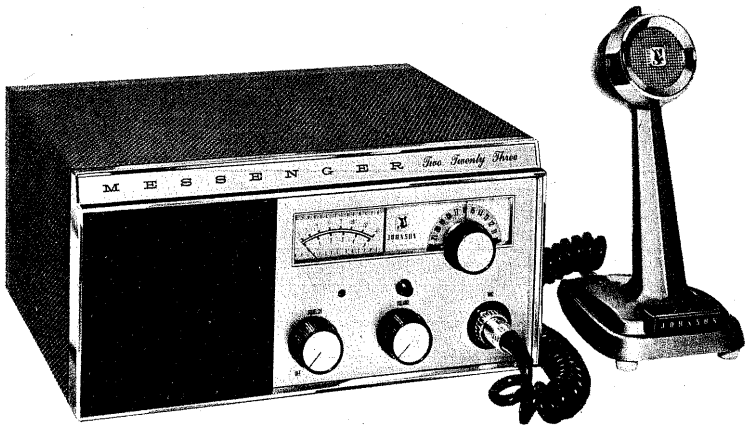
MESSENGER 223

CITIZENS RADIO TRANSCEIVER
MODEL NO. 242-223



SERVICE MANUAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION 1
GENERAL INFORMATION

1.1 SCOPE OF THIS MANUAL

This service manual includes servicing and alignment instructions for the Messenger 223 Transceiver.

Revision notices will be published as this unit is revised. Insert these notices in order at the back of this service manual.

1.2 FACTORY CUSTOMER SERVICE

A liaison between the customer and the factory is provided by the E. F. Johnson Company Customer Service Department. This department is available for consultation and assistance on technical problems, parts information, and availability of local and factory repair facilities.

If it is necessary to write to the Customer Service Department, please include any information you feel will help solve your problem.

For any of the above requirements contact:

E. F. JOHNSON COMPANY
Customer Service Department
Waseca, Minnesota 56093

1.3 FACTORY RETURNS

Normally, repair service is available locally through authorized Johnson Citizens Band Radio Service Centers; a list of these service centers is available upon request from the factory Customer Service Department. Do not return any equipment to the factory without authorization from the Customer Service Department.

1.4 PURCHASE OF PARTS

The authorized Johnson Service Centers stock commonly needed replacement parts. If a part is not available locally it may be ordered from the Customer Service Department. When ordering please supply the following information:

Model number of the unit
Serial number of the unit
Description of the part
Part number of the part

1.5 DESCRIPTION

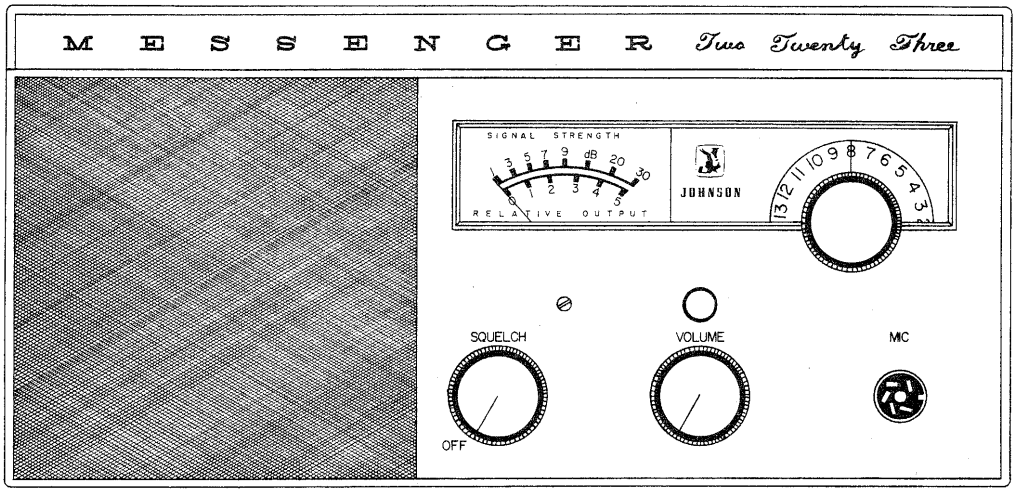
The Messenger 223 is a base station only Citizens Band transceiver. Complete 23 channel operation is provided by a 14 crystal solid state frequency synthesizer.

Electron tubes are utilized in the receiver and transmitter. A 14 crystal, 23 channel solid state frequency synthesizer generates either the transmitter frequency or the mixing frequency for the receiver second mixer. The synthesizer outputs are electronically switched between transmit and receive by diodes.

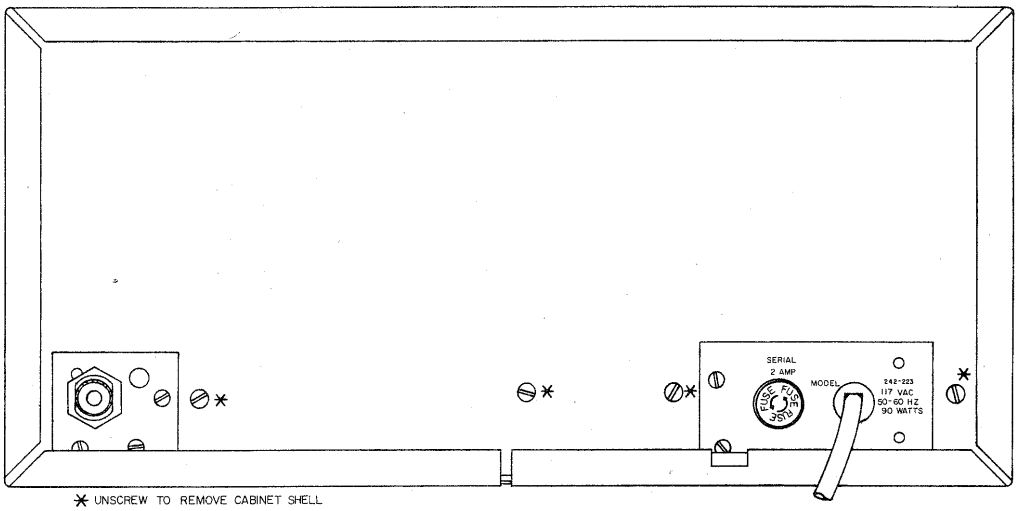
Supply voltages for operating the receiver and transmitter are provided by a fullwave electron tube rectifier. A halfwave silicon diode rectifier provides operating voltage for the frequency synthesizer.

1.6 SERIAL NUMBERING INTERPRETATION

The E. F. Johnson Company utilizes a white adhesive-backed cloth printed with the unit serial number and attached to the back of the transceiver chassis rail. Each serial number contains an alphabetical designator which indicates a major revision. The revision letters are in alphabetical order. For example: An A in the serial number indicates that the unit includes all the changes specified in revision A. The revision letter is the only part of the serial number important to servicing technicians. Units with a major revision are referred to by their alphabetical designator in this manual. A unit with revision A is called an A model, with revision B a B model, etc.



MESSENGER 223
FRONT VIEW
FIGURE 1-1



MESSENGER 223
REAR VIEW
FIGURE 1-2

SECTION 2
SPECIFICATIONS

2.1 GENERAL

Frequency Range	26.965 - 27.255 MHz
Channels	23
Dimensions of Enclosure	5 9/16" high x 11" wide x 9 1/16" deep
Unit Weight	12 pounds
Shipping Weight	18 pounds with Mic
Metering	combination received signal strength and relative output.
Circuitry	10 electron tubes, 11 diodes, 6 transistors
Antenna Impedance	50 ohms unbalanced
Compliance	FCC Type Accepted Rule 95 DOT Type Approved RSS 136

2.2 RECEIVER (Nominal unless otherwise stated)

Sensitivity	11 dB typical (S + N)/N radio with 1 microvolt (30% modulated 1000 Hz)
Selectivity	7 kHz bandwidth at -6 dB 21 kHz bandwidth at -60 dB
Frequency Control	±.005% crystal from -30° to +50° C, (-22 F to +122 F)
Spurious Rejection	50 dB except image of 30 dB
Audio Output Power	3 watts minimum at 10% distoration 0.5 VRMS
Speaker Impedance	3.2 ohms
Squelch Range	0.3 to 500 microvolts
Squelch Sensitivity	6dB or less signal change for 40 dB of quieting at 1 microvolt
Intermediate Frequency	455 kHz
AGC	Flat within ±10 dB from 50,000 to 5 microvolts 12 dB rolloff from 5 to 0.5 microvolts minimum
Noise Limiting	Series-type, automatic threshold adjustment
Circuitry	Single conversion superheterodyne using electron tubes, solid state frequency synthesizer

2.3 TRANSMITTER (Nominal unless otherwise stated)

Emission	6A3
Frequency Control	±0.005% crystal from -30° C to + 50° C (-22° F to 122° F)
RF Power Output	4 watts maximum at 117 VAC line input
RF Spurious and Harmonic Attenuation	Better than FCC and DOT requirements
Audio Input Impedance	High impedance
Audio Frequency Response	+1 to -4 dB from 400 to 2500 Hz
Modulation	High level AM, class AB1 modulator, audio peak clipping and audio filtering
Circuitry	Electron tubes, solid state frequency synthesizer

2.4 SPECIFICATIONS (Minimum Performance)

2.4.1 RECEIVER

The specifications listed in this section are absolute service minimums. Receiver RF input values given at input to a 6 dB 50 ohm pad.

Synthesizer Output	80 mV minimum, 300 mV maximum
Sensitivity	8 dB (S+N)/N ratio minimum with 1 μV input 30% modulated at 1000 Hz.
Output Level	1.0 volts minimum across voice coil with 1 μV 30% modulated at 1000 Hz.
AGC	22 dB maximum 100k μV to 10 μV.
AGC Rolloff	7dB minimum 17 dB maximum 10 to 1μV.
Hum Level	-45 dB at voice coil.
Squelch	Opens at 1 μV. Tight squelch range more than 100 μV less than 31.6k μV.
S Meter	Between S8 and S9+10 dB for 100 μV.
Frequency error	±0.0025% maximum at +25° C., cabinet off. ±0.00375% maximum at end of 1 hour ±0.005% maximum -30° to +50° C.
Diode Load Voltage	0.6 volt minimum with 1 μV input.
Low Voltage	Functions with 93.5 VAC power source.

2.4.2 TRANSMITTER

Excitation	-11 VDC minimum
Power Output	4 watts maximum, 2.3 watts minimum.
Modulation	50% or more modulation with 5 mV input at 1000 Hz.
Modulation Capability	not less than 80% but not more than 100% on positive and negative peaks with 10 dB above 5 mV input at 1000 Hz.
Relative Output	4 ± 1
Frequency Error	±0.0025% maximum at 25° C., cabinet off. ±0.0027% maximum after 1 hour, cabinet on. ±0.005% maximum from -30° C. to +50° C.
Low Voltage	Functions with 93.5 VAC power source.

2.5 POWER SOURCE 117 Volt AC, 50-60 Hz

	Receive: 72 watts Transmit: 87 watts
Circuit Protection	Fuse in 117 VAC line

2.6 ACCESSORIES

Model 250-887-1	Plug, microphone
Model 250-888-1	Microphone, desk, high impedance ceramic, touch bar for SPDT push-to-talk switch
Model 250-49-1	CB Matchbox
Model 250-849	Antenna Meter

TABLE 2-1
ELECTRON TUBE COMPLEMENT

TUBE	TYPE	FUNCTION	E.F.J. PART NUMBER
V1	6BJ6	Receiver RF Amplifier	022-1562-001
V2	12BE6	Second Mixer	022-1563-001
V3	6BJ6	First IF Amplifier	022-1562-001
V4	6BJ6	Second IF Amplifier	022-1562-001
V5	6AW8A	Squelch and Second Audio Amplifier	022-1565-004
V6	12AB5	Modulator and Receiver Audio Output	022-1566-001
V7	8077/7054	Transmitter RF Amplifier	022-1619-001
V8	7061	Transmitter Power Amplifier	022-1568-001
V9	12BW4	Power Supply Fullwave Rectifier	022-1569-001
V10	12AT7	First Audio Amplifier	022-1203-001

SPECIFICATIONS (Cont'd)

TABLE 2-2
DIODE COMPLEMENT

DIODE	TYPE	FUNCTION	E.F.J. PART NUMBER
D1	IN881	Receiver Switch	523-1000-881
D2	1N881	Noise Limiter	523-1000-881
D3	1N67A	Detector	523-1000-067
D4		Relative Output Meter Rectifier	523-0006-002
D5		Relative Output Meter Rectifier	523-0006-002
D101	1N881	Transmitter LF Crystal Switch	523-1000-881
D102	1N881	Receiver LF Crystal Switch	523-1000-881
D103	1N881	Synthesizer Receiver Output Switch	523-1000-881
D104	1N881	Synthesizer Transmitter Output Switch	523-1000-881
D105	200 V 1 AMP Rectifier	Synthesizer Power Supply Rectifier	523-0001-002
DZ101	10.0 V 1 Watt Zener	Synthesizer Power Supply Regulator	523-2003-100

TABLE 2-3
TRANSISTOR COMPLEMENT

TRANSISTOR	TYPE	FUNCTION	E.F.J. PART NUMBER
Q101	3008	LF Oscillator	576-0003-008
Q102	3008	First Mixer	576-0003-008
Q103	3008	HF Oscillator	576-0003-008
Q104	3011	Inverter	576-0003-011
Q105	1003	Switch Driver	576-0001-003
Q106	1003	Switch Driver	576-0001-003

SECTION 3
INSTALLATION

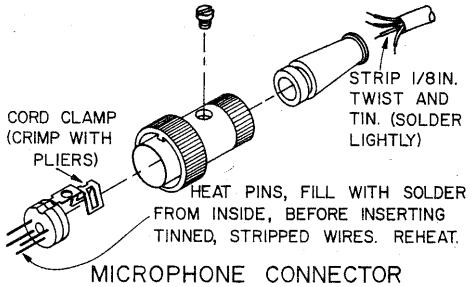
3.1 GENERAL

The Messenger 223 is available in two models. Model No. 242-223-1 includes an accessory microphone plug. Model No. 242-223-2 includes a base station microphone. Both models include the following accessory package items:

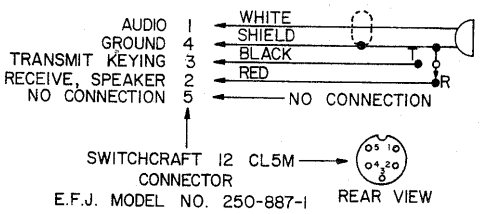
Operating Manual
Part 95 Rules and Regulations
FCC License Application Form 505
FCC Identification Card, Form 452-C
Warranty Registration Card

3.2 MICROPHONE CONNECTOR WIRING

Refer to Figure 3-1, Microphone Connector Assembly Details, and Figure 3-2, Microphone Diagram.



MICROPHONE CONNECTOR
ASSEMBLY DETAILS
FIGURE 3-1



MICROPHONE CONNECTIONS
FIGURE 3-2

3.3 TRANSCEIVER INSTALLATION

a. Select an operating location for the transceiver that allows air to circulate freely through the transceiver cabinet.

b. Ground the transceiver for safety. Attach one end of a #14 copper ground wire to one of the cabinet shell mounting screws. Attach the other end of the ground wire to a cold water pipe or any other convenient grounded metallic material.

c. Install the transmission line coaxial connectors. Figure 3-3 illustrates the correct method of installing connectors.

d. Insert a VSWR indicating device between the antenna transmission line and the transceiver antenna terminal. Use an E. F. Johnson Antenna Meter, Model No 250-849 or a Bird Model 43 Thruline Wattmeter or equivalent.

e. Key the transmitter and measure the VSWR. For best performance and range, this ratio should be 1.5 to 1 or less. If the VSWR is worse than 1.5 to 1 the antenna should be tuned to the lowest VSWR by adjusting its length or by use of the E. F. Johnson CB Matchbox Model No. 250-49. If the VSWR is worse than 1.5 to 1, the transmitter output can be tuned to improve the coupling to the antenna. Refer to the transmitter alignment section.

NOTE: Refer to the Messenger 223 Operating Manual, Part No. 002-0070-001, for antenna and operating information.

3.4 MICROPHONE OPERATING INFORMATION

The Messenger 223 transmitter audio has been designed to provide 15 dB more gain than previous Johnson tube type transceivers. This feature provides proper audio level when a desk stand microphone is used at a convenient distance. The Messenger 223 operator should speak 8 to 12 inches away from the desk stand microphone and 6 inches away from the handheld microphone for best modulation.

RG-8/U

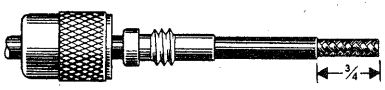
Cut end of cable even. Remove vinyl jacket 1-1/8", except 83-1SP plug remove vinyl jacket 1-1/4".

Bare 5/8" of center conductor. Trim braided shield. Slide coupling ring on cable. Tin exposed center conductor and braid.

Screw the plug sub-assembly on cable. Solder assembly to braid through solder holes, making a good bond between braid and shell. Solder conductor to contact. Do not use excessive heat.

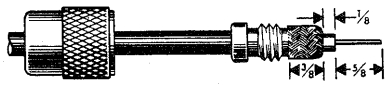
For final assembly, screw coupling ring on plug sub-assembly.

RG-58A/U

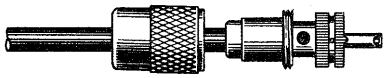


Cut end of cable even. Remove vinyl jacket 3/4". Slide coupling ring and adapter on cable.

Fan braid slightly and fold back as shown.



Position adapter to dimension shown. Press braid down over body of adapter and trim to 3/8". Bare 5/8" of conductor. Tin exposed center conductor.



Screw plug sub-assembly on adapter. Solder braid to shell through solder holes. Use enough heat to create bond of braid to shell. Solder conductor to contact.

For final assembly, screw coupling ring on plug sub-assembly.

UHF COAXIAL CONNECTORS
ASSEMBLY INSTRUCTIONS
FIGURE 3-3

3.5 MODIFICATIONS

3.5.1 TRANSMITTER FREQUENCY RESPONSE

Early base station microphones (ones with the model number not stamped on the base plate) have more low frequency (bass) response then later modified models. The modified models can be identified by the stamped model number, 250-881-1, on the base plate. If desired, transceivers used with unmodified microphones can be modified to reduce their bass response by performing the following procedure.

Parts Required:

Qty.	Part Number	Description
1	510-3004-102	0.001 μF ±20% 500V ceramic disc capacitor
1	569-1004-184	180,000 ohm ±10% 1/2 watt resistor.

a. Remove the cabinet shell.

b. Replaced C35 with a 0.001 μF capacitor described under parts required. Refer to Figure 7-3 for the location of C35.
NOTE: C35 is changed in all C and later model Messenger 223 transceivers to a value of 0.001 μF. This change also reduces the receiver bass response slightly.

c. Connect one end of the 180K resistor to pin 1 of TS9. (C24 and the shielded audio lead from pin #1 of J9 are located at pin 1 of TS9). Refer to Figure 7-2 for the location of TS9. Connect the other end of the resistor to the nearby ground lug of XV10.

3.5.2 TRANSMITTER AUDIO GAIN

A reduction in the transmitter audio gain can be effected by changing the plate load resistor of V10B, R26, to a lower value. For example: the gain of V10B can be lowered 6 dB by changing R26 to 47,000 ohms, or approximately 12 dB by changing it to 22,000 ohms.

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

The Messenger 223 utilizes electron tubes in the receiver and the transmitter. Its frequency generating source is a 14 crystal, 23 channel, solid state frequency synthesizer. The synthesizer crystal frequency and channel frequency outputs are diode switched between receive and transmit conditions. The synthesizer receiver output is 455 kHz below the received frequency. The synthesizer transmitter output is at the channel frequency. The power supply, audio circuitry and antenna are common to both the receiver and transmitter. A front panel mounted S-meter indicates received signal strength and relative output of the transmitter.

Refer to the block diagram and the schematic while following the circuit description.

4.2 FREQUENCY SYNTHESIZER

4.2.1 GENERAL

The synthesizer consists of three crystal banks, two oscillators, a mixer, a diode switch driver and two diode switching networks. The synthesizer receiver output is 455 kHz below the received frequency and the synthesizer transmitter output is the channel frequency. This is accomplished by two oscillators and one mixer operating in a single side-step operation. There is no frequency multiplication in the synthesizer or in other circuits.

4.2.2 LF OSCILLATOR

The low frequency oscillator is made up of Q101 and its associated circuitry, and crystals Y1 through Y8 which operate at their fundamental frequency. Switch SW1A selects one of these crystals. Refer to Table 4-1, synthesizer scheme, for the low crystal frequencies. The signal from the selected crystal is applied directly to the base of Q101, which has a common collector to provide a high input impedance. The signal from the emitter of Q101 is coupled through C107 to the base of the synthesizer mixer, Q102. A capacitive voltage divider, C107 and C108, reduces the voltage at the base of Q102 and provides the proper impedance match.

TABLE 4-1
SYNTHESIZER SCHEME

CHANNEL	HF CRYSTAL	RECEIVE LF CRYSTAL	RECEIVE OUTPUT	TRANSMIT LF CRYSTAL	TRANSMIT OUTPUT
1	32.700	6.190	26.510	5.735	26.695
2	32.700	6.180	26.520	5.725	26.975
3	32.700	6.170	26.530	5.715	26.985
4	32.700	6.150	26.550	5.695	27.005
5	32.750	6.190	26.560	5.735	27.015
6	32.750	6.180	26.570	5.725	27.025
7	32.750	6.170	26.580	5.715	27.035
8	32.750	6.150	26.600	5.695	27.055
9	32.800	6.190	26.610	5.735	27.065
10	32.800	6.180	26.620	5.725	27.075
11	32.800	6.170	26.630	5.715	27.085
12	32.800	6.150	26.650	5.695	27.105
13	32.850	6.190	26.660	5.735	27.115
14	32.850	6.180	26.670	5.725	27.125
15	32.850	6.170	26.680	5.715	27.135
16	32.850	6.150	26.700	5.695	27.155
17	32.900	6.190	26.710	5.735	27.165
18	32.900	6.180	26.720	5.725	27.175
19	32.900	6.170	26.730	5.715	27.185
20	32.900	6.150	26.750	5.695	27.205
21	32.950	6.190	26.760	5.735	27.215
22	32.950	6.180	26.770	5.725	27.225
23	32.950	6.150	26.800	5.695	27.255

NOTE: All frequencies in MHz

4.2.3 HF OSCILLATOR

The high frequency oscillator Q103, operates with third overtone crystals, Y9 through Y14. Switch SW1B selects one of the HF crystals at the same time as SW1A selects a LF crystal. Refer to the synthesizer scheme for the high frequency crystal frequencies. The signal from the selected series resonant crystal is applied directly to the base of the HF oscillator, Q103. The signal from the collector of Q102 is coupled through the oscillator transformer, T102, to the emitter of the synthesizer mixer, Q102.

4.2.4 MIXER

The signal from the low frequency (LF) oscillator, Q101, is coupled to the base of the mixer, Q102, by C33. The signal from the high frequency (HF) oscillator is coupled by T102 to the emitter of the mixer. The mixer output transformer, T101, is tuned for the difference frequency, i.e., the HF oscillator output minus the LF oscillator output. On channel 1 receive this would be: 32.700 MHz - 6.190 MHz = 26.510 MHz. While referring to the crystal chart, notice that in the receive condition the synthesizer output is always 455 kHz below the channel frequency. In transmit the synthesizer output is the channel frequency.

4.2.5 DIODE SWITCHING

The synthesizer contains two diode switching networks. Diodes D101 and D102 switch the transmit and receive LF crystals respectively. Diode 103 switches the synthesizer output in receive and D104 switches the output in transmit.

Q104, Q105 and Q106 change the switching state of the diode switches from receive to transmit. This is accomplished by the microphone switch placing a ground on the base of Q104 through R120 during transmit and removing it during receive.

4.3 POWER SUPPLY

The power supply utilizes a 12BW4 full wave rectifier, V9, followed by a capacitor input filter.

4.4 MICROPHONE SWITCHING

A SPDT switch on the microphone controls transceiver operation in the following manner:

4.4.1 RECEIVE

a. Opens cathode of first speech amplifier, V10B, so microphone will not feed through the speaker.

b. Grounds one end of speaker voice coil to place it in circuit.

c. Opens cathodes of transmitter oscillator and amplifier (V7 and V8) to turn them off.

d. Removes the ground from the base of Q104 through R120 which changes the state of the synthesizer diode switches from transmit to receive.

4.4.2 TRANSMIT

a. Grounds cathode of first speech amplifier, V10B, so microphone will feed through to second speech amplifier.

b. Opens speaker lead to prevent it being driven by modulator.

c. Grounds cathodes of V7 and V8 through the coil of relay, RY1, to turn on the transmitter. This energizes RY1 which transfers the antenna from receiver input to transmitter output.

d. Rectified PA grid voltage blocks the grid of the receiver's first audio amplifier, V10A, to keep audio from the receiver section out of the transmitter. The negative-going voltage at the collector of Q106 passes through diode switch, D1, and charges the A GC line and opens the squelch to allow the transmitter audio system to operate.

e. Puts a ground on the base of Q104 through R120. This changes the state of the synthesizer diode switches from receive to transmit.

4.5 ANTENNA SWITCHING

The relay, RY1, transfers the antenna from the receiver input to the transmitter output when the microphone switch, SW2, is pressed. The relay is actuated by the cathode current of the 7061 power amplifier, V8.

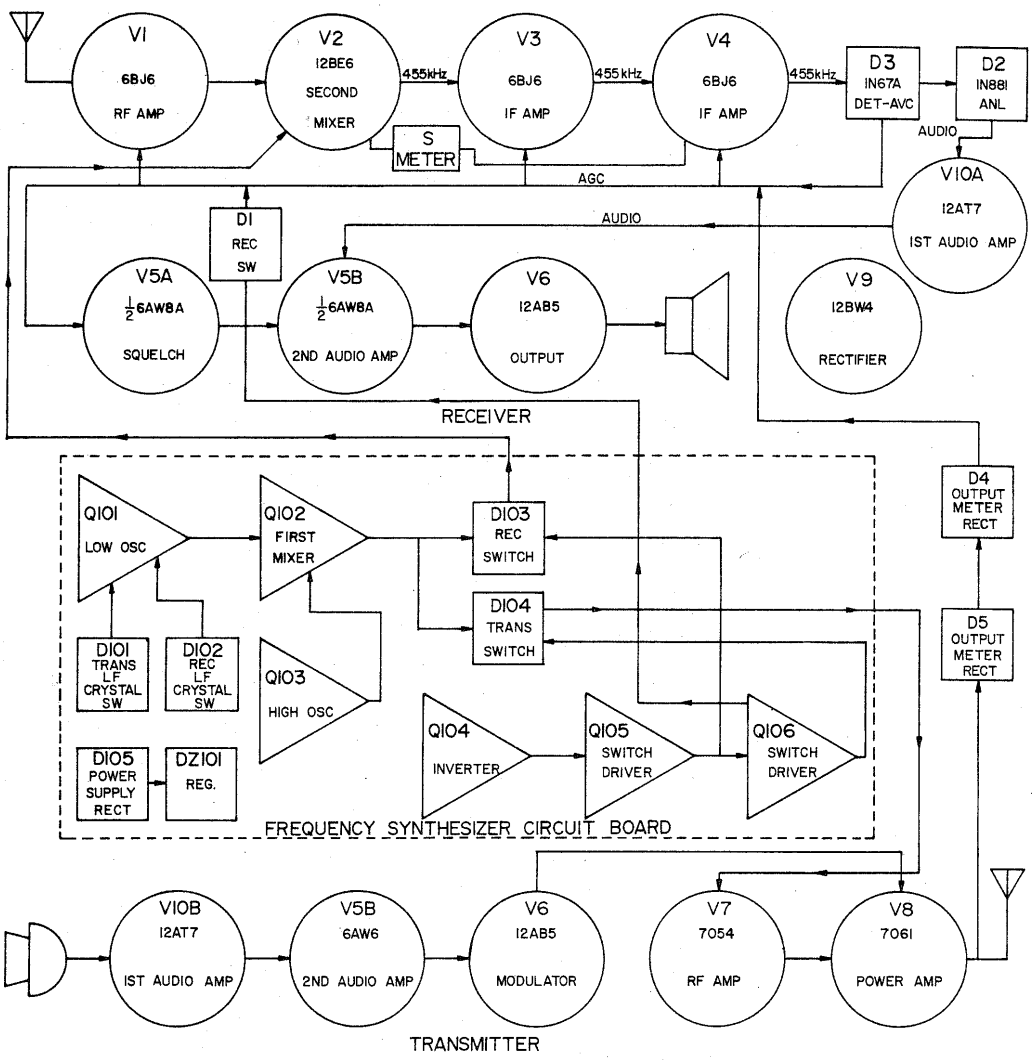
4.6 INDICATOR LIGHTING

The red colored light is a long life neon type connected across the transmitter RF amplifier screen resistor, R55, and indicates that the transmitter is turned on. Its intensity increases with modulation.

When power is applied, the S-meter and channel indicator are illuminated by three incandesent lamps. These operate at 12 VAC instead of the rated 14.4 volts which prolongs their life by a factor of 10.

4.7 FACTORY TUNING

The receiver and transmitter are aligned for opera-



MESSENGER 223 BLOCK DIAGRAM

FIGURE 4-1

tion on all 23 CB channels at the factory. The transmitter output circuit is tuned to a 50 ohm resistive dummy antenna and no further adjustment should be necessary when using antennas with a voltage standing wave ratio (VSWR) that does not exceed 1.3:1.

4.8 RECEIVER CIRCUITS

4.8.1 RF INPUT

With the antenna transfer relay, RY1, in the normal position, signals from the antenna are applied to the receiver tuned input circuit made up of L1 and C2. This circuit provides a voltage gain of approximately 8 from the 50 ohm input to the grid of V1, the 6BJ6 RF amplifier. Signals from V1 are coupled to double-tuned transformer, T3.

4.8.2 MIXER

The output of T3 is applied to the signal grid of V2, type 12BE6, which serves as the mixer. V2 receives an additional input from the synthesizer that is 455 kHz below the channel frequency. The synthesizer signal is coupled by D103, C112, L3 and C8 to the oscillator grid of V2. The difference output of V2 is 455 kHz and is selected and coupled to the first IF amplifier by T1.

4.8.3 IF AMPLIFIERS

The 455 kHz output from the mixer passes through IF transformer T1 to V3, the first 6BJ6 IF amplifier; through IF transformers T6 and T7; to V4, the second 6BJ6 IF amplifier; then through IF transformer T2 to D3, the 1N67 detector and AGC diode.

4.8.4 NOISE LIMITER

The audio output of the detector, D3, is applied to the anode of a series type noise limiter diode, D2. When audio peaks exceed a certain negative value of the anode the diode momentarily stops conducting, thereby gating the audio signal and preventing strong pulses from reaching the speaker. The threshold of limiting is set (by the bias taken from the AGC line) at approximately 30% modulation of the incoming carrier. The junction of R16 and R20 is bypassed for audio by C25 and serves as a reference for bias of the diode. The time constant is small enough, however, that this bias changes with AGC voltage and automatically adjusts the threshold of limiting for variations in carrier level.

4.8.5 RECEIVER AUDIO

Audio output of the limiter passes through the volume control, R21, and to the 12AT7 first audio amplifier, V10A. When the transmitter is operating, the grid of V10A is blocked by rectified DC grid voltage from pin 3 of the power amplifier, V8. This is done to prevent receiver audio from reaching the common audio system and modulating the transmitter.

The other half of the 12AT7, V10B, functions as the first audio amplifier for the transmitter microphone input. When the receiver is operating, the microphone switch SW2 opens the cathode of V10B, disabling the microphone input.

4.8.6 SQUELCH

The squelch control increases the screen voltage on the tetrode section of the 6AW8A tube, V5A, causing V5A to conduct. The resulting voltage drop across R29 blocks the grid of triode V5B, the second audio amplifier, which then stops conducting, hence no audio reaches the speaker. The squelch can be opened by an incoming signal which increases the AGC voltage applied to the V5A control grid, causing V5A to stop conduction; this will allow V5B to conduct and amplify the audio signal.

4.8.7 AUDIO AMPLIFIER

The type 12AB5 tube, V6, functions as a class AB1 audio amplifier for the receiver output or as modulator for the transmitter. The speaker is a PM type.

4.8.8 AGC

The negative voltage developed by D3 during detection is used for the AGC voltage. This voltage is applied across a series dropping network consisting of R83, R19 and R16. C85, connected between the junction of R83 and R19, provides RF bypassing. The AGC voltage is applied to the control grid of V1, V3 and V4.

4.8.9 S-METER

To indicate the strength of incoming signals, the S-Meter, M1, is connected in a bridge circuit between the cathode resistors of V2 and V4. The cathode voltage at V2 is constant and serves as a reference. The cathode voltage at V4 decreases with increasing signal because of AGC action at the antenna since this increasing signal ultimately develops more rectified voltage at the detector, D3. This increases the negative AGC voltage, and reduces the cathode current at V4.

Potentiometer R9 functions as the S-Meter electrical zero set and is adjusted under no signal conditions. A mechanical zero set adjustment is located directly under the meter on the front panel.

4.9 TRANSMITTER CIRCUITS

4.9.1 RF AMPLIFIER

The synthesizer output in transmit condition is coupled by L5 and C37 to the control grid of the RF amplifier

V7. V7 raises the level of the synthesizer output and provides driving power for the Power Amplifier stage, V8. V7 is neutralized by a fixed capacity bridge to prevent instability.

4.9.2 POWER AMPLIFIER

The type 7061 power amplifier, V8, operates class C. Its plate circuit is an unbalanced Pi followed by an L section for additional harmonic reduction. It is neutralized by the capacity bridge method to prevent instability. The neutralizing adjustment is made by C44, a tubular ceramic capacitor. This capacitor is adjusted to introduce into the grid circuit an amount of RF voltage equal to that coupled directly from plate to grid, but 180° out of phase with it. The phase reversal takes place when the neutralizing voltage passes from the bottom end of the resonant grid circuit to the grid end.

4.9.3 OPERATING POTENTIALS AND CURRENTS AT FINAL AMPLIFIER TUBE, V8, TYPE 7061

Plate Voltage	270 VDC
Screen grid voltage	130 VDC
Control grid voltage	-18 VDC
Cathode voltage	8 VDC
Plate current	19 mA DC
Screen grid current	6.2 mA DC
Control grid current	1.7 mA DC

4.9.4 RELATIVE OUTPUT METER

Relative output power of the transmitter is indicated on the black scale of the S-Meter.

To accomplish this, a small sample of the RF voltage at the antenna terminal is rectified by diodes D4 and D5 and the resulting negative voltage (about -15V) is applied to the AGC line. This causes a deflection of the S-Meter from AGC action.

Calibration of power output is obtained at one chosen output level by adjusting R43. This changes the negative voltage on the oscillator grid of mixer, V2, thereby adjusting the cathode voltage of V2 which is the reference voltage for the meter. The negative voltage is applied to the oscillator grid of V2 in transmit only from the collector of Q106.

The minimum reading will occur at about one half scale, since negative voltage (-11V) from the collector of Q106 is also fed through D1 to the AGC line to prevent interaction of the receiver with the transmitter during transmitter adjustment.

SECTION 5
SERVICING

5.1 GENERAL SERVICING INFORMATION

INTRODUCTION

The information in this section serves as a guide for servicing the Messenger 223 transceiver. Carefully read this information before attempting to isolate malfunctions. A little beforehand knowledge is always an asset when troubleshooting.

Refer to the circuit description, block diagrams, and the schematics at the back of this manual to familiarize yourself with the transceiver circuitry.

5.1.1 IDENTIFICATION OF PARTS

The parts list in this service manual is in alphabetical and numerical order by item number, i.e., capacitors first, chassis parts second, etc.

The parts list contains transceiver photographs with parts call outs for ease of component identification.

5.1.2 PREVENTIVE MAINTENANCE

The transceiver should be placed on a regular maintenance schedule, and an accurate record of its performance should be maintained. Important items to check are receiver sensitivity and transmitter power output. Use the performance tests in the receiver and transmitter servicing sections as guides.

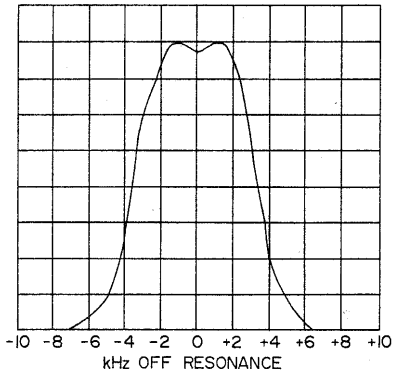
5.1.3 REPLACEMENT TRANSISTORS

You will notice when referring to the parts list that the transistors used in this unit are listed with E. F. Johnson house numbers. These transistors are specially selected for specific parameters. They must be replaced with transistors listed in the parts list of this service manual. See Section 1 in this service manual for detailed instructions on ordering replacement parts.

5.1.4 TUNING INFORMATION

1. General - Unnecessary tuning wastes valuable servicing time and can actually degrade the performance of a unit if not accomplished by an experienced technician. The Messenger 223 generally requires tuning of only those stages that have been repaired. The alignment section includes detailed tuning instructions and illustrates the tuning tools required.

2. Receiver - The Messenger 223 receiver IF transformers are overcoupled to produce a flat "nose" on the selectivity curve. (See Figure 5-1 for details.) Tuning each IF transformer for maximum audio output at the speaker will give a selectivity curve too narrow at the nose and too wide at the skirts. The receiver is stagger tuned on channels 1, 12, and 23 to provide optimum receiver performance on all 23 channels. Carefully follow the receiver alignment procedure outlined in Section 6 when tuning the receiver.



TYPICAL IF TRACE
FIGURE 5-1

5.1.5 GENERAL SOLDERING INFORMATION

The same basic soldering practices used on other printed circuit boards can be used on the Messenger 223 synthesizer circuit board. Avoid using small wattage soldering irons. Apply the amount of heat that will cause the solder to flow quickly. No iron smaller than 47 watts should be used. Use a vacuum bulb desoldering device, such as a "solder sipper", to remove excess old solder from the circuit board.

Use a heatsink pliers on coaxial cable shields when unsoldering and soldering components at fixed points where coaxial cable shields are grounded. Do this by grasping the tail of the coax shield with needlenose pliers when heat is applied. This method will prevent melting the coax center conductor insulation.

5.1.6 REMOVING CABINET SHELL

a. Disconnect the microphone and unplug the line cord.

b. Stand the transceiver on its front on a flat surface. Separate the front panel and the flat surface with a soft cloth to avoid scratching the front panel.

c. Remove the four #8 sheet metal screws that retain the cabinet at the rear of the chassis.

TABLE 5-1
TEST INSTRUMENTS REQUIRED FOR SERVICING AND ALIGNMENT

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
VTVM	A low range of 0-1.5 volts on AC and DC	Measure RF, AF and DC voltages	Heath 1M-11 with RF probes or equivalent
Oscilloscope with RF Pickup Loop	Direct connection to vertical plates, or vertical amplifier good to 30 MHz. Refer to Figure 5-6 for pickup loop fabrication details.	Check modulated waveforms and audio.	Heath I0-12 or equivalent modified for direct connection to vertical plate. Precision ES-550B
Audio Voltmeter	Measure from -40 dB to +10 dB	Measure audio	Heath 1M-21 or equivalent
Audio Generator	With variable attenuator and frequency of 400 to 2500 Hz	Check audio amps. Modulate transmitter.	Heath IG-72 or equivalent
Frequency Meter	Accuracy of ±0.0005% Frequency range of 455 kHz and from 25 to 30 MHz	Measure receiver and transmitter RF frequencies	Viking Instruments Model VFS 700
Thruline Wattmeter	Input and output impedance of 50 ohms. 5 or 10 watts. Accuracy of ±5% of full scale reading.	Measure transmitter power output. Measure antenna VSWR.	Bird Model 43 with 5A or 10A element
Dummy Antenna	Power rating of at least 5 watts 50 ohms resistive	Load for Thruline Wattmeter	Bird Model 80 coaxial resistor or equivalent
Crystal controlled RF Signal Generator with 6 dB 50 ohm pad	23 CB frequencies plus 455 kHz and attenuated output of 1 to 100,000 microvolts capable of 30% modulation at 400 and 1000 Hz	Receiver RF source	Radio Research, Model 71-4 or Model 72 or equivalent. Accuracy ±0.0005% except ±.01% at 455 kHz
RF Voltmeter with 100=1 divider	10 mV - 300 volts	Measure RF voltages	Millivac 38B or equivalent Boonton 91C or equivalent

The following is a list of instruments that can be used if the instruments in the above list are not available.

TYPE	CHARACTERISTICS	USE
International crystal C-12B test set NOTE: This instrument lacks 1000 Hz modulation for signal generator and accuracy is lower than the 0.0005% desired, but offers a desirable combination of features at low cost. It is battery operated and portable.	Frequency Meter - 23 CB frequencies, 26.965 to 27.255 MHz, with an accuracy of ±0.0015%.	Measure receiver and transmitter RF frequencies
	RF Power Meter - 5 watts ±1/4 watt	Measure transmitter power output
	Dummy antenna - 5 watts	Load for transmitter
	RF signal generator - 23 CB frequencies ±0.0015%, output 1 to 100 microvolts, 30% modulation at 400 Hz	Receiver RF source
	AM modulation meter - range 0-100% accuracy 3% at 400 Hz and 80% modulation.	Measure transmitter percent of modulation
E. F. Johnson antenna meter, Model 250-849	50 ohms	Measure antenna VSWR

d. Carefully slide the cabinet shell up and off of the chassis.

5.1.7 REPLACING INDICATOR LIGHTS

Three incandescent lamps mounted on an aluminum strip are used to illuminate the meter and channel selector dial. An E. F. Johnson red subminiature pilot lamp is used to indicate the transmit condition. This pilot lamp contains a 25,000 hour neon lamp and under normal circumstances will probably never have to be replaced. The incandescent lamps can be replaced by performing the following procedure:

a. Remove the cabinet shell.

b. Locate the aluminum strip, behind the front panel, containing the pilot lamps. The strip is easily identified by its two protruding red RIB-LOC terminals with green wires soldered to them.

c. Remove the two #4 self tapping sheet metal screws that retain the strip to the channel switch bracket.

d. Carefully lift the strip away from the front panel. It should be suspended freely by one green wire.

e. Unsolder the leads of the defective lamp and slide it out of its retaining clip.

f. Slide the replacement lamp into the retaining clip. Solder one lead to the shakeproof ground terminal. Solder the other lead to the RIB-LOC terminal.

g. Re-install the strip and fasten the two retaining screws.

5.1.8 GENERAL TROUBLESHOOTING INFORMATION

Most transceiver malfunctions will probably be the result of failures of electron tube or transistors or diodes. Always give a malfunctioning unit a quick visual check before attempting to isolate troubles. A visual check may spot an open filament or burned resistor. Do not rely on a tube tester for determining faulty tubes. Substitute a tube suspected of being faulty with a tube known to be good.

Always check cathode voltages first when troubleshooting. They will usually give the first indications of trouble and can improve your troubleshooting efficiency.

When the transmitter is turned on, sufficient voltage is developed on the AGC line to cut off the squelch control tube, V5A. This action permits the second audio amplifier, V5B to conduct and pass the audio signal through to the modulator. If transmit audio fails to get through, check V5, D1 and Q106. A malfunction of any of these devices can cause failure of V5A to be cut off.

5.2 TRANSISTOR TROUBLESHOOTING

5.2.1 GENERAL

The following information is intended to aid troubleshooting and isolation of transistor circuit malfunctions.

5.2.2 TRANSISTOR OPERATING CHARACTERISTICS

For all practical purposes the transistor base-emitter junction and the transistor base-collector junction can be considered to be diodes. For the transistor to conduct collector to emitter its base-emitter junction must be forward biased in the same manner as a conventional diode. In a germanium transistor the typical forward biased junction voltage is 0.2 to 0.4 volts. A typical silicon transistor will have forward biased junction voltage of 0.5 to 0.7 volts. When collector current is high the base-emitter voltage of both germanium and silicon transistors increases from 0.1 to 0.2 volts. The base-emitter bias voltage in the forward biased condition is then 0.4 to 0.5 volts for a germanium transistor and 0.7 to 0.9 volts for a silicon transistor. High current silicon transistors may go up to 2 volts under load.

A high impedance DC voltmeter is usually the only measuring instrument required for determining the operating status of an in-circuit transistor. The meter is used to measure the transistor bias voltages. See Figure 5-2 for the correct voltmeter connections for measuring in-circuit transistor bias.

5.2.3 IN-CIRCUIT TRANSISTOR TESTING

a. Refer to Figure 5-2 for test connections.

b. Measure the emitter voltage. Compare your measurement to the voltage listed on the schematic diagram. A correct emitter voltage reading generally indicates that the transistor is working properly. If you are in doubt as to the condition of the transistor after measuring the emitter voltage, proceed to the following tests.

c. Measure the base-emitter junction bias. The voltage measured across a forward biased junction should be approximately 0.3 volts for a germanium transistor and 0.6 volts for a small signal silicon transistor.

d. Check for amplifier action by shorting the base to the emitter while monitoring the collector voltage.* The transistor should cut off (not conduct emitter to collector) because the base-emitter bias is removed. The collector voltage should rise to near the supply level. Any difference is the result of leakage current through the transistor. Generally, the smaller the leakage current the better the transistor. If no change occurs in the collector voltage when the base-emitter junction is shorted the transistor should be removed from the circuit and checked with an ohm-

meter or a transistor tester. The following section describes the technique for testing transistors out of the circuit with an ohmmeter.

* Not recommended for high level stages under driving conditions.

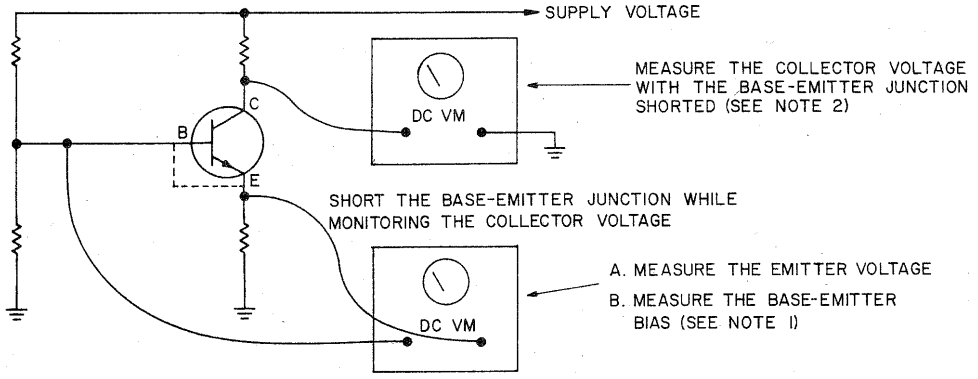
5.2.4 OUT OF CIRCUIT TRANSISTOR TESTING

Only high quality ohmmeters should be used to measure the resistance of transistors. Many ohmmeters of both VOM and electronic types have short circuit current capabilities in their lower ranges that can be damaging to semiconductor devices. A good "rule of thumb" is to never measure the resistance of a semiconductor on any ohmmeter range that produces more than 3 milliamperes of short circuit current. Also, it is not advisable to use an ohmmeter that has an open circuit voltage of more than 1.5 volts. The following section describes a method for determining the short circuit current capabilities of ohmmeters.

5.2.5 HOW TO DETERMINE OHMMETER CURRENT

When the ohmmeter test probes are shorted together (measuring the forward resistance of a diode or the base-emitter junction of a transistor amounts to the same thing) the meter deflects full scale and the entire battery voltage appears across a resistance that we will designate as R1. The current through the probes is the battery voltage divided by the resistance of R1. A very easy method is available for determining the value of R1. Look at the exact center of the ohmmeter scale. Your reading is the value of R1 on the Rx1 range.

The only other unknown required to calculate the short circuit current of an ohmmeter is the internal battery voltage. Let's take a well known meter that has a center scale reading on the ohms scale of 4.62 and a battery voltage of 1.5 volts. Its short circuit current can be calculated by using Ohm's Law. Dividing 1.5 volts by 4.62 ohms equals a short circuit current of 324 mA on the Rx1 range. Obviously, the Rx1 range of this meter cannot be used to measure the resistance of semiconductors. When the value of R1 is known for the Rx1 range it can then be de-



TEST CONNECTIONS FOR
IN-CIRCUIT TRANSISTOR TESTING
FIGURE 5-2

NOTE 1:
Enough loop current is present in the leads of some electronic voltmeters to destroy transistors if measurements are made directly across transistor junctions. If an electronic voltmeter is used, perform the above measurements with respect to the circuit voltage common.

NOTE 2:
If the collector voltage is measured with a VOM the meter leads may be connected directly across the collector resistor. The difference between the supply voltage and the collector voltage will then be indicated directly on the VOM.

NOTE 3:
Be careful when connecting test leads to in-circuit transistors. Operating transistors can be ruined by shorting the base to the collector and, in some circuit configurations, the emitter to ground.

NOTE 4:
Turn power off when removing or installing transistors.

TABLE 5-2

Transistor Type		Ohmmeter Connections + lead	Ohmmeter Connections -lead	Resistance in ohms
Germanium PNP	Power	Emitter	Base	30 to 50 ohms
		Emitter	Collector	Several hundred
	Small Signal	Emitter	Base	200 to 250 ohms
		Emitter	Collector	10 k to 100 k ohms
Silicon PNP	Small Signal	Emitter	Base	10 k to 100 k ohms
		Emitter	Collector	Very high (Might read open)
Silicon NPN	Power	Base	Emitter	200 to 1000 ohms
		Collector	Emitter	High; often greater than 1 megohm
	Small Signal	Base	Emitter	1 k to 3 k ohms
		Collector	Emitter	Very high (Might read open)

termined for any range by multiplying R1 by the multiplier value of the range. The value of R1 for the Rx10 range of a meter with an R1 value on the Rx1 range of 4.62 ohms is 4.62 x 10 or 26.2 ohms. The short circuit current on the Rx10 range can then be calculated: 1.5 volts divided by 46.2 ohms equals 32.5 mA. By using this method, the lowest safe range for measuring semiconductor resistance may be determined for any ohmmeter.

Remember that you should not measure any semiconductor resistance on any ohmmeter range which produces more than three milliamperes of short circuit current.

Table 5-2 indicates the results that should be obtained from operational transistors measured out of circuit.

5.3 RECEIVER PERFORMANCE TEST

(With Troubleshooting information) Receiver RF input values are given into a 6 dB 50 ohm pad.

5.3.1 TEST INSTRUMENT CONNECTIONS

Refer to Figure 5-3 for test instrument connections and Table 5-1 for test instruments required.

5.3.2 SENSITIVITY

1. a. Set the squelch control full counter-clockwise.

   b. Set the channel selector to channel 12.

   c. Set the generator output for 1μV modulated 30% at 1000 Hz on channel 12. (Generator must be accurately on frequency - not just tuned for peak output of receiver). Use crystal controlled signal generator.

   d. Connect audio voltmeter across voice coil.

   e. Adjust the transceiver volume control for a -10dB indication on the audio voltmeter.

   f. Switch the signal generator audio off. The audio should drop 8 dB or more (11 dB typical) as indicated on the AC-VTVM.

5.3.3 AUDIO

1. Performance Test

   a. Set the squelch control fully counterclockwise.

   b. Set the audio voltmeter range selector to the 3 volt scale position.

   c. Set the volume control full on.

NOTE: Perform the following test on channels 1, 12 and 23.

   d. Set the signal generator output for 1μV modulated 30% at 1000 Hz.

   e. The audio output, indicated on the audio voltmeter, should be 1.0 volts or more on channels 1, 12 and 23 at room temperature with cabinet off. 0.5 volts is required with the cabinet on and the transceiver hot.

2. Troubleshooting

The condition of the receiver audio section can be quickly checked by signal injection. Refer to the following procedure.

a. 1. Connect the "hot" side of an audio generator to a 0.1 μF capacitor. Connect the common side of the audio generator firmly to the chassis with an alligator clip. Any individual stage can be checked using the levels indicated in Table 5-3

2. Set the volume control maximum clockwise. Set the squelch control maximum counterclockwise.

TABLE 5-3
TYPICAL RECEIVER AUDIO LEVELS

Test Point	Volts RMS
*Diode Load, T2 Terminal 2	0.1
Top of Vol. control, R21 Term. 3	0.01
V10A grid, pin 7	0.009
V10A plate, pin 6	0.1
V10B plate, pin 1	0.08
V5B grid, pin 2	0.075
V5B plate, pin 3	2.9
V6 grid, pin 3	2.75
V6 plate, pin 9	76
T4, modulator secondary, yellow	72
T4, output secondary, green	1.15

*Reference level for all other measurements listed.

IMPORTANT:
The speaker is grounded through the microphone switch, so the microphone must be connected for the speaker to operate.

b. 1. The reference level for Table 5-3 is 0.1 volts RMS of audio at the diode load, terminal 2 of T2.

2. Use an oscilloscope to check stage to stage distortion.

3. Table 5-3, Typical Receiver Audio Levels, lists the audio gain distribution, measured with an AC-VTVM, that should be obtained from a typical receiver audio section.

5.2.4

1. AGC Performance Test

a. Set the channel selector to channel 12.

b. Set the squelch control to the maximum counterclockwise position.

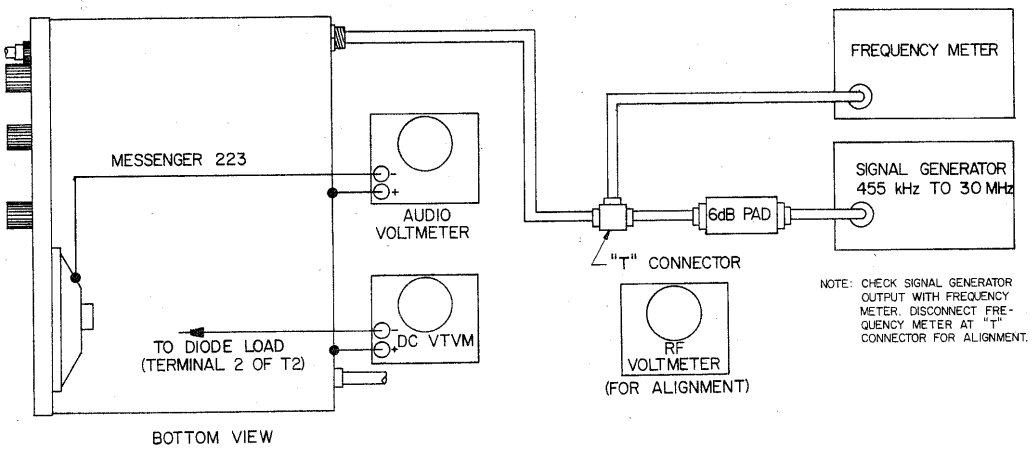
c. Set the signal generator output to 0.1 volt modulated 30% at 1000 Hz at channel 12 (27.105 MHz).

d. Adjust the volume control for a -10 dB indication on the audio voltmeter.

e. Reduce the signal generator output to 10 μV. The audio output should not change more than 22 dB. Record the value so you can reference it to the results in Step g.

f. Re-adjust the volume control for a -10 dB indication on the audio voltmeter.

g. Reduce the signal generator output to 1 μV. The output should decrease 7 dB minimum, 17 dB maximum from the value with 10 μV input.



TEST INSTRUMENT CONNECTIONS
FOR RECEIVER SERVICING AND
ALIGNMENT
FIGURE 5-3

2. AGC Troubleshooting

AGC problems can cause:

- overloading on strong signals.

- erroneous voltage readings at V1, V3 and V4.

a. Measure the AGC voltage at terminal 2 of T2 with a DC voltmeter.

b. Increase the output of the RF signal generator from 1 μV to 0.1 V. The AGC voltage should go more negative as the signal is increased. If the AGC voltage does not change, check the detector circuitry and refer to Table 5-4 for a list of typical AGC voltage readings.

5.3.5 IF and RF Troubleshooting

Check the RF and IF stages by signal injection. Connect a DC voltmeter to terminal 2 of T2. Table 5-5 lists the injection points and the input levels necessary to obtain 1.0 volts at terminal 2 of T2.

TABLE 5-4
TYPICAL AGC CHARACTERISTICS

Test Conditions:

Volume control advanced for reference of 0.775. VRMS at the speaker voice coil with 100,000 μV input to 50 ohm 6 dB pad between generator output and antenna terminal. 27.105 MHz (channel 12) 30% modulation at 400 Hz.
Audio measured with an AC-VTVM connected across the speaker voice call.

RF INPUT TO PAD (MICROVOLTS)	RELATIVE AUDIO OUTPUT (dB)	DIODE LOAD TERM. 2, T2 (VOLTS)
100K	0 *	-16
31.6K	- 2.4	-13.3
10K	- 4.5	-11
3.16K	- 6.2	- 8.8
1K	- 8.5	- 7.0
316	-10.2	- 5.6
100	-12.4	- 4.5
31.6	-15.0	- 3.5
10	-18.2	- 2.5
3.16	-22.5	- 1.6
1	-32.0	- 0.7

* Reference: 0.775 VRMS

5.3.6 Squelch Threshold Performance Test

a. Set the channel selector to channel 12.

b. Disconnect the signal generator (if connected) from the antenna terminal.

c. Set the volume control to about 1/4 on.

d. Turn the squelch control just far enough clockwise to quiet the audio.

e. Set the signal generator output for 1 μV modulated 30% at 1000 Hz.

f. Connect the signal generator cable to the antenna terminal. The squelch should open and allow audio output.

g. Turn the squelch control fully clockwise.

h. Set the signal generator attenuator to 100 μV. The squelch should not open.

i. Set the signal generator attenuator to 31,600 microvolts. The squelch should open.

TABLE 5-5
TYPICAL RF AND IF LEVELS IN RECEIVER

Reference: 1 volt DC at diode load (terminal 2 of T2), measured with DC-VTVM. Input levels are given at the input to a 6 dB 50 ohm pad.

TEST POINT	FUNCTION	INPUT FREQUENCY	INPUT LEVEL
T2, pin 5	Det. Diode	455 kHz	0.76 volts
V4 plate, pin 5	IF AMP	455 kHz	2.7 volts
V4 grid, pin 1	IF AMP	455 kHz	16,000 microvolts
V3 plate, pin 5	IF AMP	455 kHz	170,000 microvolts
V3 grid, pin 1	IF AMP	455 kHz	1,300 microvolts
V2 plate, pin 5	MIXER	455 kHz	1,200 microvolts
V2 signal grid, pin 7	MIXER	455 kHz	780 microvolts
V2 signal grid, pin 7	MIXER	27.105 MHz	1,200 microvolts
V1 plate, pin 5	RF AMP	27.105 MHz	300 microvolts
V1 grid, pin 1	RF AMP	27.105 MHz	17 microvolts
Antenna connector		27.105 MHz	1.7 microvolts

NOTE: TYPICAL VALUES MAY VARY ±20%

5.3.7 Noise Limiter Performance Test

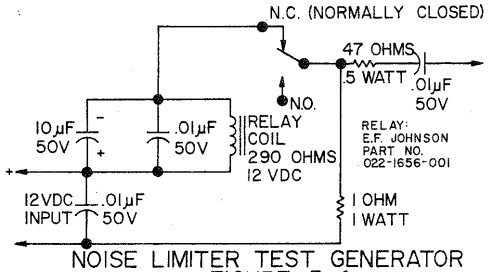
a. Turn squelch control full counterclockwise.

b. Connect the noise generator illustrated in Figure 5-4 to the antenna terminal. Set RF signal generator to 1 μV unmodulated.

c. Connect an audio voltmeter across the speaker coil and set the volume control for an indication of -10 dB on the meter.

d. Turn on the noise generator. The audio output should not increase more than 5 dB.

If the noise limiter fails the test, disconnect one end of diode D2 and check it with an ohmmeter.



NOISE LIMITER TEST GENERATOR
FIGURE 5-4

5.3.8 S-Meter Performance Test

a. Mechanical zero
With power off, set the S-Meter to mechanical zero (extreme left end of the scale). Access hole for adjusting the screw is in the front panel directly below the meter.

b. Electrical zero
Perform the electrical zero adjustment on channel 12 with the transceiver warmed up. With no signal, adjust R9 (bottom side of the chassis, left end) to give a zero reading on the S-Meter.

c. Performance Test
Set the signal generator attenuator to 100 μV. The S-Meter should read between S8 and 10 dB above S9. The S-Meter calibration is approximately 5 dB per S unit.

5.4 TRANSMITTER PERFORMANCE TEST
(With troubleshooting information)

Refer to Figure 5-5 for test instrument connections and Table 5-1 for test instruments required.

5.4.1 RF POWER OUTPUT

a. Connect the wattmeter and 50 ohm load to the antenna terminals.

b. Connect a DC-VTVM to junction of L2 and R42. (Refer to Figure 6-3, bottom view of Messenger 223).

CAUTION: Meter is floating at supply voltage above ground. Metal cases of some VTVM's may be "hot" with DC.

c. Connect DC voltmeter across R46, the 100 ohm meter shunt, with the positive terminal at the junction of R46 and R54. Each volt read will represent 10 mA PA plate current.

d. Key the transmitter with no modulation applied. Check the RF power output on channels 1 through 23 with no modulation. The limits are 4 watts maximum and 2.3 watts minimum. The power amplifier plate current should be 19 mA for 5 watts power input. Refer to section 6 for the transmitter alignment procedure.

e. Set the channel selector to channel 16.

f. Adjust R43 (bottom side, front and center) to give an indication of 4 on the black scale of the S-Meter.

g. Check meter operation on channels 1 and 23. The limits with no modulation are 3 minimum and 5 maximum.

5.4.2 MODULATION

a. Connect the "hot" side of an audio generator to the male (inside) side of pin 1 of the microphone jack, (J). Use an insulated miniature alligator clip if available.

b. Connect the common side of the audio generator to the male (inside) side of pin 4, J9.

c. Set the audio generator output for a 5 millivolt level at a frequency of 1000 Hz.

d. Couple a small sample of the modulated RF output with an RF pickup loop or other means available to the vertical plate of an oscilloscope. Refer to Figure 5-6 for connection details. Couple the pickup loop to L10.

e. Key the transmitter with the microphone.

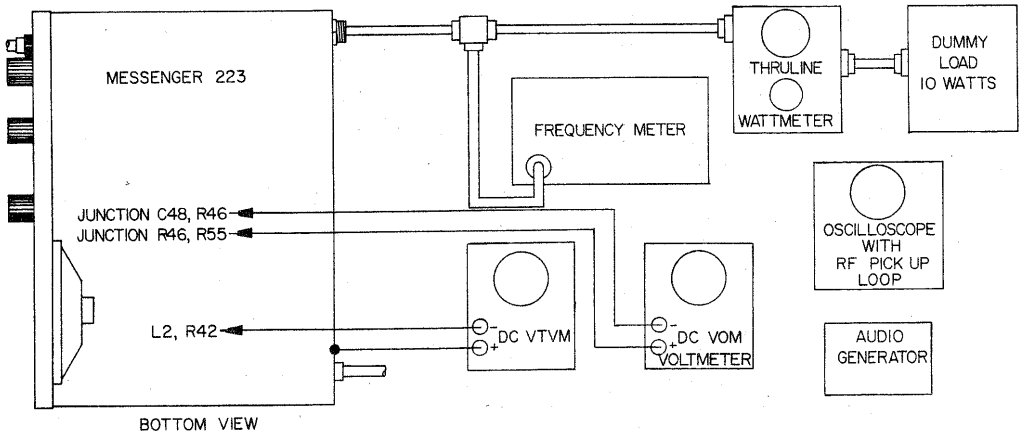
f. Use Figure 5-7 as a reference. Observe the oscilloscope waveform. A minimum of 50% modulation should be obtained. The typical level of modulation is 75% with the threshold of peak clipping at approximately 80% modulation. If these levels cannot be obtained, refer to Table 5-6 for troubleshooting information.

g. Increase the audio input of 5 millivolts by 10 dB, (15.8 millivolts input). The modulation should be a minimum of 80% and not more than 100% on both positive and negative peaks.

h. Unkey the transmitter and disconnect the audio generator.

i. 1. Key the transmitter and speak into the microphone. Check for normal modulation as indicated in Step g.

2. Check the operation of the pilot lamps. The three white lamps must glow when the transceiver is turned on. The red lamp must glow when the microphone switch is pressed and its brightness should increase with modulation.

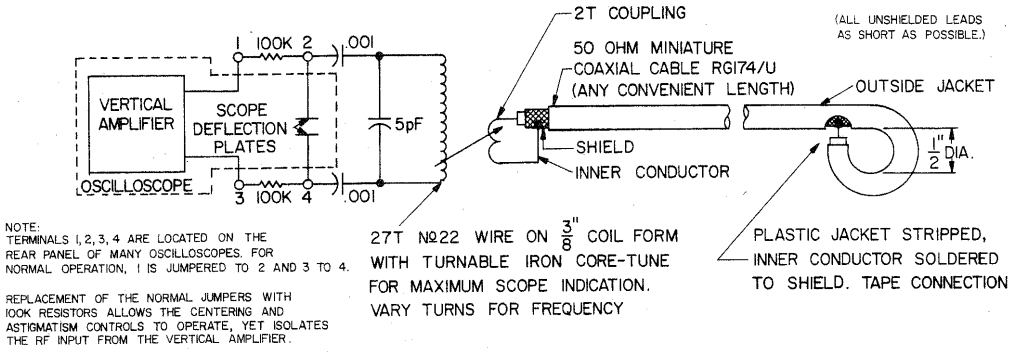


TEST INSTRUMENT CONNECTIONS FOR TRANSMITTER SERVICING AND ALIGNMENT
FIGURE 5-5

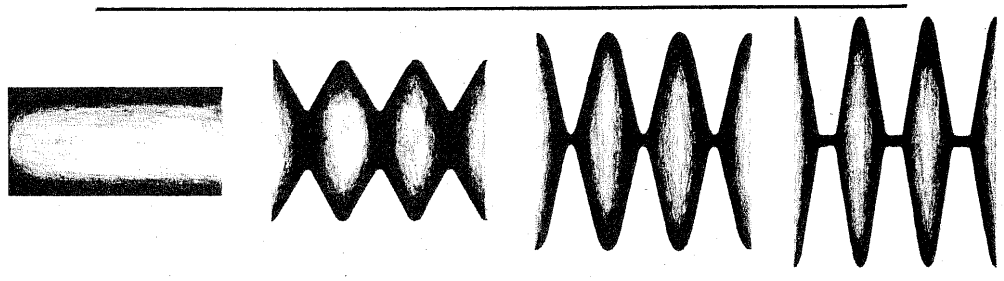
TABLE 5-6
TYPICAL AUDIO LEVELS IN TRANSMITTER

Test Conditions:
Audio measured with AC-VTVM.
Modulation measured with oscilloscope at RF output.
PA plate current 19 mA.
Modulating frequency 1,000 Hz.

	Reference 50% Modulation	Reference 80% Modulation
Microphone input	3.4 mV	7.0 mV
V10B - Pin 2 grid	3.4 mV	7.0 mV
V10B - Pin 1 plate	0.135	0.265
V10A - Pin 6 plate	0.012	0.0245



OSCILLOSCOPE RF PICK-UP LOOP
AND METHOD OF CONNECTION
FIGURE 5-6



TRANSMITTER WAVEFORMS
FIGURE 5-7

5.5 SYNTHESIZER

NOTE: The following measurements are only necessary if the synthesizer has been repaired or it is suspected of functioning improperly. Refer to Tables 5-7, 5-8 and 5-9 for synthesizer troubleshooting information.

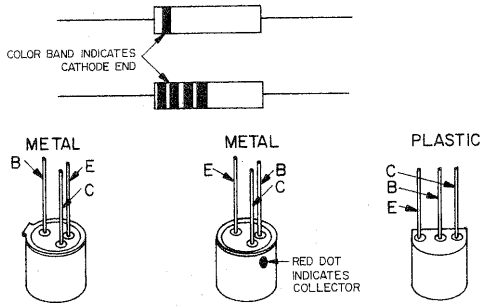
a. Couple a small sample of the transmitter power output from the dummy load to a frequency meter.

b. Measure the frequency on channels 1, 6, 11, 16, 20 and 23.

NOTE: The following table lists the maximum frequency variations at a standard temperature of +25° Centigrade (72° Fahrenheit).

c. If the synthesizer fails to meet the limits listed in Table 5-7, refer to Table 5-8 and 5-9 and the synthesizer alignment instructions in section 6.

NOTE: Refer to section 5-2 and Figure 5-8, semiconductor case diagrams, if a semiconductor is suspected of being faulty. Refer to Figures 5-10 and 5-11 for component identification.



SEMICONDUCTOR CASE DIAGRAMS
BOTTOM VIEWS
FIGURE 5-8

TABLE 5-7
LIMITS FOR TRANSMITTER FREQUENCY VARIATION

CHANNEL NO.	FREQUENCY, kHz	+0.0025% HIGH LIMIT, kHz	-0.0025% LOW LIMIT, kHz
1	26,965.000	26,965.674	26,964.326
6	27,025.000	27,025.676	27,024.324
11	27,085.000	27,085.677	27,084.323
16	27,155.000	27,155.679	27,154.321
20	27,205.000	27,205.680	27,204.320
23	27,255.000	27,255.681	27,254.319

TABLE 5-8
FREQUENCY SYNTHESIZER TROUBLESHOOTING

Trouble	Probable Cause
Receiver completely inoperative. Transmitter operates normally.	D102, D103 or Q106.
No output in transmit condition. Receiver operates normally.	D101, D104, Q104, Q105, or Q106.
Receiver and transmitter completely inoperative.	D105, Q101, Q102 or Q103.
Transceiver operation intermittent.	Alignment improper. Selector switch dirty.
Transceiver inoperative on some channels. Operates normally on others.	Faulty crystal. Refer to Table 5-9 and Figure 5-8.

5.6 TYPICAL RESISTANCE READINGS

J5, antenna socket, with antenna disconnected.

	Resistance-Ohms
Center Pin	47,000
Body	0

T4, output and modulation transformer.

Blue to red	206
Brown to yellow	164
Green to black	0.36

T5, 117 VAC transformer.

Black to black	4.3
Red to Red	295
Red-yellow to red	151 & 144
Green to green	0.19

LS1, Speaker

Voice coil	3

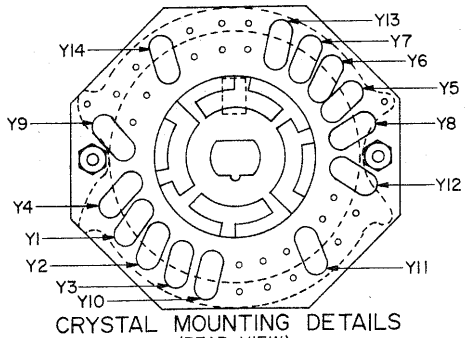
5.7 CURRENT DRAIN MEASUREMENTS

The power supply current drain can be measured by inserting a DC current meter in series with the cathode of the rectifier tube, V9.

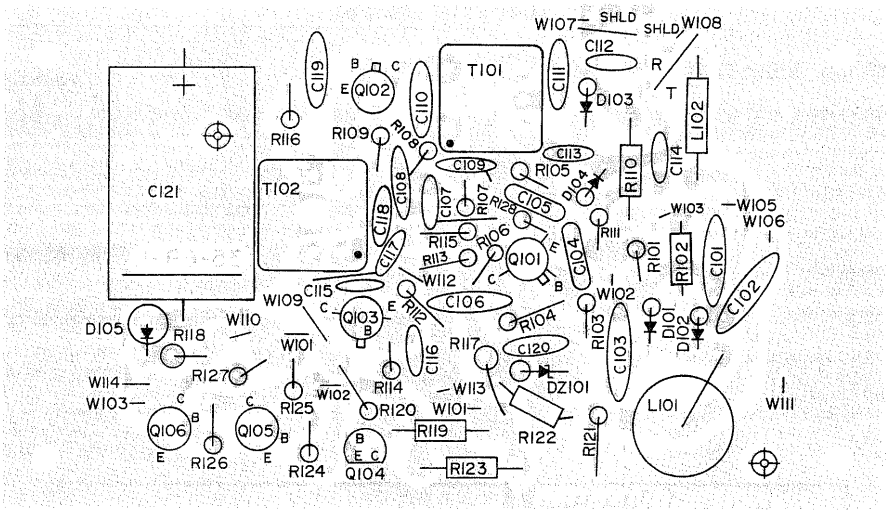
Typical Current Drain	
Transmit	118 mA
Receive	86 mA

TABLE 5-9
SYNTHESIZER CRYSTAL TROUBLESHOOTING

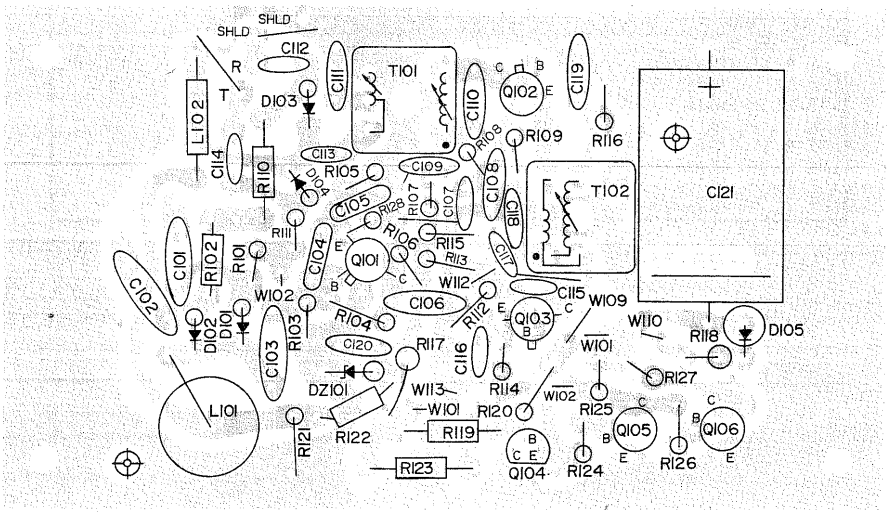
Channels Inoperative	Receive Inoperative	Transmit Inoperative	Faulty Crystal
1, 2, 3 and 4	X	X	Y9
5, 6, 7 and 8	X	X	Y10
9, 10, 11 and 12	X	X	Y11
13, 14, 15 and 16	X	X	Y12
17, 18, 19 and 20	X	X	Y13
21, 22, and 23	X	X	Y14
1, 5, 9, 13, 17 and 21	X		Y5
2, 6, 10, 14, 18 and 22	X		Y6
3, 7, 11, 15 and 19	X		Y7
4, 8, 12, 16, 20, 23	X		Y8
1, 5, 9, 13, 17 and 21		X	Y1
2, 6, 10, 14, 18 and 22		X	Y2
3, 7, 11, 15, 19		X	Y3
4, 8, 12, 16, 19 and 23		X	Y4



CRYSTAL MOUNTING DETAILS
(REAR VIEW)
FIGURE 5-9



FREQUENCY SYNTHESIZER BOARD
(VIEWED FROM SCREENED SIDE)
FIGURE 5-10



FREQUENCY SYNTHESIZER BOARD
(VIEWED FROM FOIL SIDE)
FIGURE 5-11

SECTION 6
ALIGNMENT

6.1 GENERAL

NOTES

1. Use care and the proper tuning tool in adjusting the various transformers to prevent core damage. Refer to table 5-1 for test instrument information, Figure 6-1 for tuning tools, and Figures 6-2 and 6-3 for alignment points.

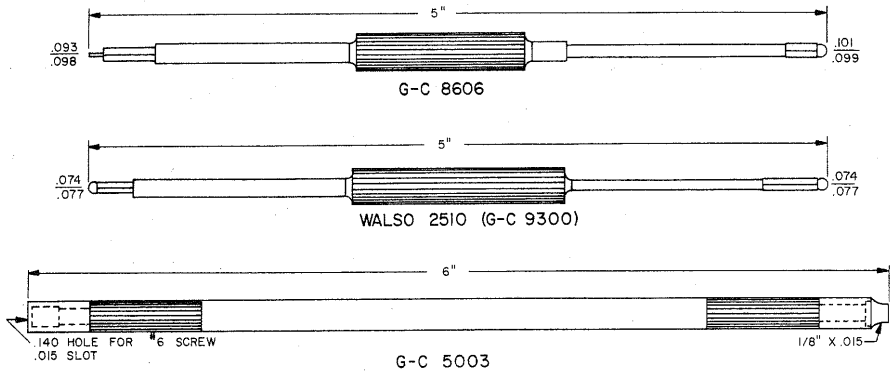
2. Keep all coaxial cables as short as possible.

3. All receiver RF input levels listed in the receiver alignment chart are numbers into a 6 dB pad connected between the generator and the transceiver.

TABLE 6-1
ALIGNMENT TOOLS REQUIRED

NOTE: All tools can be purchased from General Cement.

TOOL	TYPE	USE
GC 8606	Delrin Hex Tool	Aligning T1, T2, T3 and T6.
Walso 2510	0.075 hex	Aligning T101, T102
General Cement	5003 dual screw driver	Aligning all other adjustments



ALIGNMENT TOOLS REQUIRED
FIGURE 6-1

6.2 RECEIVER ALIGNMENT CHART

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
1. 455 kHz IF (with IF transformers completely out of alignment)	a. Connect a DC-VTVM to the diode load (terminal 2 of T2). b. Connect an AC-VTVM across the speaker voice coil (from the green wire to the chassis). c. Plug the line cord into a 117 VAC source. d. Turn the squelch control just enough clockwise to turn the power on. e. Turn the volume control fully clockwise. f. Connect the microphone. Be extremely careful not to key the mic while aligning the receiver, or remove V8, type 7061. g. Apply a 455 kHz signal modulated 400 Hz at pin 1 of XV4.	a. Adjust top cores in T2, T7, T6, and T1 flush with top of the can. b. Adjust the bottom core in T2 for maximum audio output. c. Adjust the top core of T2 for maximum audio output. d. Note: on this adjustment reduce the input and volume control as necessary. Make the final adjustment at each core of T2 with input reduced to give approximately 1.0 volts at the diode load.
	h. Transfer the signal generator to pin 1 of XV3.	e. Adjust the cores of T7 as in steps b, c, and d. f. Adjust cores of T6 as in steps b, c, and d.
	i. Transfer the signal generator to pin 1 of XV2.	g. Adjust the cores of T1 as in steps b, c, and d.
2. 455 kHz IF (with IF transformers approximately in alignment)	Connect the test instruments and perform settings as listed in steps a through g of step 1.	Adjust the following transformers in order, T2, T7, T6 and T1 bottom cores, then top cores.
3. Visual Presentation of IF selectivity curve (optional)	NOTE: A stable 455 kHz sweep generator with a narrow sweep (about 24 kHz) and an oscilloscope with linear sweep are required for this alignment procedure. a. Perform steps a through f of the connections and settings in step 1.	

ALIGNMENT (Cont'd)

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
	b. Connect the sweep generator to pin of XV2.	
	c. Connect the oscilloscope vertical input to the junction of R17 and D2.	
	d. Connect the sweep generator sawtooth sweep output to the sweep input of the oscilloscope.	
	e. Connect a 1 μF or larger paper capacitor from the AGC line to the chassis. (From the end of R2 on TS6 to the chassis is convenient).	Adjust the top core of T2 to correspond with the example in Figure 5-1 as closely as possible.
4. Synthesizer Adjustment	a. Check the voltage across DZ101. Your reading should be -10 ±0.5 volts DC.	
	b. Connect an RF voltmeter or DC-VTVM with RF probe across the receiver coax on the synthesizer board.	
	c. Set the channel selector to channel 23.	a. Adjust T102 until the voltmeter begins to indicate the presence of RF. Back off the core of T102 (toward the top of the can) until the oscillator stops then advance the core exactly 1/4 turn beyond the oscillator starting point.
	d. Set the channel selector to channel 12.	b. Adjust T101 and L3 for a maximum reading on the RF voltmeter (225 mV typical). About 130 mV minimum will be required to meet diode load specifications. Caution: Tune on the outside peaks.
		c. Check the synthesizer crystals by setting the channel selector switch to channels 1, 6, 11, 16, 20, and 23 and observe the RF voltmeter. It should approximately be the same as in step b.
5. Receiver RF Alignment	a. Perform the connections and settings listed in steps a through f in step 1.	
	b. Connect a signal generator through a 6 dB attenuator to the antenna terminal.	NOTE: The 27 MHz transformer, T3, is stagger tuned.
	c. Set the channel selector to channel 12.	
	d. Set the signal generator to channel 12 (27.105 MHz) modulated 30% at 1000 Hz.	a. Adjust the core in L1, the antenna input coil, for maximum audio out-

ALIGNMENT (Cont'd)

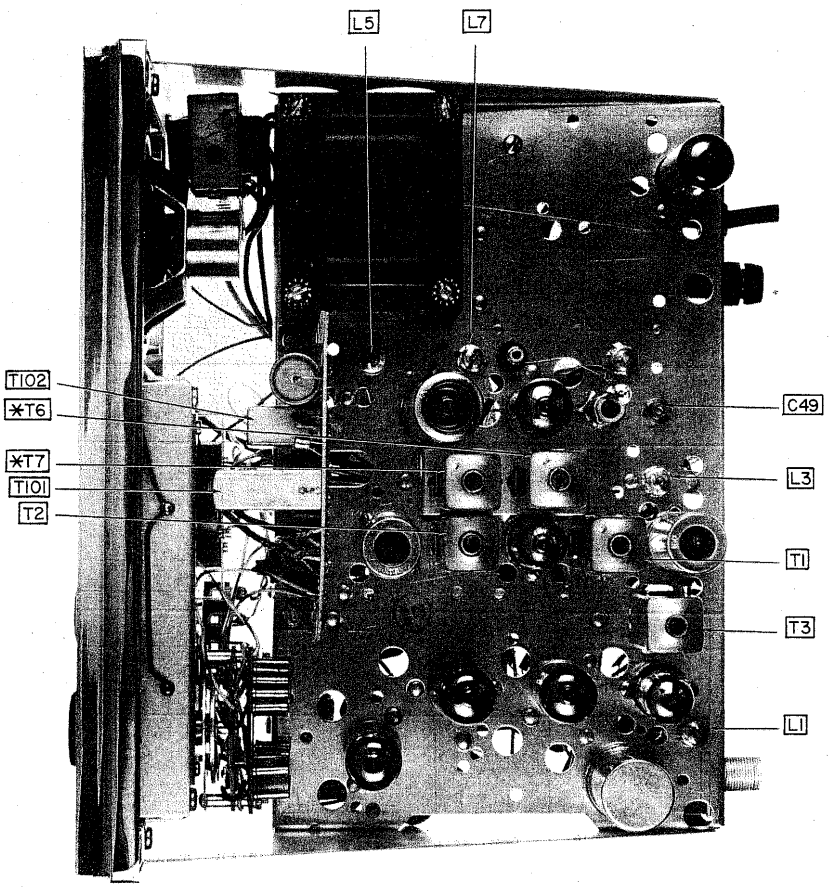
ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
		put. Start from "core out" position (to avoid tuning to the injection frequency, 26.650 MHz, or to the image frequency, 26.195 MHz). Make the final adjustment with the input reduced to give approximately 1 volt at the diode load.
	e. Set the channel selector to channel 1.	
	f. Change the signal generator frequency to channel 1 (26.965 MHz).	b. Adjust top (primary) core in T3 for maximum audio output by starting from the top (outside) end of the coil and tuning for the second peak, which occurs when the core is positioned near the bottom (inside) end of the coil. (Be sure to tune from the "high frequency" side, to avoid tuning to the receiver injection frequency, 26.510 MHz, or to the image frequency, 26.055. In this position greater coupling will result and the frequency response of T3 will be widened. Do not insert the top core so far that it enters the bottom (secondary) coil and tunes the secondary to channel 1). The top core will be approximately 7/16" from the top of the can when tuned properly.
	g. Set the channel selector to channel 23.	
	h. Change the signal generator frequency to channel 23 (27.255 MHz).	c. Adjust bottom (secondary) core in T3 for maximum audio output, starting from "core out" position at the bottom (outside) end and tuning for the first peak. (Be sure to tune from the "high frequency" side to avoid tuning to the receiver injection frequency, 26.800 MHz, and the image frequency, 26.345 MHz). d. Repeats steps a and c (adjustments on channels 12 and 23) making the final adjustment with the input reduced to give approximately 1 volt at the diode load. With 1 microvolt input, diode load voltage should not be less than 0.6 volt. (Typical 0.75 volt).
6. S-Meter		Refer to Section 5.3.7. for S-Meter alignment and performance test information.

6.3 TRANSMITTER ALIGNMENT CHART

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
1. Driver	a. Remove the cabinet shell. b. Connect a Bird Thruline wattmeter with 10A element, or equivalent to the antenna terminal, terminate the wattmeter into a 50 ohm load such as a Bird Termaline. c. Connect a DC-VTVM to the junction of L2 and R42. This connection measures the PA grid voltage. d. Connect a DC voltmeter across R46, the 100 ohm meter shunt, with the positive terminal at the junction of R46 and R55. Each volt indicated represents 10 mA of plate current. e. Plug the line cord into a 117 VAC source. f. Key the transmitter with the microphone. g. Connect a DC-VTVM to the junction of L2 and R42.	a. Grid- adjust the core in L5 for maximum PA grid voltage. b. Plate - Adjust coil L7 for maximum rectified grid voltage on the power amplifier (typical -18 volts). This will be readjusted after the power amplifier is tuned.
2. Preliminary Power Amplifier Adjustment	Connections and settings the same as in steps a through f of part 1.	a. Adjust the Pi-L network for maximum RF current to the dummy load while maintaining the standard value of PA current (19 mA). Make a preliminary adjustment before neutralizing. This is accomplished by simultaneous adjustments of PA plate tuning and coupling. b. PA Plate Tuning - Adjust L9 for a dip in PA plate current (resonance). c. Coupling - Adjust C49, 65 pF variable air capacitor, for desired PA plate current at dip, keeping L9 adjusted for a minimum PA current of standard value or a little less at the dip. Coupling will increase as C49 is turned clockwise (less capacity), as viewed from the bottom.
3. Neutralization	The same as in step 2.	NOTE rectified DC grid voltage on PA as L9 is tuned through resonance.

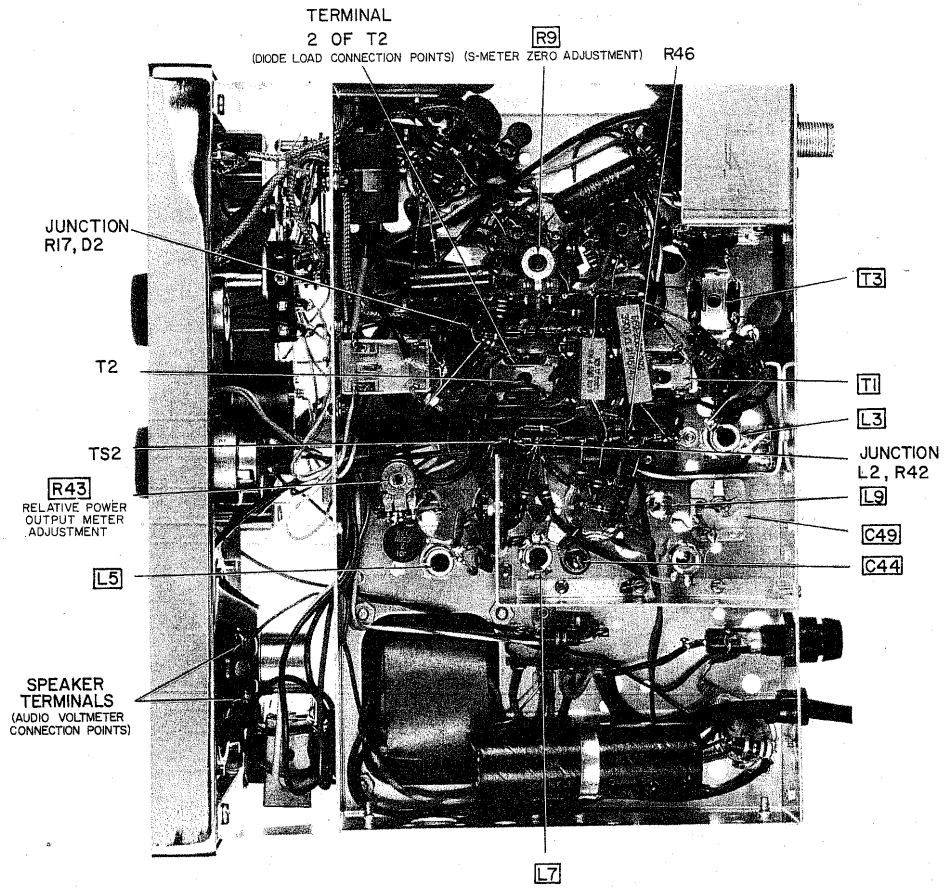
ALIGNMENT (Cont'd)

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
		If this voltage increases in magnitude when the core in L9 is backed out of the coil, the value of the tubular ceramic capacitor, C44, is too small. Increase capacity of C44 one half turn at a time (clockwise) and repeat test above. If the grid voltage increases in magnitude when the core in L9 is inserted farther into the coil, the value of C44 is too large. Decrease capacity of C44 one half turn at a time (counterclockwise) and repeat test above. A setting will be found at which the grid voltage rises equally but only slightly or not at all on each side of resonance. This adjustment is the desired one. The setting of neutralizing capacitor C44 affects the PA plate tuning, hence the PA tuning and coupling will be touched up in the following step.
4. Final Power Amplifier Adjustments	The same as in step 3.	Repeat step 2, but make the last adjustment that of detuning L9 slightly in the counterclockwise, (core out) direction for maximum RF output, while maintaining standard power amplifier plate current.
5. Final RF Drive Adjustment	The same as in step 1 except connect the DC-VTVM to the junction of L2 and R42.	Adjust plate coil, L7, for maximum rectified grid voltage on the power amplifier, then adjust for equal values on channels 1 and 23. Minimum limits: -11 volts DC. (Typical = -18 volts).
6. Relative Power Output Meter Adjustment	Same as in Step 1 except set the channel selector to channel 16.	a. Key the transmitter with no modulation. b. Adjust R43 (refer to Figure 6-3 for location) to give an indication of 4 on the black scale of the S-Meter.



* BOTH CORES MUST BE TUNED FROM TOP OF CHASSIS.

ALIGNMENT POINTS
(TOP VIEW)
FIGURE 6-2



ALIGNMENT AND TEST
INSTRUMENT CONNECTION POINTS
(BOTTOM VIEW)
FIGURE 6-3

SECTION 7
PARTS LIST

SYMBOL NO.	DESCRIPTION	PART NO.
	ASSEMBLIES	
ASY2	Crystal switch assembly Includes:	583-2029-101
Crystals	Frequency	
Y1	5.735 MHz	519-0023-004
Y2	5.725 "	519-0023-003
Y3	5.715 "	519-0023-002
Y4	5.695 "	519-0023-001
Y5	6.190 "	519-0023-008
Y6	6.180 "	519-0023-007
Y7	6.170 "	519-0023-006
Y8	6.150 "	519-0023-005
Y9	32.700 "	519-0024-001
Y10	32.750 "	519-0024-002
Y11	32.800 "	519-0024-003
Y12	32.850 "	519-0024-004
Y13	32.900 "	519-0024-005
Y14	32.950 "	519-0024-006
ASY3	Synthesizer board assembly Includes:	023-2575-001
BKT6	Mounting bracket	017-0671-001
	Printed circuit board	035-0069-001
C101	Capacitor, 0.047 μF, +80% -20% 16V Y5U	510-3007-473
C102	Same as C101	
C103	Same as C101	
C104	Capacitor, 150 pF, ±5% 100V D.M. silvered mica	510-0001-151
C105	Capacitor, 47 pF, ±5% 100V D.M. silvered mica	510-0001-470
C106	Capacitor, 0.01 μF, +80% -20% 50V, Y5U	510-3003-103
C107	Capacitor, 68 pF ±5%, N750 200V ceramic disc	510-3020-680
C108	Capacitor, 120 pF ±5%, N750 200V ceramic disc	510-3020-121
C109	Capacitor, 0.01 μF, +80% -20% 50V, Y5U	510-3003-103
C110	Capacitor, 56 pF ±5%, N750 200V ceramic disc	510-3020-560
C111	Capacitor, 68 pF ±5%, N750 200V ceramic disc	510-3020-680
C112	Capacitor, 0.01 μF, +80% -20% 16V, Y5S	510-3007-103
C113	Same as C112	
C114	Same as C112	
C115	Capacitor, 6.8 pF ±5%, N750 200V ceramic disc	510-3020-689
C116	Capacitor, 18 pF ±5%, N750 200V ceramic disc	510-3020-180
C117	Capacitor, 22 pF ±5%, N750 200V ceramic disc	510-3020-220
C118	Capacitor, 0.01 μF, +80% -20% 50V, Y5U	510-3003-103
C119	Same as C118	
C120	Same as C118	
C121	Capacitor, 1000 μF, +100% -10%, 16V, electrolytic	510-4006-005
D101	Diode, 1N881, 200V, 50 mA	523-1000-881
D102	Same as D101	
D103	Same as D101	
D104	Same as D101	
D105	Diode, rectifier 200V, 1 amp	523-0001-002
DZ101	Diode, zener, 10.0V ±5% 1W	523-2003-100
R101	Resistor, 22KΩ ±10% 1/4 W	569-1002-223
R102	Same as R101	
R103	Resistor, 4.7KΩ ±10% 1/4 W comp.	569-1002-472
R104	Resistor, 15KΩ ±10% 1/4 W comp.	569-1002-153
R105	Resistor, 3.3KΩ ±10% 1/4 W comp.	569-1002-332
R106	Resistor, 100Ω ±10% 1/4 W comp.	569-1002-101
R107	Same as R106	
R108	Resistor, 39KΩ ±10% 1/4 W comp.	569-1002-393
R109	Resistor, 6.8KΩ ±10% 1/4 W comp.	569-1002-682
R110	Resistor, 2.2KΩ ±10% 1/4 W comp.	569-1002-222
R111	Same as R110	
R112	Resistor, 470Ω " " comp.	569-1002-471
R113	Resistor, 2.7KΩ " " comp.	569-1002-272
R114	Resistor, 680Ω " " comp.	569-1002-681
R115	Resistor, 100Ω " " comp.	569-1002-101
R116	Resistor, 1KΩ " "	569-1002-102
R117	Resistor, 39Ω ±10% 1/2 W	569-1004-390
R118	Resistor, 10Ω ±10% 1/2 W	569-1004-100
R119	Resistor, 39Ω ±10% 1/2 W comp.	569-1002-105
R120	Resistor, 10Ω ±10% 1/2 W comp.	569-1002-154
R121	Resistor, 1 MΩ ±10% 1/4 W comp.	569-1002-221
R122	Resistor, 150 KΩ " " comp.	569-1002-331
R123	Resistor, 220Ω " " comp.	569-1002-272
R124	Resistor, 1K " " comp.	569-1002-102
R125	Resistor, 2.7KΩ " " comp.	569-1002-471
R126	Resistor, 1 KΩ " " comp.	569-1002-102
R127	Resistor, 470Ω " " comp.	569-1002-471
R128	Resistor, 330Ω " " comp.	569-1002-331
Q101	Transistor, 3024	576-0003-024
Q102	Same as Q101	
Q103	Same as Q101	
Q104	Transistor, 3011	576-0003-011
Q105	Transistor, 1003	576-0001-003
Q106	Same as Q105	
T101	Transformer, 26.9 MHz	592-5008-011
T102	Transformer, 32 MHz	592-5010-001
L101	Inductor, 2.4 MH	022-1193-001
L102	Inductor, 20 μH	542-3002-002

PARTS LIST (cont'd)

SYMBOL NO.	DESCRIPTION	PART NO.
ASY4	Front panel assembly	023-2577-001
	Includes:	
	Panel, front	015-0798-002
	Overlay, panel lower	559-2034-001
	Overlay, panel upper	559-2035-001
	Grille, speaker	017-0672-001
BKT3	Bracket, meter mtg.	017-0669-001
I1	Assembly, lamp T1 3/4	147-2103-922
LS1	Speaker, 3 1/2" PM	589-1004-001
R31	Potentiometer, 15K ±10%, with switch 2 W	022-1932-001
R21	Potentiometer, 1 MΩ ±30%, 1/8 W	022-1647-001
	Connector, microphone	515-1003-002
M1	Meter, 0-200 μA, DC	554-0014-001
	Speednut, push-on, 5/32 dia. stud	022-1614-001
T4	Transformer, Mod. output	592-1029-002
	Window, dial	559-1007-001
	Grille cloth	018-0827-006
ASY5	I. F. Bracket assembly (support for T6 and T7)	023-1620-001
ASY6	Cabinet assembly	023-2568-002
	Includes:	
	Shell, cabinet	017-0676-002
	Plate, rear chassis	017-1306-003
	Polethylene mounting feet	574-1005-001
ASY7	Lamp bracket assembly	023-2571-001
	Includes:	
	Bracket, lamp	017-0680-001
	Feed-thru, rib-loc	260-0202-001
I2	Lamp, incandescent unbased	549-3001-003
I3	Same as I2	
	Clip, component	016-1749-001
I4	Same as I2	
	BRACKETS	
BKT1	Front panel, right	017-0667-001
BKT2	Front panel, left	017-0667-002
BKT4	Switch mounting	017-0670-001
	CAPACITORS	
C1	0.001 μF ±20% 500 V, Y5U ceramic disc	510-3004-102
C2	22 pF ±10% 500 VW, dipped mica	510-0005-220
C3	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C4	0.001 μF ±20% 500 V, Y5U ceramic disc	510-3004-102
C5	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C6	Same as C5	
C7	22 pF ±10% 500 VW, dipped mica	510-0005-220
C8	330 pF ±10% 1000 VW, ceramic disc N1500	510-3041-331
C9	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C10	0.56 pF ±5% 500 VW, composition tubular	510-9002-568
C11	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C12	Same as C11	
C13	Same as C11	
C14	Same as C11	
C15	Same as C11	
C16	Same as C11	
C17	680 pF ±10% 300 VW, dipped mica	510-0006-681
C18	0.022 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-223
C19	0.01 μF +80% -20% 500 VW, ceramic disc	510-3005-103
C20	0.001 μF ±20% 500 V, Y5U ceramic disc	510-3004-102
C21	150 pF ±10% 500 VW, dipped mica	510-0005-151
C22	0.022 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-223
C23	100 pF ±10% 500 VW, dipped mica	510-0005-101
C24	0.0047 μF ±20% 500 VW, Y5U ceramic disc	510-3004-472
C25	0.047 μF 200 VW, paper tubular	510-9004-001
C26	0.022 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-223
C27	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C28	Capacitor, dual, 4 μF 350 VW and 8 μF 150 VW, electrolytic	510-4051-001
C29	0.0022 μF ±20% 500 VW, Y5U ceramic disc	510-3004-222

PARTS LIST (cont'd)

SYMBOL NO.	DESCRIPTION	PART NO.
C30	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C31	0.0047 μF ±20% 500 VW, Y5U ceramic disc	510-3004-472
C32	0.0033 μF ±10% 1000 VW, Y5S ceramic disc	510-3061-332
C33	15/10/10 μF 300/150/25 VW, electrolytic	022-1541-001
C34	0.01 μF ±20% 400 VW, paper	510-9005-001
C35	0.001 μF ±20% 1500V ceramic disc	510-3158-102
C37	330 pF ±10% 1000 VW, ceramic disc N1500	510-3041-331
C38	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C39	0.0047 μF ±20% 500 VW, Y5U ceramic disc	510-3004-472
C40	22pF ±10% 500 VW, dipped mica	510-0005-220
C41	220 pF ±10% 500 VW, dipped mica	510-0005-221
C42	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C43	0.001 μF ±20% 500 V, Y5U ceramic disc	510-3004-102
C44	Variable, 1-7.5 pF tubular ceramic - less hardware	512-1002-004
C45	0.001 μF ±20% 1500 VW, X5E ceramic disc	510-3158-102
C46	150 pF ±10% 500 VW, dipped mica	510-0005-151
C47	0.001 μF ±20% 1500 VW, X5E ceramic disc	510-3148-102
C48	Same as C47	
C49	Variable, 3.5-65 pF	148-0009-004
C51	0.0022 μF ±20% 125 VAC ceramic disc	510-3001-222
C52	Same as C51	
C55	0.0047 μF ±20% 500 VW, Y5U ceramic disc	510-3004-472
C59	80 μF +50% -10% 450 VW electrolytic	510-4019-004
C60	1 pF ±5% 500 VW, tubular, composition	510-9002-109
C61	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C62	5.6 μF ±20% 15 V, tantalum	510-2023-569
C63	0.1 μF ±20% 400 VW, paper	510-9005-001
C70	10 pF ±10% 500 VW, dipped mica	510-0005-100
C80	0.56 pF ±5% 500 VW, composition tubular	510-9002-568
C81	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
C82	Same as C81	
C83	Same as C81	
C84	Same as C81	
C85	Same as C81	
C86	150 pF ±10% 500 VW, dipped mica	510-0005-151
C87	0.0047 μF ±20% 500 VW, Y5U ceramic disc	510-3004-472
C88	0.01 μF +80% -20% 500 VW, Y5U ceramic disc	510-3005-103
DIODES		
D1	1N881 Silicon 200V, 50 MA	523-1000-881
D2	1N881 Silicon 200V, 50 MA	523-1000-881
D3	1N67A Germanium 60V	523-1000-067
D4	Silicon 75V, 50 MA	523-0006-002
D5	Silicon 75V, 50 MA	523-0006-002
BUSHINGS		
E1	Shoulder	029-0218-005
E2	Shoulder	029-0218-006
E3	Strain relief	574-0003-002
FUSE		
F1	Fuse, 2 ampere 250 V Type AGC-2	534-0003-024
FUSEHOLDERS		
FH1	Fuseholder	534-1002-001

PARTS LIST (cont'd)

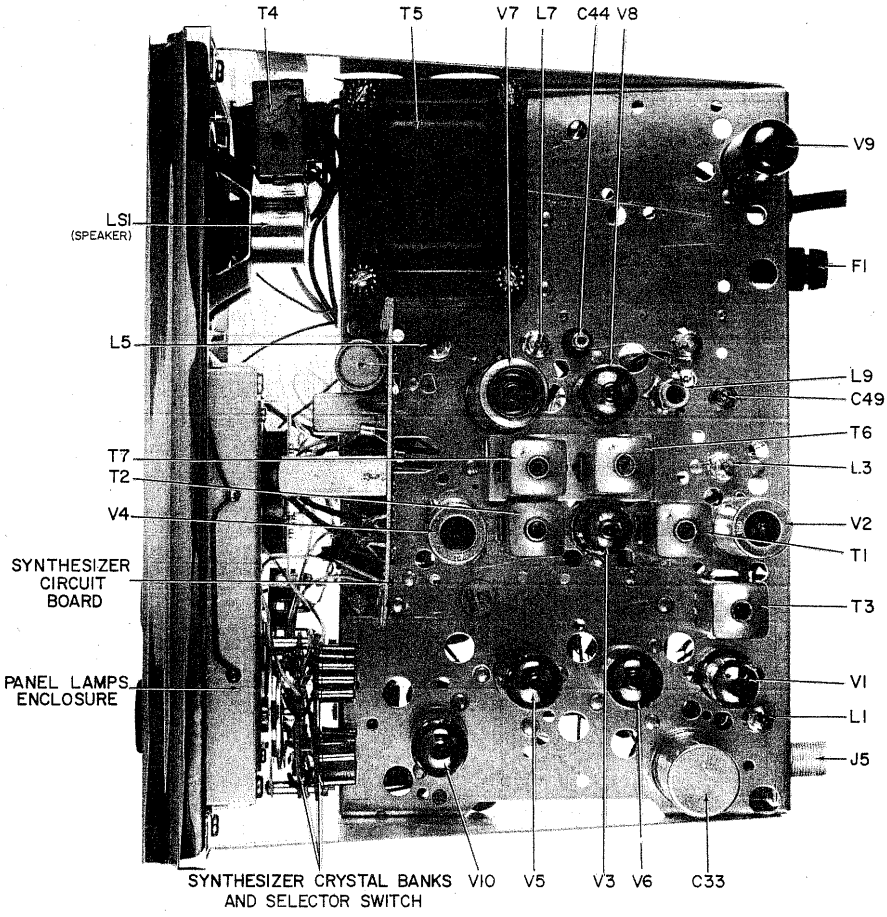
SYMBOL NO.	DESCRIPTION	PART NO.
	LAMPS	
I1	Transmitter pilot lamp	147-2103-922
I2	Incandescent unbased	549-3001-003
I3	Same as I2	
I4	Same as I2	
	COILS	
L1	Coil assembly (14 T tapped at 1.1 turns)	023-1700-021
L2	R.F. Choke, 6.8 μH, ±10%	022-1832-001
L3	Coil assembly (14T with 4 T link)	023-1176-020
L5	Coil assembly (21T with 3 T link)	023-1176-019
L7	Coil assembly (16 T)	023-1700-031
L8	R.F. Choke, 20 μH, ±10%	022-1549-001
L9	Coil assembly (23 T)	023-1700-024
L10	Coil assembly, PA L section (17 T)	023-1700-623
	MECHANICAL PARTS	
MP1	Warning tag	022-1704-001
MP2	Mounting clip for IF transformer	572-1004-001
MP3	Card, serial number.	559-3007-001
MP4	Channel indicator dial	032-0154-002
	KNOBS	
MP7	Knob, no index less #8 setscrew	547-0007-002
MP8	Knob, no index less 8-32 setscrew	547-0007-001
	Setscrew for knobs, 8-32 x 3/8 headless hex socket cup pt. CPS	011-0124-012
	MICROPHONE AND MICROPHONE PLUG	
	Microphone, desk, high impedance ceramic, touch bar for SPDT push-to-talk switch	Model No. 250-888-1
	Plug, microphone	Model No. 250-887-1
	CONNECTOR	
J5	Antenna	142-0101-002
	RESISTORS	
R1	2200 ohm ±10% 1/2 watt carbon	569-1004-222
R2	10,000 ohm ±10% 1/2 watt carbon	569-1004-103
R3	150 ohm ±10% 1/2 watt carbon	569-1004-151
R4	1 megohm ±10% 1/2 watt carbon	569-1004-105
R5	2200 ohm ±10% 1/2 watt carbon	569-1004-222
R7	3.3 ohm ±10% 1/2 watt carbon	569-1004-339
R8	22,000 ohm ±10% 1/2 watt carbon	569-1004-223
R9	Potentiometer, 300 ohm ±30% 1/4 watt	562-0004-301
R10	1500 ohm ±5% 1/2 watt carbon	569-1003-152
R11	33,000 ohm ±10% 1/2 watt carbon	569-1004-333
R12	2200 ohm ±10% 1/2 watt carbon	569-1004-222
R13	150 ohm ±10% 1/2 watt carbon	569-1004-151
R14	2200 ohm ±10% 1/2 watt carbon	569-1004-222
R15	Same as R14	
R16	1 megohm ±10% 1/2 watt carbon	569-1004-105
R17	330,000 ohm ±10% 1/2 watt carbon	569-1004-334
R18	270,000 ohm ±10% 1/2 watt carbon	569-1004-274
R19	470,000 ohm ±10% 1/2 watt carbon	569-1004-474
R20	820,000 ohm ±10% 1/2 watt carbon	569-1004-824
R22	4.7 megohm ±10% 1/2 watt carbon	569-1004-475
R23	1 megohm ±10% 1/2 watt carbon	569-1004-105
R24	220,000 ohm ±10% 1/2 watt carbon	569-1004-224
R25	10,000 ohm ±10% 1/2 watt carbon	569-1004-103
R26	100,000 ohm ±10% 1/2 watt carbon	569-1004-104

PARTS LIST (cont'd)

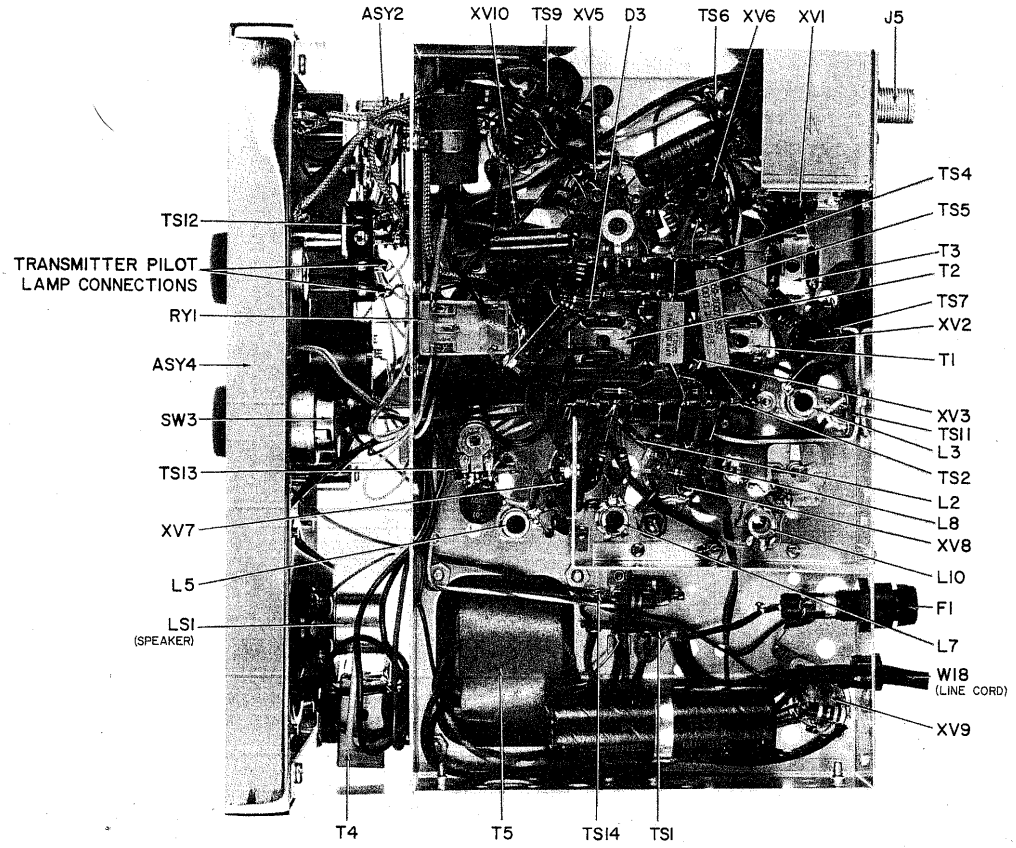
SYMBOL NO.	DESCRIPTION	PART NO.
R27	6800 ohm ±10% 1/2 watt carbon	569-1004-682
R28	470,000 ohm ±10% 1/2 watt carbon	569-1004-474
R29	47,000 ohm ±10% 1/2 watt carbon	569-1004-473
R30	2700 ohm ±10% 1/2 watt carbon	569-1004-272
R32	12,000 ohm ±10% 2 watt carbon	569-1008-123
R33	100,000 ohm ±10% 1/2 watt carbon	569-1004-104
R34	470,000 ohm ±10% 1/2 watt carbon	569-1004-474
R35	Same as R34	
R36	330 ohm ±10% 1 watt carbon	569-1006-331
R37	3900 ohm ±5% 7 watt W. W.	569-2007-392
R38	47,000 ohm ±10% 1/2 watt carbon	569-1004-473
R39	33,000 ohm ±10% 1/2 watt carbon	569-1004-333
R40	180,000 ohm ±10% 1/2 watt carbon	569-1004-184
R41	10,000 ohm ±10% 1/2 watt carbon	569-1004-103
R42	1 megohm ±10% 1/2 watt carbon	569-1004-105
R43	Potentiometer, 5000 ohm ±30% 1/8 watt	562-0004-502
R44	10,000 ohm ±1/2 watt carbon	569-1004-103
R45	150 ohm ±10% 1/2 watt carbon	569-1004-151
R46	100 ohm ±5% 1/2 watt W. W.	569-2002-101
R48	2200 ohm ±5% 5 watt W. W.	569-2005-222
R50	47,000 ohm ±10% 1/2 watt carbon	569-1004-473
R52	4.7 ohms ±10% 1 watt carbon	569-1006-479
R53	43 ohm ±5% 2 watt carbon	569-1007-430
R54	10,000 ohm ±5% 1/2 watt carbon	569-1003-103
R55	56,000 ohm ±10% 1/2 watt carbon	569-1004-563
R57	47,000 ohm ±10% 1/2 watt carbon	569-1004-473
R60	33,000 ohm ±10% 1/2 watt carbon	569-1004-333
R80	2200 ohm ±10% 1/2 watt carbon	569-1004-222
R81	10,000 ohm ±10% 1/2 watt carbon	569-1004-103
R82	150 ohm ±10% 1/2 watt carbon	569-1004-151
R83	470,000 ohm ±10% 1/2 watt carbon	569-1004-474
R84	22,000 ohm ±10% 1 watt carbon	569-1006-223
R85	10,000 ohm ±10% 1/2 watt carbon	569-1004-103
R86	2700 ohm ±5% 1/2 watt carbon	569-1003-272
R87	22,000 ohm ±10% 1 watt carbon	569-1006-223
R88	100 ohm ±10% 1/2 watt carbon	569-1004-101
RELAY		
RY1	SPDT, DC coil 290 ohms	567-0013-002
SHIELD		
SH1	Power supply	017-1122-001
SH3	Contact, 7 pin socket	016-1461-001
SH4	Contact, 9 pin socket	016-1579-001
SH5	Contact, 7 pin socket	016-1461-001
SH6	R. F.	017-1268-001
SH8	7 pin medium snap-on	022-1218-002
SH9	9 pin 2 1/16" snap-on	022-1218-004
SH11	Socket bottom (7 pin socket)	133-0280-001
SWITCHES		
SW1	Power (part of Squelch control R31)	
SW2	PTT (on microphone)	
TRANSFORMERS		
T1	I. F. 455 kHz	592-5019-001
T2	I. F. 455 kHz	592-5019-002
T3	27 MHz	022-1623-001

PARTS LIST (cont'd)

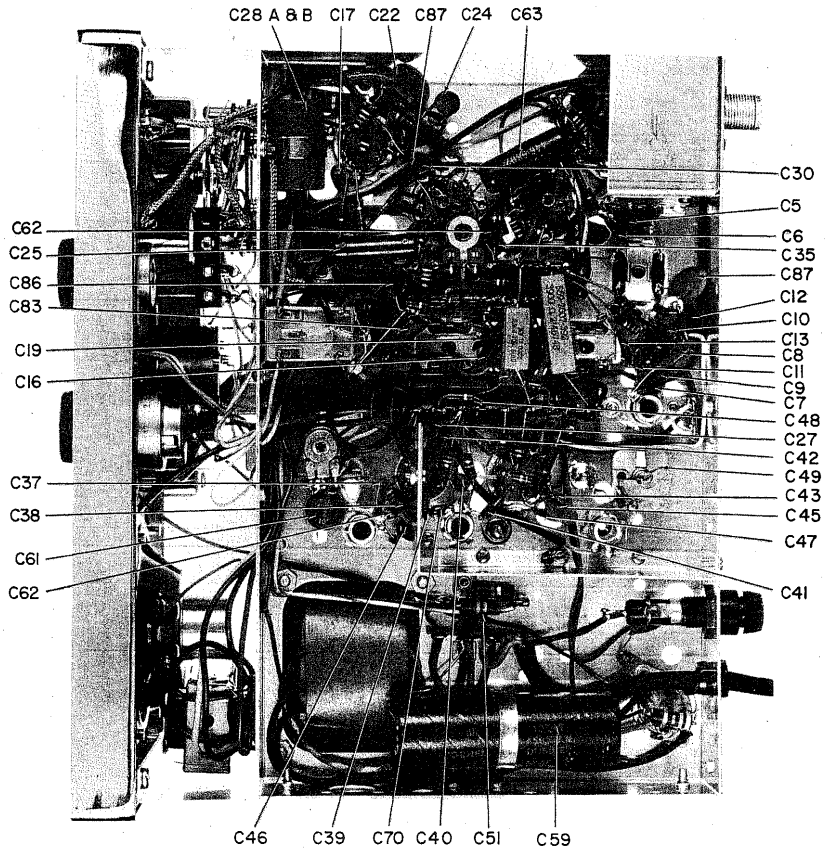
SYMBOL NO.	DESCRIPTION	PART NO.
T5	Power	592-3033-001
T6	I. F. 455 kHz	592-5019-003
T7	Same as T6	
	TERMINALS	
TS1	4 terminals, single mounting foot	586-1001-002
TS2	9 terminals	586-1004-009
TS4	11 terminals	586-1004-011
TS5	9 terminals	586-1004-009
TS6	4 terminals, single mounting foot	586-1001-023
TS7	2 terminals	022-1690-002
TS9	4 terminals	586-1004-004
TS11	2 terminals	586-1001-019
TS12	4 for #8 screw	586-9002-023
TS13	3 terminals	586-1001-020
TS14	4 terminals, single mounting foot	586-1001-023
	ELECTRON TUBES	
V1	Type 6BJ6	022-1562-001
V2	Type 12BE6	022-1563-001
V3	Type 6BJ6	022-1562-001
V4	Same as V3	
V5	Type 6AW8A	022-1565-004
V6	Type 12AB5	022-1566-001
V7	Type 8077/7054	022-1619-001
V8	Type 7061	022-1568-001
V9	Type 12BW4	022-1569-001
V10	Type 12AT7	022-1203-001
	LINE CORD	
W18	Line cord set, 117 VAC	597-1001-001
	ELECTRON TUBE SOCKETS	
XV1	7 pin, mica filled, shielded	515-1020-007
XV2	7 pin	515-1020-007
XV3	7 pin, mica filled, shielded	515-1020-007
XV4	Same as XV3	
XV5	9 pin	022-0976-001
XV6	Same as XV5	
XV7	9 pin, mica filled, shielded	022-1207-001
XV8	Same as XV5	
XV9	Same as XV5	
XV10	Same as XV5	



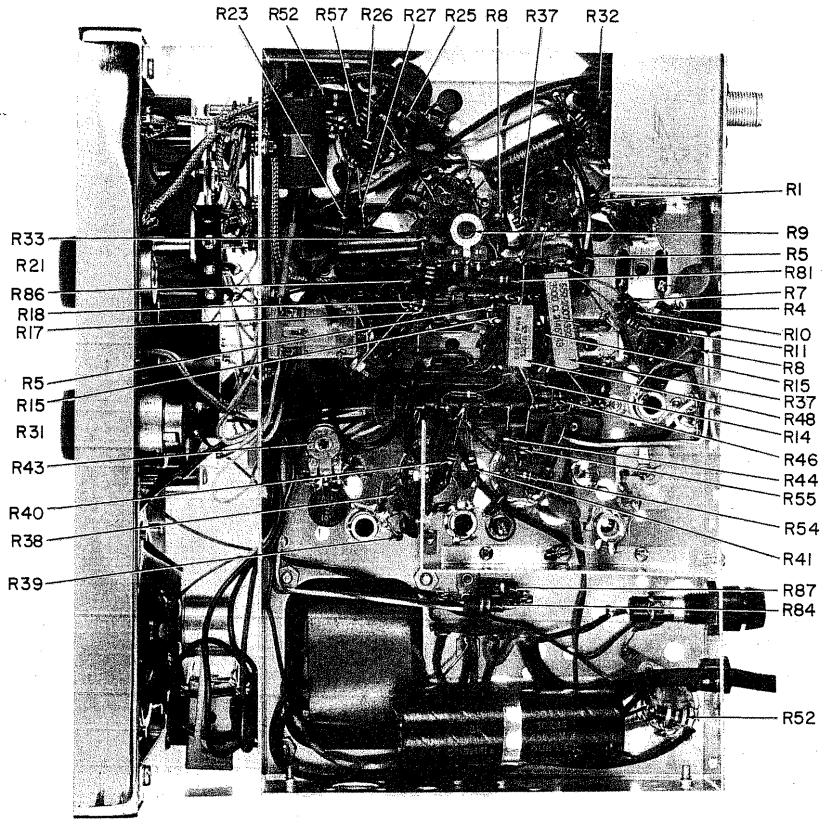
COMPONENT IDENTIFICATION
(TOP VIEW)
FIGURE 7-1



COMPONENT IDENTIFICATION
(BOTTOM VIEW SHOWING ALL COMPONENTS
EXCEPT RESISTORS AND CAPACITORS)
FIGURE 7-2



COMPONENT IDENTIFICATION
(BOTTOM VIEW SHOWING CAPACITORS)
FIGURE 7-3



COMPONENT IDENTIFICATION
(BOTTOM VIEW SHOWING RESISTORS)
FIGURE 7-4