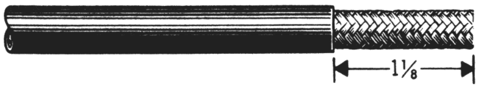
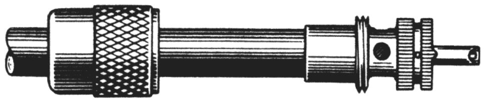
RG-8/U

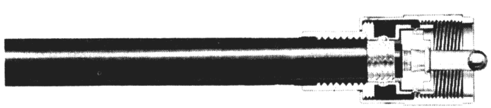


Cut end of cable even. Remove vinyl jacket 1-1/8", except 83-1SP plug remove vinyl jacket 1-1/4".

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

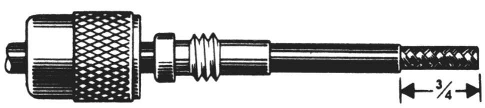


Screw the plug sub-assembly on cable. Solder assembly to braid through solder holes, making a good bond between braid and shell. Solder conductor to contact. Do not use excessive heat.

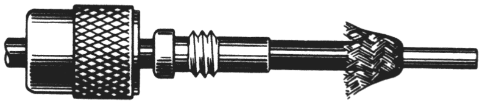


For final assembly, screw coupling ring on plug sub-assembly.

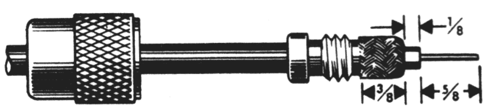
RG-58A/U



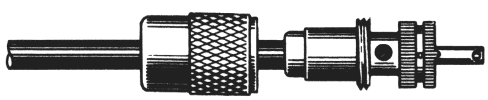
Cut end of cable even. Remove vinyl jacket 3/4". Slide coupling ring and adapter on cable.



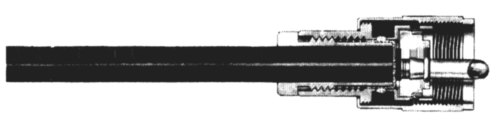
Fan braid slightly and fold back as shown.



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 MICROPHONE HANGER INSTALLATION

a. Determine a location for the microphone hanger (item 7 in Figure 3-2).

b. Follow the procedure outlined in section 3.4 b. for drilling starter holes for the No. 4 sheet metal mounting screws, item 8 in Figure 3-2. Use a No. 43 drill.

NOTE

The microphone hanger can be attached to the transceiver cabinet. Holes are provided for the No. 4 screws on the side opposite the microphone.

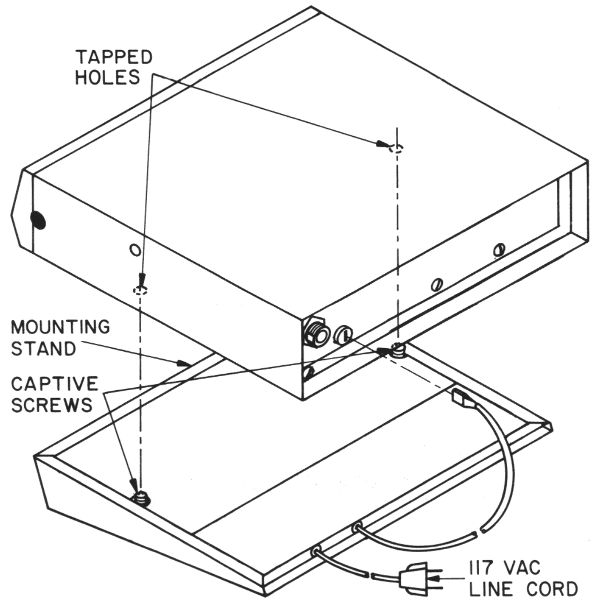
3.6 BASE STATION INSTALLATION

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

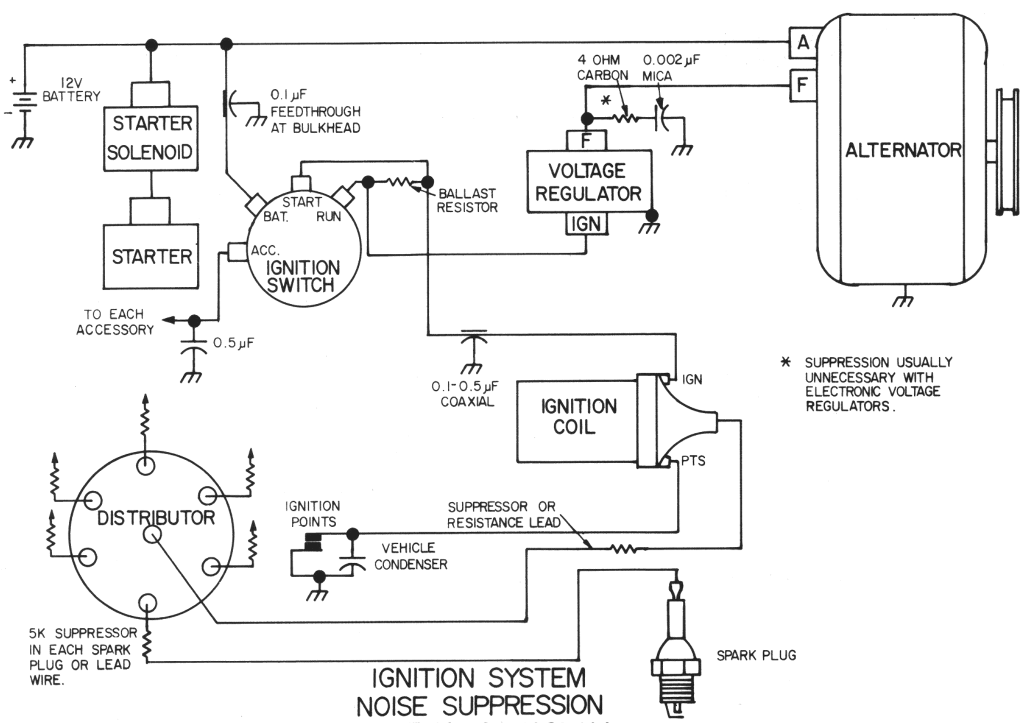
b. Attach the base station power supply to the transceiver. Refer to Figure 3-4 for details.

c. Ground the transceiver for safety. Attach one end of a No. 14 copper ground wire to one of the cabinet shell mounting screws located at the rear of the transceiver. Attach the other end of the ground wire to a cold water pipe or another convenient ground.

d. Perform final checkout outlined in section 3.7.



BASE STATION
MOUNTING DETAILS
FIGURE 3-4



IGNITION SYSTEM
NOISE SUPPRESSION
SCHEMATIC DIAGRAM
FIGURE 3-5

3.7 FINAL CHECKOUT

a. Connect a Bird Model 43 with 10A element or equivalent wattmeter into the transmission line.

b. Trim the antenna for best VSWR. The transceiver has been tuned at the factory and the output network will not require tuning to match it to the antenna. The VSWR obtained should be 1.5 to 1 or less.

c. Check the transmitter power output. Typical power is 3.5 watts. Refer to the specifications in section 2 for minimum and maximum power output.

d. Check the transmitter frequency with a frequency meter. The maximum allowable deviation from the center frequency is 0.005%.

e. Check the modulation. Minimum acceptable is 70% upward and 80% downward. A suggested method is outlined in section 5.

f. Give the transceiver a complete operational checkout. Make several contacts with another unit. Correct any noise suppression problems that affect vehicle operated transceiver performance.

3.8 NOISE SUPPRESSION

Vehicle electrical noise of some sort is a problem in almost all new mobile radio installations.

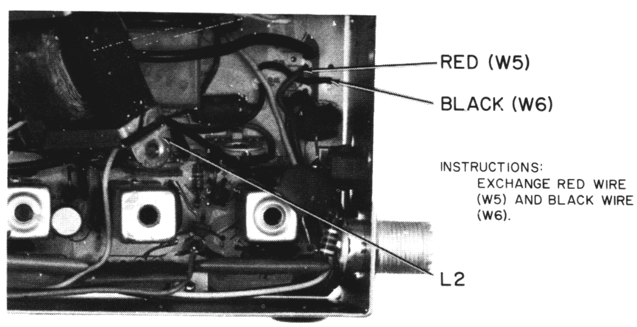
Before beginning any special noise suppression steps, be sure that the vehicle is well tuned. Clean and tighten all electrical connections, including alternator, battery, regulator and coil connections. Perform the following maintenance steps as necessary: solder crimped spark plug and distributor leads; clean and regap or replace spark plugs and ignition timing; check and clean alternator rings and brushes. Retune the engine every 10,000 miles or twice a year, whichever occurs first.

Ordinarily several sources of noise are present in any vehicle, with the strongest covering the others. Drive to a relatively quiet location (free of man-made electrical interference such as noisy power lines, industrial noise or other vehicles).

Test for ignition noise with a weak signal on channel. Vehicle may be standing still. Ignition noise will be present at all engine speeds and, if severe, may make a normally readable signal unreadable.

To reduce ignition noise, install resistor type spark plugs if these are not already installed and if non-resistance ignition wiring is used. Add a 10,000 ohm suppressor resistor in the center tower of the distributor and 5000 ohm suppressor resistors at each spark plug tower of the distributor. Install a coaxial capacitor at the ignition coil primary as close to the coil primary as possible.

A "whining" noise which varies with engine speed and continues with the ignition turned off with the vehicle



POSITIVE GROUND CONVERSION DETAILS
FIGURE 3-6

coasting in gear is characteristic of the alternator. Check and clean the alternator rings and brushes.

An irregular "clicking" sound which disappears at a slow idle characterizes the voltage regulator. Install a 4 ohm carbon resistor as close to the field terminal of the regulator as possible, then a 0.002 μF mica capacitor in series with and as close to the resistor as possible: connect the capacitor to ground.

Irregular popping noises which vary with road surfaces indicate static discharge at any of several locations in the vehicle. Tighten loose nuts and bolts and bond large areas such as the fenders, exhaust pipe, firewall, etc. to the frame with lengths of heavy braid. Figure 3-5 illustrates these and a few other suggested noise suppression steps.

3.9 MODIFICATION FOR POSITIVE GROUND

The following procedure outlines the modification required to use the Messenger 123 in a vehicle with a positive ground electrical system. Refer to Figure 3-6 for details.

NOTE

If an In-converter, Model 239-120, is used, the following modification is not necessary.

a. Remove the transceiver cabinet shell.

b. Remove the two screws that attach the filter choke, L2, to the chassis rail. Lay the filter choke away from the rear chassis rail to expose the circuit board area shown in Figure 3-6.

c. Unsolder the end of wire W6 (black) furthest from the rear of the chassis and wire W5 (red) from the circuit board. Reverse the position of the wires and solder.

d. Replace filter choke and screws.

e. Reinstall cabinet shell.

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

The Messenger 123 is an all solid state transceiver. 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 source, audio circuitry and antenna are common to both the receiver and transmitter. A front panel mounted meter indicates received signal strength and relative output of the transmitter.

Refer to the block diagram, Figure 4-1, 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.

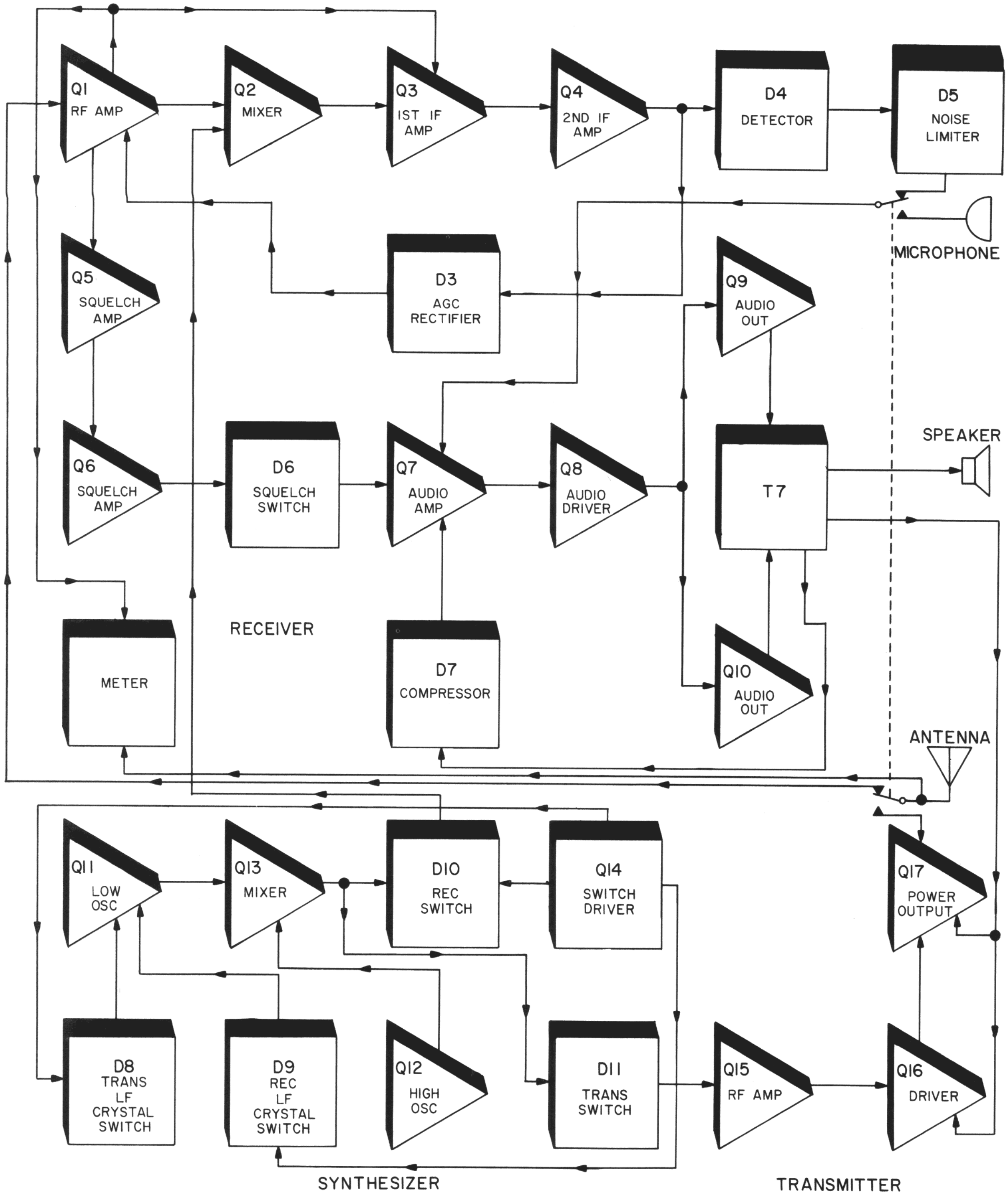
4.2.2 LF OSCILLATOR

The low frequency oscillator is made up of Q11 and

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	26.965
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



MESSENGER 123
BLOCK DIAGRAM
FIGURE 4-1

its associated circuitry and crystals Y1 through Y8 which operate at their fundamental frequency. Switch SW3A selects one of these crystals. Refer to Table 4-1, synthesizer scheme, for the low frequency crystals. The signal from the selected crystal is applied directly to the base of Q11, which has a common collector to provide a high input impedance. The signal from the emitter of Q101 is coupled through C49 to the base of the synthesizer mixer, Q13. A capacitive voltage divider, C49 and C50, reduces the voltage at the base of Q13 and provides the proper impedance match.

4.2.3 HF OSCILLATOR

The high frequency oscillator, Q12, operates with third overtone crystals, Y9 through Y14. Switch SW3B selects one of the HF crystals at the same time as SW3A 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, Q12. The signal from the collector of Q12 is coupled through the oscillator transformer, T8, to the emitter of the synthesizer mixer, Q13.

4.2.4 SYNTHESIZER MIXER

The signal from the low frequency (LF) oscillator, Q11, is coupled to the base of the mixer, Q13, by C49. The signal from the high frequency (HF) oscillator is coupled by T8 to the emitter of the mixer. The mixer output transformer, T9, 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 D8 and D9 switch transmit and receive LF crystals respectively. D10 switches the synthesizer output in receive and D11 switches the output in transmit.

The diode switch driver, Q14, is conducting during receive condition. Its conduction forward biases D9, the receive low oscillator switch, and D10, the synthesizer receive output switch, enabling the receiver.

The synthesizer is switched to the transmit condition by closing the push-to-talk switch. This action grounds (shorts out) the collector of Q14 and causes it to turn off (not conducting). The collector voltage of Q14 rises to 7.9 volts, reverse biasing D9 and D10 and forward biasing D8, the transmit low frequency crystal switch, and D11, the synthesizer transmit output switch.

4.3 RECEIVER

4.3.1 RF AMPLIFIER

The incoming signal is coupled to the base of the RF amplifier, Q1, through C75, a set of contacts on the relay and the input transformer T1. The signal is amplified by Q1 and coupled to the base of mixer stage, Q2, by T2.

4.3.2 RECEIVER MIXER

The output of the synthesizer, operating 455 kHz below the signal from the RF amplifier, from the secondary of T9 is coupled through C55, D10, C54 and C6 to the base of the receiver mixer, Q2. The mixer output transformer, T3, is tuned to the difference frequency, 455 kHz.

4.3.3 IF

The receiver IF section consists of IF amplifiers Q3, Q4 and double tuned transformers T4 and T5.

The IF output is taken off the collector of Q4 and coupled to the detector diode D4 by transformer T5. A small portion of the output of the second IF amplifier is coupled by C15 to a rectifier filter network consisting of D3, R9, C14 and C13. The DC output of the network is the AGC voltage which controls the gain of the RF amplifier and, indirectly, the first IF amplifier.

4.3.4 AGC

An increase in the gain of the second IF amplifier, the result of a stronger received signal from the antenna, causes more output from the second IF amplifier to be coupled to the AGC rectifier. This in turn causes the output of the AGC rectifier to go more positive. This positive going output is coupled to the base of the RF amplifier through a voltage divider network in Z1 and the secondary of T1. A positive going voltage appearing at the base of Q1 lowers the gain of that stage. The emitter voltage of Q1 follows the base and also goes in a positive direction. The emitter of Q1 is connected to the base of the first IF amplifier, Q3. Any change in the emitter voltage of Q1 is transferred to the base of Q3. This controls the gain of Q3.

4.3.5 AUDIO

The audio from the detector diode, D4, is applied through a noise limiting network, Z5, and the volume control to a set of contacts on the relay. During receive condition, the audio from detector D4 is coupled through Z5, R10, C21, R11, L12, C22 and a set of contacts on the relay to the base of the audio pre-amplifier, Q7. The amplified signal is then coupled to the audio driver stage, Q8, for further amplification. Q8 furnishes power to drive the Class B output stage, Q9 and Q10. The driver transformer, T6, provides the proper impedance match between the collector of Q8 and the bases of the Class B stage. The output of the Class B amplifier is transformed by T7 and applied to the speaker. T7 is a combination audio and modulation transformer. The green and black leads are the

3.2 ohm speaker windings during receive. During transmit, the orange and yellow leads provide audio for modulation. One side of the speaker is connected to B+. The other side of the speaker is connected to T7 and from T7 to ground through the push-to-talk switch on the microphone. The push-to-talk switch contacts are used to open the receiver audio during transmit and apply audio from the microphone to the pre-amp, Q7.

4.3.6 SQUELCH

In the squelched condition, Q6, the second squelch amplifier, is turned off. Its collector voltage is several volts more negative than the emitter of the audio amplifier, Q7. In this condition diode D6 is forward biased. With D6 forward biased the emitter of Q7 is at the same potential as the collector of Q6 minus the drop across D6. The base emitter junction of Q7 is reverse biased and Q7 is turned off, disabling the receiver audio.

When an RF signal is present the AGC line goes in an increasingly positive direction. This causes the base and emitter voltages of Q1 to go in a positive direction. The positive going emitter of Q1 causes the base bias of Q5 to go more positive. As the base bias of Q5 goes positive, the stage is conducting less and its collector voltage is increasing. The collector of Q5 and the base of Q6 are direct coupled and therefore at the same electrical potential. The rising collector voltage of Q5 tends to turn Q6 on. The harder Q6 conducts the more the collector voltage drops. When the collector voltage of Q7 becomes less than the emitter voltage of Q7, diode D6 becomes reverse biased. With D6 reverse biased, Q7 becomes forward biased and the audio is enabled.

Squelch temperature compensation is provided by a thermistor in Z6.

4.4 TRANSMITTER

4.4.1 AUDIO

The audio signal from the microphone during transmit condition is coupled through the relay contacts to the base of the audio pre-amp, Q7. The signal is amplified by Q7 and Q8 and coupled through the driver transformer, T6, to the bases of the Class B audio output stage, Q9 and Q10. The amplified audio signal from Q9 and Q10 is coupled through the orange and yellow leads on T7 to provide modulation of the driver, Q16, and power amplifier, Q17.

Audio compression is provided in this unit by rectifying part of the signal appearing at the secondary of T7, and applying it to the emitter of the 1st audio stage, Q7. A large signal from the microphone (caused when an operator shouts into the microphone) will in turn provide a larger signal at the secondary of T7. This in turn places a higher voltage at the emitter of Q7 and reduces its gain, thus maintaining a relatively constant audio level for a given input signal.

4.4.2 TRANSMITTER RF AMPLIFIER AND DRIVER

The synthesizer transmit output is coupled through D11, C57 and double tuned transformer T10 to the base of the transmitter RF amplifier Q15. Here the synthesizer output is increased to a level sufficient to drive the driver stage Q16. T11 couples the output of Q15 to Q16. The output of Q16 is coupled by C66, T12 and C68 to the base of the power output stage, Q17.

4.4.3 POWER AMPLIFIER

The Class C power amplifier, Q17, is designed to operate at 5 watts DC power input. Q17 is in emitter follower configuration and drives the antenna through a pi network and a set of contacts on the relay. The pi network serves as an impedance matching device and as a low pass filter for harmonic attenuation.

4.5 METER

The front panel meter, M1, serves a dual purpose. During receive it functions as an S-Meter. In transmit it indicates relative power output.

The positive side of M1 is connected directly to B+. The negative side is connected to the emitter of Q1 through R3 and R4. The meter is adjusted for an electrical zero in receive by R4. The junction of R4 and D1 is connected to the emitter of Q1 (Q1 is actually connected to B+ through R4, R3 and the meter). Any increase in the base bias of Q1 (caused by a signal at the base) also changes its emitter voltage which in turn reduces the current through M1, giving a signal strength indication.

In transmit, as in receive, a reverse current is applied to the meter which reduces the current through it; offsetting the pointer from its electrical zero and giving a relative power output indication. This is accomplished by coupling RF from the junction of L9 and C75 to rectifier diode D1 by C5. The positive output from D1 reduces the current flow through the meter. Zeroing bias is applied to the meter in transmit through D2 and R5. The meter is adjusted for an electrical zero by R5.

SECTION 5
SERVICING

5.1 GENERAL SERVICING INFORMATION

The information in this section serves as a guide for servicing the Messenger 123 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.

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, transmitter power output, and frequency output. Use the performance test procedures in the receiver and transmitter servicing sections as guides.

5.1.3 REPLACEMENT TRANSISTORS

The transistors used in this unit are listed with E. F. Johnson house numbers. These transistors are selected for specific parameters. They must be replaced with the transistors listed in the parts list of this service manual. Refer to Section 1 in this service manual for detailed instructions on ordering replacement parts.

5.1.4 TUNING INFORMATION

The Messenger 123 generally requires tuning of only those stages that have been repaired. Unnecessary tuning wastes valuable servicing time and can actually degrade the performance of a unit if not accomplished by an experienced technician. The alignment section includes detailed tuning instructions and illustrates the tuning tools required.

5.1.5 GENERAL SOLDERING INFORMATION

The same basic soldering practices used on other printed circuit boards can be used on the Messenger 123 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 RG-174 (subminiature) coaxial cable shields when unsoldering and soldering the center conductor. Do this by grasping the 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. Remove the No. 8 screws (one on each side at the rear) that fasten the cabinet shell to the chassis rail.

b. Grasp the front panel with one hand and the cabinet shell with the other.

c. Carefully slide the cabinet shell away from the front panel.

5.1.7 GENERAL TROUBLESHOOTING INFORMATION

Always give a malfunctioning unit a quick visual check before attempting to isolate troubles. A visual check may spot an overheated or burned component. Most transceiver malfunctions will probably be the result of transistor or diode failures.

Always check transistor emitter voltages first when troubleshooting. They will usually give the first indication of trouble.

5.2 TRANSISTOR TROUBLESHOOTING

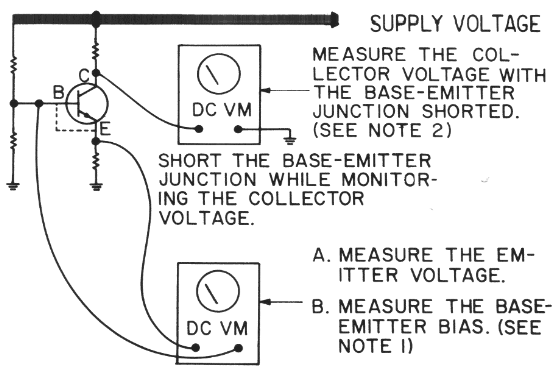
5.2.1 GENERAL

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 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 5-1 for the correct voltmeter connections for measuring in-circuit transistor bias.



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

NOTES

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.

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.

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.

4. Turn power off when removing or installing transistors.

5.2.3 IN-CIRCUIT TRANSISTOR TESTING

a. Refer to Figure 5-1 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 ohmmeter or a transistor tester. The following section describes the technique for testing transistors out of the circuit with an ohmmeter.

* Not recommended for power transistors 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.