( ) Set the REL PWR-PLATE switch to the REL PWR position.

( ) Set the BAND switch to the 21.0 position.

( ) Remove the 80-meter crystal and install the 40-meter crystal.

( ) Connect the Transceiver line cord to the 120 volt AC outlet and turn the AF GAIN control to the 12 o'clock position.

( ) Close the key and adjust the TUNE capacitor for a maximum reading on the meter.

( ) Use a screwdriver with an insulated handle and adjust neutralizing capacitor U from the top of the chassis for a minimum reading on the meter.

( ) Turn the AF GAIN control to the OFF position and disconnect the Transceiver line cord from the 120 volt AC outlet.

( ) Lay the Transceiver down with the bottom of the chassis up.

( ) Use a screwdriver with an insulated handle to short lug 1 of electrolytic capacitor DA to chassis.

( ) Remove the jumper wire that was temporarily connected across the 5600 Ω resistor. If the jumper wire was soldered to the resistor leads, check that the permanent resistor connections have not been disturbed.

( ) Reconnect the free end of the red wire to lug 2 of tube socket V9 (S-2) and reposition the sleeving on the wire so that the sleeving extends through the chassis hole.

( ) Separate the .001 μfd 1.4 KV disc capacitor lead from the .5 mH choke lead and reconnect these two leads to lug 1 of electrolyitc capacitor DA (S-3).

( ) Disconnect the 50 Ω dummy load.

( ) Disconnect the hand key and remove the crystal from the Transceiver.

This completes the Alignment of the Transmitter section.

RECEIVER ALIGNMENT

Refer to Figure 1-3 (fold-out from Page 49) for the following steps.

( ) Connect the Transceiver line cord to a 120 volt AC outlet. Preset the front panel switches and controls as follows:

REL PWR-PLATE - REL PWR.
RF GAIN - Maximum clockwise.
PWR LEVEL - Maximum counterclockwise.
AF GAIN - Maximum clockwise.
TUNE - Maximum counterclockwise.
BAND - 3.5
Main Tuning Dial -100.

NOTE: The circuit board TEST POINT is located near tube socket V2.

( ) Set the VTVM to the -50 VDC scale. Connect the positive (+) probe of the VTVM to the lead at the TEST POINT on the circuit board, and connect the negative (-) probe to the chassis.

NOTE: Coils L1, L2, L3, L4, L5, L6 and T3 are located on the circuit board; coil L7 is located on the chassis.

( ) Adjust the slug in coil L6 for a maximum VTVM reading.

( ) Set the BAND switch to the 7.0 position and adjust the slug in L5 for a maximum VTVM reading.

( ) Set the BAND switch to the 21.0 position.

( ) From the top of coil L4, turn the slug counterclockwise as far as it will go. Do not remove the slug from the coil form. Then adjust the slug in L4 for a maximum VTVM reading by turning the slug clockwise.

( ) Set the BAND switch to the 3.5 position.

( ) Disconnect both probes of the VTVM from the Transceiver.

( ) Set the VTVM to the 1.5 VAC scale, and connect the VTVM AC probes across the speaker terminals.

( ) Connect an antenna to the ANT jack and tune in a steady CW signal; or, if a signal generator is available, connect the signal generator to the ANT jack, tune the signal generator to 3600 kHz, and tune the Main Tuning Dial so that the signal is heard.

( ) Adjust the TUNE capacitor for a maximum VTVM reading.

( ) Adjust the slug in coil T3 for a maximum VTVM reading.

NOTE: The following instructions for aligning coils L1, L2, and L3 are based on the assumption that you are using an antenna and receiving a steady CW signal rather than using a signal generator.

( ) Adjust the slug in coil L3 for a maximum VTVM reading.

( ) Set the BAND switch to the 7.0 position and tune the Main Tuning Dial near 100 (7.1 MHz) so that a signal is heard.

( ) Adjust the TUNE capacitor for a maximum VTVM reading.

( ) Adjust the slug in coil L2 for a maximum VTVM reading.

( ) Set the BAND switch to the 21.0 position and tune the Main Tuning Dial near 100 (21.1 MHz) so that a signal is heard.

( ) Adjust the TUNE capacitor for a maximum VTVM reading.

( ) Adjust the slug in coil L1 for a maximum VTVM reading.

( ) Return the BAND switch to the 3.5 position.

( ) Disconnect the antenna or signal generator and then connect the 50 Ω dummy load to the ANT phono socket.

( ) Plug a 3500 kHz crystal or one slightly higher in frequency into the proper crystal socket.

( ) Set the PWR LEVEL control to its maximum counterclockwise position, and set the RF GAIN and AF GAIN controls to their maximum clockwise positions.

( ) Set the Main Tuning Dial to the exact frequency of the crystal installed. For example: If the frequency of the crystal is 3550 kHz, the BAND switch is set to 3.5 (for 3500 kHz) and the Main Tuning Dial is set at 50 (for 50 kHz). When the frequencies of the BAND switch and the Main Tuning Dial are added together they must equal the frequency of the crystal.

( ) Connect the key to the KEY jack on the back of the chassis.

( ) Close the key and adjust the TUNE capacitor for a maximum REL PWR reading on the front panel meter.

( ) Adjust the trimmer capacitor on the side of the VFO variable capacitor so that a signal is heard in the speaker. This tone is the CW spot signal from your transmitter and will be in addition to the CW sidetone.

( ) Remove the 3500 kHz crystal and plug in a 3750 kHz crystal or one slightly lower in frequency.

( ) Set the Main Tuning Dial to the frequency of the crystal.

( ) Carefully adjust the slug in VFO coil L7 until the spot signal is heard in the speaker. Only 1/4 turn or less should be required since the coil is preset at the factory.

( ) Repeat the previous nine steps, checking calibration near 3500 kHz and 3750 kHz. If necessary, repeat the previous nine steps several times to get the signal at the proper frequency at both ends of the dial (near 3500 kHz and 3750 kHz).

This completes the alignment of all three bands of your Transceiver. CAUTION: Do not attempt to align coils T1 and T2.

( ) A further check can be made with a crystal calibrator, if one is available. The Heathkit 100 kHz Crystal Calibrator Model HD-20 can be used for checking the calibration or for more accurate calibrating. Check the calibration at 3500 kHz, 3600 kHz, and 3700 kHz by connecting the calibrator to the Transceiver ANT jack.

FINAL ASSEMBLY

Refer to Pictorial 19 for the following steps.

( ) Install four 6-32 speednuts on the chassis. Be sure the flat surface of each speednut is on the outside of the chassis.

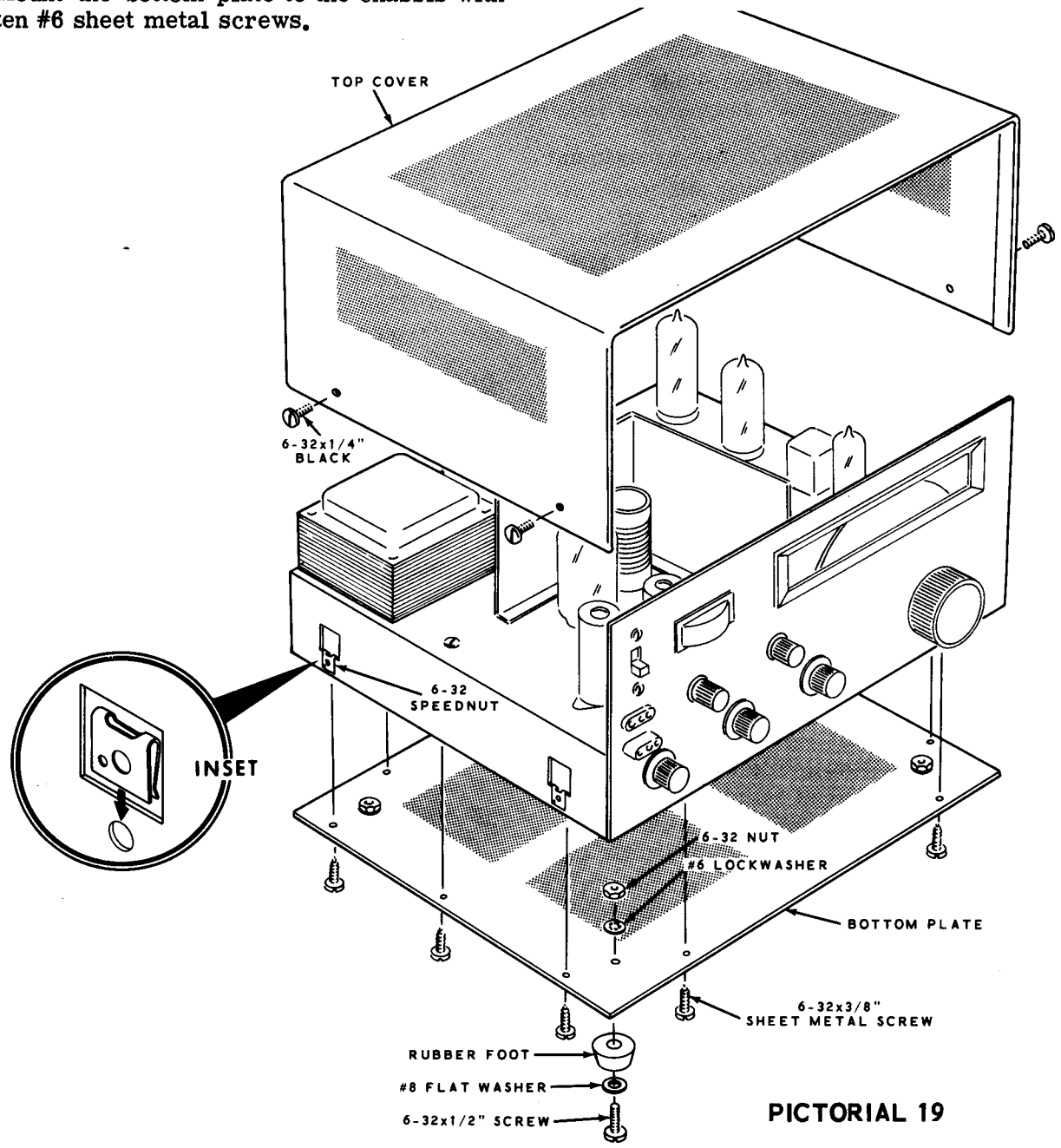
( ) Install four rubber feet on the bottom plate. Use four 6-32 x 1/2" screws, four #8 small flat washers, four #6 lockwashers, and four 6-32 nuts.

( ) Mount the bottom plate to the chassis with ten #6 sheet metal screws.

NOTE: In the next step, place the rolled edge of the top cover in front of the front panel.

( ) Place the top cover over the chassis and secure it with two 6-32 x 1/4" black screws on each side.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear of the chassis between the two screws at the left of the SPKR jack.



PICTORIAL 19

OPERATION

NOTE: An Amateur Radio Operator and Station License is required to place the transmitter section of this Transceiver on the air. Information regarding licensing and amateur frequency allocations may be obtained from publications of the Federal Communications Commission or the American Radio Relay League.

Refer to Figure 1-4 (fold-out from Page 49) for connecting accessories and for grounding to the Transceiver.

( ) Connect a true earth ground to the GND connector at the rear of the chassis. To create a true earth ground connection, drive a metal stake into the earth and route a wire from the stake to your Transceiver.

( ) Connect an 8 ohm speaker to the SPKR socket at the rear of the chassis.

( ) Connect a manual key or electronic key to the KEY jack at the rear of the chassis.

( ) Connect a 50 ohm antenna to the ANT socket. Refer to the section on Antennas.

( ) Connect the additional accessories you wish to use, such as headphones to the PHONES jack and a VFO to the VFO phono socket and to the VFO power socket.

NOTE: A Novice Class operator can only transmit signals created by a crystal controlled oscillator. Do not use a VFO unless you are properly licensed to do so.

ANTENNAS

The pi network circuit of the Transceiver will match a pure resistive load of 50 Ω.

The simplest type of antenna that falls into this impedance range is the "dipole," constructed so that its length is 1/2 wave at the frequency of operation. The 50 Ω impedance range of antennas also includes beam, vertical, and dipole types.

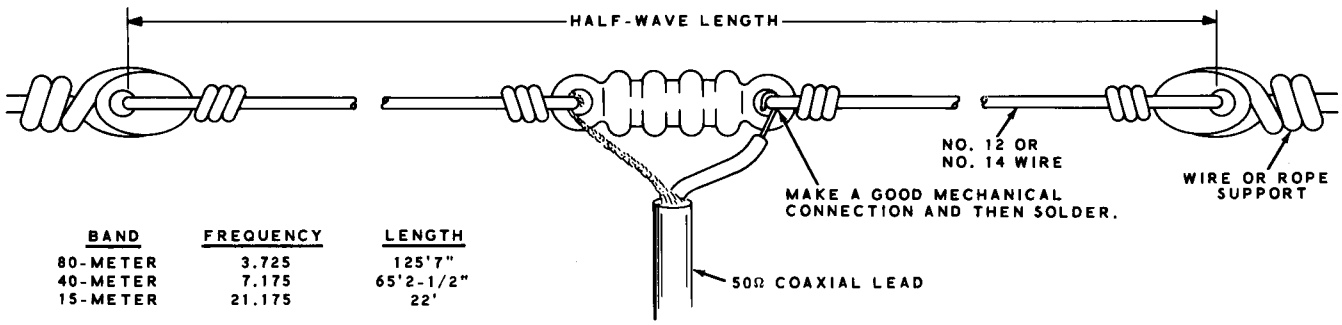
The following paragraphs tell you how to construct a dipole antenna fed by a 50 Ω coaxial line. This combination will give very satisfactory operation with this Transceiver. Figure 1-5 illustrates a half-wave dipole antenna and lists the proper antenna lengths for the center frequencies of the 80-, 40-, and 15-meter bands.

The best material for antenna wire is number 14 gauge hard-drawn copper wire. Number 14 or number 12 guage enameled copper-clad steel wire may also be used, but it is subject to rust and corrosion. Soft-drawn copper wire is not satisfactory because it tends to stretch, and stretching increases the length of the antenna which lowers the resonant frequency.

50 ohm coaxial cable, such as RG-58, may be used for the transmission line. A coaxial transmission line is heavier and more expensive, but it has less feedline radiation than a twin lead transmission line.

Any type of antenna insulator may be used, but the small "egg" type insulators are econimical and readily available. The antenna and insulators may be supported by any wire or rope.

When cutting the antenna to the frequency desired, cut the antenna wire a foot longer than is required. When the antenna is installed in its permanent location, a SWR (standing-wave ratio) bridge, such as the Heathkit Reflected Power Meter and SWR Bridge, can be used to check the amount of mismatch present between the transmitter and the antenna. The excess antenna



BAND	FREQUENCY	LENGTH
80-METER	3.725	125'7"
40-METER	7.175	65'2-1/2"
15-METER	21.175	22'

Figure 1-5

wire may be cut off in 2" to 3" pieces and then reinstalled to check the SWR of your installation at the desired operating frequency. An SWR of less than 2:1 is necessary for your Transceiver.

Much has been published on the subject of antennas and excellent articles can be found in the ARRL Handbook, Radio Handbook, and in many issues of CQ and QST magazines.

OPERATION WITH CRYSTALS

The Transceiver may be operated satisfactorily using the following crystals:

BAND	FUNDAMENTAL CRYSTALS
80-meter	80-meter (3500-3750 kHz).
40-meter	80- or 40-meter (3500-3625 kHz or 7000-7250 kHz).
15-meter	40-meter (7000-7083 kHz).

Crystal Information:

Crystal socket X1 - Pin spacing .486".
Pin diameter .050".

Crystal socket X2 - Pin spacing .486".
Pin diameter .093".

Novice operation imposes restrictions on operating frequencies as follows:

BAND	FREQUENCY kHz	USE CRYSTAL FREQUENCY kHz
80-meter	3700-3750	3700-3750
40-meter	7150-7200	7150-7200 or 3575-3600
15-meter	21,100-21,250	7034-7083

Novice power input is limited to 75 watts. Therefore, the plate current should be set at or below the red mark on the meter by adjusting the PWR LEVEL control after peaking relative power.

The transmitter frequency must be crystal controlled. In the operating instructions to follow, the final amplifier is loaded to 125 ma for Novice operation, which is within the present Novice power limitation.

CAUTION: Be sure to check the latest FCC regulations on frequency allocations. When ordering crystals be sure to stay well within amateur band edge limits to avoid violations.

OPERATION WITH VFO

When using an external VFO, be sure there is no crystal in either crystal socket on the front panel of the Transceiver. Use a VFO with grid block keying that is compatible with the keying system of the Transceiver. The Heathkit Model HG-10 VFO is designed to match the operation of this Transceiver and to plug directly into it. To use the HG-10 VFO, just plug its power cable into the VFO power socket on the Transceiver and connect the RF cable to both units.

The Transceiver VFO power socket supplies 6.3 V AC, 300 V DC, and about -65 V DC (with key-up) for an external VFO with grid-block keying. See the Schematic and the lettering on the Transceiver rear panel for the filament, bias and B+ connections.

CONTROL FUNCTIONS

The functions of the front panel controls are outlined below. Read the following paragraphs carefully to become familiar with the operation of each control before operating this Transceiver.

Rel Pwr-Plate

This slide switch connects the meter either across the output circuit or into the final amplifier of the transmitter section. When this switch is in the REL PWR position and the key is held down, the meter indicates the relative power output. Use this position for peaking the RF power output with the Tune control. When the switch is in the PLATE position, the meter indicates power input to the final amplifier. The meter is inoperative in the receive condition.

RF Gain

This control varies the amount of gain in the RF and IF amplifier stages of the receiver section.

Pwr Level

This control varies the input power of the final amplifier. When the REL PWR-PLATE switch is in the PLATE position, the PWR LEVEL control is used to adjust the power input. The red mark on the meter scale indicates 75 watts, which is the limit for Novice operation. For operation with General Class or higher license, higher plate current may be used.

AF Gain

This control turns the Transceiver on or OFF and varies the audio output of the receiver.

Tune

This control adjusts the pi network to resonate the final amplifier of the transmitter section. It also adjusts for maximum received signal.

Band

The BAND switch selects one of the three amateur bands to which this Transceiver can be tuned.

Main Tuning

This control tunes the receiver section to the desired station. The frequency is read by adding the BAND switch reading and the Main Tuning dial reading. For example: BAND switch is set to 3.5, Main Tuning dial reads 52; therefore, the frequency being received is 3552 kHz or 3.552 MHz. Again, if the BAND switch is set to 21.0 and the Main Tuning dial reads 205, the received signal is at 21.205 MHz. This knob does not affect the transmitter.

TRANSCEIVER OPERATION

( ) Plug the line cord into a 120 volt 50/60 Hz AC outlet.

( ) Check the SPKR, ANT, KEY, and GND connections.

( ) Set the front panel controls as follows:

REL PWR-PLATE - REL PWR.
AF GAIN - 12 o'clock.
RF GAIN - Fully clockwise.
PWR LEVEL - Fully counterclockwise.

CAUTION: Do not plug in two crystals at one time.

( ) Select a crystal and plug it into the proper crystal socket. If you desire to contact a specific station, select a crystal equal to or near the frequency of that station.

( ) Depress the key and adjust the TUNE control for a maximum REL PWR meter indication.

( ) Place the REL PWR-PLATE switch to the PLATE position and check the input current reading.

NOTE: Novice Class operators must not exceed the red mark on the meter scale. This indicates 75 watt limitation for Novice transmission.

( ) Adjust the plate current to the desired level with the PWR LEVEL control.

( ) Place the REL PWR-PLATE switch to the REL PWR position and readjust the TUNE control for a maximum REL PWR meter readings.

( ) Return the REL PWR-PLATE switch to the PLATE position and check that the meter reading does not exceed the allowable limit.

The Transceiver is now ready to receive and transmit.

OPERATING REMINDERS

1. Operation of the transmitter with an improperly tuned amplifier (not tuned to resonance) may result in component failure. Always retune after changing crystals or VFO frequency.

2. Operation of the transmitter without a proper antenna or a dummy load will result in component failure.

3. Use caution and observe rules of safety in taking voltage and current measurements.

4. Do not cover the cabinet ventilation holes.

IN CASE OF DIFFICULTY

Review the Operation section of the Manual.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of the Kit Builders Guide.

3. Check to be sure that all tubes and cable connections are in their proper locations. Make sure that all tubes light up properly.

4. Check the tubes with a tube tester or by substitution of tubes of the same types that are known to be good.

5. Check the values of the parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check the voltage readings against those shown on the Schematic (fold-out from Page 63). All voltage readings were taken with an 11 megohm vacuum tube voltmeter. Voltages may vary as much as ±10%.

8. A review of the Circuit Description will help you to know where to look for trouble.

NOTE: To aid in servicing or troubleshooting the Transceiver, refer to the Circuit Board X-Ray View on Page 59 and Chassis Photographs on Pages 57 and 58.

Breaks in the foil of the circuit board can be detected by placing a bright light under the foil side of the board and looking through the board from the lettered side. A break will appear as a hairline crack in the foil.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the Service and Warranty section of the "Kit Builders Guide", and to the "Factory Repair Service" information on Page 63 of this Manual.

TROUBLESHOOTING CHART

NOTE: References will often be made to previous Symptoms and Causes. Therefore, each Symptom is identified by a number, and each Possible Cause has an identifying letter. If you are directed, for example, to "check items 3A through 3D," refer to Symptom number 3, Possible Causes A, B, C, and D.

SYMPTOMS	POSSIBLE CAUSE
1. No power; pilot lamps and tube filaments do not light, no B+ or bias voltage.	A. AF GAIN control in OFF position. B. Line cord disconnected from 120 VDC source. C. Circuit breaker open. D. Defective AC switch on AF GAIN control. E. Black leads of power transformer open. F. Open primary winding of power transformer.
2. Pilot lamps and tube filaments light, bias voltage OK, but no B+ voltage.	A. Red lead of power transformer open. B. Diodes D202, D203, D204, and/or D205 defective. C. Capacitors C202 and/or C204 shorted. D. Resistors R202 and/or R203 shorted. E. Resistor R204 open.
3. Pilot lamps and tube filaments light, B+ voltage OK, but no bias voltage.	A. Diode D201 defective. B. Brown wires of power transformer open. C. Resistor R201 open. D. Capacitor C201 shorted. E. Short between bias circuit and chassis.
4. Bias and B+ voltage OK, but pilot lamps and tube filaments do not light.	A. Yellow and/or yellow-green wires of power transformer open. B. Short across filament circuit.
5. Low B+ voltage OK, but no 600 volts.	A. Rectifier D204 and/or D205 open.
6. Low resistance reading from pin 7 of tube socket V9 to ground.	A. Resistors R202 or R203 shorted. B. Rectifiers D202 and/or D203 shorted. C. Capacitor C19 shorted.
7. Low resistance reading from pin 3 of tube socket V9 to ground.	A. Resistor R9 shorted. B. Resistors R2, R8, and/or R69 shorted. C. Capacitors C3, C13, C14, or C92 shorted. D. Key closed or shorted.

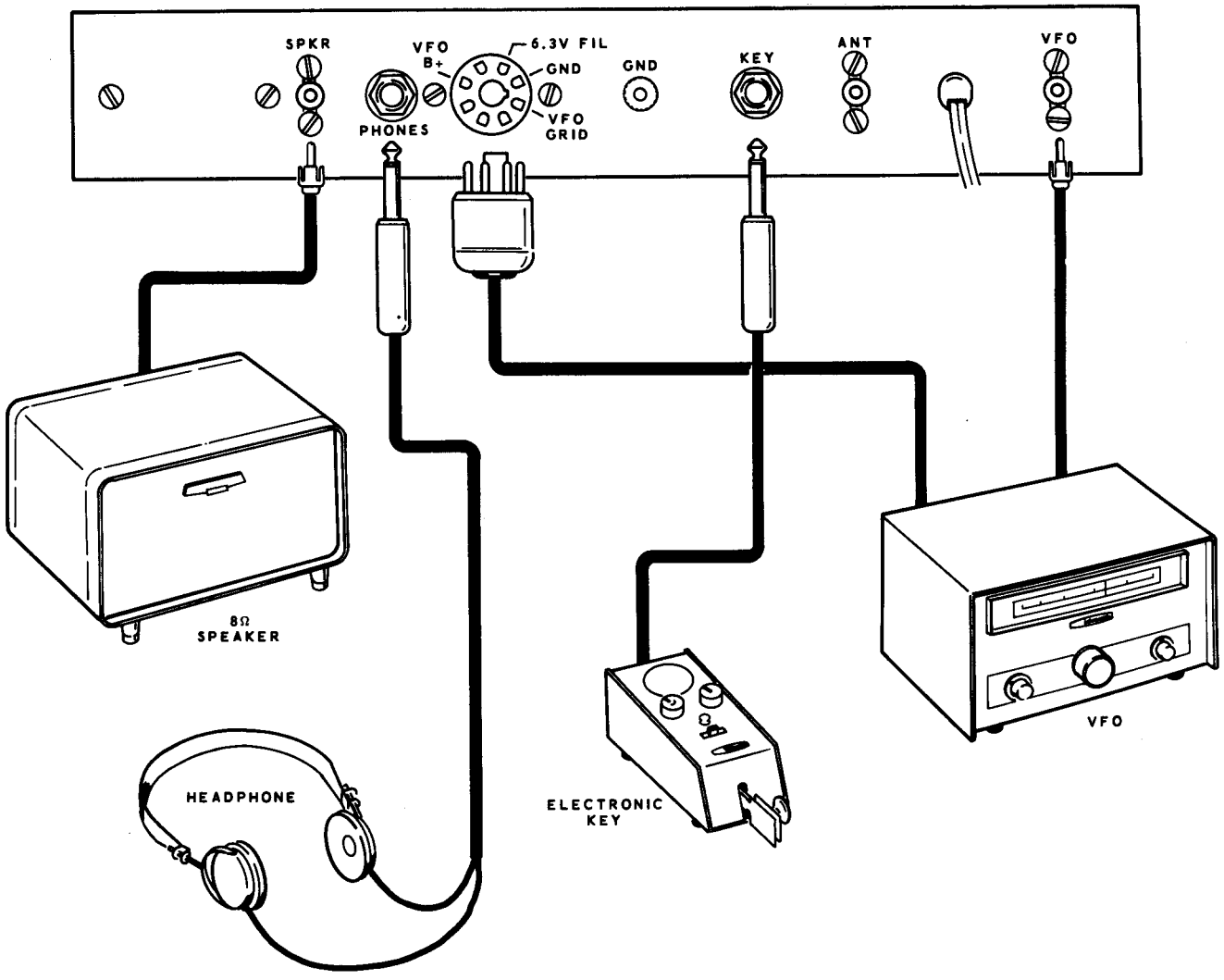
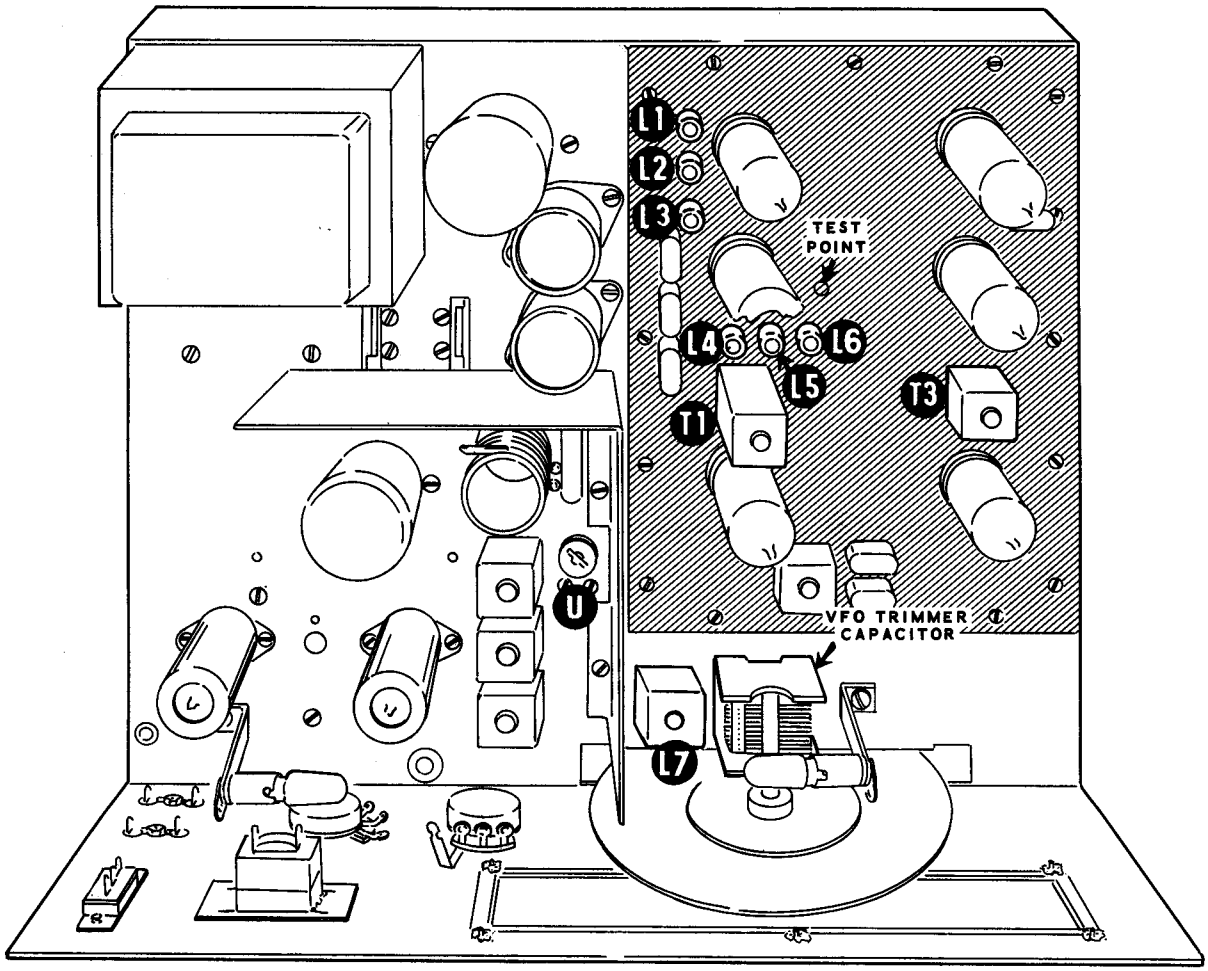

SPKR
VFO B+
6.3V FIL
GND
VFO GRID
PHONES
GND
KEY
ANT
VFO
8Ω SPEAKER
HEADPHONE
ELECTRONIC KEY
VFO

FIGURE 1-4


L1
L2
L3
TEST POINT
L4
L6
L5
T1
T3
U
VFO TRIMMER CAPACITOR
L7

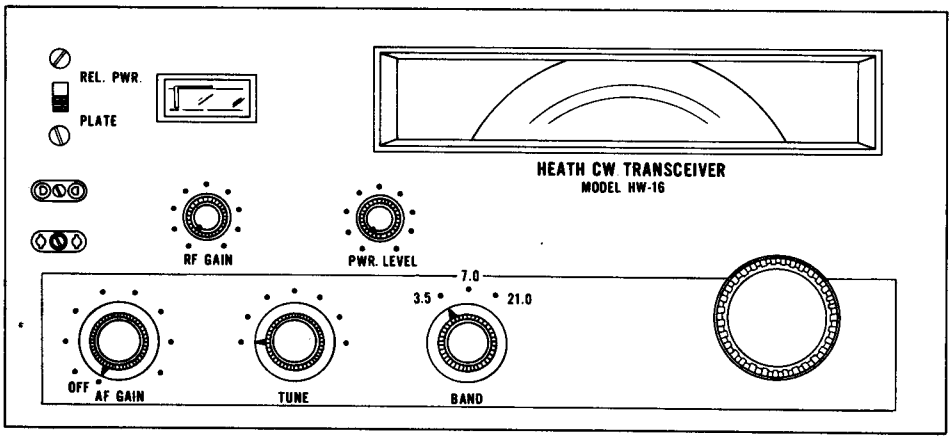
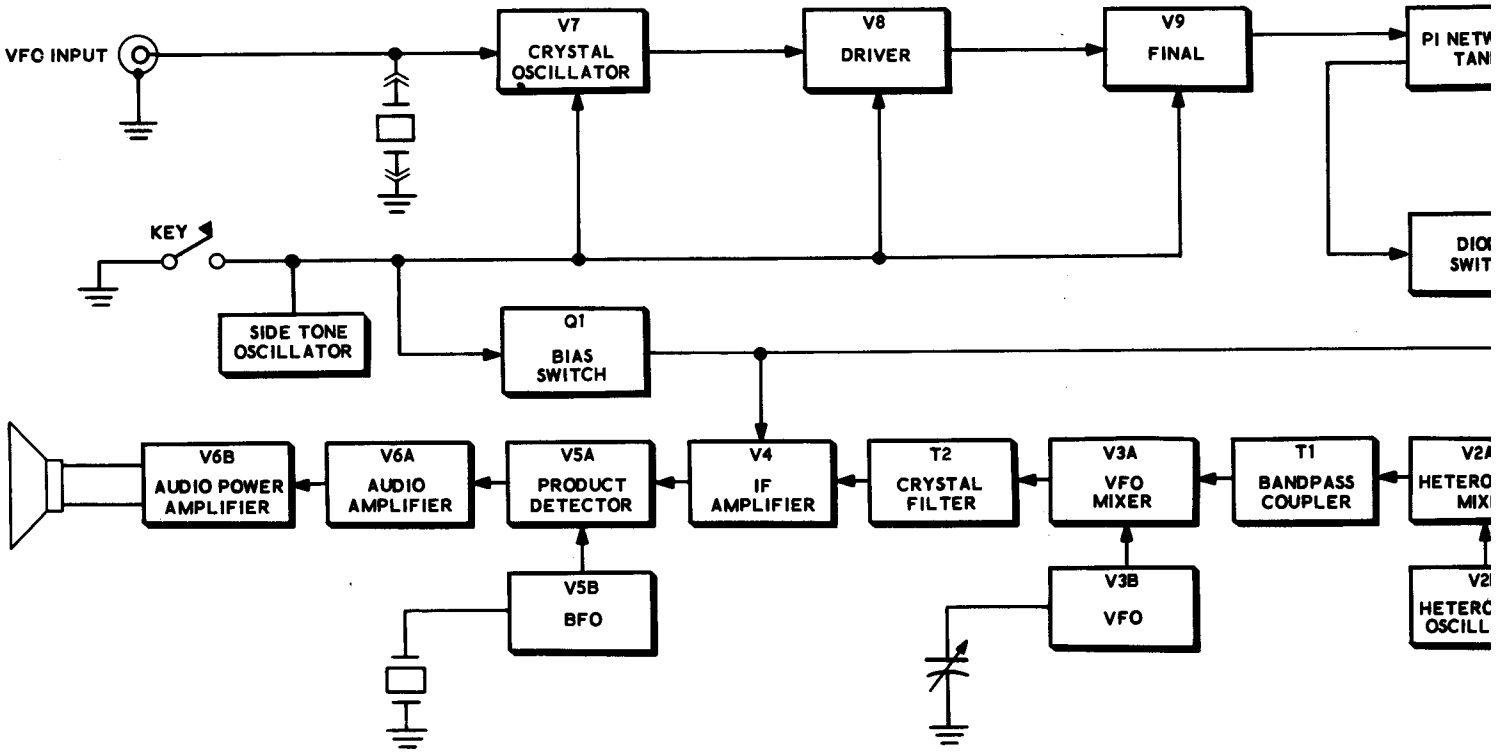
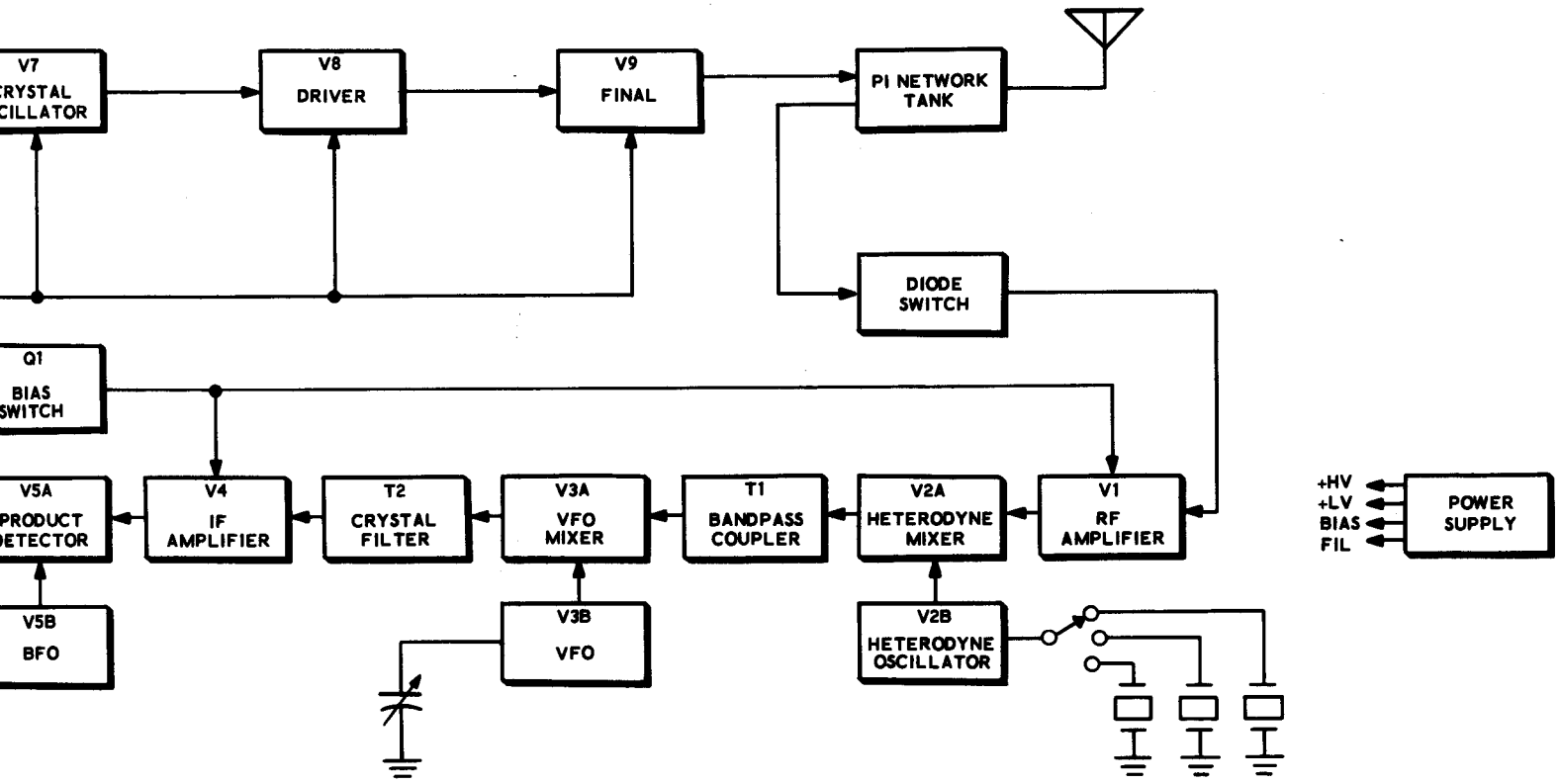

REL. PWR.
PLATE
HEATH CW TRANSCEIVER
MODEL HW-16
RF GAIN
PWR. LEVEL
7.0
3.5
21.0
OFF
AF GAIN
TUNE
BAND

FIGURE 1-3



BLOCK DIAGRAM



BLOCK DIAGRAM

SYMPTOMS	POSSIBLE CAUSE
8. Low resistance reading from pin 6 of tube socket V8 or tube socket V7 to ground.	A. Resistors R7, R13, R14, R203, and/or R205 shorted. B. Capacitors C4, C6, C12, and/or C13 shorted.
9. Tone not audible in the speaker.	A. Audio amplifier tube V6A defective. B. Coupling capacitor C85 open. C. Power amplifier tube V6B defective. D. Capacitor C91 shorted. E. Audio transformer T4 defective. F. Speaker or speaker connections defective. G. PHONES jack open. H. Headphones connected into PHONES jack.
10. Tone not audible in the headphones, speaker OK.	A. PHONES jack open or shorted. B. Headphones defective.
11. Side tone oscillator does not oscillate or Transceiver is apparently operating, but tone for monitoring the keyed signal is not heard.	A. Open connection from neon lamp NE-2H and capacitor C86 to bias voltage source. B. Neon lamp NE-2H defective. C. Capacitor C86 defective. D. Capacitor C84 open. E. Resistors R63 or R64 open.
12. No RF output at final. (Driver output appears to be OK.)	A. Check items 2A through 2D. B. RF choke L16 open. C. Parasitic choke, coil L15 and resistor R11 open. D. Final amplifier tube V9 defective. E. Bias voltage too high at grid V9. F. BAND switch defective.
13. Bias voltage at V7, V8, and V9 is too high.	A. Resistors R8, and/or R9 shorted.
14. No RF output from driver (Oscillator appears to be OK.)	A. Driver tube V8 defective. B. Resistors R5 or R7 open. C. BAND switch defective.

SYMPTOMS	POSSIBLE CAUSE
15. No signal from crystal oscillator V7.	A. Check items 2A through 2D. B. Resistors R1 and/or R3 defective. C. Capacitors C1 or C4 defective. D. Defective crystal at crystal socket X1 or X2. E. Crystal oscillator tube V7 defective.
16. No signal at the grid of RF amplifier V1.	A. Capacitors C26, C27, C28, C29, C31, and/or C32 shorted. B. Diode D1 shorted. C. Inner lead of the coaxial cable connected to diode D1 shorted to the shield of the coaxial cable. D. Resistor R18 shorted.
17. No signal at the grid of Heterodyne Mixer V2A.	A. RF amplifier V1 defective. B. Capacitor C42 open. C. BAND switch defective.
18. No signal injection from the Heterodyne oscillator V2B.	A. Wire disconnected from BAND switch (wafer C, lug 3). B. Heterodyne oscillator tube V2B defective.
19. Bias switch Q1 does not conduct when receiving. No audio output.	A. Transistor Q1 is defective. B. Resistor R44 and/or R45 shorted.
20. Meter is inoperative or indicates backwards.	A. Leads connected to the meter are reversed. B. PLATE-REL PWR switch is improperly wired.
21. REL PWR-PLATE meter switch is in PLATE position, transmitter is apparently operating, but meter reads 0.	A. Capacitors C33 and/or C25 shorted. B. Resistor R15 shorted. C. Choke L17 open. D. Diode D1 defective or wired in reverse. E. REL PWR-PLATE switch defective. F. Rel Pwr-Plate meter defective.
22. REL PWR-PLATE switch is in REL PWR position, transmitter is apparently operating, but meter reads 0.	A. Capacitors C33 and/or C34 are shorted. B. Resistor R17 is shorted. C. Diode D2 is defective. D. REL PWR-PLATE switch is defective. E. Rel Pwr-Plate meter is defective.

SYMPTOMS	POSSIBLE CAUSE
23. REL PWR-PLATE switch is in REL PWR position, transmitter is apparently operating, but meter is pegged to full scale.	A. Jumper wire across R16 was not removed. B. Diode D2 shorted.
24. Loud oscillation in speaker or headphones when AF Gain is turned clockwise.	A. Blue transformer lead positioned too close to circuit board.
25. TUNE does not peak.	A. Final tank coil L12 has leads interchanged. B. Capacitor C26, C27, C28, C29, C31, or C32 defective. C. Crystal or VFO frequency not within specified range.
26. Sidetone is too loud.	A. Resistance value of R63 too small, replace with a 1 megohm (brown-black-green) 1/2 watt resistor.

SPECIFICATIONS

TRANSMITTER

RF Power Input.	50 to 90 watts (adjustable).
Frequency Control.	80-meter crystal or VFO on 80-meter band. 80- or 40-meter crystal, or VFO on 40-meter band. 40-meter crystal or VFO on 15-meter band.
Keying.	Grid-block, break-in, with automatic antenna switching and receiver muting.
Output Impedance.	50 Ω unbalanced, SWR not to exceed 2:1.
Side Tone.	Neon relaxation oscillator.