

READ THIS IMPORTANT INFORMATION



RAY-TEL
Citizens Band
RADIOTELEPHONE

Installation and Operation

Model TWR-2

R A Y T H E O N C O M P A N Y

Distributor Products Division

411 Providence Turnpike

Westwood, Mass.

LITHO IN U. S. A.

IMPORTANT USER INFORMATION

It is a well known fact that the finest automobiles built need the right grade of gasoline if they are to operate at maximum efficiency. Also, before delivery to the purchaser, the dealer tunes the engine for best performance.

A similar situation exists with Citizens Band two-way radio equipment. While it is true that fine precision equipment such as your Ray-Tel will operate in many instances without adjustment, it is also true that maximum performance is obtainable only when this equipment is operated in conjunction with a good antenna, and with the equipment properly tuned to the antenna.

Raytheon antennas, designed especially for use with your Ray-Tel equipment, are available from your Ray-Tel dealer. Detailed instructions for proper tune up of the equipment at time of installation are covered in your Ray-Tel user manual. We strongly recommend that these be followed so that you will get top performance from this fine instrument.

WHEN THIS EQUIPMENT IS USED AS A BASE STATION, THE ANTENNA SUPPORT MUST BE CONNECTED TO A GOOD ELECTRICAL GROUND. This will provide a path for static discharge picked up by the antenna so that it will go directly to ground rather than through the equipment. Your home or office will thus have better protection against lightning than it had without your Citizens Band installation. In addition, the equipment will operate better with such an arrangement; and the unit will also be grounded through the connecting coaxial cable, thereby providing protection against any possible electrical shocks.

To validate your Ray-Tel warranty, we suggest that you complete and mail your warranty card without delay.

WARRANTY

Raytheon warrants all parts of this equipment to be free from all defects in material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of any unit of its manufacture provided the unit is delivered by the owner to Raytheon's Certified Service Station intact for examination, with all transportation charges prepaid, within ninety (90) days after purchase by the consumer or user provided that an examination discloses that such defects have not been caused by abuse or tampering.

This warranty does not apply in the event of improper installation, or to use in violation of instructions furnished by Raytheon.

The foregoing is in lieu of any other warranty or liability expressed, implied, or statutory and in no event shall Raytheon be liable for special or consequential damages. Raytheon Company neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with this equipment.

RAYTHEON COMPANY
Distributor Products Division
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Westwood, Mass.

RAY-TEL
MODEL TWR-2

CITIZENS RADIOTELEPHONE
INSTRUCTION BOOK

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I. DESCRIPTION

The Ray-Tel TWR-2 is a compact, dual conversion superheterodyne, 10-tube, 5-channel, portable or fixed station for use in the Class D citizens band. A two-way power supply permits operation from either a 12 volt DC or 117 volt AC power source.*Both the transmitter and receiver are crystal controlled and will operate on any of the 23 channels available in this band. The set is designed to meet all FCC requirements for Class D service.

CAUTION: IT IS ILLEGAL TO OPERATE THE TRANSMITTER UNLESS A STATION LICENSE AND CALL SIGN HAVE BEEN ISSUED BY THE FEDERAL COMMUNICATIONS COMMISSION.

II. LICENSING

A. How to Obtain a License. First, read the sections covering Class D citizens radio stations in Part 19 of the FCC Rules and Regulations which accompany this manual. This is required by law. Then fill in FCC Form 505 according to the instructions on the first page. Should any assistance be required, your dealer will be glad to help you. Do not operate the transmitter until the station license has been received.

NOTE: Under Item 9 on the form, be sure to state the kind of business and/or personal activities in which the radio facilities are proposed to be used, as well as the manner and purpose of such use. Examples:

"In the operation of my real estate and restaurant businesses, for communication between my home, my car, my place of business, and my employees."

"In the operation of my taxicab and service station businesses, for communication between my offices, my cabs, my service trucks, my car, and my residence."

"For personal communications between my boat, my car, my residence, and my summer camp."

B. Conelrad. FCC Rules Part 19 (e) specify that all licensed transmitting stations are required to maintain either a visual or an aural watch for a Conelrad alert. The easiest way to
* 6 volt DC or 117 volt AC unit also available.

maintain this watch is to use a separate broadcast receiver or television set. If standard broadcast stations go off the air, signifying a Conelrad alert, stop any transmission on the citizens radio.

C. Frequencies available. The following list shows the 23 channels allocated to Type D citizens stations and the crystals used to operate on these channels. Two crystals are required on each operating channel. The set is shipped with Channel 11 transmitting and receiving crystals installed in the Channel A position. Channels B, C, D, and E will not operate until crystals are installed in the appropriate sockets. Caution: The crystals required for your radiotelephone are precision ground, close tolerance units. The dealer who sold you your radiotelephone can supply you with crystals made especially for your set. If crystals other than those designed for your radiotelephone are used, your transmitter may operate outside the legal bandwidth limits.

<u>Channel Number</u>	<u>Channel Frequency Kc</u>	<u>Transmitter Crystal KC</u>	<u>Receiver Crystal KC</u>
1	26,965	13,482.5	32,965
2	26,975	13,487.5	32,975
3	26,985	13,492.5	32,985
4	27,005	13,502.5	33,005
5	27,015	13,507.5	33,015
6	27,025	13,512.5	33,025
7	27,035	13,517.5	33,035
8	27,055	13,527.5	33,055
9	27,065	13,532.5	33,065
10	27,075	13,537.5	33,075
11	27,085	13,542.5	33,085
12	27,105	13,552.5	33,105
13	27,115	13,557.5	33,115
14	27,125	13,562.5	33,125
15	27,135	13,567.5	33,135
16	27,155	13,577.5	33,155
17	27,165	13,582.5	33,165
18	27,175	13,587.5	33,175
19	27,185	13,592.5	33,185
20	27,205	13,602.5	33,205
21	27,215	13,607.5	33,215
22	27,225	13,612.5	33,225
23	27,255	13,627.5	33,255

Receiver crystals are ground for 20 mmfd load capacity; transmitter crystals are ground for 20 mmfd load capacity also.

III. OPERATING PROCEDURE

A. Receiver. The receiver ON/OFF switch and Volume Control is located near the bottom center of the front panel. Advance the knob clockwise to turn the set on. Allow 30 seconds for the tubes to reach operating temperature with the channel switch set to a position in which crystals are installed. The POWER ON indicator will light and a background hiss, controllable in intensity by the Volume Control, will be heard, assuming the ANL-Squelch control is in the OFF position.

The lower right knob on the front panel controls the automatic noise limiter (ANL) and the Squelch. When ignition or other noise interference is present, the knob should be advanced beyond the click at the counter-clockwise end of rotation. This activates the ANL function which greatly attenuates noise without materially affecting the readability of desired signals.

The Squelch Control silences the receiver during periods when no transmissions are being received. Thus, the annoying background noise usually heard when standing by is eliminated. To operate this control, adjust the volume control to a comfortable level and, with no signal being received, turn the Squelch Control clockwise until the background noise just disappears. Do not turn the control beyond this point, since this would impair the set's ability to receive weak signals. The adjustment should be made slowly since there is some lag in its effect.

B. Transmitter. To operate the transmitter, first place the TALK-REC.-REC. ONLY switch in the upward position. Allow 30 seconds for the transmitter tube to warm up, and then press the microphone button. The TALK INDICATOR lamp will glow and its brightness will increase as you speak into the microphone.

The unit is now ready for operation and contact may be established with other units operating on the same channel. Note: To save battery drain on battery operated units, the TALK-REC. switch should be left in the REC. ONLY position during listening periods when the transmitter is not in frequent use.

IV. INSTALLATION

A. Equipment Furnished. Unpack the carton containing your radiotelephone and check the contents carefully. It should contain the following:

1. Raytheon RAY-TEL TWR-2 radiotelephone
2. Instruction Manual
3. Two crystals (one transmit, one receive) installed in Channel Position A
4. Battery and 117 volt AC connecting cords
5. Spare fuses
6. Microphone and mounting post
7. Mounting yoke assembly

If any items are missing or broken, contact your dealer immediately.

The following accessories are available at extra cost:

1. A complete line of mobile whip antennas, springs, and mounts
2. A complete line of base station antennas
3. Sets of matched crystals for all Class D citizens band channels

B. Dimensions and Weight

Width: 9-5/8" Height: 5" Depth: 9-1/4" Weight: 12 lbs.

C. Mobile or Marine Installation. Select a convenient operating location for the radiotelephone. It may be mounted with the yoke either on the top or on the bottom. See drawing at end of book for mounting bracket and over-all dimensions.

Note: When connecting the DC power cord, the black lead connects to the grounded side of the battery system, regardless of polarity.

The set is designed so that insertion of the appropriate line cord plug into the receptacle on the rear apron automatically makes the circuit connections for either 12 volt DC or 117 volt AC* operation. The mounting yoke permits the set to be mounted

* WHEN OPERATED ON A 117 VOLT AC POWER SUPPLY SOURCE, THIS EQUIPMENT MUST BE CONNECTED TO A GOOD ELECTRICAL GROUND.

securely, yet be quickly removed for base station use as desired. It is merely necessary to loosen the thumb screws at the side of the cabinet and disconnect the DC power-cord plug and antenna plug to remove the radiotelephone from the vehicle or boat.

D. Antenna Installation. The unit must be installed with an adequate antenna. This is normally done by the dealer, but the owner may perform the installation if he wishes. Be sure to read Part 19, paragraph 19.25 (c) of the FCC Rules, covering antenna installations for Class D. It must be emphasized that the better the antenna installation, the more satisfactory will be the results obtained, and the greater the range of operation.

The antenna installation for use with your citizens band radio will depend upon the type of service. For base stations a coaxial feed dipole antenna or ground plane antenna is suggested. Antennas for automobile installations will normally be of the quarter-wave vertical type, either helical wound or of a whip type. A whip antenna will measure 96 to 102 inches. A helical wound loaded antenna will be substantially less. The dealer from whom you purchased your equipment will be glad to make recommendations.

A type SO-239 antenna receptacle is provided for connecting to the antenna lead-in cable. This mates with a type PL-259 plug. If the antenna uses some other type of connector, an adaptor may be used or a PL-259 plug may be installed on the cable in place of the existing plug.

Mounting instructions for the various antennas will accompany the units.

V. TECHNICAL DATA AND TUNE-UP PROCEDURE

A. Circuit Description. The TWR-2 receiver consists of a 6BH6 r-f stage, a 12AT7 first mixer/oscillator, a 12BE6 (6BE6*) crystal controlled second mixer/oscillator, two 6BH6 i-f stages, a 12AL5 (6AL5*) detector/AVC/ANL, one-half of a 12AX7 squelched audio amplifier, and a 6AQ5 audio power amplifier.

The 6CX8 performs all of the functions required in the r-f section of the transmitter. The triode section operates as a crystal oscillator-doubler, while the pentode section is a Class C power amplifier. One half of the 12AX7 tube is connected to a microphone amplifier and the 6AQ5 serves as a modulator when trans-

* 117/6V DC units.

mitting. The power supply incorporates a 12X4 (6X4*) to furnish all high-voltage requirements on both receive and transmit.

Switching from receive to transmit is accomplished by two single-pole, single-throw switches located in the microphone and connected in a single-pole, double-throw configuration with one switch normally open and the other normally closed. On receive, the switch connects the speaker to the audio power amplifier and places + 120 volts on the controlled B+ line. Since the 6CX8 cathodes and the 12AX7 microphone amplifier cathode are connected to this line, these stages are disabled. In addition, the first and second receiver oscillators and the r-f stage screen grid are tied to this line. These stages thus operate normally.

When the microphone button is pressed, the speaker is disconnected and the +120 volt line is grounded. The transmitter stages are activated and both receiver oscillators are disabled. A small portion of the transmitter output is rectified by the r-f stage control grid and the high negative voltage produced cuts off all stages connected to the AVC buss. A resistor in the cathode of the 6CX8 pentode section furnishes operating voltage for the microphone. Audio output from the microphone is amplified by the 12AX7 and applied to the 6AQ5 modulator grid.

Padders are provided across all transmitter crystal sockets for precise adjustment of transmitter frequencies.

B. Transmitter Tune-up. (Note: It is unlawful for anyone except properly licensed technicians to make internal adjustments to the transmitter.)

The transmitter is factory adjusted for correct operation into a 35 to 50 ohm resistive load. At the time of installation, the loading adjustment should be checked. Connect the antenna and press the microphone button. Adjust the load control (knurled shaft on the rear panel - see Chart on rear of set) for maximum TALK INDICATOR brilliance. Should the output be low, connect a 0-100 ma. meter to the rear panel meter jack. Rotate the LOAD Control clockwise until it becomes tight and tune the PA TUNE Control for minimum meter indication. Then rotate the LOAD Control counter-clockwise about 1/4 turn and retune the PA TUNE Control. Repeat this procedure until the meter indicates 21 ma. with the PA TUNE adjusted for minimum meter reading. The TALK INDICATOR lamp should light to moderate brilliance, indicating that power is being delivered to the antenna.

* 117/6V DC units.

When the set is alternated between base and mobile positions, compensation is easily made for variation between antennas by adjusting the LOAD Control for best lamp brilliance. If inadequate performance is found using this method, it indicates a drastic variation between antennas. Proper adjustment of each antenna length will eliminate the problem. In some cases, it may be necessary to either lengthen or shorten the coaxial antennalines so that each presents about the same load impedance to the transmitter.

C. Receiver Tune-up. The unit as shipped from the factory should not require any adjustment. If it becomes necessary to realign the receiver, it can be done either by using the signal from a crystal controlled transmitter of the correct frequency and with a VTVM connected to the AVC line, peaking all circuits for maximum AVC voltage or by accurately aligning the i-f amplifier to 6 mc with the signal injected into pin #7 of the 12AT7, preferably using a frequency meter to check the signal generator frequency, and then aligning the r-f and mixer stages, again using the signal generator.

VI. MAINTENANCE

Caution: Maintenance procedures described in this section which apply to the transmitter must be performed by a technician holding a valid FCC radiotelephone license, first or second class.

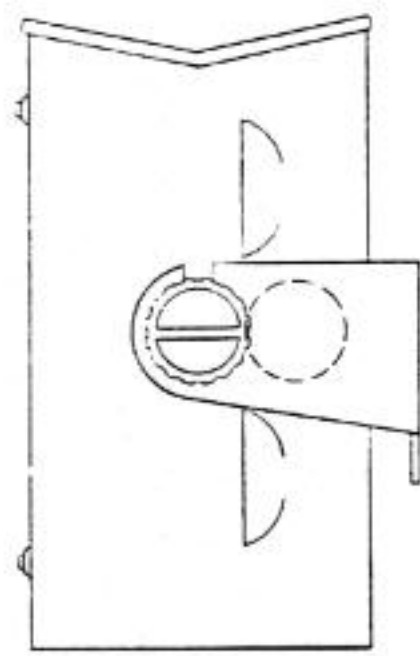
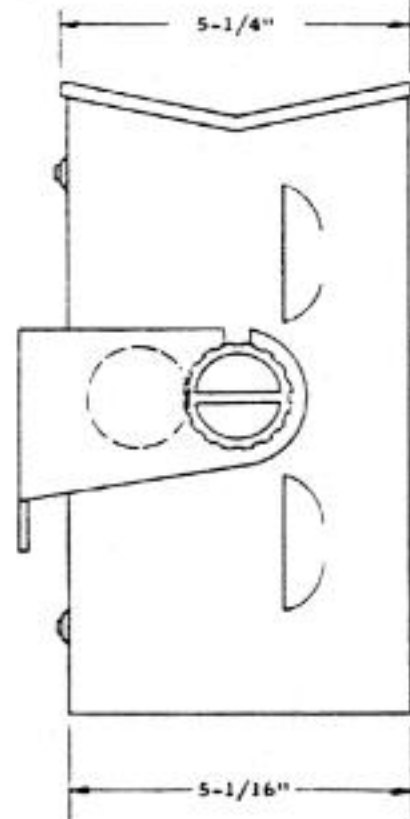
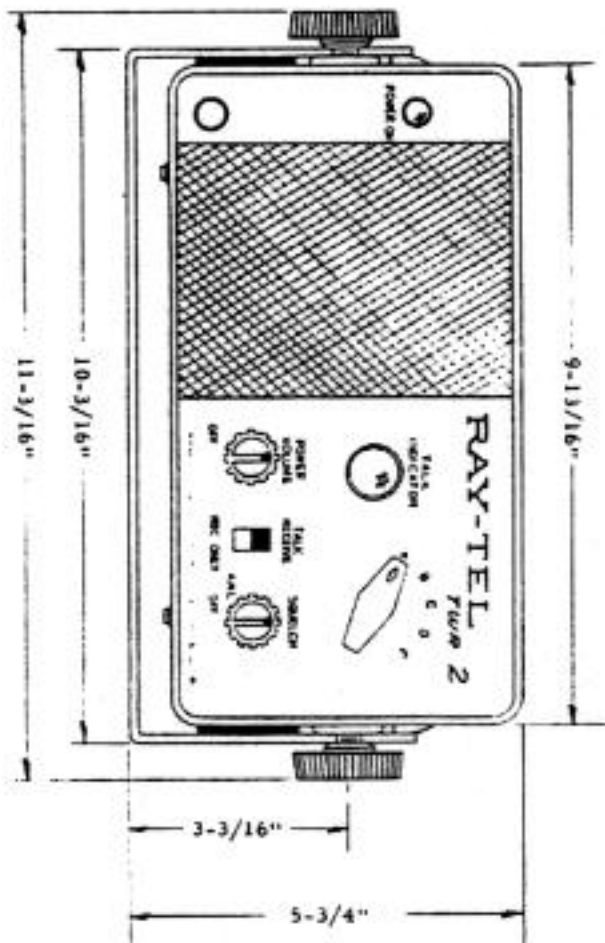
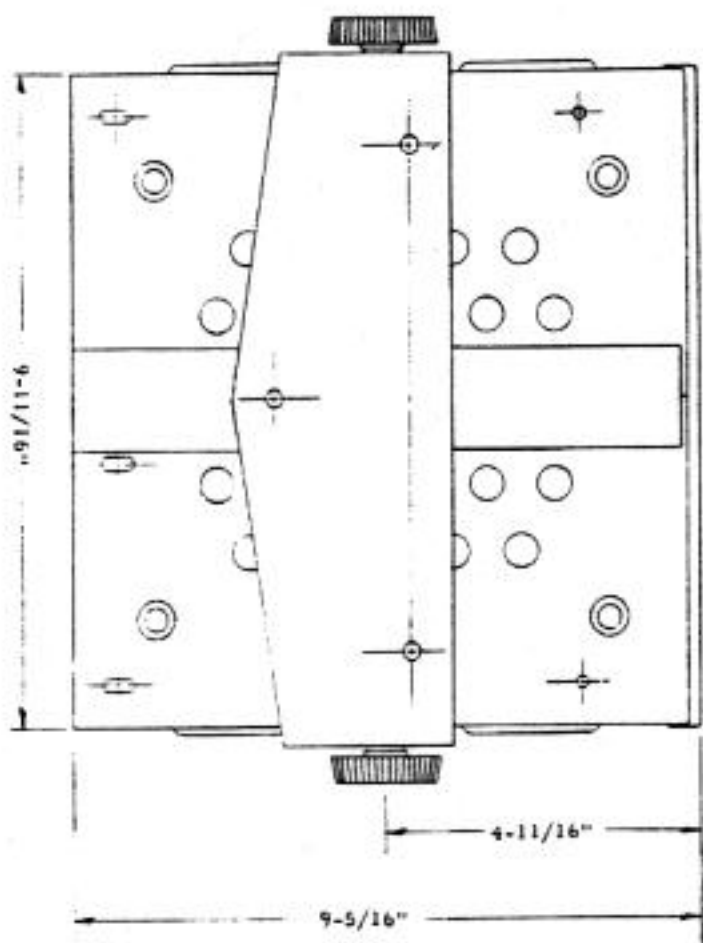
A. Receiver. Gradual decrease in receiver sensitivity is usually due to weak tubes. Replace as necessary. If tube replacement does not restore the receiver to normal performance, check the alignment. Also check crystal activity by replacing with a crystal of known activity.

B. Transmitter. Gradual decrease in transmitter performance is usually indicative of tube or crystal deterioration; check both and replace as necessary. The transmitter doubler coil may require adjustment after extended use. The adjustment is located just forward of the 6CX8 transmitter tube. Adjust for maximum output with the set loaded into the antenna.

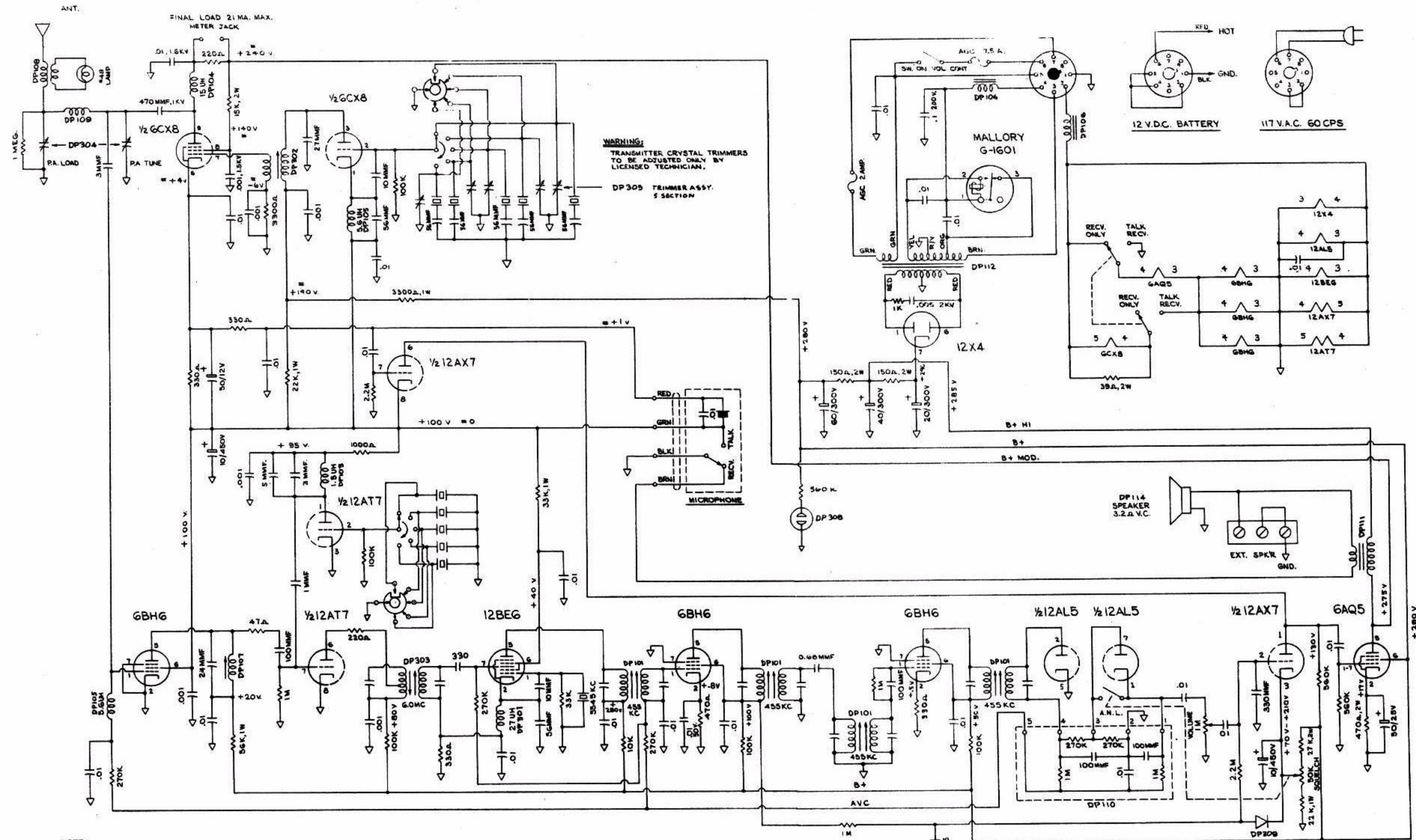
C. Power Supply. A heavy-duty vibrator is provided with the set which should give years of service. A faulty vibrator is usually indicated by fuses blowing repeatedly. If this occurs, the vibrator should be replaced with the exact type shown on the schematic diagram.

VII. REPLACEMENT PARTS LIST

<u>Part No.</u>	<u>Supplier</u>	<u>Description</u>
DP-01 through		
DP-23	Raytheon	Crystals, matched sets
DP-101	Raytheon	I.F. Transformer, 455 Kc
DP-103	Raytheon	1.5 mH RF Choke
DP-104	Raytheon	15 mH RF Choke
DP-105	Raytheon	5.6 mH RF Choke
DP-106	Raytheon	Hash Choke
DP-107	Raytheon	Rec. RF Coil
DP-108	Raytheon	Ant. Indicator Coil
DP-109	Raytheon	Trans. Tank Coil
DP-110	Raytheon	Couplate
DP-111	Raytheon	Output Transformer
DP-112	Raytheon	Power Transformer, 117/12V
DP-113	Raytheon	Power Transformer, 117/6V
DP-114	Raytheon	Speaker
DP-121	Raytheon	Switch, DPDT, Trans.-Rec. Only
DP-122	Raytheon	Microphone, complete w/coiled cord
DP-123	Raytheon	Coiled Cord for DP-122
DP-301	Raytheon	27 mH RF Choke
DP-302	Raytheon	Trans. Buffer Coil
DP-303	Raytheon	I.F. Transformer, 6 mc.
DP-304	Raytheon	Trimmer Assy, 2 section
DP-305	Raytheon	Trimmer Assy, 5 section
DP-306	Raytheon	Rotary Switch, 4 pole, 5 position
DP-307	Raytheon	Crystal, Rec. Mixer, 5545 Kc.
DP-308	Raytheon	"Power On" Lamp Assy.
DP-309	Raytheon	Crystal Diode, 1N54A or 1N270
DP-310	Raytheon	Knob, Round
DP-311	Raytheon	Knob, Bar
DP-312	Raytheon	Power Cable, 6V DC
DP-313	Raytheon	Power Cable, 12V DC
DP-314	Raytheon	Power Cable, 117V AC



OUTLINE DIMENSIONS
 MODEL TW-R-2
 RAYTHEON COMPANY



NOTE:
 ALL RESISTORS ARE 1/2 WATT, CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE INDICATED.
 RECEIVE VOLTAGES MEASURED WITH AUDIO GAIN CONTROL C.C.W. (MIN. VOLUME) NO ANTENNA.
 * INDICATES TRANS. VOLTAGE MEASURED WITH ANT. CONNECTED AND TRANS. "ON".
 .001 MFD CAPS. ARE 500 VOLT, .01 MFD. CAPS. ARE 600 VOLT UNLESS OTHERWISE INDICATED.

- | | | | |
|--------|------------------------|--------|--------------------------------|
| DP-101 | IF Transformer, 455 Kc | DP-111 | Transformer, Output |
| DP-103 | RFC, 1.5 uh | DP-112 | Transformer, Power |
| DP-104 | RFC, 15 uh | DP-301 | RFC, 27 uh |
| DP-105 | RFC, 5.6 uh | DP-302 | Coil, Trans., Buffer |
| DP-106 | Hash Choke | DP-303 | IF Transformer, 6 mc |
| DP-107 | Coil, Rec., RF | DP-304 | Trimmer Assy, 2 section |
| DP-108 | Coil, Ant. Indicator | DP-305 | Trimmer Assy, 5 section |
| DP-109 | Coil, Trans. Tank | DP-308 | Lamp Assy |
| DP-110 | Couplate | DP-309 | Diode, Crystal, 1N54A or 1N210 |