDV	NDV	--	--	--
	XMT												
V3	RCV	48	NDV	0	H	H	115	116	NDV	2.7	--	--	--
	XMT												
V4	RCV				H	H	115	80	NDV	1.25	--	--	--
	XMT	10	NDV	0	H	H							
V5	RCV	NDV	0.55	H	H	55	57	0.55	--	--	--	--	--
	XMT												
V6	RCV	NDV	0	-33	H	H	292	295	0.5	56	--	--	--
	XMT	NDV	0	-25	H	H	240	245	0.55	65	--	--	--
V7	RCV	25	NDV	0	H	H	292	295	62	205	--	--	--
	XMT	22	NDV	0	H	H	240	245	53	172	--	--	--
V8	RCV												
	XMT	0	NDV	240	H	H	0	NDV	185	240	--	--	--
V9	RCV												
	XMT	0	H	155	0	NDV	0	H	0	--	--	plate	240
V10	RCV												
	XMT	175	NDV	0	H	H	235	175	NDV	0.2	--	--	--

NDV: No detectable voltage.

RETURNING THE UNIT FOR REPAIRS

In the event that repair is necessary (either in or out of warranty), we recommend that you return the transceiver to the Lafayette store from which it was purchased. If the unit is to be shipped to our main office for service, please read the instructions which follow.

SHIPPING INSTRUCTIONS

Pack the unit very carefully to avoid damage in transit, preferably in its original carton. If the original carton is not available, use a sturdy carton with at least 3 inches of shredded paper or excelsior around the unit. In the latter case, wrap the unit in paper first to avoid particles of packing material getting into it. Include with the unit a letter explaining exactly what difficulties you have encountered (remember to add an extra 5¢ postage and indicate on the outside of the carton that First Class Mail is enclosed). Ship by prepaid express if possible and mark ELECTRONIC EQUIPMENT - FRAGILE. Clearly address the carton as follows:

SERVICE DIVISION
LAFAYETTE RADIO ELECTRONICS CORP.
111 JERICHO TURNPIKE
SYOSSET, L.I., N.Y. 11791

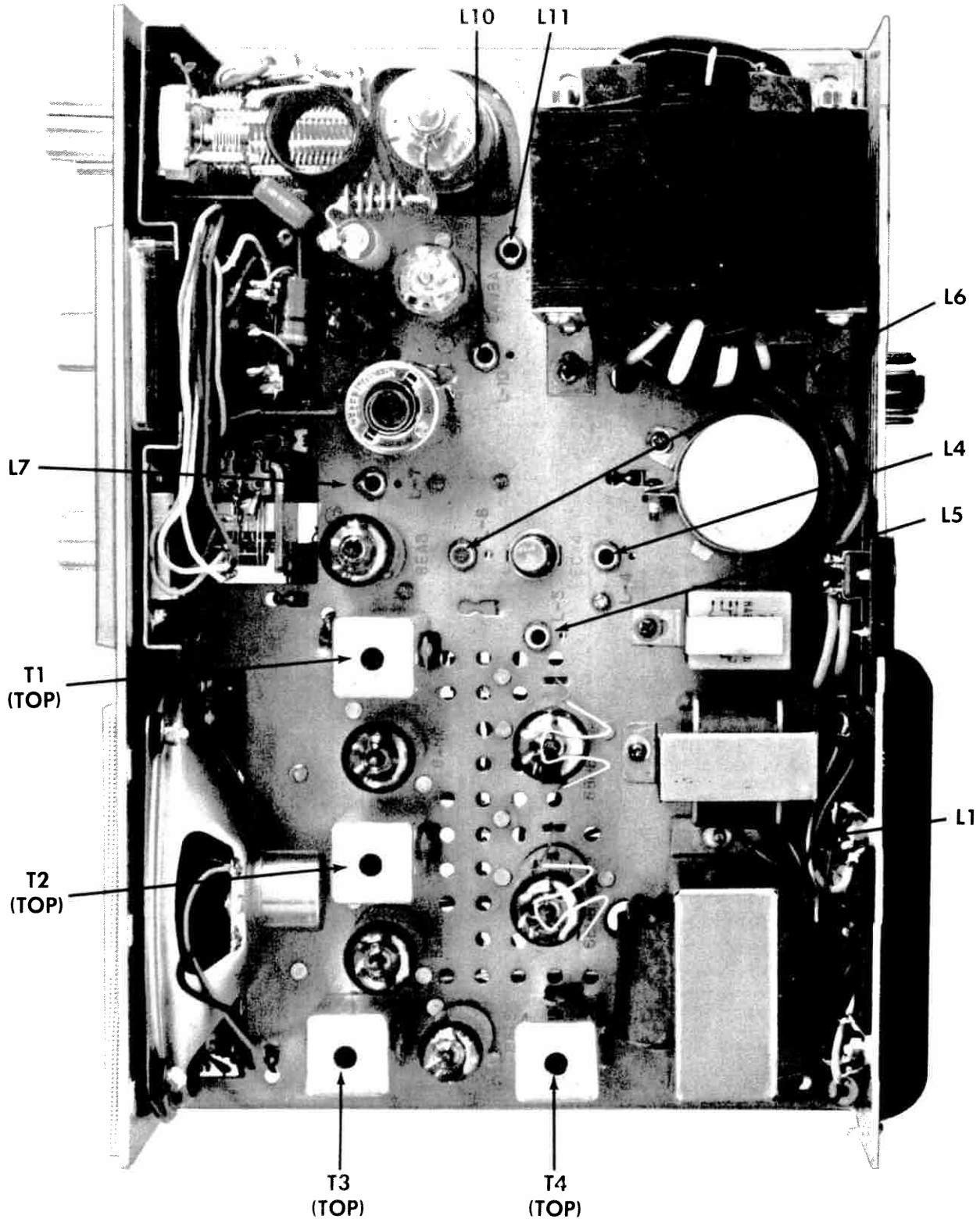

FIGURE 6—ALIGNMENT POINTS (TOP VIEW)

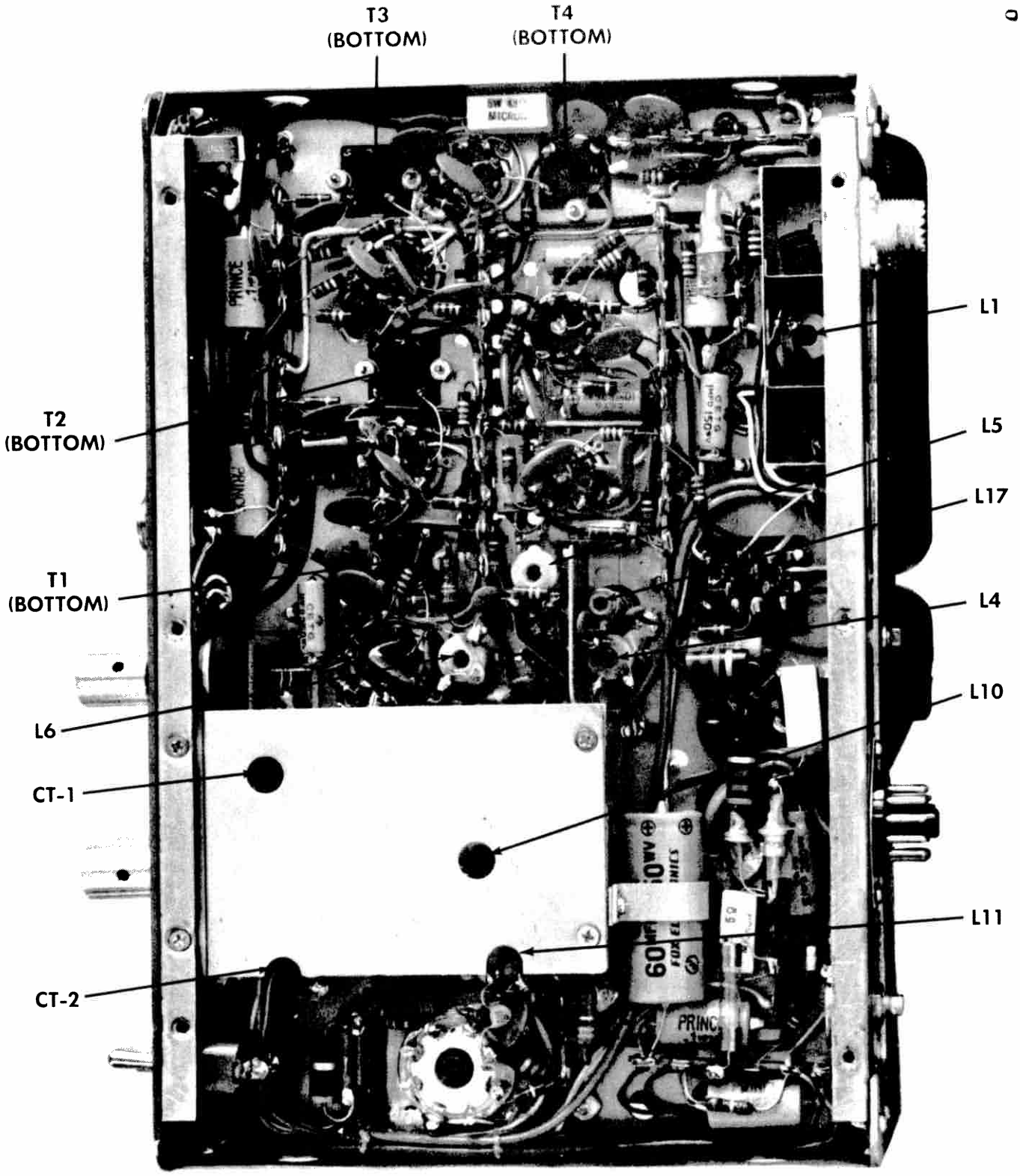

FIGURE 7—ALIGNMENT POINTS (BOTTOM VIEW)

RECEIVER

To align the receiver portion of the HA-410 obtain the test equipment listed below and proceed as directed in Table 4.

Test Equipment Required:
1. Calibrated signal generator
2. AC VTVM
3. Non-metallic alignment tool

TABLE 4. RECEIVER ALIGNMENT PROCEDURE

Step	Purpose	S. G. Coupling & Input Signal	AC VTVM Connections	RCVR Dial Setting	Adjust	Indication	Location of Alignment Point
1	Local Oscillator No. 1 Alignment	Connect S. G. to antenna input. (a) Set S.G. to 28.0 Mc	Across Speaker Terminals	28.0 Mc	L7	Maximum output on AC VTVM	See Figure 6
		(b) Set S.G. to 29.7 Mc		29.0 Mc	CT1	"	See Figure 7
		(c) Repeat (a) and (b) until no further improvement is obtained.					
2	Align 5745K IF transformer. Note: Ground pin 9 of V2 during this step. Remove ground after completing this step.	Connect S.G. to pin 2 of V2 and set it to 5745Kc	Across Speaker Terminals	-----	T1 (Top & Bottom)	"	See Figures 6 and 7
3	Align 455 Kc IF transformers. Note: ground pin 2 of V3 during this step. Remove ground after completing this step.	Connect S. G. to pin 8 of V3 and set it to 455 Kc.	Across Speaker Terminals	-----	T2, T3 and T4 (Top & Bottom)	"	See Figures 6 and 7

4	Neutralization of RF amplifier. Note: disconnect R5 (4.7 K) at B+ end during this step. Reconnect R5 after step has been completed.	Connect S. G. to antenna input & set it to 29.0 Mc. Increase S. G. output high enough to produce an indication on the AC VTVM.	Across Speaker Terminals	29.0 Mc	L5. Note: After adjustment is completed. Do not touch this adjustment again for remainder of alignment procedure.	Minimum output on AC VTVM	See Figure 7
5	RF Amplifier Alignment.	Connect S. G. to antenna input & set it to 29.0 Mc	Across Speaker Terminals	29.0 Mc	L6 then L 17 then L4. Note: Repeat adjustments until no further improvement can be obtained.	"	See Figures 6 and 7
6	Adjust S-meter	Connect S.G. to antenna. Set it to 29.0 Mc with an output of 50 microvolts.	-----	29.0 Mc	Meter Adj. Pot.	S9 on S-meter	See Figure 3

TRANSMITTER

To align the transmitter portion of the HA-410 obtain the equipment listed below and proceed as directed in Table 5.

Equipment Required:

1. Milliammeter (Simpson Model 260 or equivalent)
2. 7.250 Mc crystal. Note: Any crystal which will produce an output frequency between 28.0 and 29.7 Mc may be used. The proper adjustments must be made in Table 5 to compensate for using a crystal with a frequency other than 7.250 Mc.
3. Non-metallic alignment tool
4. Ten watt dummy load
5. TV Receiver

TABLE 5. TRANSMITTER ALIGNMENT PROCEDURE

Step	Purpose	Alignment Conditions	VFO Dial Setting	Adjust	Indication	Location of Alignment Point
1	Align Transmitter VFO	1. Insert 7.250 Mc xtal into XTAL socket and set XTAL-VFO switch to XTAL 2. Set SPOT switch to ON and tune receiver until unmodulated signal is heard. 3. Set XTAL-VFO switch to VFO	29.0 Mc	CT2	Zero beat as heard on receiver.	See Figure 7
2A	Align driver stage.	1. Connect 10 watt load to antenna connector. 2. Connect milliammeter between "Test Point" (See schematic) and ground. 3. Tune PLATE TUNE and ANT. LOAD controls for maximum output.	29.0 Mc	L10 and L11	Maximum grid drive on milliammeter. Note reading.	See Figure 7
2B		1. Retune PLATE TUNE and ANT. LOAD controls for maximum output.	29.7 Mc		Note milliammeter reading.	
2C		1. Compare readings obtained in steps 2A and 2B. Carefully trim L11 until grid drive is equal at 28.0 and 29.7 Mc. *		L11	Grid drive as shown on Milliammeter.	
3	Align harmonic filter	1. Use TV set tuned to channel 2 as an indicator. 2. Energize transmitter and observe TV set.	29.0 Mc	L1	Minimum interference on TV set.	See Figure 7

* When L10 and L11 are properly adjusted, the grid drive to the 2E26RF output tube will be somewhat lower on either end of the band as opposed to the middle (i.e.: Lower at 28.0 and 29.7 Mc as opposed to 29.0 Mc).