while it is in motion and how fast the vehicle can travel at any given range and still satisfactorily receive other stations.

3.2.2 CAUSES OF IGNITION NOISE

The engine of any vehicle contains at least a dozen or more tiny "spark" radio transmitters such as spark plugs, regulator points, distributor points, generator brushes, etc. The ignition wiring of the engine acts as an antenna to radiate the radio noise from these arcs into the radio. Additional noise may be generated by unnecessary arcs which are caused by poor connections. Loose connections between the spark plugs and the connectors on the spark plug wires or between the wires and the distributor cap cause unnecessary arcs. Another noise source is the build-up of static electricity on moving parts of the engine and its accessories, such as the armature of the generator. When these charges of static electricity "discharge", the effect is much the same as a bolt of lightning but on a much smaller scale. Since the car body is usually used as the ground return for lights, accessories and the ignition system, small arcs may occur between various parts of the car body that are not properly bonded together electrically. These small arcs also generate noise.

Spark plug noise is identified by a regular popping noise which increases with engine speed. Generator noise is characterized by a whirring sound which also increases with engine speed. Regulator noise creates an uneven, rasping sound only when the generator is charging.

3.2.3 METHODS OF SUPPRESSING IGNITION NOISE

One of the first methods of reducing ignition noise is to insure that the ignition system of the engine is in good condition and working properly. This means that the distributor points and condenser should be in good condition and the points properly adjusted. The regulator points should be free from pitting and should be properly adjusted. The spark plugs should be clean and properly adjusted. The generator brushes and commutator should be in good condition and the brushes properly seated.

The generator cover should be free of paint and grease that might prevent good electrical connection to the generator frame. All connections in the high voltage wires between the spark plugs and the distributor should be making good contact. Soldering the wires to the connectors on the ends of the wires will insure this. All other connections in the ignition system should be free of corrosion and thoroughly tightened. All the wires in the distributor cap should be pushed as far into the cap as they will go. The high voltage wire to the coil should also be pushed into its socket as far as it will go. The inside of the distributor cap should be free of any dirt or carbon deposits since these can cause arcing between the distributor terminals.

When the entire ignition system is in good condition, the next step toward suppressing ignition noise is to install noise suppressing devices in the ignition wiring of the engine. The noise suppressing devices to be installed consist mainly of distributor and spark plug suppressors, coaxial capacitors and shielded wires. The distributor and spark plug suppressors are small devices similar to radio resistors, which are inserted in the distributor and spark plug wires. They suppress the electrical noise caused by the spark plugs and distributor. The coaxial capacitors are highly efficient electrical devices which "filter out" or "bypass" directly to ground (ground is the car frame, body or engine) the electrical noise caused by the generator and regulator. The shielded wires prevent the escape of any remaining noise from the generator and regulator wires.

3.2.4 RESISTOR-TYPE SPARK PLUGS

Resistor-type spark plugs may be installed in place of the regular spark plugs. Resistor-type spark plugs are normally "quieter" than standard plugs with suppressors. Since resistor-type spark plugs are standard equipment on some later model cars, they should be checked before resistor-type plugs are purchased. Spark plug suppressors should not be used with resistor spark plugs.

Radio resistor ignition wire is standard equipment on most late model vehicles. If the vehicle does not have radio resistor ignition wire it should be installed.

3.2.5 ADDITIONAL NOISE SUPPRESSION MEASURES

1. Installing short lengths of heavy shield braid or metal straps between various parts of the automobile and engine to improve the electrical bonding will usually reduce interference in the more stubborn cases. These straps should be installed between the firewall and the engine, the engine and the frame, the generator and the frame (or the engine or both), the exhaust pipe and the frame (in one or more places) and in some cases the hood to the frame or firewall. Be sure the cases of the coil and the regulator are well grounded.

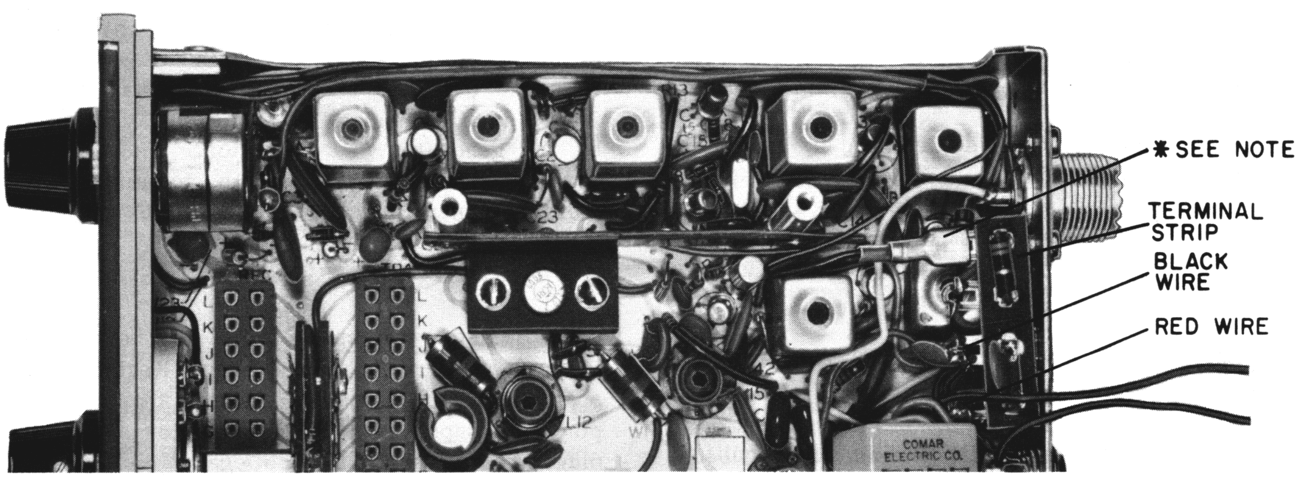
2. In stubborn cases of generator whine, a carbon brush (mounted on a short spring-loaded bracket) which rides on the end of the generator shaft will usually reduce this interference. Be sure the brush and bracket are well grounded to the generator or car frame with a short connection.

3. Some interference may be caused by the dash instruments, accessories (such as electric windshield wipers, heater blowers and fans, etc.) and the lighting system. In cases where this interference is objectionable, it may be reduced by installing bypass capacitors from the terminals of the troublesome instruments or accessories directly to ground (car frame or dash, etc.) The wire leads of the capacitors should be kept as short as possible. These capacitors should be of the mica or ceramic disc variety and should be from 0.001 μF to 0.01 μF.

3.3 POSITIVE GROUND CONVERSION
(Models 242-143 and 242-149 only)

The Messenger may be used in positive ground systems by modifying the unit in accordance with the following outline:

a. Remove the Messenger from its cabinet by removing the four screws at the rear of the



* QUICK-DISCONNECT MAY BE DISCONNECTED FROM THE TERMINAL STRIP WHEN USING THE BATTERY OPERATED POWER PACK, MODEL 250-856-2. THIS WILL DISCONNECT THE RECEIVE/TRANSMIT INDICATOR LIGHT AND REDUCE CURRENT DRAIN APPROXIMATELY 100mA

POSITIVE GROUND CONVERSION
MODELS 242-143 AND 242-149
FIGURE 5

cabinet.

b. Locate the terminal strip at the bottom of the rear chassis rail between the antenna jack and the Tone-Alert receptacle. (See Figure 5).

c. Unsolder the red and black wires located on the two terminals nearest the relay and Tone Alert receptacle. Interchange the positions of these wires as shown.

d. Install the transceiver in its cabinet and secure it with the screws at the rear of the unit.

e. Make a label warning that the unit has been converted for positive ground operation.

NOTE:
Units converted for positive ground operation cannot be operated with the Messenger AC operated power supplies or other negative ground sources.

3.4 CHANNEL NUMBER INSTALLATION

The following procedure is for changing Messenger channel indicator dials to read in numbers rather than letters. Refer to Figure 6.

To prevent errors, it is suggested that you first make a list relating the channel letters to channel numbers. For example:

A=Channel 1
B=Channel 7
C=Channel 9
D=Channel 11

Use this list to set up the channel numbers on the dial. The channel numbers, supplied with the Messenger, are die cut to fit the channel selector dial, and are adhesive backed for easy mounting. A pair of tweezers will be found useful for removing the numbers from the card and attaching them to the dial. Fold the card on the perforated line-- tear the card on this line to expose one edge of that row of numbers. Replace this portion of the card to protect the adhesive backing on the remaining numbers in that row. Use the following illustration as a guide for the following channel selector dial conversion.

a. Loosen the set screws and remove the three front panel knobs.

b. Remove the two nuts and washers on the two outside controls.

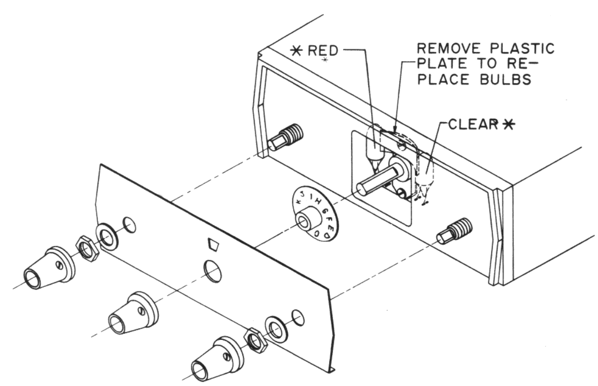
c. The front panel overlay can now be removed.

d. Remove the old letters.

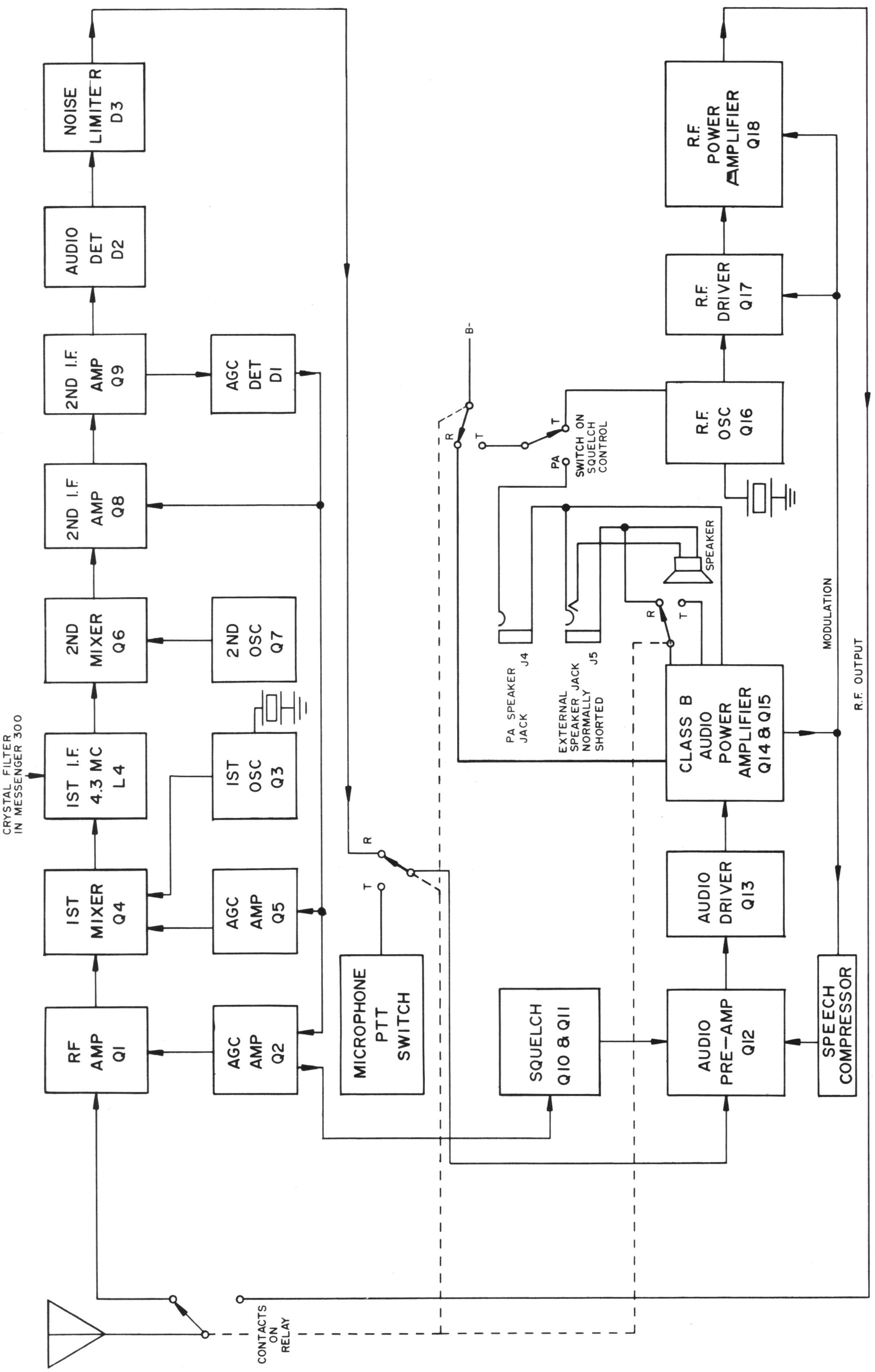
e. Remove the desired numbers from the die cut card and place in position on the dial.

f. Replace the front panel overlay and the washers and nuts on the two outside controls.

g. Replace the three knobs and tighten the set screws.



FRONT PANEL EXPLODED VIEW
FIGURE 6



BLOCK DIAGRAM
FIGURE 7

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

While studying the circuit description it may be desirable to refer to the block diagram, Figure 7, the simplified schematic diagram, and the schematic diagram found in the back of the manual for a better understanding of the circuitry involved.

4.2 RECEIVER

4.2.1 GENERAL

The receiver is a crystal controlled, dual conversion superheterodyne with intermediate frequencies of 4.3 MHz and 455 kHz. All of the interstage transformers are double-tuned. A 4.3 MHz crystal filter is used between the first and second mixer in the Messenger 300. A delayed and amplified AGC and series diode noise limiter are included in the receiver.

4.2.2 RF AMPLIFIER

During receive condition the incoming RF signal from the antenna passes through a set of contacts on the switching relay to pin 6 of L1. Transformer L1 furnishes impedance matching and RF tuning. The RF amplifier, Q1, amplifies the incoming signal. The signal at the collector of Q1 is transformed by L2 and coupled to the base of Q4, the first mixer. Transistor Q2 is connected in common emitter configuration between the emitter of Q1 and B+. Q2 acts as a variable emitter resistor and its conduction is controlled by the AGC voltage.

4.2.3 OSCILLATORS

The two crystal oscillators, Q3 and Q7, are in grounded base configuration and use a third overtone crystal. The first oscillator Q3, operates 4.3 MHz above the incoming signal. The second oscillator, Q7, operates at 455 kHz above the first IF frequency or 4.755 MHz.

4.2.4 FIRST MIXER

The first mixer, Q4, has two inputs. One input is supplied by the first oscillator, Q3, and is injected at the emitter of Q4. The second input is the channel frequency RF signal from the RF amplifier. These two inputs are mixed by Q4. A crystal filter connected between the collector of Q4 and the base of Q6 provides the difference frequency tuning of 4.3 MHz in the Messenger 300. Transformer L4 provides difference frequency tuning in the Messenger III.

The gain of the first mixer is controlled in the same manner as the gain of the RF amplifier. A common emitter stage, Q5, is connected between the emitter of Q4 and B+. The conduction of Q5, which determines the emitter voltage of Q4, is controlled by the AGC voltage.

4.2.5 SECOND MIXER

The outputs of the 4.3 MHz crystal filter and second oscillator, operating at 4.755 MHz, are applied to the base of the second mixer, Q6. These two signals are mixed to produce the second IF frequency. Transformer L5 provides 455 kHz difference frequency tuning at the collector of Q6 and couples the 455 kHz signal to the base of the first IF amplifier, Q8.

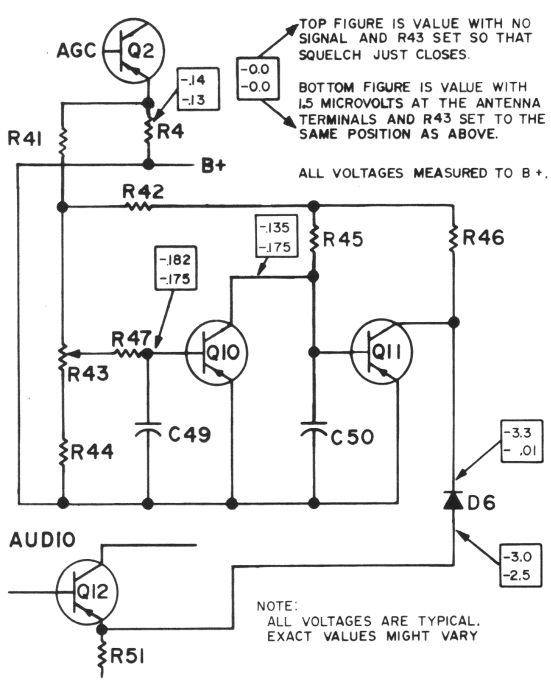
4.2.6 IF AMPLIFIERS

The IF amplifiers, Q8 and Q9, raise the output of the second mixer to a level suitable for detection by detector diode D2. The second IF amplifier also provides the necessary RF voltage for rectification by the AGC detector, D1. AGC is applied to the first IF amplifier through R14 and the secondary of L5.

4.2.7 SQUELCH

The squelch circuit consists of a direct coupled pair of common-emitter DC amplifiers and a diode switch. The control voltage for the squelch circuit is furnished by the action of AGC amplifier Q2. Refer to Figure 8 for the squelch circuit levels in the squelched and unsquelched condition.

Under no signal conditions the DC level at the base of Q10 determines the squelch threshold level. This is set by potentiometer R43. In the squelched condition the base voltage of Q10 is set for a level that will keep Q10 conducting. Q11 is turned off because its base bias is dropped across Q10. When Q11 is turned off approximately -3.5 volts is present at the cathode of D6. D6 is then in the forward biased condition and the emitter voltage of the audio amplifier Q12 is raised to a level sufficient to turn that stage off.



SQUELCH CIRCUIT VOLTAGES
FIGURE 8

When an on frequency RF signal is present at the antenna, the emitter of Q2, due to AGC action, goes in a positive direction or becomes less negative. The base voltage of Q10 follows the emitter of Q2 and tends to turn Q10 off. The collector voltage of Q10 rises sharply and switches Q11 into a heavily conducting state. The anode voltage of D6 is dropped across the heavily conducting Q11 and D6 becomes reverse biased, restoring Q12 to the forward biased condition and enabling the audio. Squelch temperature compensation is provided by thermistor assembly R45.

4.2.8 AGC

AGC is applied directly to the first IF amplifier and indirectly to the RF amplifier and first mixer. A portion of the second IF amplifier output is coupled by C29 to a rectifier filter network consisting of D1, R23, C27 and C28. Because of the diode configuration, an increase in the output of the second IF amplifier causes a positive going DC voltage at the junction of R23 and C28. This positive going DC voltage is applied to the bases of Q2, Q5 and Q8 and causes a decrease in the conduction of the three stages. Q2 and Q5 are connected between the emitters of Q1 and Q4, and through resistors R4 and R35, respectively, to B+. The collectors of Q2 and Q5 are direct coupled to the emitters of Q1 and Q4. Any change in the conduction of Q2 and Q5 results in a change in the gain of Q1 and Q4. An increase in the AGC voltage, the ultimate result of a stronger received signal at the antenna, applied to the bases of Q2 and Q5 causes these stages to conduct less, which increases their collector voltage. This results in an increase in the emitter voltages of Q1 and Q4 and reduces their gain. AGC temperature compensation is provided by thermistor assembly R21.

4.2.9 AUDIO

Audio detected by D2 is applied through R27 to the cathode of the series noise limiting diode, D3. The noise limiter clips off the positive peaks of impulse noise on the detected audio. Negative impulse noise spikes are clipped by a combination of IF limiting and the detector action of diode D2. The voltage dividing network of R27 and R28 determines the bias of the series noise limiter. RF filtering is performed by capacitor C24. Diodes D7 and D8 provide temperature compensation of the detector and noise limiter.

The detected and filtered audio is coupled by C37 to the volume control, R40. The audio at the movable contact of the volume control is coupled by C52 to a set of contacts on the transmit-receive relay, through pins 4 and 5 of P3 and to the base of the audio preamplifier, Q12. The amplified audio from the collector of Q12 is coupled to the base of the audio driver, Q13, by C62. Q13 raises the audio from the preamplifier to a level suitable to drive the class B output stage. The output stage furnishes up to three watts of audio to the speaker in receive condition and to the transmitter driver and power output stage during transmit condition.

4.3 TRANSMITTER

4.3.1 GENERAL

The transmitter consists of oscillator, driver, and power output stages. Modulation is furnished by the class B audio stage.

4.3.2 MODULATOR

Audio from the microphone during transmit condition is coupled through the push-to-talk contacts on the microphone to the base of the audio preamplifier, Q12. Operation of the audio stages in transmit is the same as during receive except that secondary terminals 3 and 4 of T2 provide the modulating audio. The audio section contains a speech compressor that provides a gain stabilizing AGC to the emitter of Q12. The AGC feedback loop begins at pin 3 of T2. Audio is coupled from pin 3 by C10 to a rectifier filter and time constant network consisting of D9, R24, C20 and R20. This network converts the audio coupled by C10 from pin 3 of T2 to DC and regulates the attack and decay time of the AGC voltage applied to the emitter of Q12. The larger the audio voltage across the secondary, the greater the AGC that is applied to Q12. This raises the emitter voltage of Q12 and reduces its gain.

4.3.3 OSCILLATOR

The transmitter oscillator, Q16, is a temperature compensated, modified colpitts type. A third overtone crystal operating at the carrier frequency is utilized. Capacitors C67 and C68 are the temperature compensating elements. Transformer L11 provides coupling and oscillator tuning.

4.3.4 DRIVER

The driver stage, Q17, increases the power of the carrier to a level suitable for driving the power output stage Q18.

4.3.5 POWER AMPLIFIER

The grounded collector power amplifier, Q18, is designed to operate at 5 watts DC power input, The power amplifier drives a 50 ohm antenna through a pi network and a set of contacts on the relay.

SECTION 5
SERVICING

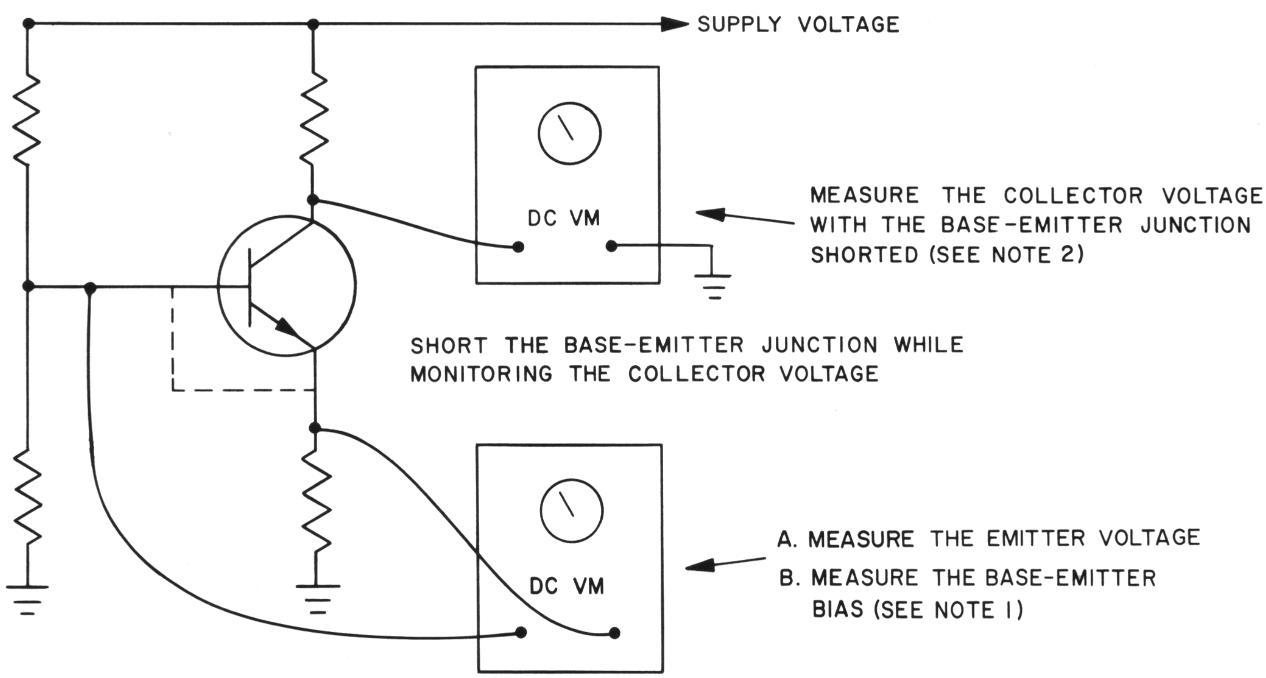
5.1 TRANSISTOR TROUBLE SHOOTING

5.1.1 GENERAL

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

5.1.2 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



TEST CONNECTIONS FOR
IN-CIRCUIT TRANSISTOR TESTING
FIGURE 9

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.

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

5.1.3 IN-CIRCUIT TRANSISTOR TESTING

a. Refer to Figure 9 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 high level stages under driving conditions.

5.1.4 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. A current limiting resistor may be used in series with ohmmeter probes to make the lower ranges safe for measuring semiconductor resistances. If a current limiting resistor is used its value must be subtracted from the ohmmeter reading. The following section describes a method for determining the short circuit current capabilities of ohmmeters.

5.1.5 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

Rxl range it can then be determined 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 Rxl range of 4.62 ohms is 4.62 x 10 or 46.2 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.

The following chart indicates the results that should be obtained from operational transistors measured out of the circuit.

Transistor Type		Ohmmeter Connections + lead	- 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)

5.2 RECEIVER SERVICING

5.2.1 GENERAL

This section covers receiver trouble isolation procedures. When a transistor is suspected of being faulty the servicing technician should refer to Section 5.1, Transistor Troubleshooting.

5.2.2 CHASSIS REMOVAL

1. Access to the chassis is gained by removing the four screws at the rear of the cabinet.

2. Place the transceiver front panel down on a flat surface. Hold the front panel while carefully withdrawing the cabinet assembly from the chassis.

5.2.3 SPEAKER REMOVAL

1. The speaker is held in place by three screws