

Assembly and Operation
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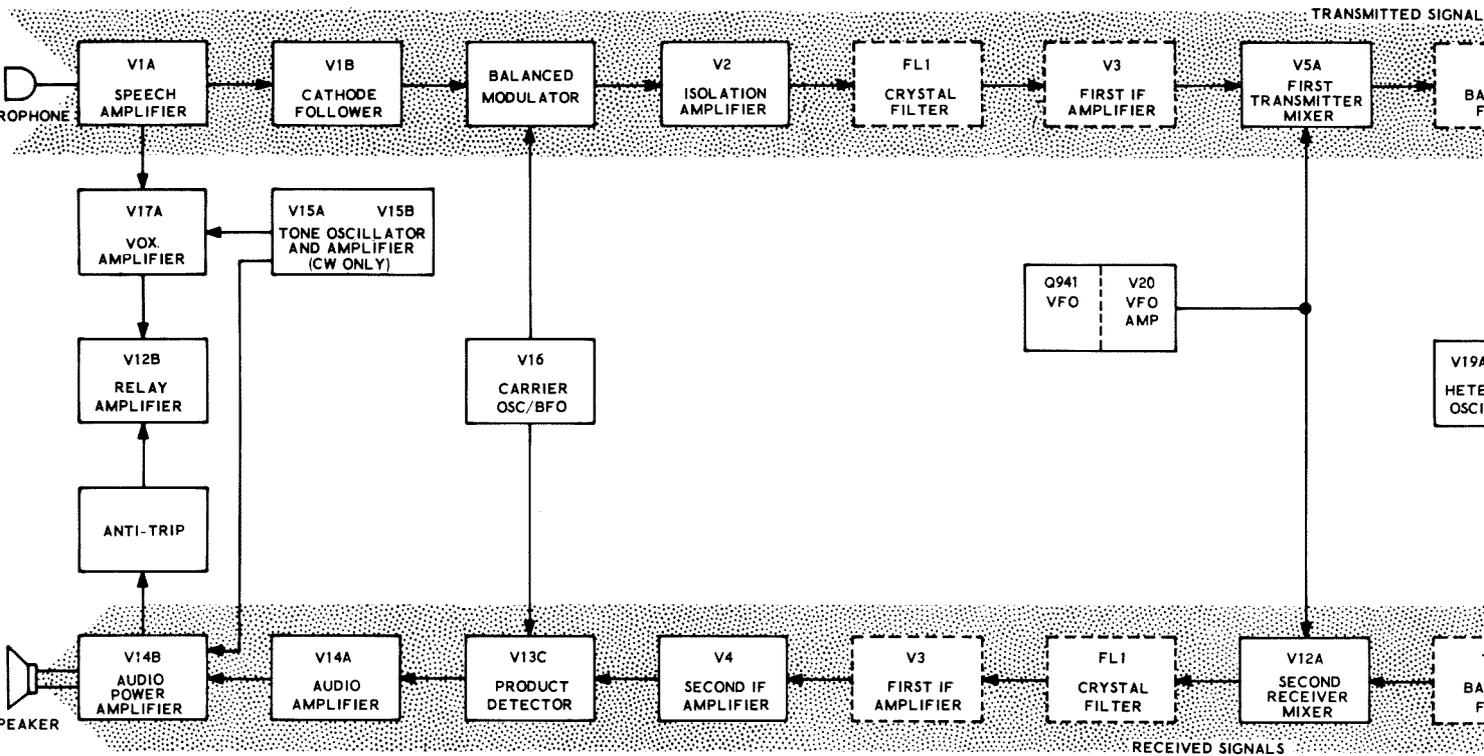
SSB TRANSCEIVER

MODEL HW-100

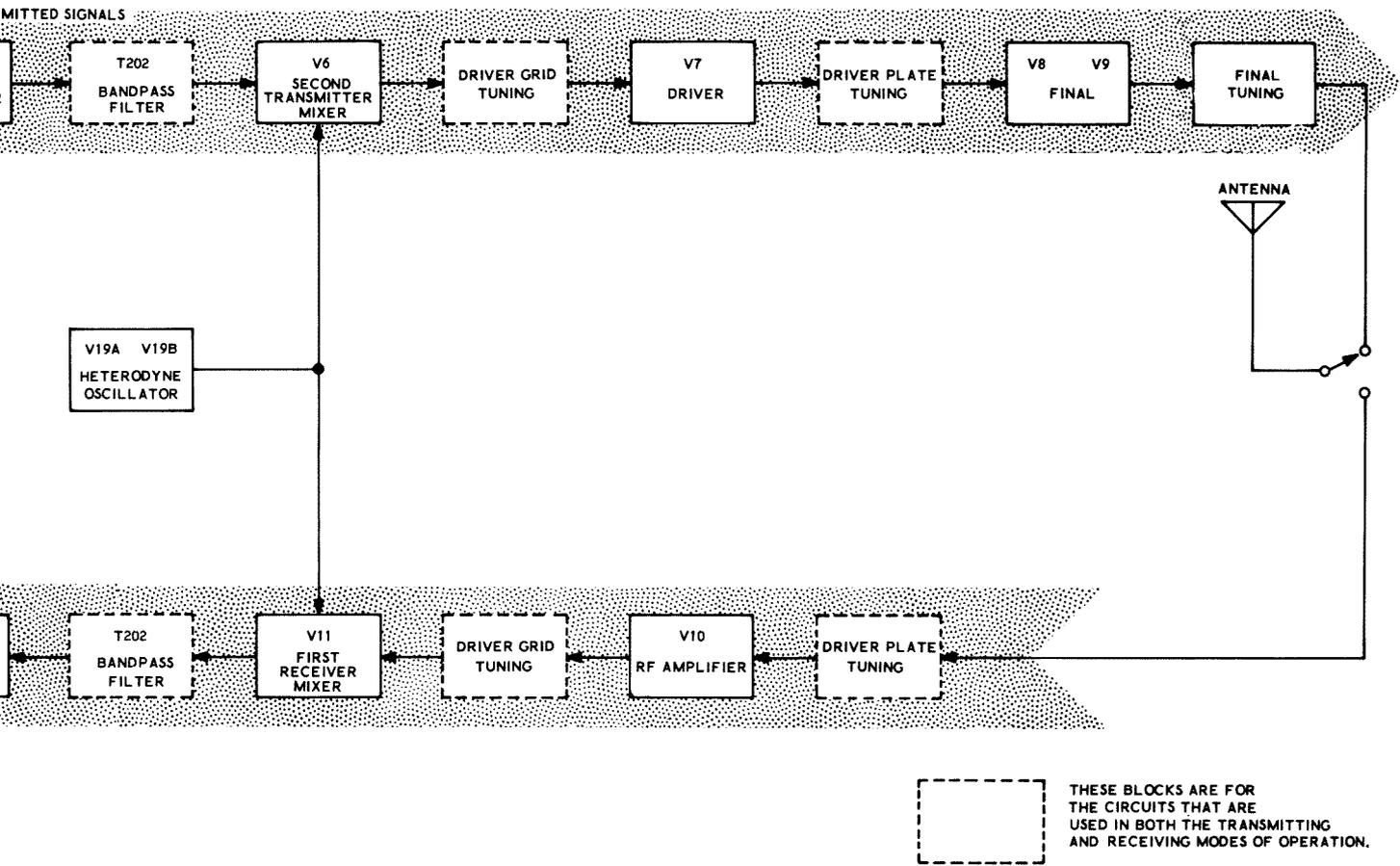


HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

7/5/68



BLOCK DIAG



DIAGRAM

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INTRODUCTION

The Heathkit Model HW-100 SSB Transceiver transmits and receives SSB (single sideband) and CW (continuous wave) signals on the 80 through 10 meter amateur bands. It may also be used as an exciter for a linear amplifier, and it has an ALC (automatic level control) input for use in this service. The Heathkit AC power supply is available for fixed station use, and the Heathkit DC power supply and Mobile Mounting Bracket may be used for mobile operation.

Provisions are made for both VOX (voice-operated transmit) and PTT (push-to-talk) operation. An anti-trip circuit prevents a signal received over the speaker from feeding back to the microphone and switching the transmitter on during VOX operation. The crystal-controlled heterodyne oscillator assures accurate, stable operation.

The dial mechanism has a large tuning knob which operates smoothly and provides convenient, backlash-free tuning. A built-in crystal calibrator allows the dial to be accurately calibrated

at 100 kHz intervals. Other features include TALC* (triple action level control) to prevent overdriving the final amplifiers, and tone-actuated CW operation. The panel meter operates as an S-meter on receive, and reads ALC voltage on transmit. The same meter can be switched manually to read either relative power output or final amplifier cathode current.

A total of twenty tubes and nineteen semiconductors are used. The VFO uses a field-effect transistor as the oscillator. The use of circuit boards, Switch-Boards*, and a wiring harness provides a clean, compact chassis layout and greatly simplifies kit assembly.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

*Registered Trademark, Heath Company.

CONTROL AND CONNECTOR FUNCTIONS

The functions of the front panel and chassis controls are outlined in this section. Read the following paragraphs carefully, so you will be familiar with the operation of each control before

starting to check, align, or operate this Transceiver. The location of the controls is shown in Figure 1-1 (fold-out from Page 98) and in Figure 1-2.

FRONT PANEL FUNCTIONS

DRIVER PRESELECTOR

This control is used to peak the receiver RF amplifier and transmitter driver tuned circuits. The adjustment can be made in either the receive or transmit mode of operation, and must be adjusted at each position of the BAND switch. This adjustment should also be made when the operating frequency is changed appreciably.

MIC/CW LEVEL

When the MODE switch is in the LSB or USB position, this control is used to adjust the audio drive. The control has range enough to adjust for most high impedance crystal or dynamic microphones.

With the MODE switch in the Tune or CW position, the carrier output level of the transmitter is adjusted with this control.

PHONES

High impedance headphones can be connected to this jack. When the headphone plug is inserted, the speaker volume is reduced to a very low level.

MIC (Microphone)

A high-impedance microphone should be connected to this socket. Provisions are made in the socket for connecting a microphone with a push-to-talk switch.

FINAL TUNE AND LOAD

The round knob is the FINAL TUNE control. After the MAIN TUNING control has been set to the desired operating frequency, and the MODE switch set to the TUNE position, this control is adjusted for maximum (Relative Power) meter indication to tune the transmitter for maximum output.

The lever arm is the FINAL LOAD control. It is also tuned for a maximum (Relative Power) meter indication. At this point, there is a proper impedance match between the final amplifier circuit and the antenna.

The FINAL TUNE and FINAL LOAD controls have some interaction and must be adjusted alternately until maximum relative power is achieved.



MODE

This switch selects the LSB, USB, or CW mode of operation for the receive and transmit sections. In the TUNE position, the transmitter is turned on so the driver and final RF stage can be tuned.

BAND

In the first four positions, this switch selects the following bands: 3.5 to 4 MHz (80 meters); 7 MHz to 7.3 MHz (40 meters); 14 to 14.35 MHz (20 meters); and 21 to 21.450 MHz (15 meters).

The following 500 kHz portions of the 10-meter band are selected in the other four positions of this switch: 28.0 MHz to 28.5 MHz, 28.5 MHz to 29.0 MHz, 29.0 MHz to 29.5 MHz, and 29.5 MHz to 30.0 MHz (upper band limit is 29.7 MHz).

MAIN TUNING

The MAIN TUNING dial controls the frequency of the VFO over its range of 500 kHz. The dial is scaled 0 to 500. To read frequency directly, calibrate the dial at the closest harmonic of the calibration oscillator. Then turn the dial to the desired frequency. Add the dial reading in kHz to the setting of the band switch in MHz. For example:

1. Band Switch reads:	3.5
Dial reads:	<u>335</u>
Approximate frequency:	3.835 MHz

or

2. Band Switch reads:	14.0
Dial reads:	<u>335</u>
Approximate frequency:	14.335 MHz

ZERO SET

Pushing this button while turning the MAIN TUNING knob locks the dial scale while the VFO frequency is being changed. This permits the MAIN TUNING dial to be calibrated at 100 kHz intervals.

FUNCTION

This switch selects the PTT (push-to-talk) or the VOX (voice-operated transmit) methods of controlling the Transceiver, and turns the CAL (calibration oscillator) on and off. This switch should be in the PTT or VOX position when the MODE switch is in the TUNE position.

In the PTT switch position, the Transceiver is changed from receive to transmit operation by closing a push-to-talk microphone switch, or by closing the key when set up for CW.

In the VOX position, the Transceiver is changed from receive to transmit operation when the operator talks into the microphone, or when the key is closed in the CW mode.

In the CAL position, the 100 kHz crystal oscillator is turned on to calibrate the MAIN TUNING dial at 100 kHz intervals. The harmonics of this oscillator are easily discernible throughout the range of the Transceiver.

RF GAIN

The receiver sensitivity is controlled by the RF GAIN control. This control is set at the full clockwise position for maximum gain. In the presence of extremely strong signals which tend to overload the receiver, or to eliminate background noise, the gain can be reduced by turning this control counterclockwise.

METER

The meter indicates the strength of incoming signals, ALC (automatic level control) voltage, relative output power, and total cathode current of the output tubes.

NOTE: The METER switch must be in the ALC position for the meter to act as an S-meter while receiving.

AF GAIN

The AF GAIN control adjusts the audio output volume when receiving.

RIGHT SIDE CONTROL FUNCTIONS

VOX SENS

The VOX SENS (Sensitivity) control adjusts the VOX relay circuit to operate at the voice level desired by the operator. When the operator talks into the microphone, the VOX relay is energized and turns the transmitter on.

VOX DELAY

When the FUNCTION switch is set at VOX, this control adjusts the "hold-in" time (length of time the transmitter stays on) after a spoken word or a keyed character. Proper setting of the VOX DELAY control eliminates excessive keying of the transmitter between words or characters.

ANTI-TRIP

The ANTI-TRIP control adjusts the VOX circuit to keep the received signal (at the speaker) from turning on the transmitter by feeding back into the microphone.

ZERO ADJUST

The meter ZERO ADJ control is adjusted for a zero reading on the meter, in the receive mode of operation, with the antenna disconnected and with the RF GAIN control turned fully clockwise.

BIAS

This control adjusts the bias voltage on the final RF amplifier tubes for linear operation.

TOP CHASSIS CONTROL FUNCTIONS

CARRIER NULL CONTROL (Modulator Circuit Board)

This control balances the modulator to suppress the carrier.

CARRIER NULL CAPACITOR (Modulator Circuit Board)

The adjustment of this capacitor completes the modulator balance.

CAL XTAL (Bandpass Circuit Board)

This trimmer adjusts the 100 kHz oscillator to exact frequency.



REAR APRON CONNECTIONS

CW KEY: This jack is used to connect a key or keyer to the Transceiver. Use a phones plug having a 1/4" sleeve. Connect the hot lead of your key to the tip of the plug and the ground lead to the sleeve.

8 Ω : This phono socket is used to connect a speaker to the Transceiver. It accepts a standard phono plug. The output transformer is designed for a speaker having an impedance of 8 ohms, although other speakers from 4 to 16 ohms impedance may be used.

ALC: Automatic level control voltage from an external amplifier may be applied to the Transceiver through this phono socket. If you make this connection, be sure that the external ALC voltage is connected to the pin of a standard phono plug, and is not inadvertently grounded.

SPARE: For accessories.

GND: For safety, a low-impedance, heavy-duty ground connection should be permanently connected to this terminal.

PWR. and ACC.: The cable socket from your power supply engages this plug.

ANTENNA: This socket is used to connect the antenna to the Transceiver. If the Transceiver is to be used with an amplifier, refer to the Installation section of this Manual.

NOTE: The unoccupied hole at one edge of the rear apron is used only with the Heathkit Mobile Mount.

PRELIMINARY CHECKS

Before applying power to the Transceiver, complete the preliminary checks as outlined in this section. These checks are needed to be sure there are no short circuits or open connections that would cause damage to the Transceiver components.

- (✓) Make sure the pointer of the panel meter is at zero. If it is not, adjust the screw in the front of the meter.
- () Turn the following front panel controls to a fully counterclockwise position.

DRIVER PRESELECTOR control
 MIC/CW LEVEL control
 MODE switch
 BAND switch
 RF GAIN control
 AF GAIN control

- () Set the front panel slide switches as follows:

FUNCTION switch:	PTT
METER switch:	ALC

- (✓) Set the following controls to a fully counterclockwise position. Refer to Figure 1-1 (fold-out from Page 98) to help locate the controls.

ZERO ADJ
 BIAS
 VOX DELAY
 VOX SENS
 ANTI-TRIP
 CARRIER NULL control

METER CIRCUIT CHECKS

An ohmmeter will be used for the resistance checks on the following pages. Before making the first check, the polarity of the ohmmeter test leads will be determined. Then the test points for the common and positive (+) leads will be called out in each step.

- () Set the ohmmeter to the RX1 range.
- () Set the front panel METER switch to the PLATE position.



() Check the polarity of the ohmmeter leads as follows: Connect one ohmmeter lead to the Transceiver chassis and the other lead to pin 1 of tube socket V9. If an "up-scale" deflection of the Transceiver panel meter is not obtained, reverse the ohmmeter leads. When an "up scale" meter indication is obtained, the meter lead connected to pin 1 of tube socket V9 should be marked (+) positive. This lead should be used as the positive (+) lead for the remaining checks.

NOTE: Perform the two steps in the following box. The panel meter should read up-scale, which shows that it is connected correctly. If the panel meter does NOT read up-scale, the meter or meter switch circuits are incorrectly wired (or faulty) and must be corrected before additional tests are made.

METER SWITCH	OHMMETER RANGE	COMMON LEAD	POSITIVE (+) LEAD
(✓) ALC	RX1	Pin 7 of tube socket V3 (on IF circuit board)	Chassis
(✓) REL PWR	RX1	lug 1 of terminal strip BE	Chassis

RESISTANCE CHECKS

Refer to Figure 1-2 (fold-out from Page 98), 1-3 (fold-out from Page 105), and 1-4 for the following resistance checks.

Complete the resistance checks listed in each of the three charts. Connect the common and positive (+) ohmmeter leads and set the switches as listed in the chart. For each check, the panel meter should indicate in an up-scale direction.

When more than one switch setting is given, make the resistance check at each setting of the switch. Also, observe the special instructions given in the NOTES column.

NOTE: If readings within 20% of the stated values are not obtained in the following steps, refer to In Case Of Difficulty section on Page 140. Before doing any actual troubleshooting, however, complete all the checks. The resistance readings thus obtained may establish a pattern which will make the difficulty easier to locate.

IMPORTANT: The word "Diode" in the NOTES column of the following charts indicates that a diode is in the circuit under test. Therefore, the measured resistance can vary due to the forward current of the diode, and depending on the range setting of the ohmmeter. The ohmmeter readings in the chart were made with a Heath IM-11 VTVM. Readings made with other ohmmeters may be considerably different.

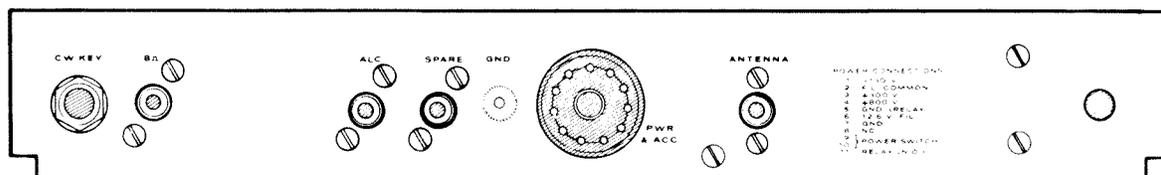
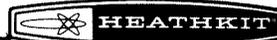


Figure 1-4



OHMMETER TEST POINTS		MODE SWITCH	RESISTANCE IN OHMS	NOTES
COMMON LEAD	POSITIVE (+) LEAD			
(✓) Chassis	CW KEY jack, lug 3	CW	50 k	
() CW KEY jack, lug 3	Chassis	"	30 k	(Diode)
(✓) "	"	TUNE, LSB, and USB	80 k	(Diode)
() Chassis	8 Ω jack, lug 1	TUNE	.7	
(✓) "	Spare jack, lug 1	"	INF	
(✓) "	ALC jack, lug 1	"	5 to 20	(Diode)
(✓) ALC jack, lug 1	Chassis	TUNE and CW	10 k to 500 (use RX100 scale)	(Diode) Varies with setting of MIC/ CW LEVEL control.
(✓) "	"	LSB and USB	1M to 3M	(Diode)
(✓) Power plug, Pin 1	"	TUNE	13k	
(✓) Chassis	Power plug, Pin 2	"	0	
(✓) "	" Pin 3	TUNE, USB, CW	37 k	
(✓) "	" Pin 3	LSB	27 k	
(✓) "	Power plug, Pin 4	TUNE	INF	
(✓) "	" Pin 5	"	0	
(✓) "	" Pin 6	"	1	
(✓) "	" Pin 7	"	0	
(✓) "	" Pin 8	"	INF	
(✓) "	" Pin 9	"	INF	
(✓) "	" Pin 10	"	INF	
(✓) "	" Pin 11	"	INF	

CHART #1



OHMMETER TEST POINTS		MODE SWITCH	RESISTANCE IN OHMS	NOTES
COMMON LEAD	POSITIVE (+) LEAD			
(✓) Power plug, Pin 9	Power plug, Pin 10	TUNE	INF	
(✓) " "	" "	"	0	Turn the AF GAIN control clockwise until a click is heard. Then return the AF GAIN to the full counter-clockwise (OFF) position.
(✓) Chassis	ANTENNA jack, lug 1	"	0	
(✓) "	PHONES jack, contact 4	"	Closed 0 Open INF	Press on contact 4 to open contact for lug 2.
(✓) "	MIC socket, lug 1	"	1M	
(✓) "	" lug 2	"	0	
(✓) "	" " "	LSB, USB, and CW	500 k	
(✓) "	RF GAIN control, lug 2	TUNE	70 k to 10	Varies with setting of RF GAIN control.
(✓) "	AF GAIN control, lug 2	"	25 to 1 M	Varies with setting of AF GAIN control.
(✓) 13 on the IF circuit board	Chassis	All	4 M	



OHMMETER TEST POINTS		BAND SWITCH	RESISTANCE IN OHMS
COMMON LEAD	POSITIVE (+) LEAD		
(✓) Chassis	Capacitor lug DB-1	3.5 and 7.0	10 k
(✓) "	" " "	14.0 through 29.5	INF
	<u>CIRCUIT BOARD LOCATION</u>		
(✓) Power Plug, Pin 3	RF DRIVER Foil 7	3.5	100
(✓) "	" 3	"	100
(✓) "	" 3	7.0 through 29.5	22 k
(✓) "	" 9	3.5	1000
(✓) "	" 4	"	1000
(✓) "	" 4	7.0 through 29.5	INF
(✓) Chassis	Lug 1 (Wafer BS1 of BAND switch)	3.5	4700
(✓) "	"	7.0 through 29.5	INF
(✓) "	Audio Circuit Board 22	3.5	35 k
(✓) Audio Circuit Board 22	Bandpass Circuit Board B	All Positions	100

This completes the Preliminary Checks.

CHART #2

COIL COVER AND TUBE INSTALLATION

Refer to Pictorial 8-21 for the following steps.

- () Refer to Detail 8-21A and install four pairs of spring clips on the under side of the coil cover. Use 3-48 x 3/8" hardware. Bend the clip ends down slightly as shown in the inset drawing. Make sure the clips still touch each other after bending.

CAUTION: Be sure that none of the lugs of the switch wafers mounted on the circuit boards extend beyond the edges of the circuit boards. Bend the lugs down so they cannot short-circuit when the coil cover is in place.

- () As shown in the Pictorial, push the plain edge of the coil cover under the support rail in such a manner that the spring clips on the under side of the coil cover will engage the two metal switch shields. The slots in the two lips of the coil cover will fit under the heads of the four sheet metal screws in the center shield and final switch shield.
- () Tighten the four sheet metal screws.
- () Connect the common lead of your ohmmeter to the chassis and check the resistance to pin 3 of the power plug. A resistance reading under 25 k Ω indicates that the

coil cover is touching one or more of the switch lugs. This condition must be corrected before turning on the Transceiver.

- () Check the resistance between pin 4 of the power plug and the chassis. It should be infinity (∞).
- () Remove the common lead of the ohmmeter from the chassis and connect it to pin 1 of the power plug. The minimum resistance to the chassis should be 13 k Ω .

If resistances are below those shown, refer to the In Case Of Difficulty section, or otherwise correct the trouble.

Place the tube shields on loose tubes as follows:

- () 7-pin tube shield on a 6CB6 tube (for V6).
- () 9-pin tube shield (2" long) on a 6CL6 (for V7).
- () 9-pin tube shield (1-3/4" long) on a 6EA8 (for V1).
- () Install all of the tubes in their sockets, as identified on the circuit boards and shown in Figure 1-2 (fold-out from Page 98).

POWER SUPPLY CONNECTIONS

The Transceiver was designed to operate with the Heathkit Models HP-13 (12 VDC power source) and HP-23 (117 VAC power source) Power Supplies. The following information will help you wire the 11-pin socket (supplied with

the Transceiver) for the power cable of the Power Supply you intend to use. The same cable and power supplies can be used with many other Heathkit models. Be sure to use the correct low B+ voltage for each model.

HP-13 SERIES POWER SUPPLY CONNECTIONS

CAUTION: Be sure the alternate connection in the low voltage DC circuit of the HP-13 Power Supply is connected for +300 volts output as outlined in the HP-13 Manual. Be sure the automobile voltage regulator is set to less than 14.5 volts.

NOTE: If the Heathkit Mobile Mount is used, complete the power supply connections as directed in that manual.



Refer to Figure 1-5 for the following steps.

- () Install the 11-pin socket cap over the free end of the 8-wire cable from the Power Supply, as shown.
- () Remove 3/4" of the outer insulation from the end of the 8-wire cable. Then remove 1/4" of insulation from the end of each wire.
- () Melt a small amount of solder on each of the exposed wire ends to hold the small strands of wire together.
- () Insert the lead from the cap end of the fuseholder (an in-line fuseholder with lead is supplied with the Power Supply) through the socket cap as shown.
- () Cut seven 5/8" lengths of black sleeving and slip them over the indicated wires.
- () Connect the wires of the 8-wire cable and the fuseholder lead to the 11-pin socket lugs as shown. Solder each connection.
- () Push the lengths of sleeving over the lugs of the socket.
- () Snap the socket cap onto the 11-pin socket. **IMPORTANT:** When using the HP-13 Power Supply with the Transceiver, be sure the Bias control of the Power Supply is in its fully clockwise position. This setting will supply a maximum bias voltage at pin 9 of the power socket.

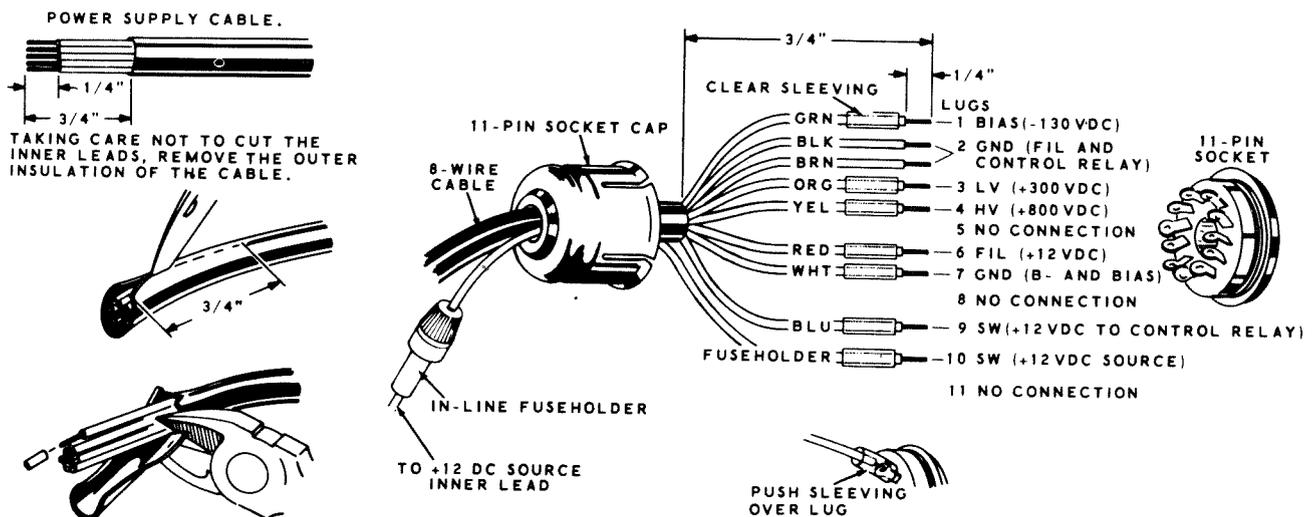


Figure 1-5

HP-23 SERIES POWER SUPPLY CONNECTIONS

CAUTION: Be sure the alternate connection in the low voltage DC circuit of the HP-23 Power Supply is connected for +300 volts DC output as outlined in the HP-23 Manual.

Refer to Figure 1-6 for the following steps.

- () Install the 11-pin socket cap over the free end of the 8-wire cable from the Power Supply.
- () Remove 3/4" of the outer insulation from the end of the 8-wire cable. Then remove 1/4" of insulation from the end of each wire.
- () Melt a small amount of solder on each of the exposed wire ends to hold the small strands of wire together.

For the SB-200 and other Linear Amplifiers, use a piece of coaxial cable through the cap to bring out the relay connections.

- () Cut seven 5/8" lengths of clear sleeving and slip them over the indicated wires.
- () Connect the wires of the 8-wire cable and the coaxial cable (if a Linear Amplifier is used) to the 11-pin socket lugs as shown. Solder each connection.
- () Push the lengths of sleeving over the lugs of the socket.
- () Snap the socket cap onto the 11-pin socket. Be careful not to pinch any wires.

NOTE: With the above connections, the BIAS control in the HP-23 Power Supply is inoperative. Proper bias settings are accomplished with the BIAS control in the Transceiver.

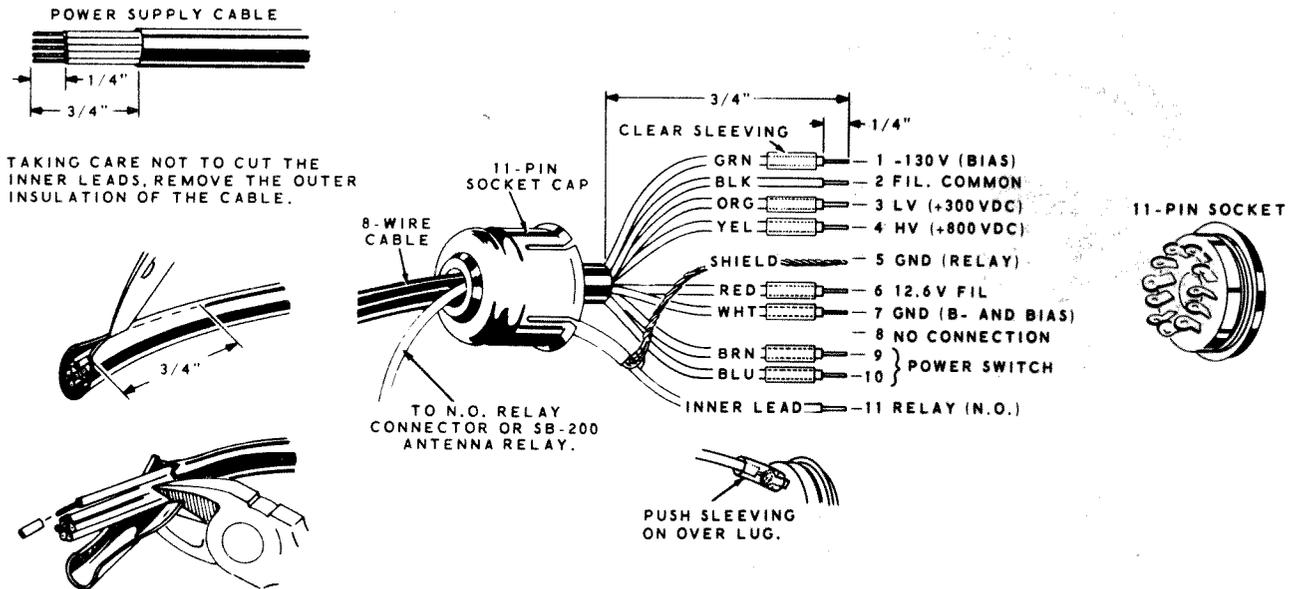


Figure 1-6

INITIAL TEST

CAUTION: BEFORE APPLYING POWER TO THE TRANSCEIVER, NOTE THAT LETHAL VOLTAGES ARE PRESENT BOTH ABOVE AND BELOW THE CHASSIS. DO NOT TOUCH ANY HIGH VOLTAGE POINTS WITH YOUR HANDS. USE WELL INSULATED TOOLS FOR ANY ADJUSTMENTS ON THE CHASSIS.

TO LESSEN THE SHOCK HAZARD, CONNECT A LEAD FROM A GOOD EARTH GROUND TO THE GROUND TERMINAL LOCATED ON THE REAR OF THE CHASSIS AND TO ALL TEST EQUIPMENT.

- () Set the front panel controls as follows:
 - FINAL TUNE (round knob) . . .to 10 o'clock.
 - FINAL LOAD (lever knob) . . .to 4 o'clock.
 - MODE.LSB.
 - RF GAIN.fully clockwise.
 - AF GAIN.power OFF.
- () Set the remaining front panel controls fully counterclockwise.
- () Set the BIAS control (on the right side of the chassis) fully counterclockwise.
- () Connect the socket on the power supply cable to the Transceiver power plug.
- () Connect the power supply to the proper power source.
- () Connect an 8 Ω speaker to the 8 Ω socket at the rear of the Transceiver. CAUTION: Never operate the Transceiver unless a

speaker or headphones are connected. For safety reasons, it is not recommended that headphones be used during the testing of the Transceiver.

If abnormal operation is encountered at any time during the following tests, turn the Transceiver off immediately, and refer to the In Case Of Difficulty section of the Manual on Page 140.

- () Set the FUNCTION switch to PTT.
- () Turn the AF GAIN clockwise until a click is heard. The Receiver is now On, and the pilot lamps should light.
- () Visually check all parts for any signs of overheating, and check to see that each tube filament glows.
- () Set the METER switch to PLATE. The panel meter should indicate zero.
- () Turn the AF GAIN control clockwise until noise is heard from the speaker. NOTE: If no noise is heard, check to be sure the transmitter is not keyed by a depressed switch on a PTT microphone, a closed key, or the MODE switch being in TUNE position.

Check the voltages listed in the next two steps with a voltmeter. Refer to Figure 1-3 (fold-out from Page 105) for the location of test points.

- () +300 volts DC from point 5 on the bandpass circuit board to chassis ground.
- () -111 volts DC (bias) from point 4 on the audio circuit board to chassis ground.

ALIGNMENT

The coils and transformers in your Transceiver have been preset at the factory. Only minor readjustments should be necessary during the following alignment procedure.

The following equipment is necessary for alignment of the Transceiver.

1. An 11 megohm input voltmeter, such as the vacuum tube and solid-state models found in the Heath catalog. A 20,000 ohm-per-volt VOM may be used, but will load the circuits to a greater extent.
2. A 50 Ω nonreactive dummy load that is capable of 100 watts dissipation, such as the Heathkit Cantenna. Do not use light bulbs as a dummy load, as their resistance varies radically with voltage.
3. A receiver capable of receiving WWV at 2.5, 5, 10, or 15 MHz. If this type of receiver is not available, a receiver tunable to a standard broadcast station that is operating at an even multiple of 100 kHz (such as 600 kHz, 1000 kHz, etc.) can be used.
4. An accurate 100 kHz standard oscillator may be used.

For the alignment of the transmitter section it is recommended that you use an oscilloscope, such as the Heathkit Signal Monitor Scope to observe the output RF envelope.

WARNING: Do not place the Transceiver in the transmit mode of operation until directed to do so or the Transceiver may be seriously damaged.

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() Connect a 50 Ω dummy load, capable of 100 watts dissipation, to the ANTENNA jack on the rear of the chassis. **CAUTION:** Do not use light bulbs as a dummy load.

() Be sure an 8 Ω speaker is connected to the 8 Ω jack on the rear of the chassis.

() Preset the CAL XTAL trimmer so its notch is towards the 100 kHz crystal as shown in Figure 1-2 (fold-out from Page 98).

() Preset the front panel controls as follows:

DRIVER PRESELECTOR - 12 o'clock position (3.7, 7.2, 14.2).

MIC/CW LEVEL - fully counterclockwise.

MODE - LSB

BAND - 3.5

Main tuning dial (VFO) - 200 kHz.

FUNCTION - PTT.

RF GAIN - fully clockwise.

METER - ALC.

AF GAIN - 9 o'clock position.

S-METER ADJUSTMENT

- () Adjust the ZERO ADJ control (on the right side of the chassis) for a zero indication on the meter with the antenna disconnected and the RF GAIN control at the full clockwise position.



RECEIVER ALIGNMENT

- () Set the test meter switches so the meter will indicate a negative (-) DC voltage.
- () Connect the common lead of the test meter (11 megohm input voltmeter) to the chassis and the other lead to the circuit board foil at TP (Figure 1-2) on the screened side of the bandpass circuit board near tube V19. If your meter reads 0 at TP, contact instead the adjacent lead of the 100 k Ω (brown-black-yellow) resistor. A reading of -.3 V without a signal is normal.

The heterodyne oscillator output will be checked at each position of the BAND switch in the following steps. If necessary, the heterodyne oscillator coils will be adjusted to obtain a preliminary output voltage reading. Final adjustment will be made later. Carefully insert the slim end of the alignment tool fully into each slug before turning, to avoid core breakage.

NOTE: The heterodyne oscillator crystals that are supplied with the Transceiver provide coverage from 3.5 to 4.0 MHz, 7.0 to 7.3 MHz, 14.0 to 14.5 MHz, 21.0 to 21.5 MHz, and 28.0 to 30.0 MHz. Since the driver grid and driver plate coils must be sequence-tuned, because of their series-parallel arrangement, other heterodyne crystals for out-of-band operation could introduce a wide variety of possible tuning conditions. Therefore, we recommend that you do not use crystals of frequencies other than those supplied.

It is not abnormal to receive "birdies" in the vicinity of 3740 kHz and 21,200 kHz.

- () With the BAND switch at 3.5, the test meter should indicate about -0.5 to -2 volts DC. If necessary, adjust coil 3.5 (near tube V11 on the top side of the RF driver circuit board) for the proper test meter reading. NOTE: When adjusting this coil in one direction, the oscillator output voltage will change rapidly; when adjusting the coil in the opposite direction from the peak, the output voltage will change slowly. Adjust the coil in the direction that gives the slower change in output voltage.
- () Similarly, check the heterodyne oscillator output voltage at all positions of the BAND switch. If necessary, adjust the correct

heterodyne oscillator coil for any BAND switch position that does not give an indication of about -0.5 to -2 volts DC on the test meter. The heterodyne oscillator coils for bands 3.5, 14, and 28.5 are marked, and adjusted at the top side of the RF driver circuit board; the coils for the other bands are marked on the shield cover, and are adjusted from the bottom of the chassis.

- () Turn the VFO TRIMMER capacitor clockwise until snug. Then turn it counterclockwise one full turn.
- () Set the FUNCTION switch to CAL and the BAND switch to 3.5; then turn the MAIN TUNING dial back and forth around 400 kHz to get a calibrator signal. Check for the calibrate signal by turning the FUNCTION switch to VOX and back to CAL; the signal should stop and then start again and should peak with the DRIVER PRESELECTOR.
- () Reset the DRIVER PRESELECTOR to the 12 o'clock position.
- () Disconnect the test meter leads from the Transceiver.

The S-Meter will be used as an output indicator during the remaining alignment of the Transceiver, and the 100 kHz calibrator will be used as a signal source.

When adjusting the transformers in the following steps, use the large end of the tuning tool for the top core. Use the long, thin end (which is inserted through the top core) for the bottom core.

- () Adjust transformer T201 for maximum volume.
- () Adjust the top and bottom slugs of transformer T102 for a maximum volume or S-Meter indication.
- () Adjust the slug of transformer T103 for a maximum S-Meter indication.
- () Repeat the adjustments of transformers T201, T102, and T103 for a maximum S-Meter indication.



VFO ALIGNMENT

- () Make sure the Transceiver has been warmed up for at least 30 minutes before making the following adjustments.
- () Find the CAL signal within approximately 25 kHz of 3900 kHz (400 on the dial). A general coverage receiver tuned to 5100 kHz will aid in identifying the VFO signal. If you are receiving a CAL signal, it will cease when the Function switch is set at VOX.
- () Find the CAL signal near 4000 kHz. Then carefully turn the dial to its counter-clockwise stop and adjust the "500" end of the dial scale marked "Stop", to the hairline (Detail 8-9B on Page 77).
- () Again tune in the 4000 kHz CAL signal.
- () Carefully tune off the 4000 kHz CAL signal to the side toward the 500 dial reading. Then adjust the VFO COIL to move the CAL signal to your listening frequency. By alternately moving your listening frequency and then adjusting the VFO COIL, you can "walk" the CAL signal in the desired direction until it coincides with the 500 dial reading.
- () Turn the dial to the vicinity of 0 and identify the 3500 kHz CAL signal. Move this signal so that it coincides with the 0 dial reading by adjusting the VFO TRIMMER.
- () Since the two preceding adjustments interact to some extent, repeat them until the 3500 kHz and 4000 kHz CAL signals coincide respectively with the 0 and 500 marks on the dial.

NOTE: The VFO signal may be tuned in on a general coverage receiver at 5000 kHz for the "500" dial setting, and at 5500 kHz for the "0" dial setting.

DRIVER GRID AND PLATE COILS

The driver grid and driver plate coils will be adjusted in the following steps. The coil locations are marked on the shield cover at the bottom of the chassis. These coils must be adjusted in the proper sequence as follows:

- () Set the MAIN TUNING dial to 200, and the DRIVER PRESELECTOR to the 12 o'clock position.
- () Adjust driver grid coil 3.5 and driver plate coil 3.5 for a maximum S-Meter indication. The S-Meter will move slowly during the adjustment of these two coils.
- () Change the setting of the front panel controls as follows:

DRIVER PRESELECTOR - 29.2 position.
See the inset drawing on Figure 1-3 (fold-out from Page 105).

BAND - 29.0

MAIN TUNING dial (VFO) - 200 kHz

- () Turn the MAIN TUNING dial back and forth around 29.2 MHz to get the loudest signal. Check for the calibrate signal by turning the DRIVER PRESELECTOR to see if there is any variation in volume. Return the DRIVER PRESELECTOR to the 29.2 position.
- () Adjust driver grid coil 29 and driver plate coil 29 for a maximum S-Meter indication.
- () Change the setting of the front panel controls as follows:

DRIVER PRESELECTOR - 21.2 position.
See the inset drawing on Figure 1-3.

BAND - 21.0.

MAIN TUNING dial - 200 kHz.

NOTE: In the following step, the CAL signal and the VFO harmonic will be found very close together, showing that the VFO is correctly calibrated. The CAL signal is much stronger and can be identified by switching the FUNCTION switch between CAL and VOX.

- () Turn the MAIN TUNING dial back and forth around 21.2 MHz for the loudest signal.
- () Adjust driver grid coil 21 and driver plate coil 21 for a maximum S-Meter indication.



- () Turn the BAND switch to 14.0, the MAIN TUNING dial to 200 kHz, and the DRIVER PRESELECTOR to the 14.2 position.
- () Tune the MAIN TUNING dial for the loudest signal and check for the calibrate signal.
- () Adjust driver grid coil 14 and driver plate coil 14 for a maximum S-Meter indication.
- () Set the BAND switch at 7.0 and the MAIN TUNING dial at 200 kHz.
- () Tune the MAIN TUNING dial for the loudest signal.
- () Adjust driver grid coil 7 and driver plate coil 7 for a maximum S-Meter indication.
- () Set the FUNCTION switch to PTT.

Proper receiver operation will be indicated by minimum calibrator signals of S9 +20 dB at 3700 kHz and decreasing to S3 at 29.2 MHz.

TRANSMITTER ALIGNMENT

See the "Reading The Meter" section on Page 135 before making any more adjustments.

NOTE: The coil cover must be in place for transmitter operation.

- () Connect a push-to-talk microphone to the MIC connector on the front panel.
- () If an oscilloscope is available, connect the oscilloscope between the ANTENNA jack and the dummy load. Be sure the dummy load is capable of 100 watts dissipation. Do not use light bulbs for a dummy load, as damage may result.
- () Turn the adjusting screw of the NEUTRALIZING CAPACITOR (through the hole in the front of the RF Cage) clockwise until resistance is felt. Then turn the screw counterclockwise one full turn.
- () Set the front panel controls as follows:
 - DRIVER PRESELECTOR - 12 o'clock position.
 - MIC/CW LEVEL - fully counterclockwise.
 - FINAL (round knob) - to 10 o'clock.
 - FINAL (lever knob) - to 4 o'clock.
 - MODE - LSB.
 - BAND - 3.5.
- () Press the microphone button and turn the BIAS control (on the right side) of the Transceiver to set the meter needle at the ▼ mark (above the Figure 3) on the meter scale. This sets the resting cathode current. Do not press the microphone button more than a few seconds at one time until this resting cathode current has been properly adjusted.
- () Set the METER switch to REL PWR. The meter needle should show 0.
- () With the MODE switch set at the TUNE position, slowly turn the MIC/CW LEVEL control in a clockwise direction until there is an indication of RF output on the meter or oscilloscope.
- () Adjust the DRIVER PRESELECTOR control for maximum RF output.
- () Adjust the FINAL tune (round knob) control for maximum RF output.
- () Turn the MIC/CW LEVEL control counterclockwise to reduce the RF output to an S3 level.
- () Adjust transformer T1 for maximum RF output. It should not be necessary to adjust this transformer more than one complete turn.

MAIN TUNING dial - 200 kHz.

FUNCTION - PTT.

METER - PLATE.

- () Again reduce the MIC/CW LEVEL for a low meter indication and again adjust Transformer T1 for maximum output.
- () Turn the MIC/CW LEVEL control and DRIVER PRESELECTOR control to obtain maximum RF output on the meter or oscilloscope.
- () Set the METER switch to the PLATE position.
- () Adjust the FINAL tune control for minimum plate current. Set the METER switch to REL PWR or observe the output on an oscilloscope. Adjust the FINAL tune control for maximum meter indication and note the position of the control. If maximum relative power and minimum plate current do not occur at the same point of tuning, then turn the neutralizing capacitor a small amount. Check the position of the FINAL tune control at minimum plate current and also at the maximum relative power indication. The neutralizing capacitor should be adjusted a small amount at a time until minimum plate current and maximum relative power occur at the same point of tuning the FINAL tune control.
- () Turn the MIC/CW LEVEL control fully counterclockwise.
- () Turn the MODE switch to LSB, push the microphone button, and adjust the CARRIER NULL control for minimum RF output. Note that the smaller end of the nut starter fits the shaft of this control.
- () Adjust the CARRIER NULL capacitor for minimum RF output.
- () Turn the MODE switch to USB and, with the microphone button pressed in, adjust the CARRIER NULL control for minimum RF output.
- () Adjust the CARRIER NULL capacitor for minimum RF output.
- () Repeat the adjustments of the CARRIER NULL control, and the CARRIER NULL capacitor until the RF output or null reading

is about the same on both the LSB and USB positions of the MODE switch. A receiver with an S-Meter can be used for the carrier null indication if desired.

NOTE: An 11 megohm input voltmeter with an RF probe can also be used at this time, if one is available, to obtain additional accuracy in the carrier null adjustments. To null the carrier in this manner, measure the RF voltage with the RF probe at lug 1 (the center conductor) of the ANTENNA connector. Then adjust the CARRIER NULL control and CARRIER NULL capacitor for the lowest RF voltage, which should be 1/4 volt or less.

CAUTION: The 6.8 MHz trap coil is sealed, and should not be turned.

- () Turn the MODE switch to TUNE and set the METER switch at the REL PWR position.
- () Adjust the DRIVER PRESELECTOR and the FINAL TUNE and LOAD controls for maximum output. Then adjust the MIC/CW LEVEL control for a reading between 3 and 9 on the panel meter.
- () Adjust heterodyne oscillator coil 3.5 for maximum output, with the tuning on the "slow" side of the peak.
- () Repeat the two preceding steps for each position of the BAND switch, except adjust the HET. OSC. coil that has the same number as the BAND switch position.
- () Set the BAND switch at 21.0 and turn the MAIN TUNING dial to read 21.2 MHz.
- () Adjust the DRIVER PRESELECTOR control and the FINAL TUNE and LOAD controls for maximum RF output; then turn the DRIVER PRESELECTOR control back and forth to see if this produces a smooth peaking in RF output.
- () If turning the DRIVER PRESELECTOR control causes ragged changes in the RF output, readjust the position of, or bend, the free end of the driver neutralizing wire to produce a smooth peaking in RF output (this is the white, insulated wire inserted in hole W of the RF Driver circuit board, as shown in Figure 1-2, fold-out from Page 98).



- () Set the BAND switch to 14.0 MHz and the MAIN TUNING dial to 14.2 MHz. As you did before on the 3.5 MHz band, peak the DRIVER PRESELECTOR and FINAL controls for maximum output. Compare the control settings at which maximum relative power output and minimum plate current occur. Again adjust the neutralizing capacitor until these points coincide. This completes the neutralization.
- () Rezero the ALC position of the S-Meter while receiving, with the BAND switch at 29.5. Then check to be sure the meter reads zero in each BAND switch position. If the S-Meter does not read zero on any band, readjust the heterodyne oscillator coil for that band, as directed in previous steps.

NOTE: The S-Meter may rest below zero while you are transmitting. This condition is normal.

CRYSTAL CALIBRATOR ALIGNMENT

In the following steps, the 100 kHz crystal calibrator signal is adjusted by "zero beating" it against the accurate signal from WWV on another receiver, or against the signal from a standard broadcast station that is on a multiple of 100 kHz.

Zero beat will occur when a harmonic of the 100 kHz crystal calibrator signal corresponds to the frequency of the station tuned in on the external receiver. As zero beat is approached, a tone will be heard that decreases in frequency until it stops completely at the zero beat point; then the tone begins to increase again.

If the external receiver has an S-Meter, accurate alignment can be achieved by observing the S-Meter as zero beat is approached. When you tune close to zero beat, the S-Meter will start to pulsate. The closer you approach zero beat, the slower the pulsations will become. At zero beat the pulsations will stop. Use a "fast" AVC position, if one is available.

IMPORTANT: For greatest accuracy, be sure to adjust the crystal calibrator as close to zero beat as possible. A 20 Hz error at the 100 kHz calibrator frequency, for example, would cause a 740 Hz error at 3.7 MHz (where the 37th harmonic of 100 kHz would be used for dial calibration purposes; $100 \text{ kHz} \times 37 = 3.7 \text{ MHz}$; $20 \text{ Hz} \times 37 = 740 \text{ Hz}$). In view of this, it is recommended that the crystal calibrator be adjusted to the 15 MHz signal of station WWV.

- () Connect a random length of wire from the antenna connection of the external receiver to the ANTENNA connection of the Transceiver. If necessary, use one of the phono plugs furnished. It can be removed later.

- () Set the Transceiver controls as follows:

FUNCTION switch - CAL.

AF GAIN control - full counterclockwise.

MODE switch - CW, LSB, or USB.

- () Tune the external receiver to WWV, or a standard broadcast station transmitting at a frequency which is a multiple of 100 kHz.
- () Carefully adjust the CAL XTAL trimmer capacitor (on the bandpass circuit board) for a "zero beat" in the external receiver. When WWV is tuned in, the period when no tone modulation is present allows the zero beat to be more easily heard.
- () Switch the Transceiver FUNCTION switch between VOX and CAL to be sure the external receiver S-Meter stays steady, thus insuring a true zero beat.
- () Remove the external receiver antenna wire from the ANTENNA jack on the Transceiver.

NOTE: To make sure it is heard on each band, a high content of harmonic energy is needed in the 100 kHz calibrate signal. Because of this, some spurious signals may also appear when tuning across some segments of the bands. The desired 100 kHz calibrate signals are easily identified by their greater signal strength. Also, the proper harmonics may be peaked by the DRIVER PRESELECTOR.

VFO SHIFTER ADJUSTMENT

- () Adjust the MAIN TUNING dial to 200 kHz and the BAND switch to 3.5.
- () Set the FUNCTION switch to CAL.
- () Turn the MODE switch to USB.
- () Carefully zero beat the calibrator signal. Use the MAIN TUNING dial and peak the DRIVER PRESELECTOR control.
- () Set the MODE switch to LSB. Be careful not to touch the MAIN TUNING dial. Note that the calibrator signal may or may not be exactly at zero beat in the LSB position.
- () Turn the SHIFT ADJUST on the VFO for an exact zero beat in the LSB mode. See Figure 1-2 (fold-out from Page 98).
- () Recheck the zero beat in the USB mode to be certain of the adjustment. Repeat the procedure if necessary.

DIAL CALIBRATION

NOTE: The instructions in this section use the 0 mark on the MAIN TUNING dial as the dial calibration point. The same instructions also apply at any other 100 kHz marking.

- () Set the BAND switch at 3.5 and the MAIN TUNING dial at 0 kHz. Zero beat the crystal calibrator signal at 3.5 MHz. If the 0 mark on the dial is not behind the index line in the dial window, proceed with the following steps.
- () Note which way you turn the dial, and move the 0 on the dial behind the index mark in the dial window.
- () Push the ZERO SET button to lock the dial in place, and turn the dial knob in the opposite direction to bring the calibrate signal into zero beat at the 0 mark on the dial. Release the ZERO SET button.
- () Check the accuracy of the adjustment and repeat the above steps if necessary.

This completes the alignment of your Transceiver.

CABINET INSTALLATION

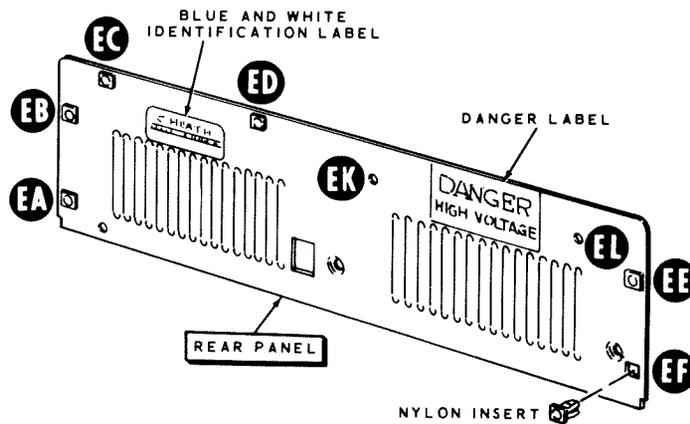


Figure 1-7

Refer to Figure 1-7 for the following steps.

- () Position the rear panel on your table or bench as shown, being sure to have square openings EC and ED to your left.
- () Remove the backing from the red Danger Label and press the label firmly into position between holes EK and EL.
- () In a like manner, mount the blue and white identification label on the rear panel as shown. NOTE: Refer to the numbers on the blue and white label in any communications with the Heath Company about this kit; this will assure you the most complete and up-to-date information in return.
- () Push nylon inserts into square openings EA, EB, EC, ED, EE, and EF.

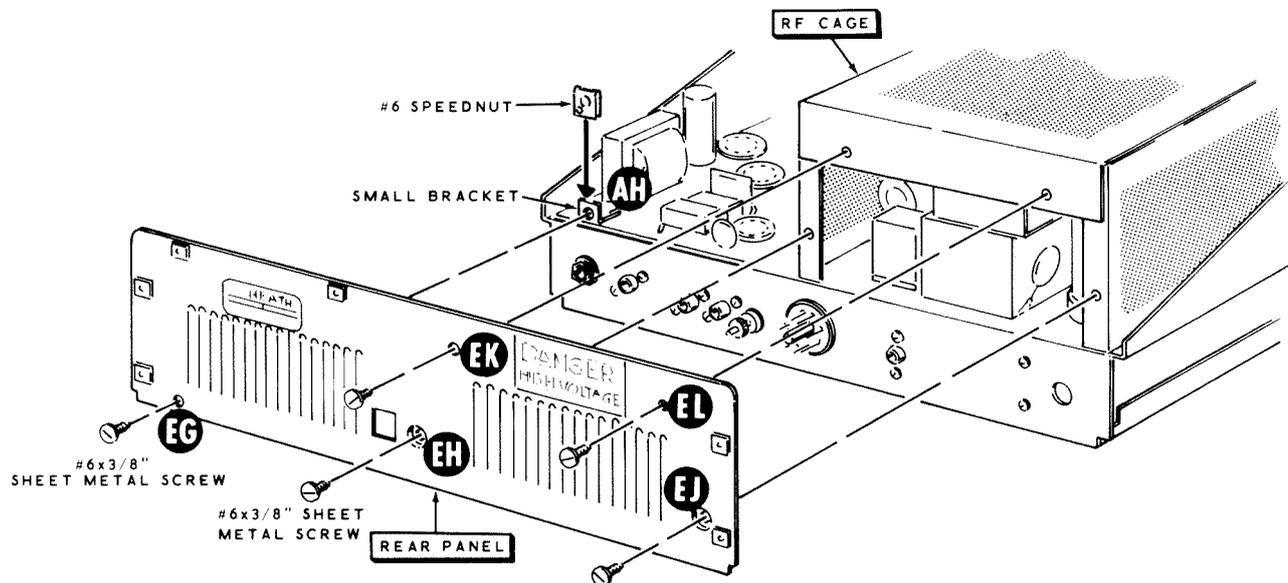


Figure 1-8

Refer to Figure 1-8 for the following steps.

- () Mount a #6 speednut on the angle bracket at AH. Position the curved lip of the speednut toward the audio transformer.
- () Mount the rear panel on the chassis. Use #6 x 3/8" sheet metal screws at EG, EH, EJ, EK, and EL.
- () Place the chassis into the cabinet bottom so that the front panel is against the lips upon which the speednuts are mounted. Be sure the five control access holes are on the right side.
- () Fit the cabinet top over the chassis. The lips on the rear will be just outside the nylon inserts on the rear panel.

Refer to Figure 1-9 for the following steps.

- () If a mobile mount is to be used, mount 5/16" grommets in holes EK and EL in the cabinet top.
- () Install #6 speednuts on the cabinet bottom at EN, EP, ER, ES, and at the four corresponding holes on the opposite lip of the cabinet bottom.
- () Attach the cabinet top to the rear panel. Use #6 x 3/8" sheet metal screws at EA, EB, EC, ED, EE, and EF.
- () Attach the cabinet top to the cabinet bottom. Use 6-32 x 3/8" screws at EN, EP, ER, ES, and the four corresponding holes on the opposite side of the cabinet.

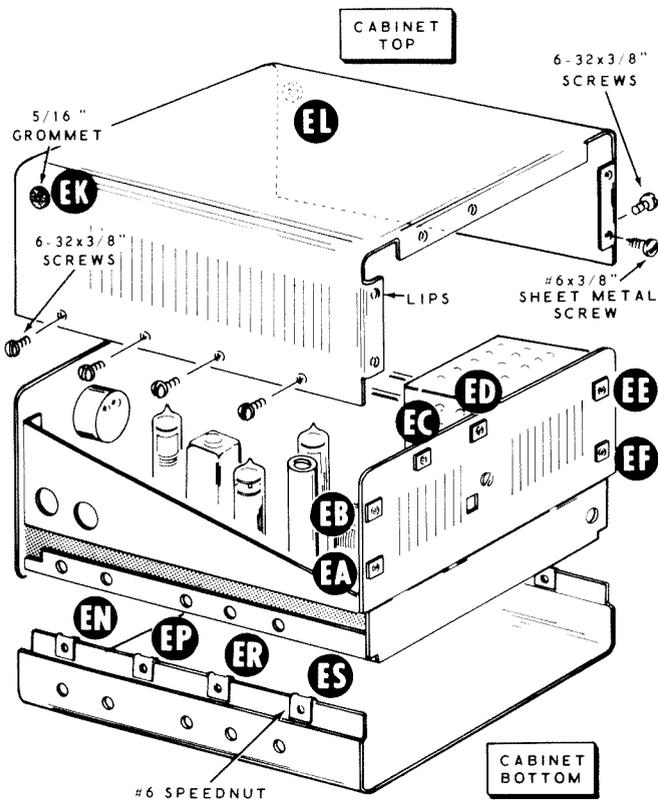


Figure 1-9

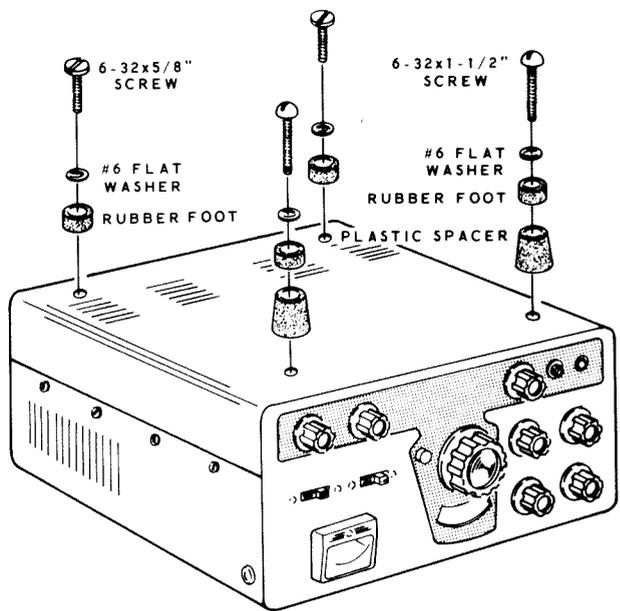


Figure 1-10

Refer to Figure 1-10 for the following steps.

- () Install supports at the front corners on the bottom of the cabinet. Use a plastic spacer, a rubber foot, a #6 flat washer, and a 6-32 x 1-1/2" screw at each corner.
- () Install a rubber foot at each rear corner of the bottom of the cabinet with a #6 flat washer, and a 6-32 x 5/8" screw.

The chassis may be removed from the cabinet as follows:

1. Remove the four feet.
2. Remove screws EA through EF (see Figure 1-9).
3. Slide the chassis forward. Be sure all wires clear the screws on the sides of the cabinet.

This completes the assembly of your Transceiver.

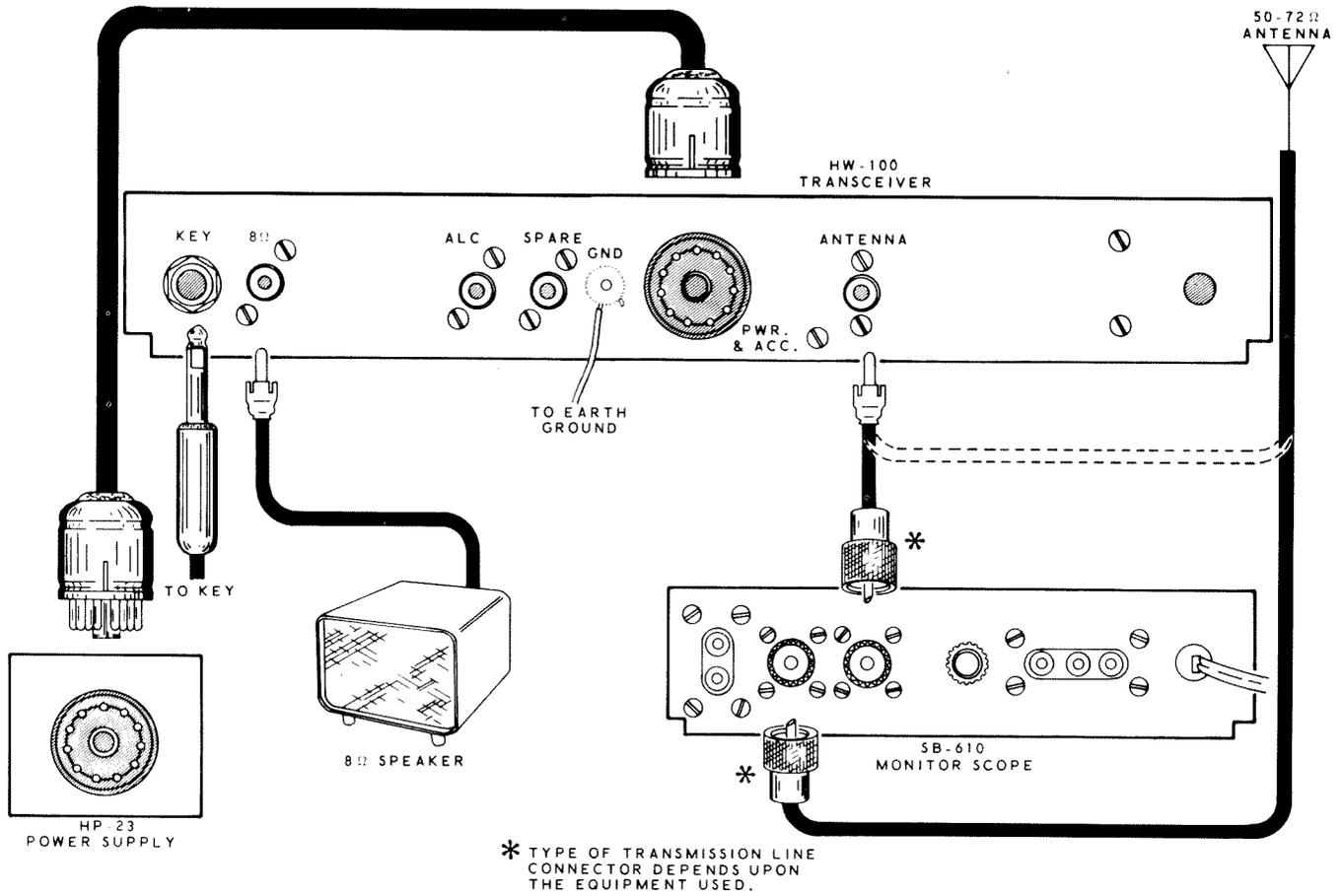


Figure 1-11

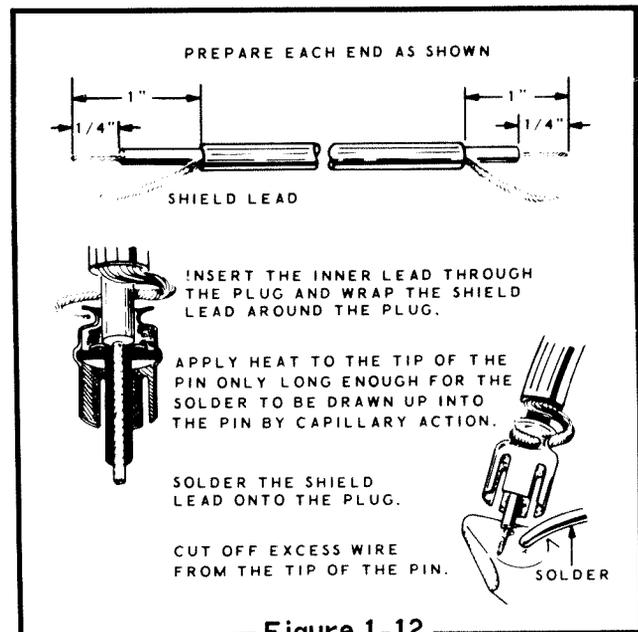
INSTALLATION

Be sure to allow for adequate heat dissipation from the Transceiver. Do not obstruct air passage through the unit by placing other equipment, papers, or objects under or on top of the Transceiver.

FIXED STATION INSTALLATION

Figure 1-11 shows a typical fixed station hook-up. A Monitor Scope is shown that may be used with the Transceiver. The Transceiver may also be used with a linear amplifier; however, the linear amplifier is shown separately in Figure 1-13 for clarity.

Cables can be prepared following the instructions in Figure 1-12. Make the cables to the lengths required for your installation.



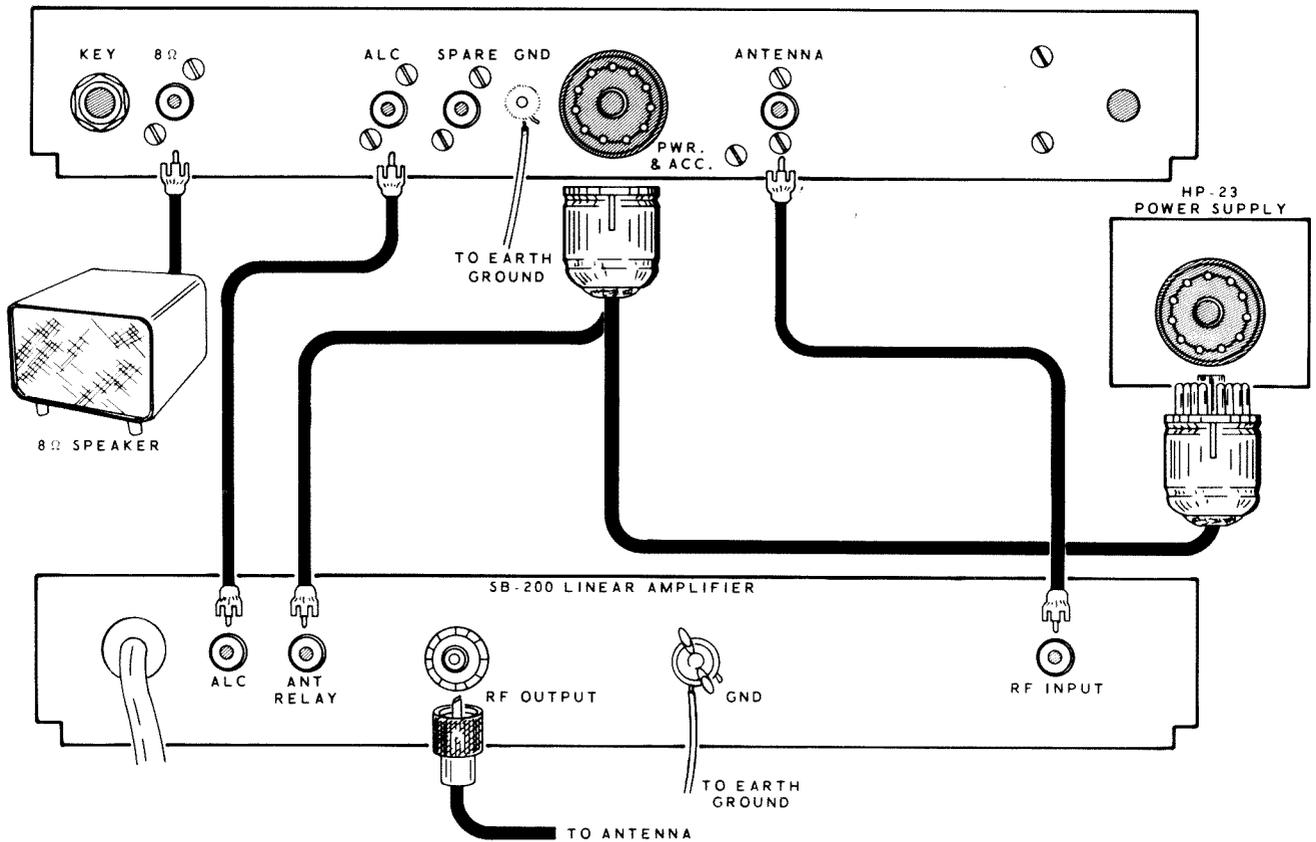


Figure 1-13

LINEAR AMPLIFIER CONSIDERATIONS

SB-200

Figure 1-13 shows a typical installation using an SB-200 amplifier. This linear amplifier provides ALC voltage and has internal antenna switching. The amplifier input does not normally require a swamping pad.

OTHER LINEAR AMPLIFIERS

Information regarding antenna switching, cutoff

bias, and ALC should be obtained from the Linear Amplifier Instruction Manual.

A spare set of SPST relay contacts is available at the PWR and ACC plug of the transceiver (pins 5 and 11). These contacts can be used to switch an external antenna relay by grounding pin 11 in the transmit mode. The current rating of these contacts is 3 amperes maximum at 30 VDC or at 120 VAC.

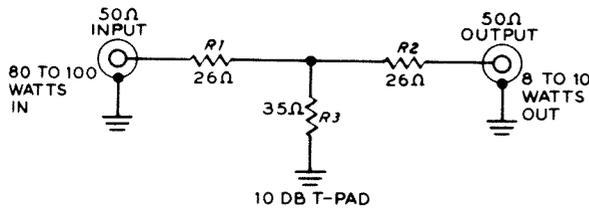


Figure 1-14

T-Pad

If the output power of the Transceiver is too high for the drive requirements of the linear amplifier, a swamping T-pad must be used between the two units. Such a pad is shown in Figure 1-14. This pad will provide 10 dB attenuation with a terminal impedance of 50 ohms. This will allow adequate driving power for a linear amplifier that requires 10 watts input.

Resistors R1, R2, and R3 in Figure 1-14 can be made from combinations of common 2 watt carbon resistors wired into a metal box with phono-type jacks or connectors. NOTE: Do not use wire-wound resistors; the resistors in the T-pad must be a noninductive type.

Combinations of 2 watt 10% carbon resistors for a pad suitable for SSB service at reduced power levels, are listed below. WARNING: Steady full level carrier excitation should be avoided except for very brief test periods, since the dissipation rating of the resistors will be exceeded.

R1 = thirteen 330 Ω 2 watt carbon resistors in parallel.

R2 = two 47 Ω 2 watt carbon resistors in parallel.

R3 = eight 270 Ω 2 watt carbon resistors in parallel.

MOBILE INSTALLATION

A Heathkit Mobile Mount is available for use with the Transceiver, and is recommended for Mobile operation. With this mount, the Transceiver can be quickly and easily installed or removed so it can be used for both mobile and fixed station operation.

CAUTION: Be sure the voltage regulator of the automobile is set in accordance with the manual for your DC power supply. Have the regulator adjusted at a competent garage.

MOBILE ANTENNAS

Mount the antenna according to the manufacturer's instructions. Make a good ground connection between the shield of the coaxial cable and the car body at the antenna base. Eliminate any coating between two adjacent metal surfaces which can add resistance to the ground connections. Be sure the antenna is grounded to large metal areas of the car body and NOT to small panels which may be isolated by paint or rubber from the metal mass of the body.



Mobile antennas present loading situations which must be carefully handled for each band. Because whip antennas must be kept short for mobile use, they represent only a fraction of a wavelength on the lower frequency bands. Their radiation resistance is extremely low and their reactance is capacitive. Therefore, loading coils must be used and the losses kept low to insure a minimum loss of radiated power in the form of heat in the loss resistances.

A good quality antenna will have low resistance losses, and with a high "Q" loading coil, its bandwidth on 75 meters could be less than the IF bandwidth of many receivers used for AM reception. A typical loading coil with a "Q" of 300 would have a bandwidth of 13 kHz to the half-power points at 3.9 MHz.

Because of this sharp tuning, deviation from the center frequency of the antenna will quickly introduce enough reactance to present an impossible loading situation to the transmitter. The antenna should be carefully adjusted for a low SWR (standing wave ratio) before placing the transmitter in operation.

The following is a list of antenna considerations for each band of the Transceiver.

3.5 MHz

This band presents the greatest problem. The normal tuning range of a good antenna on this band is about 10 kHz on each side of the antenna's resonant frequency.

Actual measured resistance at the base of an antenna at these frequencies is 15 to 20 ohms; this represents an SWR of nearly 3 to 1. In order to get proper matching to the 50 ohm line, some antennas may require a 1000 pF mica capacitor

connected between the inner conductor and shield of the coaxial line at the base of the antenna. Other antennas may require a different value, somewhere between 300 and 1500 pF. This capacitor is part of an L network that is used to get a 50 ohm match. The inductive portion of this network is formed by a portion of the loading coil. The correct combination is the one which produces the lowest SWR at the desired operating frequency.

7 MHz

This band ordinarily does not need a correcting network, and has a useful bandwidth of about 50 kHz.

14 MHz

No network needed. Bandwidth is approximately 100 kHz.

21 MHz

No network needed. Bandwidth is about 150 kHz.

28 MHz

The antenna for this band is normally cut for 1/4 wavelength, with no loading coil required. The bandwidth is about 200 kHz.

TYPICAL TUNING PROCEDURE

The following is a typical tuning procedure.

A whip antenna that is properly tuned on 75 meters will have a high peak of receiver activity for about 25 kHz around the antenna's resonant frequency. Turn on the receiver and tune through the band to discover where this high peak of receiver activity is for the present setting of your



antenna. Then adjust the length of the whip in 1/4 inch increments and retune the receiver until the peak of receiver activity is centered around the frequency at which you normally operate. The antenna can then be tuned as described in the following steps. The receiver peaking may not be noticeable on bands other than 75 meters.

NOTE: The Heathkit Solid-State Tunnel Dipper, since it requires no power line connection, is the ideal instrument for determining the resonant frequency of mobile antennas (as well as installed fixed antennas).

DETERMINING SWR

- () 1. Connect an SWR meter in series with the lead to your antenna.
- () 2. Set the SWR meter to the "forward" position.
- () 3. Set the Meter switch on your Transceiver to PLATE. If the meter needle does not point to the ▼ mark on the meter scale when the PTT button is depressed, perform bias adjustment in the fifth step after the Transmitter Alignment title on Page 118.
- () 4. Turn the MODE switch to TUNE.
- () 5. Peak the FINAL TUNE, LOAD, and DRIVER PRESELECTOR controls. Adjust the MIC/CW LEVEL control for a full-scale meter indication on the SWR meter.
- () 6. Switch the SWR meter to the "reverse" position. Note the SWR reading.
- () 7. Switch the SWR meter to the "forward" position. Then set the transmitter to several higher and lower frequencies, and repeat steps 5 and 6 at each frequency, until you find the minimum SWR.

Adjusting Antenna Length

- () Set the transmitter to the desired operating frequency. Then adjust the length of the antenna as follows:
 - A. If the point of the lowest SWR is lower than the desired operating frequency, shorten the antenna as described below.
 - B. If the point of lowest SWR is higher than the desired operating frequency, lengthen the antenna as described below.
 - C. Change the antenna length in 1/4" increments and repeat steps 2, 4, 5, and 6 at each new length until the minimum SWR is obtained. The SWR should be about 1.2 or less at the desired frequency. **NOTE:** It may be necessary to add a capacitor at the base of the antenna, as described previously, if you cannot get the SWR down to about 1.2.

Noise Suppression Troubleshooting Chart

TYPE OF NOISE	POSSIBLE CAUSE	RECOMMENDED REMEDY
Loud popping increasing with engine speed.	Ignition system.	<ol style="list-style-type: none"> 1. Replace plugs with resistor type. (Highly recommended.) 2. Loose crimped connections should be cleaned and soldered. 3. Place resistors in distributor system.
Whine - varies with engine speed.	Generator or alternator.	<ol style="list-style-type: none"> 1. Coaxial type capacitor in series with the armature or stator lead. 2. Clean commutator. 3. Replace brushes. 4. Ground generator shaft. 5. Parallel trap (#10 wire-coil and suitable capacitor) in series with armature lead, tuned to operating frequency.
Distinct but irregular clicking noise.	Voltage regulator.	<ol style="list-style-type: none"> 1. Coaxial type capacitor in series with the battery (B) and armature (A) leads. 2. A series combination of a .002 μF mica capacitor and a 4 Ω carbon resistor to ground from the field (F) terminal. All components should be mounted as shown in diagram, close to voltage regulator.
Same as above.	Energy transfer to primary system.	<ol style="list-style-type: none"> 1. Bypass at the following points: coaxial bypass in lead to coil from ignition switch; battery lead to ammeter; to gas gauge; to oil signal switch; head and tail light leads; accessory wiring from engine compartment.
Loud popping noise that changes from one type road to another. Most pronounced on concrete.	Wheel static.	<ol style="list-style-type: none"> 1. Installation of front wheel static collectors (available from most automotive distributors). These should be checked every 5000 miles for excessive wear.
Same as above.	Tire static.	<ol style="list-style-type: none"> 1. Injection of anti-static powder into tire through valve stem.
Irregular popping noise when on bumpy roads, particularly at slow speeds.	Body static.	<ol style="list-style-type: none"> 1. Tighten all loose screws. 2. Use heavy flexible braid and bond the engine to the frame and fire wall. Bond the control rods, speedometer cable, exhaust pipes, etc., to the frame.

If an extensive amount of suppression is required, the engine should be retimed and tuned up by a competent mechanic.



NOISE SUPPRESSION

To obtain good noise suppression, you must suppress electrical interference at its source, so it does not reach the input of the receiver. Once it has been radiated, noise cannot be suppressed by bypassing, etc.

It is difficult to determine the source of various types of noise, particularly when several items are contributing to the noise. Follow the procedure outlined below to isolate and identify the various noise sources.

In most cases, one source of interference will mask others. Consequently, it will be necessary to suppress the strongest item first, and then continue with the other steps. Figure 1-15 (fold-out from Page 139) shows a typical ignition system and the suggested placement of noise suppression components.

1. Position the vehicle in an area that is free from other man-made electrical interference such as power lines, manufacturing processes and particularly other automobiles.
2. With the Transceiver on, run the automobile at medium speed. Then let up on the gas, and turn the ignition switch off and to the "accessory" position or "off". Allow the vehicle to coast in gear. If the interference stops, the major source of interference is the ignition system.

3. If the noise interference continues from step 2, but at a reduced level, both the ignition and generator systems are at fault.
4. If the noise has a "whine" characteristic and changes in pitch with varying engine speed and is still present with the ignition off, then the generator is the major source of interference.
5. A distinct but irregular clicking noise, or "hash" as it is sometimes called, that disappears with the engine idling, indicates the voltage regulator is at fault.
6. A steady popping noise that continues with the ignition off indicates wheel or tire static interference. This is more pronounced on smooth roads.
7. The same type of interference as in step 6, but more irregular when on bumpy roads, particularly at slow speeds, indicates body static.

Refer to the Troubleshooting Chart on Page 132 and Figure 1-15 (fold-out from Page 139), to help determine how to suppress most noise interference. Naturally, not all vehicles will require suppression to the extent shown in Figure 1-15, but some stubborn cases may require all the suppression components shown, plus shielding of the ignition system.

Bonding of various parts of the automobile, starting from the hood and continuing to the trunk, even including bonding of the transmission line every few feet from the antenna may be necessary.

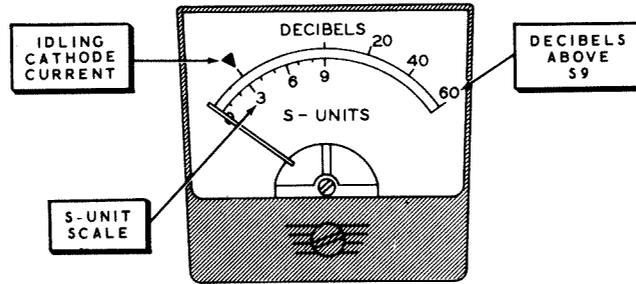


Figure 1-16

OPERATION

NOTE: YOU MUST HAVE AN AMATEUR RADIO OPERATOR AND A STATION LICENSE BEFORE PLACING THE TRANSMITTER SECTION OF THE TRANSCEIVER ON THE AIR. INFORMATION ABOUT LICENSING AND AMATEUR FREQUENCY ALLOCATIONS IN THE UNITED STATES IS AVAILABLE FROM PUBLICATIONS OF THE FEDERAL COMMUNICATIONS COMMISSION OR THE AMERICAN RADIO RELAY LEAGUE, 225 West Main Street, Newington, Connecticut 06111.

Operation of the Transceiver has been simplified as much as possible to permit rapid adjustment by the operator. Once the initial set-

tings have been made, it should not be necessary to readjust most of the controls. Read the following information carefully. Good operating techniques will provide good clean signals and long trouble-free life of the Transceiver.

CAUTION: Be sure a 50 to 75 Ω nonreactive load is connected to the ANTENNA jack before operating the Transceiver. This load can be an antenna, a dummy load, or a properly adjusted linear amplifier. (See the Installation section of the Manual on Page 127.)

READING THE METER

Figure 1-16 illustrates the meter face. The figures 0 to 9 under the left half of the arc are read as "S-units," and the figures above the right half of the arc are read as "decibels over S9." The \blacktriangledown mark is the point to which the cathode current is adjusted.

The ALC (automatic level control) position of the meter switch results in "S-Meter" action during reception, and indicates the relative ALC voltage during transmission. No S-Meter action can be secured with the meter switch in the REL PWR or PLATE positions.

The REL PWR position causes the meter to read an uncalibrated amount of rectified output power. This position is useful for determining the tuning conditions for maximum output power.

The PLATE position of the switch causes the meter to read cathode current to the final stages. There are six numbers on the S-meter (in addition to 0). When reading cathode current, each number represents 50 milliamperes. Thus:

<u>Scale Number</u>	<u>Milliamperes of Cathode Current</u>
0	0
3	50
6	100
9	150
20	200
40	250
60	300



RECEIVER SECTION

1. Set the MODE switch to either LSB or USB.
2. Turn the RF GAIN control to its fully clockwise position.
3. Turn the AF GAIN knob and allow the Transceiver to warm up.
4. Adjust the AF GAIN control clockwise until some receiver noise is heard.

If an extremely strong station overloads the receiver front end, leave the AF GAIN control set for comfortable listening; then adjust the receiver level with the RF GAIN control. This will keep the front end from overloading and masking weaker signals.

The S-Meter will move with adjustment of the RF GAIN control, but will still read correctly with the RF GAIN set at less than maximum (if the received signal level is high enough to regis-

ter on the S-Meter). For example, if the RF GAIN control is set for a no-signal meter reading of S5, and the meter registers S9 with a signal, then the received signal is S9.

5. The Transceiver is now ready to receive. Turn the BAND switch to select the desired 500 kHz band segment. The frequency of the tuned signal is determined by adding together the settings of the BAND switch, and the circular dial.
6. Peak the DRIVER PRESELECTOR for maximum signal.
7. Set the FUNCTION switch to CAL. Rotate the MAIN TUNING dial (VFO) to the nearest 100 kHz point on the circular dial.
8. Adjust the MAIN TUNING dial until the calibrate signal is at zero beat. (To be sure that the correct calibrate signal is being used, check the DRIVER PRESELECTOR tuning. If the signal strength varies, you are tuned to the correct calibrator signal.)

TRANSMITTER SECTION

WARNING: Portions of each band are for CW operation only. DO NOT operate the Transceiver with voice modulation in any portion of a CW sub-band. To do so (in the U.S.A.) will invite disciplinary action by the Federal Communications Commission.

Make SURE your dial calibration is correct, since it is possible for the circular dial to be 100 kHz off frequency. For example, your dial could read 14.3 MHz but your actual transmitting frequency could be 14.4 MHz, which is out of the amateur band. Checking with the built-in calibrator can insure that the circular dial is exactly on a 100 kHz point, but you can not be sure which one it is on. Therefore, before transmitting, make sure you hear other amateur signals on both sides of your chosen frequency. If you do not, check your dial by turning the MAIN TUNING KNOB counterclockwise to the end of its travel. The circular dial should now be at the "500" end of its scale (refer to Detail 8-9B). If the calibration is correct for one band, it will be correct for the other bands.

INITIAL TUNE UP

The 10 steps of this procedure must be performed for all modes of operation.

1. Set the BAND switch and Main Tuning dial for the desired frequency.
2. Place the METER switch in the PLATE position.
3. Turn the MIC/CW LEVEL control fully counterclockwise.
4. With the RF load connected to the ANTENNA jack, set the MODE switch to TUNE. The meter should read 50 mA (at the ▼ mark).

If the meter needle indicates other than 50 mA, perform the BIAS adjustment described on Page 118 under Transmitter Alignment.



CAUTION: Do not turn on full output power continuously for more than 30 seconds at one time, or the final amplifier tubes or power supply may be damaged. Each time full output power is turned off, allow the tubes to cool for at least a minute.

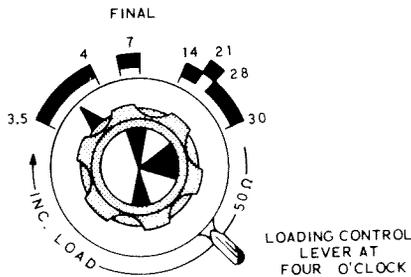


Figure 1-17

Refer to Figure 1-17 for settings of the FINAL TUNE knob and lever.

5. Set the METER switch to REL PWR and adjust the LOAD lever to the four o'clock position.
6. Set the FINAL TUNE knob to the position corresponding to the band in use.
7. Turn the MIC/CW LEVEL control clockwise to obtain a small up-scale indication on the meter. Then alternately adjust the PRESELECTOR, the FINAL TUNE knob, and the LOAD lever for a maximum indication on the meter.
8. Turn the MIC/CW LEVEL control clockwise until the meter reading no longer increases with knob rotation, and again peak the FINAL TUNE and FINAL LOAD controls for maximum output.
9. Set the METER switch to PLATE. The meter needle should read approximately 40 on the scale, indicating a plate current of 250 mA. (See Reading The Meter, Page 135).
10. Return the MIC/CW LEVEL control to its full counterclockwise position.

CAUTION: The Transceiver should be retuned if the frequency is changed by any great amount. Be sure to readjust the FINAL TUNE controls. It may also be necessary to repeak the DRIVER PRESELECTOR control.

NOTE: The DRIVER PRESELECTOR peaks at a slightly different position in transmit than in receive. For transceive operation it should be peaked on transmit. Receiver sensitivity is not adversely affected.

This completes the Initial Tune Up. Before placing the Transceiver in operation, complete either the following CW or Single Sideband adjustments.

CW OPERATION

For CW operation, the FUNCTION switch can be set to either the PTT or VOX positions. Even though CW operation is possible in the Calibrate position, it is not recommended because of possible spurious outputs from calibrator signals being present at the grid of the driver stage.

NOTE: For 400 Hz CW selectivity, the Heath SBA-301-2 CW crystal filter may be installed in place of the SSB crystal filter supplied in the Transceiver. No other circuit changes are required. However, with the CW crystal filter installed, it is not possible to transmit or receive signals in other modes.

Be sure steps 1 through 10 have been satisfactorily completed before proceeding with the following adjustments.

- () Place the MODE switch in the CW position.
- () Plug a key into the CW KEY jack.

The VOX DELAY control is located on the right side of the Transceiver.

- () While sending a series of "V's", adjust the VOX DELAY control so the relays stay energized between groups of characters. Clockwise rotation of this control will increase the holding time of the relays.

The final setting of the VOX DELAY control will be determined by the sending speed of the operator. The slower the sending speed, the higher the setting of this control. **NOTE:** Be sure the VOX DELAY control is adjusted so the relays do not open after each character is sent.

- () Set the MIC/CW LEVEL control to the minimum position that produces full output (increasing the control setting above this level DOES NOT increase the output or the REL PWR reading).

NOTE: After the dial is set to zero beat the calibrator signal, the frequency of the CW output signal is 1000 Hz higher than the dial reading. The received signal is actually in the USB position even though the MODE switch is set at CW. Consequently, cross-mode operation is possible between USB and CW without any resetting of the MAIN TUNING dial. For example, if two stations begin operation in the USB mode of operation and one operator changes to CW, the other station will hear a 1000 Hz note without retuning his receiver. Also, the station operating in the CW mode will receive the USB signal from the other station without changing back to the USB position of the MODE switch. When two stations are operating in the LSB mode and the operator of one changes to USB or CW, contact will be lost until the other station changes to either USB or CW.

SINGLE SIDEBAND OPERATION

Be sure steps 1 through 10 have been satisfactorily completed before proceeding with the following adjustments.

- () Set the MODE switch to either the USB or LSB position.
- () Connect a microphone to the MIC connector.
- () Place the FUNCTION switch in the PTT position. (If your microphone does not have push-to-talk capabilities, make the VOX Adjustments first, and then proceed with the next step.)
- () Set the METER switch to ALC.

NOTE: It is not harmful if the meter needle "rests" below zero in the Transmit mode.

PTT Adjustments

- () Actuate the transmitter and, while speaking into the microphone, turn the MIC/CW LEVEL control clockwise until the peak deflections register at about S3 on the meter. Keep the meter deflection below the S6 point on voice peaks for most linear output.

Vox Adjustments

- () Turn the MIC/CW LEVEL control fully counter clockwise. Leave this control in this position for the following adjustments.
- () Set the FUNCTION switch to VOX.

NOTE: Close-talk into the microphone when using VOX operation to prevent background noise from tripping the Transceiver into transmit operation.

- () While speaking into the microphone, turn the VOX SENS control to just beyond a setting that will energize the relays. Be sure this control is not set so high that it will allow background noise to trip the relays.
- () Tune the receiver to a fairly strong signal and adjust the AF GAIN control for a comfortable listening level.
- () Place the microphone where it will normally be used. Advance the ANTI-TRIP gain control to just beyond a setting that will keep the speaker signal from tripping the VOX circuits. Be sure this control is not set so high that it completely disables the relay closing action.
- () Speak into the microphone and turn the VOX DELAY control to a setting that will hold the relays energized during the slight pauses between words. This prevents the relays from tripping at the beginning and end of each word.

NOTE: There will be a slight interaction between the VOX SENS, ANTI-TRIP, and VOX DELAY controls. Consequently, it may be necessary to readjust these controls to achieve the desired results.

The Transceiver is now ready for operation in the SSB mode. Speaking into the microphone (VOX) or using the microphone push-to-talk switch (PTT) will change the Transceiver from receive to transmit operation.

OPERATION WITH A LINEAR AMPLIFIER

Operation with a linear amplifier is similar to operation with an antenna at the output of the Transceiver, except that the linear amplifier input may have a different impedance. This will make it necessary to adjust the FINAL TUNE controls for maximum output (input to the linear amplifier). Figure 1-3 (fold-out from Page 105) shows the proper connections between a linear amplifier and the Transceiver.

MOBILE OPERATION

If the Heathkit DC Mobile Power Supply is to be used with the Transceiver in a mobile installation, and the BIAS control in the Transceiver has already been preset for fixed station operation, make the following adjustments.

- () Turn the MIC/CW LEVEL control fully counterclockwise.
- () Place the MODE switch in either the USB or LSB position.
- () Set the FUNCTION switch to PTT.
- () Place the METER switch in the PLATE position.

NOTE: The following adjustment should be made with the automobile engine running at about a 30 mph speed so the battery is being charged.

Activate the transmitter with the push-to-talk button on the microphone, and adjust the bias control in the mobile power supply for a cathode current reading of ∇ (50 mA). This will make it unnecessary to readjust the BIAS control of the Transceiver each time it is changed from mobile to fixed station use.

The VOX SENS, VOX DELAY, and ANTI-TRIP circuits will operate in mobile use, but because of the different power supplies, it may be necessary to readjust these controls.

Transmitter loading may be somewhat more critical on mobile antennas because of their sharper frequency characteristics. Consequently, the mobile antenna must be tuned as closely as possible to the desired operating frequency with the lowest possible SWR. Review "Typical Tuning Procedure" in Mobile Installation section (Page 129).

IN CASE OF DIFFICULTY

Refer to the Kit Builders Guide for Service and Warranty information.

A review of the Operation and Installation sections of the Manual may indicate any conditions overlooked.

Refer to the Schematic Diagram (fold-out from Page 189) and to the Chassis Photos and X-Ray Views (Pages 180 to 187) for the location of parts.

Check the receiver and transmitter voltage readings against those shown in Figures 1-18 and 1-19 (fold-out from Page 140). Check the resistance readings against the readings shown in Figure 1-20 (fold-out from Page 151). All voltage readings were taken with an 11 megohm input electronic voltmeter. Voltages may vary as much as 10%.

Refer to the Receiver Signal Voltage Chart (Figure 1-18) if a signal generator is used to troubleshoot the Transceiver.

NOTE: Breaks in the foil of the circuit boards can easily 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 hair-line crack in the foil.

Wiring errors and poor soldering are the most common causes of difficulty. Therefore, the first step in troubleshooting is to recheck all wiring against the Pictorials and Schematic Diagrams. Often, having a friend check the wiring will locate an error consistently overlooked by the builder.

Quite often, soldered connections that appear good will have an insulating coating of rosin between the wire, the terminal, and the solder. This results from insufficient heat being applied when soldering. Many troubles can be eliminated by reheating each connection to make sure that it is properly soldered as illustrated in the Soldering section of the Kit Builders Guide. The power supply should be turned off and the power cable should be removed from the power supply for such tests. As additional insurance against shock, a screwdriver blade should be used to short from the chassis to the red B+ wires.

If fuses blow instantly when power is applied to the unit, check the power supply, B+ circuits, and filament circuits. Check all tubes for possible shorts. Also refer back to the Initial Test section on Page 113. Check to be sure that all tubes are in their proper locations.



Be sure to read the Circuit Description so that "Cause-and-Effect" reasoning may be employed as the search for the trouble progresses. If some difficulty still persists after the steps outlined in the Troubleshooting Chart have been completed, try to localize the trouble to a particular stage in the circuit by using the voltage and resistance charts. Then refer to the Block Diagram and Schematic to visualize circuit relationships.

An 11 megohm input electronic voltmeter will be needed to measure voltages. Most of the RF voltages can be measured with the aid of an RF probe.

A grid dip meter or wavemeter and a general coverage receiver are ideal instruments for checking operation of the RF circuits.

NOTE: If there is instability in the unit, check all circuit board mounting screws. These screws should be tight to the chassis and to the circuit board. Be sure lockwashers are against the foil side of the boards for good grounding.

The enclosed relays used in this unit should be troublefree for years of normal use.

DO NOT REMOVE ANY OF THE TUBES OR PILOT LAMPS WITH POWER APPLIED TO THE UNITS. Because of the series-parallel filament circuit arrangement, removing a tube with power applied may destroy other tubes due to an increase in filament current through them.

RF Voltage Servicing

On the Schematic at the end of this Manual, the symbol  encloses a number indicating the RF voltage at that point. Most of these symbols are found near the top of the Schematic, although others will be observed near V16, the VFO output, V19B, and the antenna output.

RF voltages are shown at the grid and plate of most tubes carrying RF so you can determine whether the problem lies in the grid or the plate circuit.

A Heathkit 11 megohm input voltmeter with a Heathkit RF probe was used to measure the RF voltages. However, the voltages to be expected at the grids and in the output circuits of the final stages exceed the 30 volt maximum reading of the RF probe. Before applying the RF probe to these points, turn the MIC/CW LEVEL control fully counterclockwise, touch the probe to the measurement point, and then turn the MIC/CW LEVEL clockwise until a meter reading of 30 volts is obtained. If this occurs, consider that the reading at this point is satisfactory. It should be expected that voltages will vary from Transceiver to Transceiver. Crystal oscillator voltages will vary considerably.

This procedure traces the RF signal voltage from stage to stage. By this method, it is easy to isolate a problem stage so that steps can be taken to correct the trouble. You should start at the carrier oscillator and work through to the final, as each stage is dependent on the previous stage.

Trace the RF up to the point it is lost; then back up one stage. Should one or two bands be operating properly and the rest have difficulty, make reference RF voltage measurements on one of the operating bands and make comparison measurements on the inoperative bands. In this way the stage causing difficulty is quickly isolated.

Once the stage is isolated, steps can be taken to correct the problem. Check for wiring errors, intermittent solder connections, loose hardware and bent switch contacts first; then look for weak tubes, and last, for defective components.

VFO Troubleshooting

VFO troubleshooting instructions are included on Page 150.

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 item 1C," refer to Symptom number 1, Possible Cause C.

SYMPTOM	POSSIBLE CAUSE
1. No power, pilot lamps and tube filaments do not light, no B+ or bias voltage.	<ul style="list-style-type: none"> A. Power supply switch at off position. B. Power plug wired incorrectly. C. Power cable from power supply wired incorrectly or has loose connections. D. Defective AC snap switch on AF Gain control switch. E. In mobile installation, power supply leads reversed to battery. F. Fuses or circuit breakers open. G. Defective power supply. H. Faulty battery or battery cables.
2. Pilot lamps and tube filament light, but no bias or B+ voltage.	<ul style="list-style-type: none"> A. Check items 1B and 1C. B. Rectifiers defective in power supply. C. Transistors defective in DC power supply.
3. Bias and B+ voltage OK, but pilot lamps and tube filaments do not light.	<ul style="list-style-type: none"> A. Check items 1B and 1C. B. Large brown-white wires in wire harness open, wired incorrectly, or shorted to ground.
4. Low and high filament voltages on various tubes or pilot lamps.	<ul style="list-style-type: none"> A. Check item 3B. B. Brown leads used to balance filament voltages connected incorrectly, or not connected.
5. No regulated B+ (+150).	<ul style="list-style-type: none"> A. Relay RL2 wired incorrectly. B. Bad OA2 regulator tube, V18. C. Resistor R304 and/or R305 open or wired incorrectly. D. B+ voltage is 250 V instead of 300 V.
6. Regulated B+ voltage too high.	<ul style="list-style-type: none"> A. Check items 5A and 5B. B. Resistor R304 and/or R305 wrong value.



SYMPTOM	POSSIBLE CAUSE
7. Regulated B+ voltage too low.	<ul style="list-style-type: none"> A. Check items 5B and 6B. B. Shorted bypass capacitor in regulated B+ line.
8. No screen voltage at tubes V10 and V11.	<ul style="list-style-type: none"> A. Lugs 3, 7, or 11 of relay RL2 wired wrong.
9. High-pitched audio oscillation unaffected by AF Gain control.	<ul style="list-style-type: none"> A. Red and blue audio output transformer leads reversed. B. AVC line shorted - no cutoff bias to V10 or V11.
10. No audio output from speaker or headphones.	<ul style="list-style-type: none"> A. Check items 5A, 5B, and 5C. B. Defective transformer T301. C. AF Gain control incorrectly wired, or defective. D. Filter capacitor C304 shorted or installed backwards. E. Audio amplifier output tube V14 defective. F. Coaxial cable connected to AF Gain control shorted. G. Leads reversed at lugs 3, 7, or 11 of relay RL2. H. Leads reversed at lugs 2, 6, or 10 of relay RL2. I. Speaker leads shorted.
11. No audio output from speaker, but headphone output OK.	<ul style="list-style-type: none"> A. Contacts 1 and 2 of Phones jack open. B. Leads to Phones jack improperly connected. C. Speaker lead connected to wrong phono socket. D. Defective speaker. E. Output transformer green, black, or white leads connected wrong.
12. Low or no audio output from headphones, but speaker output OK.	<ul style="list-style-type: none"> A. Phones jack wired incorrectly. B. Defective headphones.
13. No signal or noise output, but very low hum output can be heard (speaker or phones).	<ul style="list-style-type: none"> A. Check items 10A, 10F, and 10G. B. RFC101 open. C. Product detector tube V13 faulty. D. No carrier generator injection signal at product detector. (Check items 30A through 30F.) E. Coaxial cable #1 connected to AF Gain control open or shorted. F. IF transformer T102 misaligned or defective. G. IF amplifier tubes V3 or V4 defective. H. Coaxial cable #4 from V12 to crystal filter FL1 open or shorted. I. RF Gain control wired backwards, or turned down.



SYMPTOM	POSSIBLE CAUSE
<p>14. No signal output, but noise output can be heard.</p>	<p>A. Transformer T201 misaligned or defective. B. No VFO injection signal at the cathode of V12A. (Check items 31A through 31E.) C. Coaxial cable connected between the bandpass and driver plate circuit boards, open or shorted. D. First IF amplifier tube V3 defective. E. Second receiver mixer tube V12A defective. F. No heterodyne oscillator injection signal at the cathode of V11. (Check items 33A through 33I.) G. First receiver mixer V11 or RF amplifier V10 defective. Also check item 4A. H. Coaxial cable connected between relay RL1 and the driver plate circuit board, open or shorted. I. Relay RL1 wired incorrectly. J. Bandpass filter T202 defective. K. Crystal filter FL1 defective. NOTE: One filter terminal may normally have a 3 Ω to 5 Ω resistance to ground.</p>
<p>15. Audio output with signal, but weak.</p>	<p>A. Low B+ supply voltage. B. Coils on driver plate, driver grid, and heterodyne oscillator circuit boards misaligned. C. Check items 4A, 7A, 13A through 13I and 14A through 14K. D. RF Gain control is partially counterclockwise or wired incorrectly.</p>
<p>16. Receiver tends to be unstable, oscillates. (Receiver noise may be extremely high, or many "birdies" appear across tuning range.)</p>	<p>A. RF driver and IF circuit board mounting hardware not tight, or lockwashers left out between the chassis and circuit boards. B. Antenna transmission line open or shorted, or has high SWR. C. Supply voltage too high. (Check items 6A and 6B.) D. Transmitter cutoff bias too low (V6 and V7).</p>
<p>17. Sideband reception reversed or highly distorted.</p>	<p>A. Carrier generator crystals Y1 and Y2 interchanged. B. CW carrier generator crystal Y3 interchanged with either Y1 or Y2. C. Leads reversed at lugs 13 and 17 on the Mode switch. D. Check VFO shifter adjustment.</p>



SYMPTOM	POSSIBLE CAUSE
<p>18. S-Meter inoperative, indicates backwards, is inoperative in some Meter switch positions, does not zero, or zero shifts on some bands.</p> <p>NOTE: When transmitting, the meter may rest below zero in the ALC position without harm.</p>	<ul style="list-style-type: none"> A. Leads connected to the meter are reversed. B. Improper wiring of Meter switch. C. Meter Zero control improperly adjusted. D. One of the following resistors is a wrong value: R103, R105, R106, R107, R110, or R115. E. First or second IF amplifier tubes (V3 or V4) defective. F. AVC line shorted to chassis. G. Lugs 4, 8, or 12 of relay RL2 wired wrong. H. V19, wrong type. I. Heterodyne oscillator coils improperly set. Readjust (see steps on Page 116). J. Defective Meter switch.
<p>19. No screen voltage at driver tube V7.</p>	<ul style="list-style-type: none"> A. Relay RL2 not energized. Check items 34A through 34C, and 35A through 35H. B. Lugs 3, 7, and 11 of RL2 connected incorrectly.
<p>20. Bias voltage does not shift to operating levels in transmit conditions.</p>	<ul style="list-style-type: none"> A. Check item 19A. B. Lugs 2, 6, and 10 of relay RL2 wired wrong. C. Bias Adjust control set improperly.
<p>21. No RF output from final, regardless of Mode switch position.</p>	<ul style="list-style-type: none"> A. No high voltage B+ at the plates of final amplifier tubes V8 and V9. B. RF choke L901 open. C. Lugs 8 and 12 of relay RL1 wired wrong. D. Bias voltage too high at the grids of V8 and V9. (Check items 20A through 20C.) E. Final controls not adjusted properly. F. Final amplifier tubes V8 and/or V9 defective. G. Rotor in switch on driver plate circuit board, or final tank switch, 180 degrees out of rotation. H. Final knobs or shafts loose.
<p>22. No RF output from driver regardless of Mode switch position. (Second transmitter mixer appears to be OK.)</p>	<ul style="list-style-type: none"> A. No B+ voltage at the screen of V7. (Check items 19A and 19B.) B. RFC801 open. C. Bias voltage at grids of V8 and V9 too high. (Check items 19A, 20B, and 20C.) D. Coils on the driver plate and grid circuit boards misaligned. E. Driver Preselector control not adjusted properly. F. Driver tube V7 defective.

SYMPTOM	POSSIBLE CAUSE
23. Low relative power reading.	<ul style="list-style-type: none"> A. MIC/CW Level control set too low. B. Transceiver not properly tuned. C. Antenna shorted, or too low impedance. D. Improper voltages to V8 or V9.
24. High relative power reading.	<ul style="list-style-type: none"> A. Antenna too high impedance. B. Open-circuited antenna.
25. No RF output from second transmitter mixer, regardless of the Mode switch setting. (First transmitter mixer appears to be OK.)	<ul style="list-style-type: none"> A. Check items 5A through 5C, 19A, 19B, 22D, and 22E. B. No heterodyne oscillator injection signal at cathode of V6. (Check items 33A through 33K.) C. Coaxial cable connected between the band-pass and driver plate circuit board open or shorted. D. Second transmitter mixer tube V6 defective. E. Check item 25B.
26. No output from first transmitter mixer regardless of the Mode switch position. (First IF amplifier appears to be OK.)	<ul style="list-style-type: none"> A. Check items 19A, 19B, 20B, 20C, 22D, and 22E. B. No VFO output signal to cathode of V5 (pin 7). C. First transmitter mixer tube V5A defective. D. Bandpass filter T202 defective.
27. No RF output from first IF amplifier, regardless of the Mode switch position. (Isolation amplifier output appears to be OK.)	<ul style="list-style-type: none"> A. Check items 14A, 14C, 14D, 14K, 19A, and 19B.
28. No RF output from isolation amplifier, regardless of the Mode switch position.	<ul style="list-style-type: none"> A. Check items 20B and 20C. B. Resistors R18, R19, R23, R24, R937, and/or R938 wrong value. C. Transformer T1 misaligned or faulty. D. Isolation amplifier tube V2 defective. E. Carrier oscillator not operating. (Check items 30B through 30E, and 31B through 31E.)



SYMPTOM	POSSIBLE CAUSE
<p>29. No RF output with the Mode switch in USB or LSB, but output in Tune or CW positions OK.</p>	<ul style="list-style-type: none"> A. Check items 10C, 10D, 10E, 20A, and 25A. B. No carrier injection signal to balanced modulator. (Check items 30B through 30E and 31B through 31E.) C. Balanced modulator diodes CR1 through CR4, installed improperly, wrong type, or defective. D. Coaxial cable #3 connected to the MIC/CW Level control open or shorted. E. Wafer 1F or 1R of the Mode switch wired incorrectly. F. MIC connector wired wrong. G. Speech amplifier tube V1 defective. H. Microphone defective. I. MIC/CW Level control defective.
<p>30. No RF output with the Mode switch in Tune or CW, but output in LSB or USB OK.</p>	<ul style="list-style-type: none"> A. Check items 19A, 19B, 20C, 29B, 30C, 30D, and 30E. B. MIC/CW Level control defective. C. Rear wafer of Mode switch wired wrong.
<p>31. No carrier oscillator injection signal with the Mode switch in Tune or CW positions, but LSB and USB output OK.</p>	<ul style="list-style-type: none"> A. Check items 19A and 19B. B. CW crystal Y3 improper frequency or defective. C. Lugs 1, 5, and/or 9 of the Mode switch wired incorrectly. D. Incorrect wiring of Mode switch wafers 1F or 2R. E. Tube V16 defective.
<p>32. No carrier oscillator injection signal with the Mode switch in either LSB or USB positions. Tune and CW output OK.</p>	<ul style="list-style-type: none"> A. Check items 19A and 19B. B. Coaxial cable from IF circuit board to modulator circuit board shorted. C. USB crystal Y1, or LSB crystal Y2, improper frequency or defective. D. Capacitors C4 through C8, C16 and C17, wrong value. E. Resistors R6 through R9, or R11, wrong value. F. Tube V16 defective.



SYMPTOM	POSSIBLE CAUSE
33. Very low output in USB or LSB modes.	<ul style="list-style-type: none"> A. T1 not aligned. B. Microphone output level too low. C. Tube V1 defective.
34. No VFO injection signal at cathodes of V5 or V12.	<ul style="list-style-type: none"> A. Check items 5A, 5B, and 5C. B. Tube V20 defective.
35. VFO frequency does not shift properly with Mode switch in various positions.	<ul style="list-style-type: none"> A. Check items 2A, 2B, 2C, 5A, 5B, 5C, 30B, 30D, 31C, 32D, and 32E. B. Mode switch wafer 1F wired incorrectly. C. Resistor R306 or R307 wrong value.
36. No heterodyne oscillator injection signal at cathodes of V6 and V11.	<ul style="list-style-type: none"> A. Check items 5A, 5B, and 5C. B. One of the crystals Y501 through Y508 defective, depending on the band being used. C. Coaxial cable from heterodyne oscillator circuit board to bandpass circuit board, open or shorted. D. Capacitors C208 or C223 wrong value. E. Tube V19 defective or wrong type. F. Coils L601 through L608 misaligned or faulty. G. Capacitor C604 wrong value. H. No 150 V B+ voltage to the heterodyne oscillator circuit board. I. Rotors reversed 180 degrees in the switch wafer on the crystal or heterodyne oscillator circuit boards.
37. Relays RL1 and RL2 do not energize with the Mode switch in the Tune position.	<ul style="list-style-type: none"> A. Tube V12B defective. B. Relays RL1 or RL2 defective. C. Wafer 2F of Mode switch wired incorrectly.
38. Relays RL1 and RL2 will not energize with Mode switch in LSB or USB, and Function switch in VOX position.	<ul style="list-style-type: none"> A. Check items 10C, 10D, 28G through 28J, 35A, 35B, and 35C. B. VOX SENS control improperly adjusted. C. Tube V17A defective or wrong type. D. Diode D201 wrong type or installed backwards. E. Zener diode D202 installed backwards or defective. F. Function switch wired incorrectly. Check the white-red-red wire to lug 3. G. Anti-Trip control set too high.



SYMPTOM	POSSIBLE CAUSE
<p>39. Relays energize and stay energized regardless of VOX Sens control setting.</p>	<p>A. Check items 37D, and 37E. B. PTT switch on microphone stuck closed or shorted. C. Key closed. D. C213 defective. E. V12 defective. F. Low B+, at 250 VDC instead of 300 VDC.</p>
<p>40. Transmitter tends to be unstable.</p>	<p>A. Final and/or driver neutralization not proper. B. Mounting hardware for Modulator and RF driver circuit board not tight. Lockwashers between circuit boards and chassis left out. C. Check items 16C and 16D. D. Coils L802 through L805 and/or L801 misaligned. E. Antenna impedance wrong. F. Coil shield cover loose or missing. G. Ground clips for tube shields bent out. H. Hardware loose on sockets V8 and V9. I. Excessive lead lengths of components around V8 and V9.</p>
<p>41. Receiver has slow recovery from transmit condition.</p>	<p>A. Diode D101 defective.</p>
<p>42. Output falls off.</p>	<p>A. Excessive heat due to restricted air circulation. B. Incorrect bias setting. C. Improper load to RF output. D. Gassy 6146 tubes. E. Tube V7 weak.</p>
<p>43. Zero setting of main tuning dial changes considerably from band to band.</p>	<p>A. 100 kHz calibrator is not set exactly at 100 kHz. B. Heterodyne oscillators not properly tuned.</p>

VFO TROUBLESHOOTING

A tube adapter may be used to check "in circuit" voltages present at tube V20 in the VFO. Other than this, it will normally be necessary to remove the VFO chassis from the main chassis. Instructions follow for removing and replacing the VFO and circular dial assembly as a unit.

VFO ASSEMBLY REMOVAL

- () Remove tube V19 from its socket.
- () Unplug the coaxial cable from the VFO output socket.
- () Unsolder the bias, B+ and filament wires from the Bias, B+, and Fil terminals on the back of the VFO chassis.
- () Turn the Main Tuning dial at least one-quarter turn from one end of its scale, and pry the knob from the Main Tuning dial.
- () Remove the 6-32 nuts and lockwashers from the spade bolts which hold the VFO chassis to the main chassis.
- () Work the VFO chassis upward until the spade bolts are out of their slots.
- () Turn the VFO chassis counterclockwise (viewed from the front panel) so that the trimmer side is down.
- () Carefully work the VFO to the rear and upwards until the shaft of the tuning capacitor is free of the knob assembly and the circular dial is out of its slot. CAUTION: The flexible spline will fall when the VFO shaft is removed. Take care that it is protected and does not get dirty.
- () Tack solder extensions to the power wires that were removed from the back of the VFO chassis; tape the joints to avoid short circuits. Connect and solder the extensions to the appropriate terminals on the removed VFO chassis.

- () Use a clip lead or wire to ground the VFO chassis to the main chassis.
- () Turn the power on and test the unit in operation.

VFO ASSEMBLY REPLACEMENT

To replace the VFO chassis, remove and discard the temporary power extension wires and, in reverse order, perform the steps detailed for chassis removal. Take care to check the following points:

- A. That the VFO shaft is centered in its hole.
- B. That the power wiring is reconnected properly (white-gray to BIAS; orange to B+; brown to FIL).
- C. That the mounting hardware is tightened after the VFO is positioned.
- D. That the circular dial properly clears the pushbutton.
- E. That the flexible spline is clean, lubricated, and replaced properly with respect to the flat on the VFO shaft.
- F. That the dial does not wobble after replacement of the Main Tuning knob. If it does, remove the knob, rotate it a quarter turn, and replace the knob.



VFO Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE
1. Output low (after calibration).	<ul style="list-style-type: none"> A. Tube V20 weak. B. Turn the Main Tuning dial to 300 and tune the top core of coil FM for maximum VFO output.
2. Output high.	<ul style="list-style-type: none"> A. Resistor R221 not soldered to point F on the bandpass circuit board. B. Core of VFO coil turned to wrong end. It should be approximately 1-3/8" below the end of the coil.
3. No output.	<ul style="list-style-type: none"> A. Q942 connected backwards. B. Q941 connected wrong. C. Lugs of C950 touching the chassis. D. Output cable shorted.
4. VFO shifter does not work.	<ul style="list-style-type: none"> A. CR941 reversed.
5. Microphonics generated by tapping VFO chassis.	<ul style="list-style-type: none"> A. Bend the leads of, or reposition, the two 56 pF disc capacitors so their surfaces are separated more than 1/8". B. Component leads too long, permitting vibrations or motion.

VFO RF TROUBLESHOOTING

Figure 1-21 shows the AC, DC, and RF voltages to be expected in the VFO. These measurements were made with an 11 megohm input voltmeter and, in the case of RF voltages only, a Heathkit RF probe. RF voltage measurements were made at 3700 kHz, LSB, receiving, with VFO output open circuited. RF voltages may vary 25%.

Follow the same step-by-step procedure as outlined for the other parts of the Transceiver. Look for poorly soldered joints, stray bits of wire or solder, and component leads improperly touching each other or the chassis.

SPECIFICATIONS

RECEIVER

Sensitivity.	Less than .5 microvolt for 10 dB signal-plus-noise to noise ratio for SSB operation.
Selectivity.	2.1 kHz minimum at 6 dB down, 7 kHz minimum at 60 dB down (3.395 MHz filter).
Input.	Low impedance for unbalanced coaxial input.
Output Impedance.	8 Ω speaker, and high impedance headphone.
Power Output.	2 watts with less than 10% distortion.
Spurious Response.	Image and IF rejection better than 50 dB.

TRANSMITTER

DC Power Input.	SSB: (A3J emission) 180 watt P.E.P. (normal voice, continuous duty cycle). CW: (A1 emission) 170 watts (50% duty cycle).
RF Power Output.	100 watts on 80 through 15 meters; 80 watts on 10 meters (50 Ω nonreactive load).
Output Impedance.	50 Ω to 75 Ω with less than 2:1 SWR.
Oscillator Feedthrough Or Mixer Products.	55 dB below rated output.
Harmonic Radiation.	45 dB below rated output.
Transmit-Receive Operation.	SSB: PTT or VOX. CW: Provided by operating VOX from a keyed tone, using grid-block keying.



CW Side-Tone.	Internally switched to speaker or headphones, in CW mode. Approximately 1000 Hz tone.
Microphone Requirement.	High impedance with a rating of -45 to -55 dB.
Carrier Suppression.	45 dB down from single-tone output.
Unwanted Sideband Suppression.	45 dB down from single-tone output at 1000 Hz reference.
Emissions not possible or not recommended.	A0, A2, A3b, A4 through A9, F0 through F9, and P0 through P9.
Third Order Distortion.	30 dB down from two-tone output.
RF Compression (TALC*).	10 dB or greater at .1 mA final grid current.

GENERAL

Frequency Coverage.	3.5 to 4.0; 7.0 to 7.3; 14.0 to 14.5; 21.0 to 21.5; 28.0 to 28.5; 28.5 to 29.0; 29.0 to 29.5; 29.5 to 30.0 (megahertz).
Frequency Stability.	Less than 100 hertz per hour drift after 30 minutes warmup from normal ambient conditions. Less than 100 Hz for $\pm 10\%$ line voltage variations.
Modes Of Operation.	Selectable upper or lower sideband (suppressed carrier) and CW.
Dial Calibration.	5 kHz divisions.
Calibration.	100 kHz crystal.
Bandsread.	28 revolutions for 500 kHz.
Audio Frequency Response.	350 to 2450 Hz.
Front Panel Controls.	Main tuning dial. Driver tuning and Preselector. Final tuning. Final loading. Mic and CW Level control. Mode switch. Band switch. Function switch. Meter switch. RF Gain control. Audio Gain control.

*Triple Action Level ControlTM.

Side Controls.	Meter Zero control. Bias Adjust. VOX Sensitivity. VOX Delay. Anti-Trip.
Internal Controls.	Carrier Null (control and capacitor). Neutralizing. Crystal calibrator. VFO trimmer. VFO shifter.
Tube Complement.	OA2 Regulator (150 V). 6AU6 RF amplifier. 6AU6 1st receiver mixer. 6AU6 Isolation amplifier. 6AU6 1st IF amplifier. 6AU6 2nd IF amplifier. 6BN8 Product detector and AVC. 6AU6 VFO Amplifier. 6CB6 2nd transmitter mixer. 6CL6 Driver. 6EA8 Speech Amplifier and cathode follower. 6EA8 1st transmitter mixer. 6EA8 2nd receiver mixer and relay amplifier. 6EA8 CW side-tone oscillator and amplifier. 6GW8 Audio amplifier and audio output. 12AT7 Heterodyne oscillator and cathode follower. 12AT7 VOX amplifier and calibrator oscillator. 12AU7 Sideband oscillator. 6146 Final amplifiers (2).
Diode Complement.	6 Germanium Diodes: Balanced modulator, RF sampling, and crystal calibrator harmonic generator. 9 Silicon Diodes: ALC rectifiers, anti-trip rectifiers, and DC blocking. 1 Zener Diode: cathode bias.
Transistors.	MPF-105 FET-VFO. 2N3393 Voltage regulator.
Rear Apron Connectors.	CW Key. 8 Ω output. ALC input. Power and accessory plug. Antenna. Spare.

Power Requirements.	700 to 850 volts at 250 mA with 1% maximum ripple. 300 volts at 150 mA with .05% maximum ripple. -115 volts at 10 mA with .5% maximum ripple. 12 volts AC/DC at 4.76 amps.
Cabinet Dimensions.	14-13/16" wide x 6-5/16" high x 13-3/8" deep.
Net Weight.	17-1/2 lbs.
Equipment Used To Prepare Specifications.	Heath HN-31 "Antenna." Heath SB-610 Monitorscope. Heath IM-11 VTVM. Heath MM-1 VOM. Heath IG-72 Audio Generator. Heath HDP-21A Microphone. Hewlett-Packard Electronic Counter, Model 5246L. Tektronix Oscilloscope, Model 581A. Hewlett-Packard Signal Generator, Model 606A. Panoramic Radio Products Inc., "Panalyzer," Model SB-12A. Boonton RF Voltmeter, Model 91-CA. Dynascan Digital Voltmeter, Model 111.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram (fold-out from Page 152) and to the Schematic (fold-out from Page 189) while reading the Circuit Description. Small sections of the Schematic are also included in this Description to make the circuits easier to follow.

Note that the receiver circuits are across the bottom, and the transmitter circuits are across the top of the Schematic and Block Diagrams. Also, several of the circuits that are used for transmitting are also used for receiving (such as the crystal filter and the first IF amplifier). These circuits, which are shown in both the transmitter and receiver portions of the Block Diagram, are identified in the Block Diagram by dotted lines.

Each rotary switch wafer is identified by the front panel name of the switch, and by a letter-number designation that shows the position of that wafer in the switch. See Figure 2-1.

Letter-number designations for the resistors, capacitors, coils, etc., are placed in the following groups:

- 0- 99 Modulator circuit board.
- 100-199 IF circuit board.
- 200-299 Bandpass circuit board.
- 300-399 Audio circuit board.
- 400-499 RF driver circuit board.
- 500-599 Crystal circuit board.
- 600-699 Heterodyne oscillator circuit board.
- 700-799 Driver grid circuit board.
- 800-899 Driver plate circuit board.
- 900-999 Chassis and VFO.

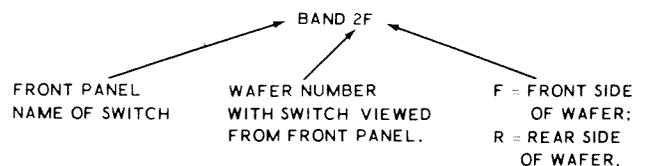


Figure 2-1

TRANSMITTER CIRCUITS

The chart in Figure 2-2 lists the various frequencies that will be found throughout the transmitter on each band. The transmitted lower side-band frequency of 3,895 MHz, modulated with a 1400 hertz audio tone, which is shown on the first line, will be used when tracing through the transmitter circuits. The other frequencies referred to in the Circuit Description will also be found on the first line.

VOX AMPLIFIER (Figure 2-3)

The Transceiver can be switched from receive to transmit by either the VOX (voice operated transmit) or the push-to-talk method. The VOX circuit works in the following manner.

The audio signal from the microphone is coupled through speech amplifier V1A and capacitor C9 to the VOX Sensitivity control. From the arm of this control the signal is coupled through resistors R213 and R214 to the grid of VOX amplifier V17A. The signal is amplified in V17A. It is then coupled through capacitor C211, rectified by diode D201, and applied to relay amplifier V12B, which actuates the transmit-receive relays. V12B is biased to cutoff by zener diode D201 in the cathode circuit. When the grid voltage overcomes the cathode bias, the tube conducts.

In the PTT and Calibrate positions of the Function switch, and in the CW position of the Mode switch, the lead from the VOX Sensitivity control to the grid of V17A is connected to ground. This keeps stray microphone signals from activating the VOX circuit during PTT and CW operation, or during calibration.

RELAY AMPLIFIER (Figure 2-4)

Relay amplifier V12B is held in cutoff during receive operation by the positive voltage that is maintained at its cathode by zener diode D202. V12B is made to conduct for transmit operation by the VOX voltage at its grid, or by the push-to-talk switch on the microphone which shorts the cathode to ground. (The cathode of V12B is also shorted to ground by wafer 2F of the Mode switch in the Tune position.) Diode D201 rectifies the audio signal from the VOX amplifier so that a positive voltage appears at the grid of relay amplifier V12B. The positive voltage at the grid causes the relay amplifier to conduct, and the plate current of V12B causes relays RL1 and RL2 to close and place all circuits in the transmit mode of operation.

The VOX hold-in time is adjusted by varying the discharge time for capacitor C213 with the VOX Delay control.

BAND	CARRIER OSCILLATOR (3393.6 kHz plus 1400 Hz modulation), CRYSTAL FILTER AND IF FREQUENCIES	VFO FREQUENCY (BETWEEN 5 AND 5.5)	SIGNAL FREQUENCY AT BANDPASS FILTER (BETWEEN 8.395 AND 8.895)	HETERODYNE OSCILLATOR FREQUENCY (CRYSTAL FIXED)	TRANSMITTED SIGNAL FREQUENCY
3.5 to 4	3.395	5.105	8.5	12.395	3.895
7 to 7.3	3.395	5.3	8.695	15.895	7.2
14 to 14.5	3.395	5.3	8.695	22.895	14.2
21 to 21.5	3.395	5.2	8.595	29.895	21.3
28 to 28.5	3.395	5.4	8.795	36.895	28.1
28.5 to 29	3.395	5.3	8.695	37.395	28.7
29 to 29.5	3.395	5.3	8.695	37.895	29.2
29.5 to 30	3.395	5.4	8.795	38.395	29.6

All frequencies are in MHz.

Figure 2-2

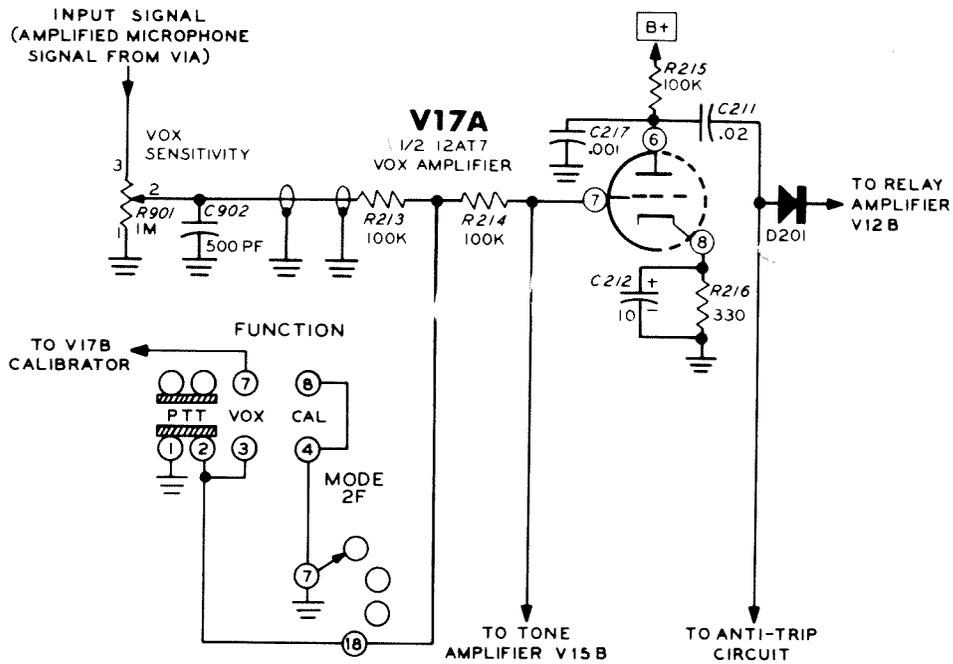


Figure 2-3

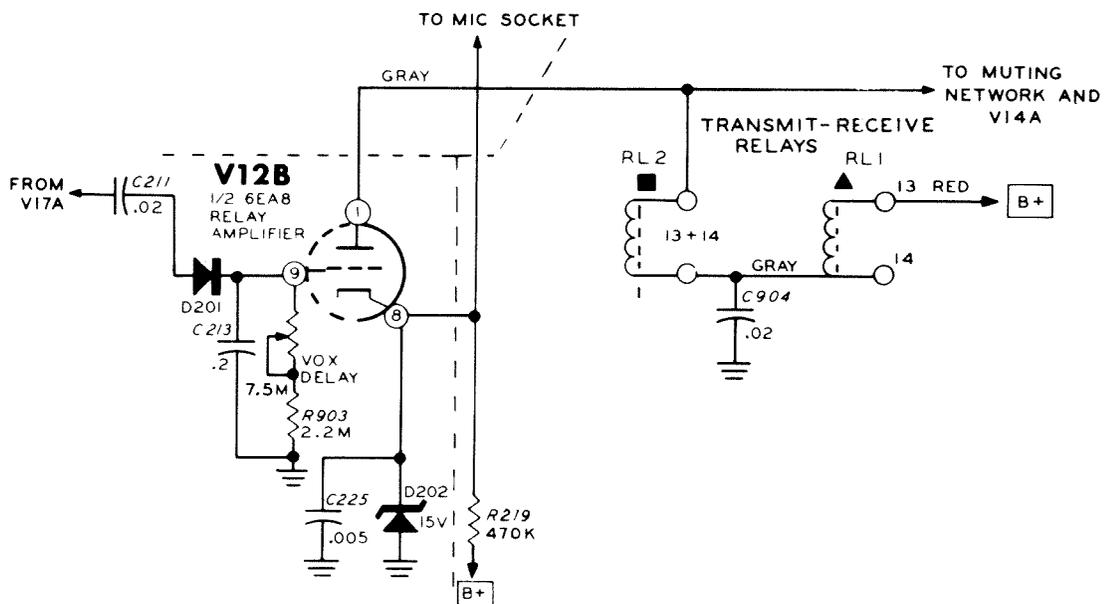


Figure 2-4

ANTI-TRIP CIRCUIT (Figure 2-5)

The anti-trip circuit is used in the receive mode of operation to keep the speaker signals from activating relay amplifier V12B.

An audio signal is coupled through capacitor C305 from audio power amplifier V14B to the Anti-Trip control. This audio signal is then coupled through isolation resistor R25 and rectified by diodes D1 and D2, resulting in a negative DC voltage across capacitor C25 and resistor R16. This negative voltage is then coupled through resistor R27 to diode D201 as back bias, where it cancels out the voltage from the VOX amplifier. Thus, with no positive voltage at its grid, relay amplifier V12B remains cut off, and the relays remain in the receive position.

SPEECH AMPLIFIER AND CATHODE FOLLOWER (Figure 2-6)

The audio signal from the microphone is coupled directly from lug 1 of the Microphone socket through resistor R931 to the grid of speech amplifier V1A. Lug 2 of the Microphone input

socket is returned to ground through the push-to-talk switch on the microphone. The cathode of relay amplifier V12B is also connected to lug 2 so it will be returned to ground when the push-to-talk switch is depressed, to operate the transmit relays.

Capacitor C1, at the grid of V1A, limits the high frequency response of this stage and bypasses to ground any RF signals present at this point. The amplified signal from the plate of V1A is coupled through capacitor C9 to the Microphone Level section of the Mic/CW Level control and also to the VOX amplifier circuit.

The setting of the Microphone Level control determines the amount of modulation since it adjusts the amount of speech signal that is coupled through cathode follower V1B to the balanced modulator circuit. For LSB and USB operation, V1B grid resistor R12 is returned to ground through wafer 1F of the Mode switch and contacts 6 and 10 of relay RL2. When the Mode switch is in the Tune or CW position, cathode follower V1B is cut off by a bias voltage that is supplied to it from the junction of bias voltage divider resistors R308 and R309.

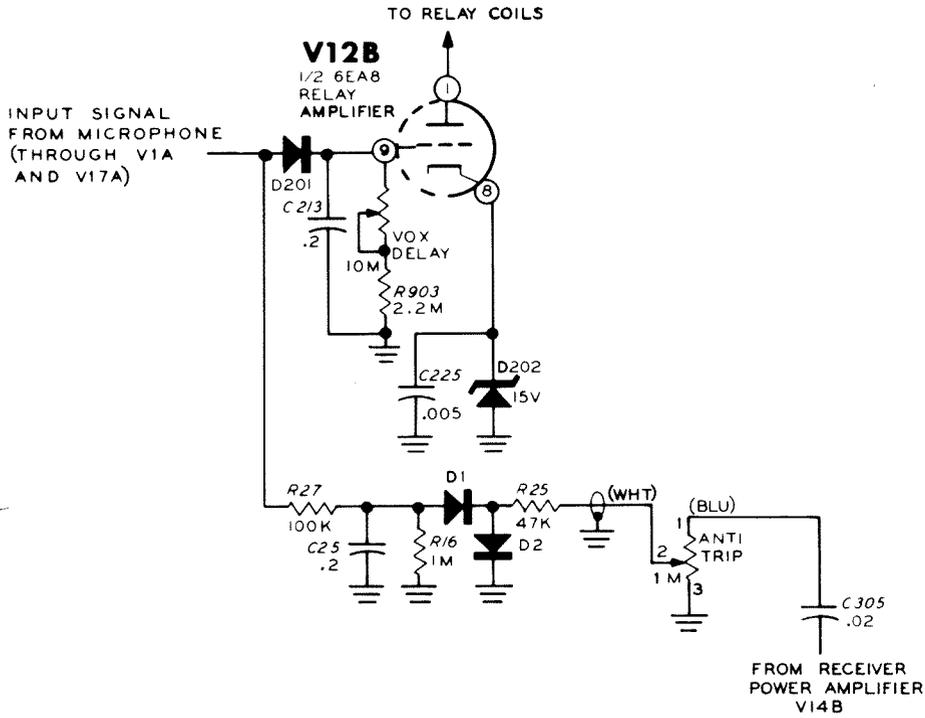


Figure 2-5

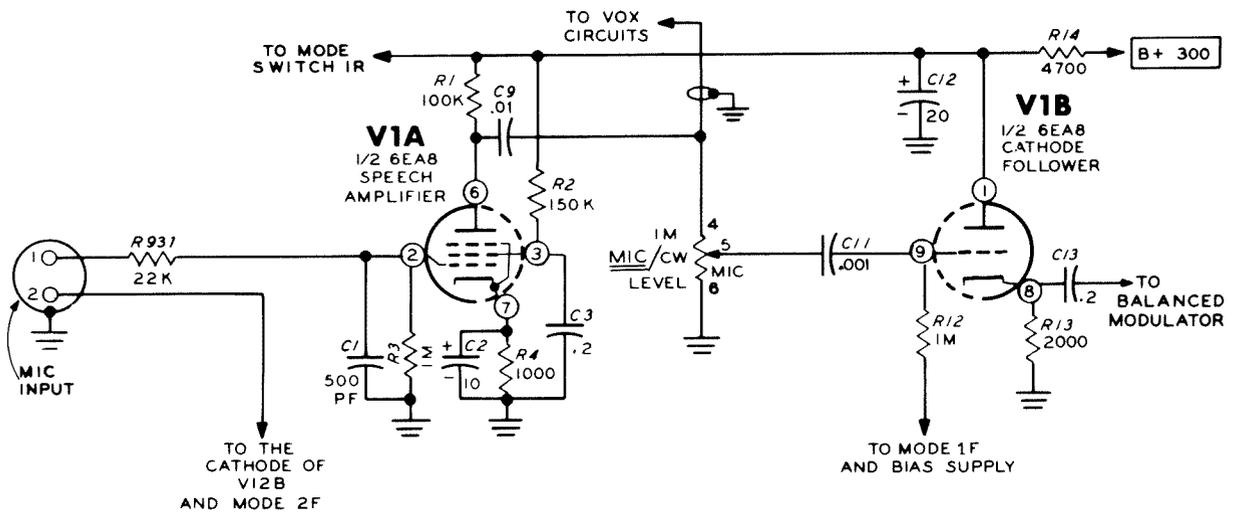


Figure 2-6

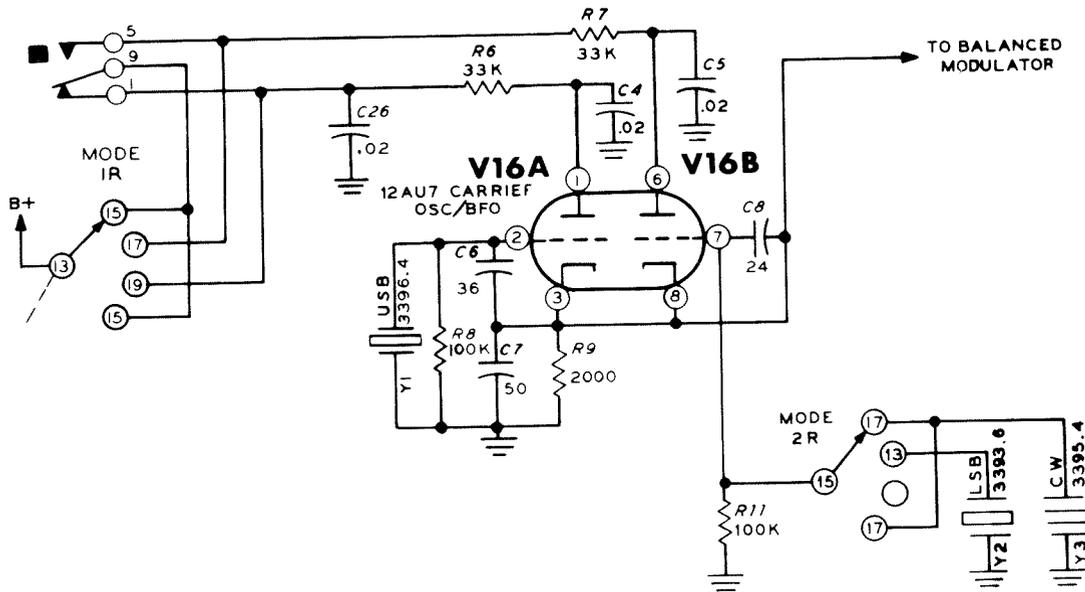


Figure 2-7

CARRIER OSCILLATOR (Figure 2-7)

The carrier oscillator consists of two Colpitts crystal oscillators. These oscillators supply an RF signal to the balanced modulator for transmit operation, and a heterodyne signal to product detector stage V13 for receive operation. Tube V16A and crystal Y1 (3396.4 kHz) serve as the USB (upper sideband) carrier oscillator, and tube V16B with crystals Y2 (3393.6 kHz) and Y3 (3395.4 kHz) acts as the LSB (lower sideband) and CW carrier oscillator.

The desired carrier oscillator, V16B for the transmitted frequency being used in this Description (3393.6 kHz), is placed in operation by wafer 1R of the Mode switch which connects its plate circuit to B+. Wafer 2R of the Mode switch plate circuit connects the proper crystal to the grid of V16B: Y2 for LSB operation and Y3 for tune or CW transmit operation.

When the Mode switch is in the CW position, B+ is connected through part of relay RL2 to either V16A (for receive) or V16B (for transmit).

For receiving CW signals, lugs 9 and 1 of relay RL2 place tube V16A and crystal Y1 in operation. For transmitting CW, lugs 9 and 5 of relay RL2 place tube V16B and crystal Y3 in operation.

When receiving CW signals, the receiver is automatically tuned 1 kHz below the incoming signal (this signal is zero beat against your transmitting frequency) by V16A and crystal Y1, which are used as a BFO (beat frequency oscillator). This generates a 1000 Hz audible signal. When transmitting, tube V16B and crystal Y3 cause the output signal of the Transceiver to be at the same frequency as the incoming signal from the other stations.

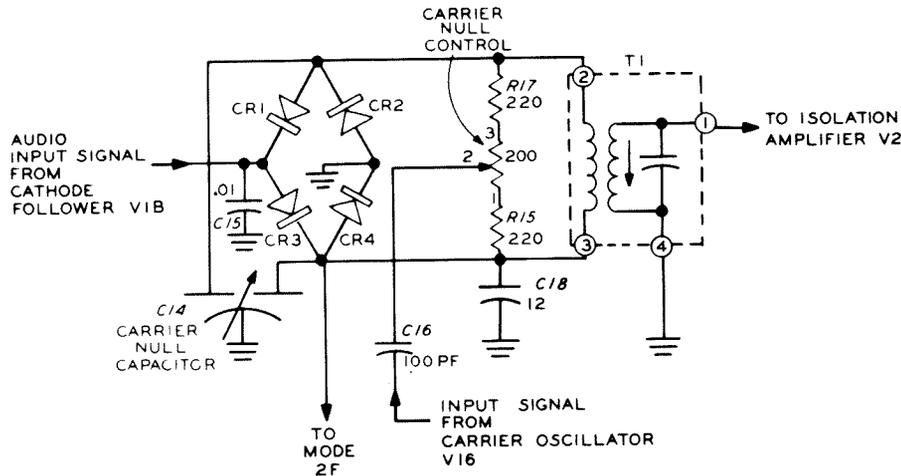


Figure 2-8

BALANCED MODULATOR (Figure 2-8)

Diodes CR1, CR2, CR3, and CR4, are connected in a ring type balanced modulator circuit. When the audio signal from cathode follower V1B and the RF signal from carrier oscillator V16 are applied to this balanced modulator, two additional frequencies are produced: one is equal to the sum of the audio and carrier frequencies; and the other is equal to the difference between them. These sum and difference frequencies are the upper and lower sidebands; and only these upper and lower sideband signals appear at the output of the balanced modulator circuit.

The 3393.6 kHz LSB carrier oscillator signal is applied through capacitor C16 and across a bridge circuit that consists of the Carrier Null control, resistors R15 and R17, and diodes CR1, CR2, CR3 and CR4 of the modulator diode ring. The carrier signal is balanced out by the Carrier Null control and the Carrier Null capacitor; so there is no output signal from this circuit (until audio signal is applied).

The audio signal that is coupled to diodes CR1, CR2, CR3, and CR4 from cathode follower V1B unbalances the modulator at an audio rate, causing the sum and difference sideband frequencies to appear at the output of balanced modulator transformer T1. When no audio signal appears at the input, there is no output signal from the balanced modulator circuit. Capacitor C15 is an RF bypass.

When the Mode switch is turned to the CW or Tune position, wafer 2F connects one side of the diode ring to ground. This ground connection unbalances the nulled circuit and the unbalance causes an RF output signal to be produced at the secondary of balanced modulator transformer T1. This signal is then coupled through capacitor C22 to isolation amplifier V2. The secondary of transformer T1 is tuned to the CW carrier frequency.

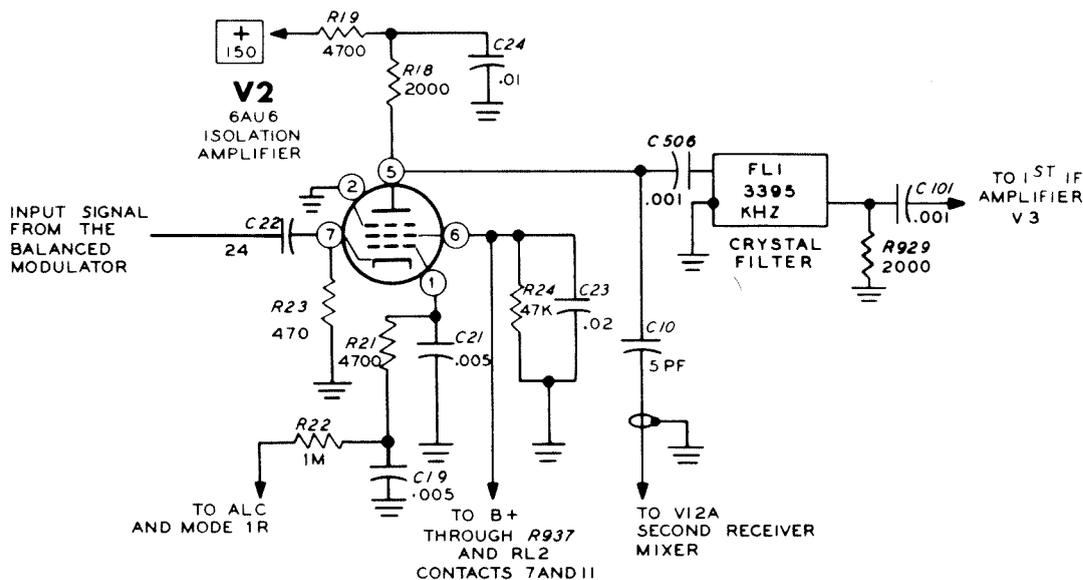


Figure 2-9

ISOLATION AMPLIFIER (Figure 2-9)

Both the sideband and CW signals from the balanced modulator circuit are coupled through capacitor C22 to the cathode of isolation amplifier V2, which operates as a grounded grid amplifier. V2 isolates the balanced modulator circuit from the crystal filter, and provides proper impedance matching to the crystal filter. The gain of isolation amplifier V2 is varied by the ALC (automatic level control) voltage that is connected to its grid circuit through resistors R21 and R22. The complete ALC circuit will be described later under the heading ALC Circuit.

When transmitting, the output of V2 is coupled through capacitor C506 to the crystal filter. In the CW mode of operation, the gain of V2 is controlled by the CW section of the Mic/CW Level control. This control supplies a variable negative bias to the grid of V2 through wafer 1R of the Mode switch and resistors R22 and R21.

B+ is supplied to the screen of V2 in the transmit mode only, through resistor R937 and contacts 7 and 11 of relay RL2.

CRYSTAL FILTER (Figure 2-10)

Crystal filter FL1 has a center frequency of 3395 kHz and a usable bandwidth of 2.1 kHz (3393.95 kHz to 3396.05 kHz at the 6 dB points). See Figure 2-10. This filter, in the LSB mode of operation, passes only the sum frequencies

(the 3393.6 kHz carrier frequency plus all the audio frequencies from 350 to 2450 Hz), which contain the upper sideband intelligence. The carrier frequency itself is further reduced 20 dB by the crystal filter. This attenuation plus the attenuation of the balanced modulator gives an ultimate carrier attenuation of at least 50 dB. (The apparent frequency discrepancy here in sidebands and carrier is overcome later, when the sidebands are inverted in the second mixer.)

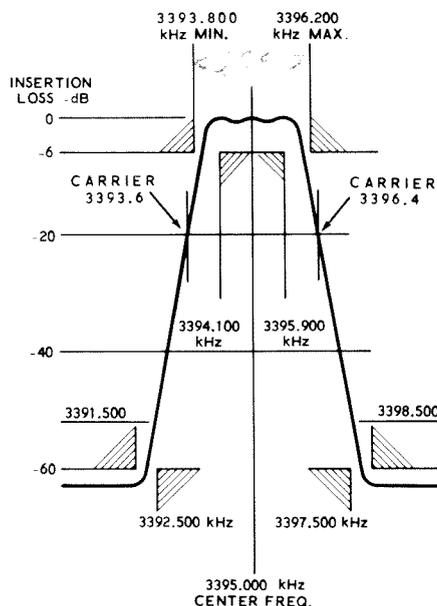


Figure 2-10



In the USB Mode, the filter passes only the difference frequencies (the 3396.4 kHz carrier oscillator frequency minus the audio frequencies from 450 to 2550 Hz); this contains the lower sideband intelligence. In the CW Mode, a carrier of 3395.4 kHz passes through the crystal filter with no attenuation.

IF AMPLIFIER (Figure 2-11)

IF amplifier V3 amplifies the signal received from crystal filter FL1. The second IF amplifier, V4, is not used in transmit operation. IF transformer T102, which is tuned to 3.395 MHz, acts as the plate load for V3. The output signal from V3 is then coupled through capacitor C111 to the grid of first transmitter mixer stage V5A. The 6.8 MHz trap is used to remove the second harmonic of the 3.395 MHz signal.

ALC voltage is applied through lugs 8 and 12 of relay RL2 to the grid circuit of V3 to provide automatic level control for the transmitted signal. When the Mode switch is in the CW and Tune positions, the gain of IF amplifier V3 is controlled by a variable DC bias applied to its grid. This bias voltage, which originates at the arm of the Mic/CW Level control, is coupled to V3 through wafer 1R of the Mode switch, and through lugs 8 and 12 of relay RL2.

The front panel meter, in the ALC position, is connected in a DC bridge between the screen and cathode circuits of V3. The metering circuits are explained separately on Page 176 of this Circuit Description.

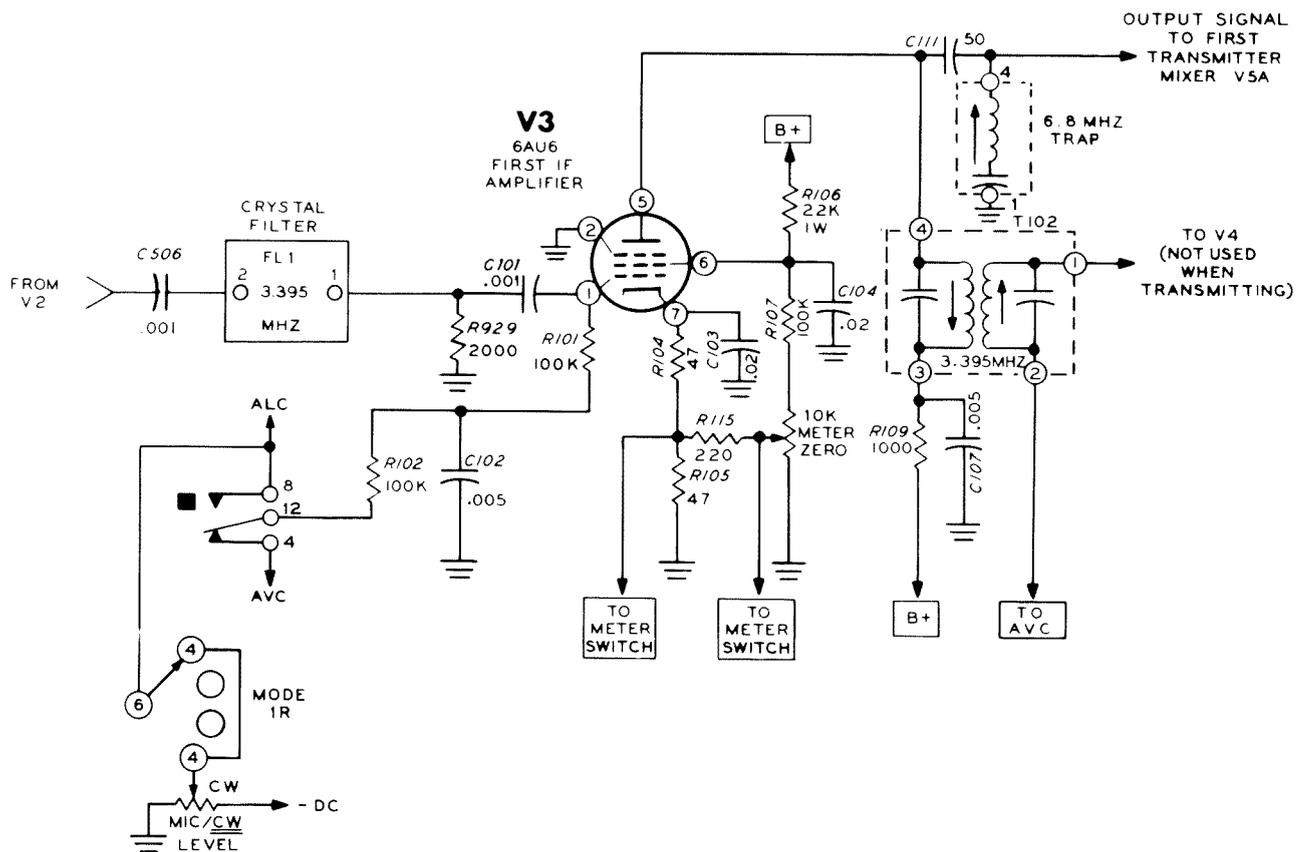


Figure 2-11

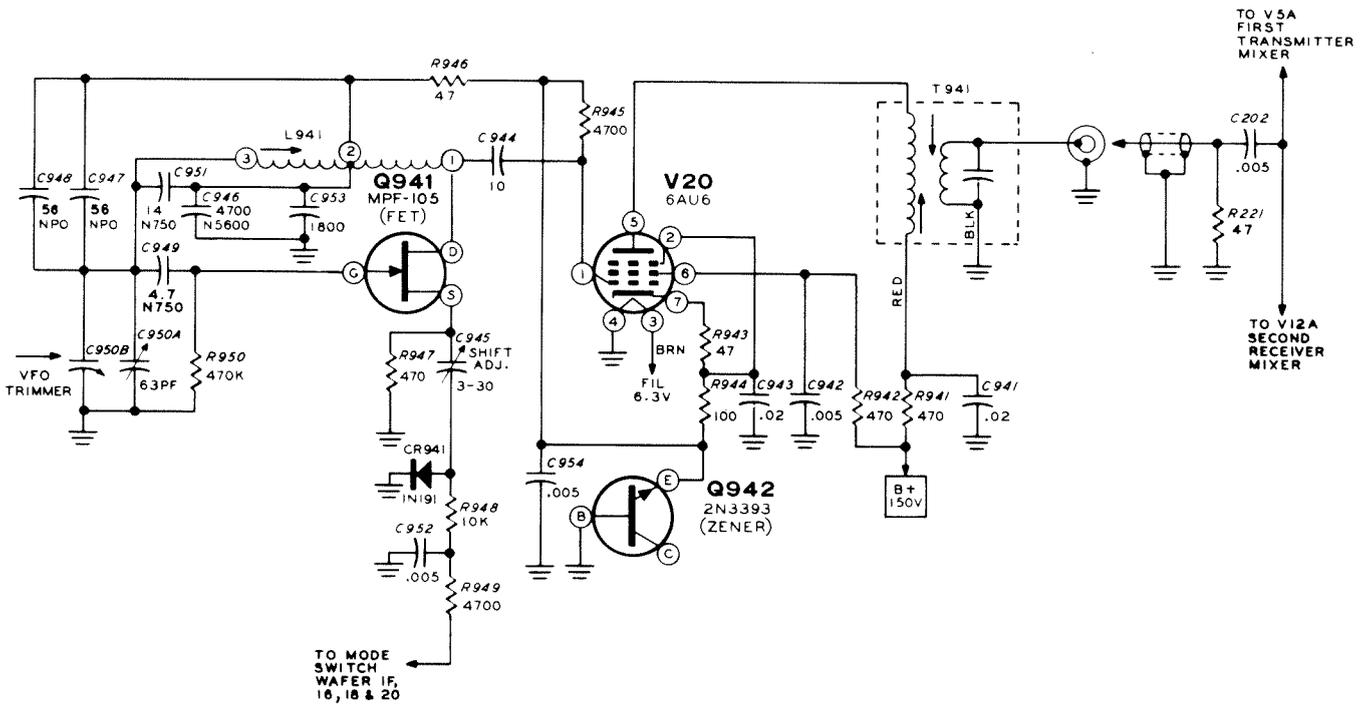


Figure 2-12

VFO (Figure 2-12)

A field effect transistor is used in a type of Hartley oscillator circuit in the VFO. Part of coil L941, variable capacitor C950A (the main tuning capacitor), and fixed temperature compensating capacitors are used in the frequency determining circuits. The remaining part of coil L941 is used for feedback to maintain oscillation.

Diode CR941 acts as a switch to add or remove C945 from the circuit. This capacitor shifts the VFO frequency so the output carrier - frequency remains the same when you switch sidebands. CR941 is switched by the polarity of the voltage applied to its anode by contacts 16, 18, and 20 of Mode switch wafer 1F.

Capacitor C944 couples the signal to the grid of tube V20, which amplifies the VFO signal and couples it through T941 to the cathode of mixer tube V5A.

The transistor in the cathode circuit of V20 acts as a Zener diode, using the base to emitter junction only.

FIRST TRANSMITTER MIXER (Figure 2-13)

The 3.395 MHz IF signal at the grid, and the 5.105 MHz VFO signal at the cathode, are mixed in first transmitter mixer tube V5A to produce sum and difference frequencies. The 8.5 MHz sum of these two signals is coupled from the plate of V5A through bandpass filter T202 to second transmitter mixer V6.

The Bandpass filter T202 is tuned to pass only those signal frequencies between 8.395 and 8.895 MHz; all other frequencies are attenuated. Only the 8.5 MHz sum of the IF and VFO signals falls within this frequency range, so it only is passed on to the second mixer.

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First transmitter mixer V5A, second transmitter mixer V6, and driver V7 are cut off during the receive mode of operation by a negative voltage that is applied to their grids through diode D301 and resistor R301. This negative voltage is removed for the transmit mode by contacts 6 and 10 of relay RL2, which cause the cathode side of diode D301 to be grounded.

HETERODYNE OSCILLATOR AND CATHODE FOLLOWER (Figure 2-14)

Heterodyne oscillator V19A operates as a tuned-plate crystal oscillator. The proper plate coil for each band, L601 through L608, is selected by wafer 2F on the Band switch. The output signal from the plate of the oscillator is coupled through cathode follower V19B to the cathode of second transmitter mixer V6 and to the cathode of first receiver mixer V11. The correct oscillator crystal for each band is selected by wafer 1R of the Bandswitch. The crystals below 20 MHz are fundamental types, and the higher frequency crystals operate on their third overtones.

The grid voltage of V19A can be metered at TP to check oscillator activity.

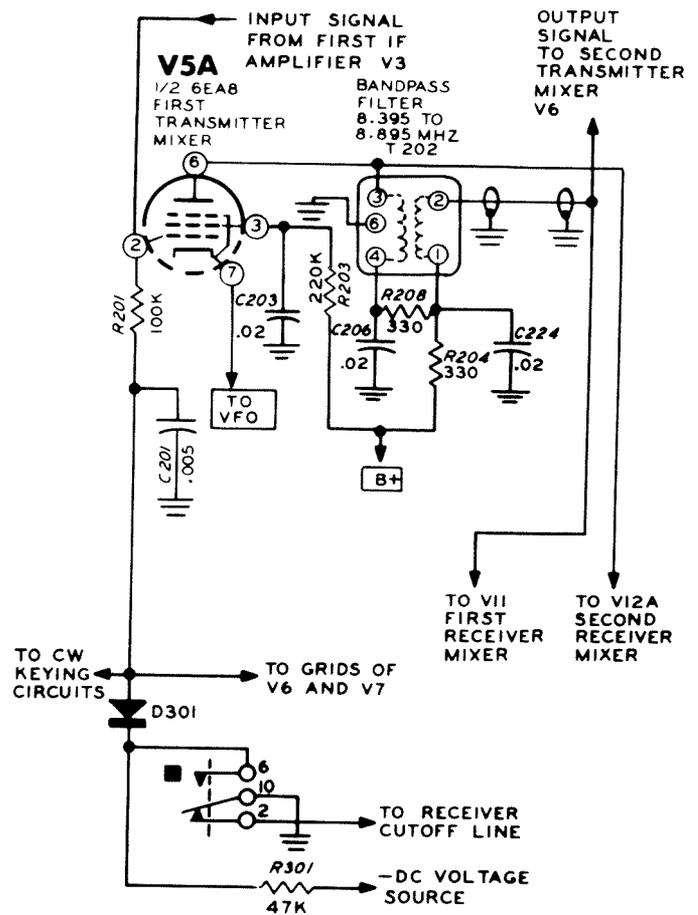


Figure 2-13

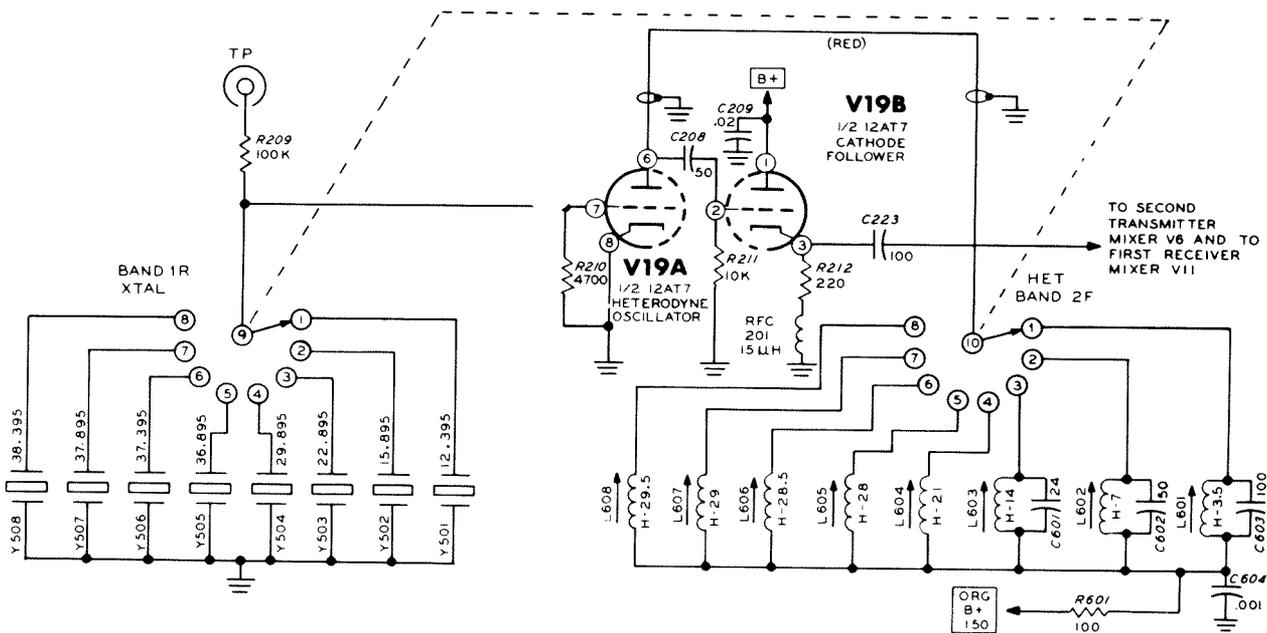


Figure 2-14

SECOND TRANSMITTER MIXER (Figure 2-15)

The 8.5 MHz signal from the first transmitter mixer and bandpass filter is coupled to the grid of second mixer tube V6. The 12.395 MHz output from the heterodyne oscillator is coupled to the cathode of V6. These signals are mixed in V6 to produce the operating frequency of 3.895 MHz.

The frequency of the tuned plate circuit of second mixer V6 is the operating frequency. All other frequencies are attenuated.

The difference between the 8.5 MHz input frequency and the 12.395 MHz heterodyne oscillator frequency results in a second mixer output frequency of 3.895 MHz. This output signal is coupled to the grid of driver stage V7.

The 3.5 MHz plate tuning coil, L701, is connected across the plate tuned circuit on all bands. Band switch wafer 3F connects the correct amount of inductance in parallel with L701 to tune each band, except the 3.5 MHz (80 meter) band, which uses coil L701 only.

Tuning capacitor C421B is connected across the tuned circuit on all bands. Band switch wafer 3R connects tuning capacitor C421A on the 3.5 MHz band only, C703 on 3.5 and 7.0 MHz

bands, and C704 on 14 MHz and lower frequencies.

DRIVER (Figure 2-16)

Driver stage V7 amplifies the 3.895 MHz signal from second transmitter mixer V6 to a level that is sufficient to drive the final amplifiers.

The 3.5 MHz plate tuning coil, L801, is connected across the plate tuned circuit on all bands. A secondary (link) winding on L801 is used in the receive mode of operation to couple the received signal into the Transceiver.

Band switch wafer 4F connects the correct amount of inductance in parallel with L801 to tune each band, except the 3.5 MHz (80 meter) band, which uses coil L801 only. Band switch wafer 4R connects additional capacitance in parallel with tuning capacitor C422B for the 80 meter (3.5 MHz), 40 meter (7 MHz), and 20 meter (14 MHz) bands.

Neutralization of V7 is accomplished by feeding a portion of the plate signal back to the grid through a "neutralizing wire" capacitor to the plate tuned circuit of the second transmitter mixer.

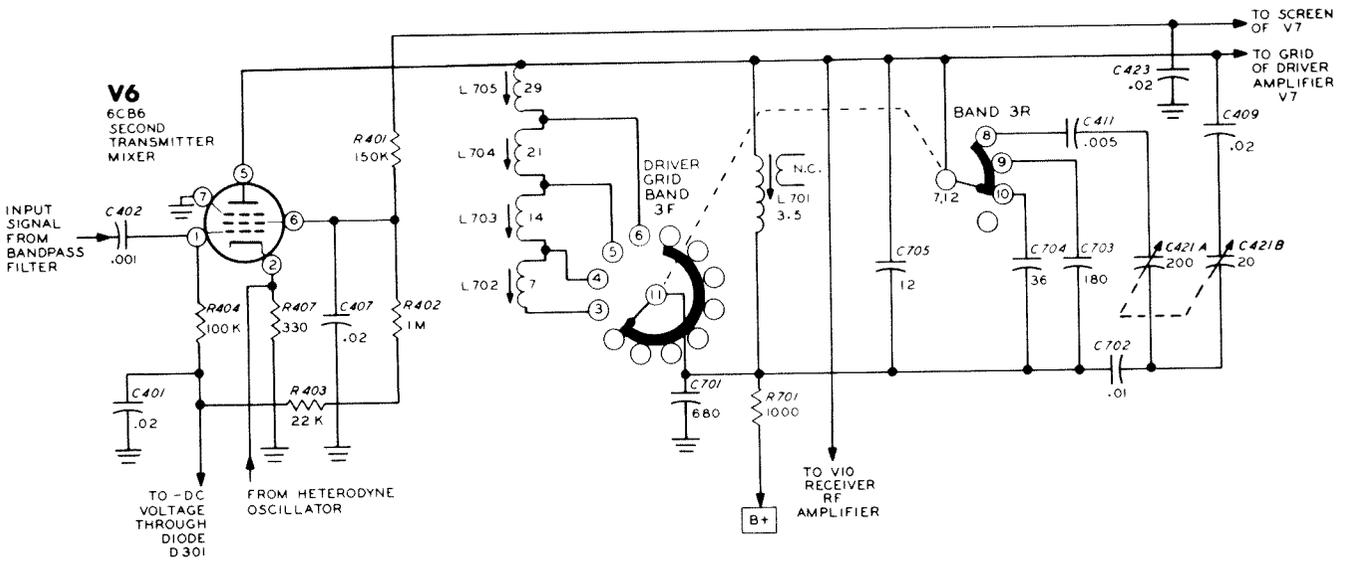


Figure 2-15

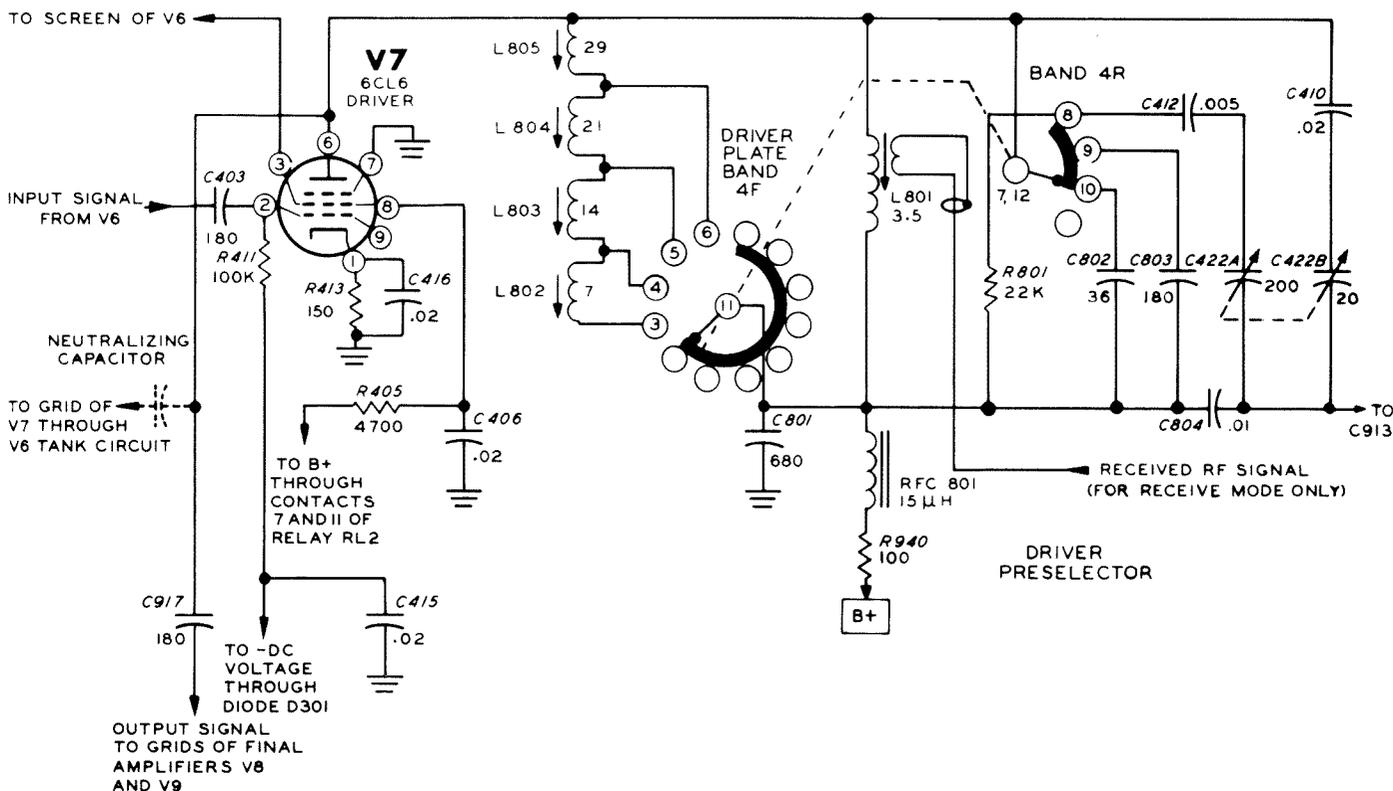


Figure 2-16

FINAL AMPLIFIERS (Figure 2-19, fold-out from Page 171)

Final amplifier tubes V8 and V9 are connected in parallel and function as class AB1 linear amplifiers. A fixed negative bias is applied to the grids of these tubes through resistor R916 and choke L903. This bias limits zero-signal plate current. B+ is removed from the screen grids under receive conditions, by lugs 7 and 11 of relay RL2 to reduce the plate current to zero and cut off the tubes. RF driving voltage is developed across RF choke L903. Plate voltage is shunt fed through RF choke L901.

For the LSB and USB modes of operation, the peak driving voltage is controlled by the Microphone level control (in the grid circuit of V1B) and the limiting action of the ALC (automatic level control) voltage. This ALC voltage is fed back to isolation amplifier V2 and IF amplifier V3.

The output signal from V8 and V9 is coupled through RF parasitic chokes L904 and L902 and through capacitor C915 to the final tuning capacitor C925 and plate tank coils L905 and L906. The parasitic chokes eliminate any tendency toward VHF parasitic oscillation.

Wafer 5R of the Band switch connects the proper portion of the plate tank coil in the circuit for each band by shorting out the unused section. Wafer 5R also selects the proper combination of final tank tuning and loading capacitors for each band.

Neutralization of the final amplifier is accomplished by feeding a portion of the plate signal back to the grid through neutralizing capacitors C913 and C914, and across C801 in a bridge circuit.

The output signal from the final tank coil is coupled through lugs 8 and 12 of relay RL1 to the Antenna socket.



ALC CIRCUIT (Figure 2-17)

The ALC (automatic level control) bias voltage is developed from a small portion of the signal in the final amplifier stage. This signal is then rectified, filtered, and fed back to the preceding stages to adjust their gain automatically, as needed. ALC voltage assures maximum transmitter output without overloading.

The ALC voltage for this Transceiver is developed in the Heath TALC *(Triple Action Level Control) circuit. This circuit keeps the transmitter from overloading, without causing the voice peaks to be flat-topped, by compressing the speech waveform. The triple action of this circuit is described below in paragraphs 1, 2, and 3.

1. Any peak voltages at the grids of final tubes V8 and V9 that drive the grids positive into grid current will develop bursts of voltage across resistor R916. This forms an audio-frequency voltage that is coupled through capacitor C911 to voltage doubler rectifiers D902 and D903. The rectified negative output voltage goes to the ALC line.
2. The variations that occur in the final amplifier screen supply voltage on speech peaks produce a varying voltage which is coupled through capacitor C908 to rectifiers D902 and D903. This second voltage source produces additional ALC voltage.
3. The ALC voltage that is obtained from an external linear power amplifier can be applied through the ALC connector to rectifiers D902 and D903. With proper conditions, this source should have predominate control, thus regulating the drive in the Transceiver for best operation.

The rectified voltage from diode D903 is applied to an RC network consisting of resistors R914 and R915, and capacitors C931 and C932. This network filters the DC bias voltage, and allows it to build up quickly and decay slowly.

From the RC filter network, the ALC voltage is applied to the grid of isolation amplifier V2, where it limits the output, thus reducing the drive available to the final amplifiers. The ALC voltage is also coupled through lugs 8 and 12 of relay RL2 to IF amplifier V3.

*Registered Trademark, Heath Company

ALC voltage is not developed for CW operation. Adjustable bias from the Mic/CW Level control is used instead.

TONE OSCILLATOR AND AMPLIFIER (Figure 2-18)

The tone oscillator circuit, V15, generates a 1000 Hz audio signal that is used for CW operation only. This tone is inserted into the VOX circuit to turn on the transmitter. It is also coupled to the receiver audio amplifier so the operator can monitor his transmitted signal.

Tone oscillator V15A is turned on when its cathode is connected to ground through wafer 2F of the Mode switch. The output frequency of V15A is determined by the phase-shift network (P.E.C. #84-22) in its grid circuit. From the plate of V15A, the 1000 Hz tone is coupled through capacitor C315 and resistor R329 to the grid of tone amplifier V15B.

Tone amplifier V15B is normally cut off by a negative bias that is applied to its grid from the junction of resistors R311 and R312. When the CW key is closed, this cut-off bias is removed (resistor R311 is shorted out through Mode switch wafer 1F and the key), and V15B conducts.

From the plate of V15B, the 1000 Hz tone is coupled through capacitor C311 to audio amplifier V14B. The 1000 Hz tone is also coupled through capacitor C313 and resistor R328 to the grid of VOX amplifier V17A, where it causes the transmitter to be turned on.

CW OPERATION

When the Mode switch is turned to the CW position, the following circuit changes occur:

1. Cathode follower V1B is cut off and the arm of VOX Sensitivity control is grounded so stray microphone signals do not reach the balanced modulator or VOX circuits.
2. CW crystal Y3 is connected to the grid of carrier oscillator V16B.
3. The balanced modulator circuit is unbalanced so it will produce an output signal (see Mode switch wafer 2F).

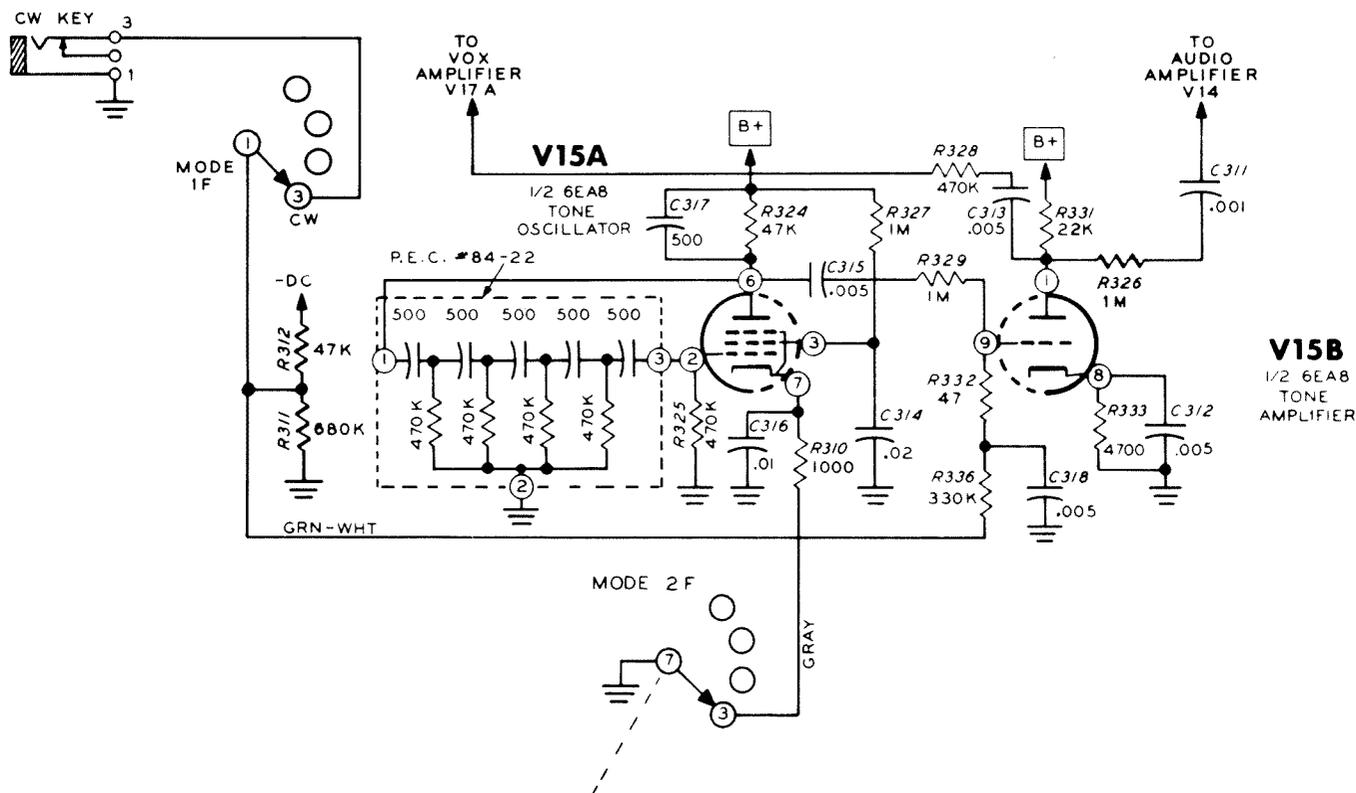


Figure 2-18

4. The transmitter CW signal passes through the SSB Filter.
5. The drive to the final amplifiers is controlled by the CW section of the MIC/CW Level control, which adjusts the bias of isolation amplifier V2 and IF amplifier V3.
6. Cutoff bias is applied to the grids of transmitter mixers V5A and V6, and to the grid of driver amplifier V7, through Mode switch wafer 1F and diode D904.
7. Tone oscillator V15A is turned on.

When the key is closed, the 1000 Hz tone signal is coupled to the VOX circuit, where it causes the relays to be switched to the transmit position.

The relays stay in this position for a length of time that is determined by the setting of the VOX Delay control.

At the same time, the key shorts out the cutoff bias that is applied to the transmitter mixer stages and to the driver amplifier stage, allowing them to conduct and place the transmitter on the air.

The RF output signal from CW carrier oscillator V16B is coupled to the balanced modulator stage. The unbalanced condition of this stage causes the RF signal to be coupled through transformer T1 to isolation amplifier V2. From V2, the signal proceeds through the transmitter in the same manner as the LSB and USB signals.

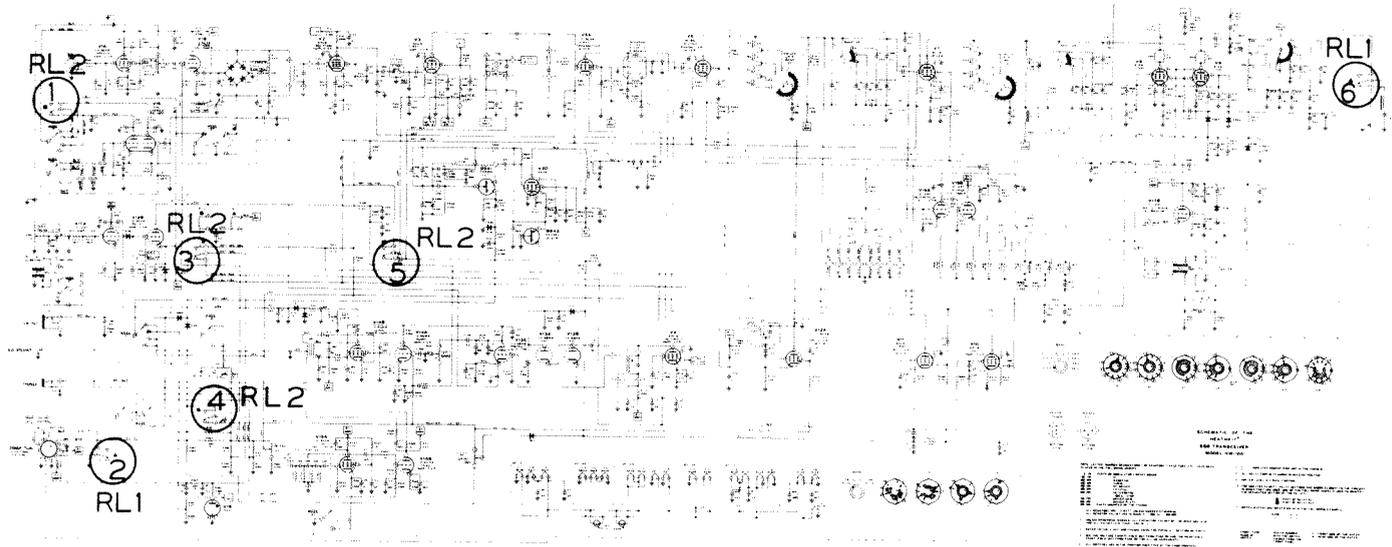


Figure 2-19

SWITCHING (Figure 2-19)

Figure 2-19 shows the position and assigns an identifying number to each of the relay sections on the Main Schematic. The numbers will be used in the following paragraphs to explain how each section is used.

1. This section applies B+ voltage to the correct half of carrier oscillator tube V16 in the Tune and CW positions of the Mode switch.
2. This section is connected to the Power and accessory plug for external use with linear amplifiers and other devices. The contacts have a rating of 3 amperes at 117 VAC or 30 VDC.
3. These contacts apply B+ voltage to the screens of V2, V7, V8, and V9 in the transmit mode, and to the screen of V4, V10 and V11 in the receive mode of operation.
4. These contacts ground the receiver cutoff bias in the receive mode. In the transmit mode they ground the cutoff bias that is applied through diode D301 to transmitter stages V5A, V6, and V7.
5. In the transmit mode, these contacts apply ALC voltage (or CW bias) to the grid of V3. In the receive mode they apply AVC voltage to V3.

6. This section switches the antenna between the receive and transmit circuits.

When the Transceiver is in the transmit mode, a large negative bias (approximately -90 volts) is applied through the RF Gain control and diode D905 to the grids of RF amplifier V10 and first receiver mixer V11. Smaller amounts of negative bias are also applied to second receiver mixer V12A, second IF amplifier V4, and audio amplifier V14A. The large bias is necessary at V10 to keep the transmitter signal at the driver plate from causing V10 to conduct on large voltage peaks. (If this happens, spikes will appear at the peaks of the envelope on the transmitted signal.)

First audio amplifier V14B is cut off by the bias voltage to quiet the receiver audio stages when LSB or USB signals are being transmitted. A negative pulse is also applied to the grid of V14A to cut it off before the relay contacts close. This is done so the switching transients, which cause a "popping" sound, will not be heard in the speaker.

The negative pulse that is applied to V14B is formed by the sudden voltage change that occurs at the plate of relay amplifier V12B when that stage is turned on by the VOX circuit. This pulse is shaped by a network that consists of resistors R337, R338, R339, and R340 and capacitors C320, C321, C322, and C323.



RECEIVER CIRCUITS

NOTE: Figure 2-20 shows the various frequencies that will be found throughout the Transceiver on the different bands. A received signal (lower sideband) frequency of 3.895 MHz, shown on the first line of the chart, will be used when tracing through the receiver circuits. The other associated frequencies used in this Description are also shown on the first line.

BAND	RECEIVED SIGNAL FREQUENCY	HETERODYNE OSCILLATOR FREQUENCY (CRYSTAL)	SIGNAL FREQUENCY AT BANDPASS FILTER (BETWEEN 8.395 AND 8.895)	2ND RECEIVER MIXER CRYSTAL FILTER AND IF FREQUENCIES	VFO FREQUENCY (BETWEEN 5 AND 5.5)
3.5 to 4	3.895	12.395	8.5	3.395	5.105
7 to 7.3	7.2	15.895	8.695	3.395	5.3
14 to 14.5	14.2	22.895	8.695	3.395	5.3
21 to 21.5	21.3	29.895	8.595	3.395	5.2
28 to 28.5	28.1	36.895	8.795	3.395	5.4
28.5 to 29	28.7	37.395	8.695	3.395	5.3
29 to 29.5	29.2	37.895	8.695	3.395	5.3
29.5 to 30	29.6	38.395	8.795	3.395	5.4
All frequencies in MHz. 35.86					

Figure 2-20

RF AMPLIFIER (Figure 2-21, fold-out from Page 172)

The 3.895 MHz input signal from the antenna is coupled through lugs 4 and 12 of the antenna relay (RL1) to the link winding of coil L801. The secondary of L801, part of the Driver Preselector capacitor, and the other components in the driver plate tank circuit, are also used as the input tuned circuit for RF amplifier V10. From L801, the signal is coupled through capacitor C408 to the grid of V10.

The received signal is amplified in V10, and then coupled through capacitor C419 to first

receiver mixer V11. The plate tuned circuit of V10 consists of coil L701, part of the Driver Preselector capacitor, and the other components of the second transmitter mixer plate tank circuit.

The gain of RF amplifier V10 and first receiver mixer V11 are controlled by the AVC voltage, and an adjustable negative bias that is coupled to their grids from the RF Gain control.

The 8.5 MHz trap at the antenna switching relay helps to prevent entry of very strong signals (at this frequency) which might interfere with the IF circuits.

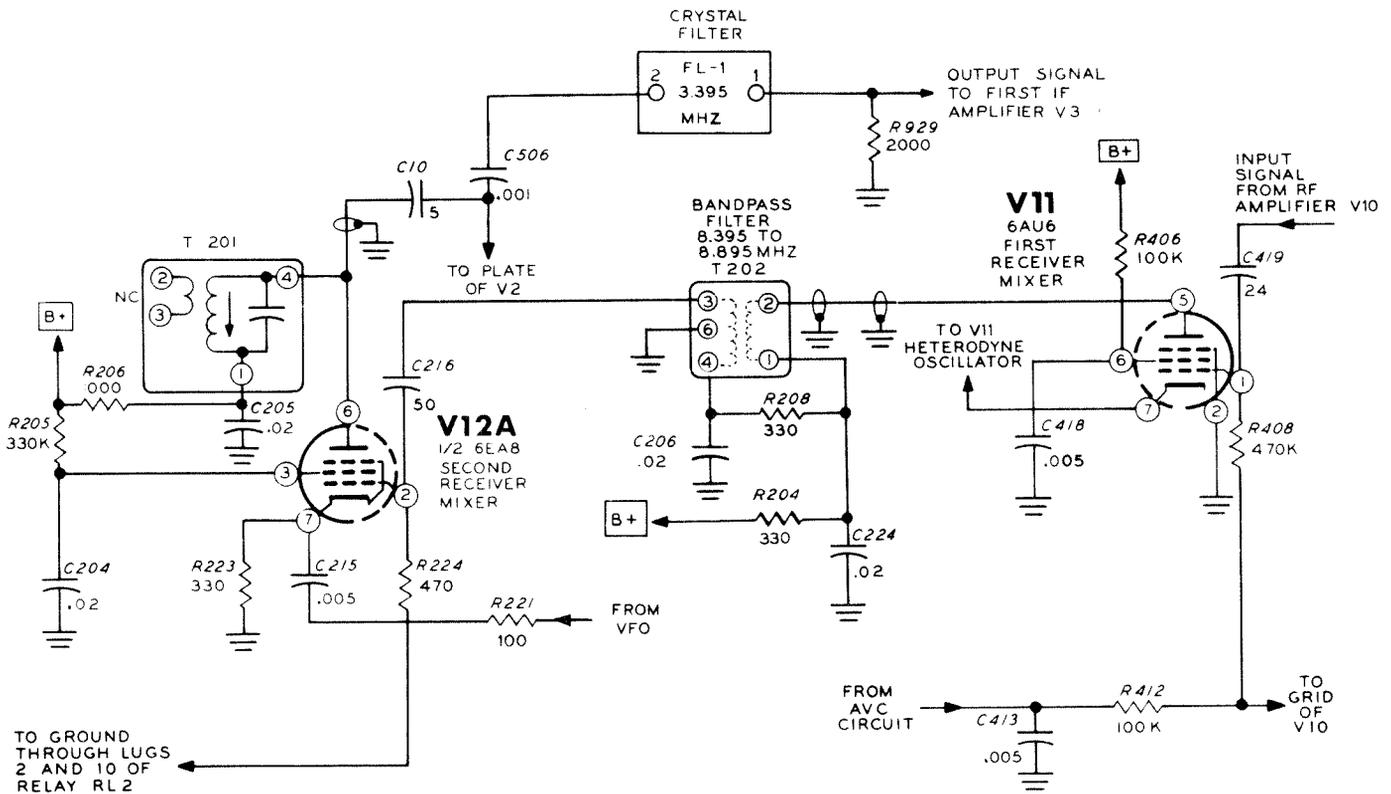


Figure 2-22

FIRST AND SECOND RECEIVER MIXERS (Figure 2-22)

The amplified 3.895 MHz signal from RF amplifier V10 is coupled through capacitor C419 to the grid of V11, the first receiver mixer. At the same time, a crystal controlled 12.395 MHz signal is coupled to the cathode of V11 from V19B, the heterodyne oscillator cathode follower. These two signals are then mixed together in V11 and the sum and difference frequencies are coupled to the bandpass filter.

The bandpass filter, which passes only the frequencies between 8.395 and 8.895 MHz, allows the 8.5 MHz difference frequency to pass on from V11 to the grid of second mixer tube V12A.

A 5.105 MHz signal is coupled from the VFO to the cathode of V12A. The 8.5 MHz signal at the grid and the 5.105 MHz signal at the cathode are then mixed together in tube V12A and the 3.395 MHz difference frequency is coupled through crystal filter FL1 to the IF amplifiers.

AVC CIRCUIT (Figure 2-24)

The negative bias at the control grids determines the amount of amplification that will be obtained from RF amplifier V10, first receiver mixer V11, and IF amplifiers V3 and V4. The DC bias for these stages comes from the following two sources: from the -DC voltage at the arm of the RF Gain control; and from the AVC voltage. These two voltage sources are connected to diodes D101 and D905, which act as a diode gate. This diode gate permits either voltage to control the gain (of V10, V11, etc.) without interacting with each other.

From the two diodes, the bias voltage is coupled through resistor R412 to the grids of V10 and V11, and through resistor R415 to the grids of V3 and V4. Voltage divider resistors R415 and R416 cause only one half of the total bias voltage to be coupled to the grids of IF amplifiers V3 and V4.

AVC voltage is obtained by coupling part of the IF signal through capacitor C112 to AVC diodes V13A and V13B. These diodes produce a negative DC voltage at pin 1 of V13A that is proportional to the signal strength. This negative voltage is developed across resistors R124 and R117, and capacitors C110 and C124. Capacitor C124 charges quickly to the peak voltage so the AVC will respond quickly to keep large signals from being distorted in V3, V4, V10, and V11. Capacitor C110 charges more slowly, and causes the AVC voltage to be proportional to the average signal level of the received signal. This produces a fast-attack, slow-release AVC characteristic.

An incoming signal that produces a negative AVC voltage that is significantly higher than the bias voltage from the RF Gain control causes the gain of V10, V11, V3, and V4 to be reduced. This keeps the output of the RF and IF amplifier stages at a nearly constant level despite wide amplitude changes in the received signal.

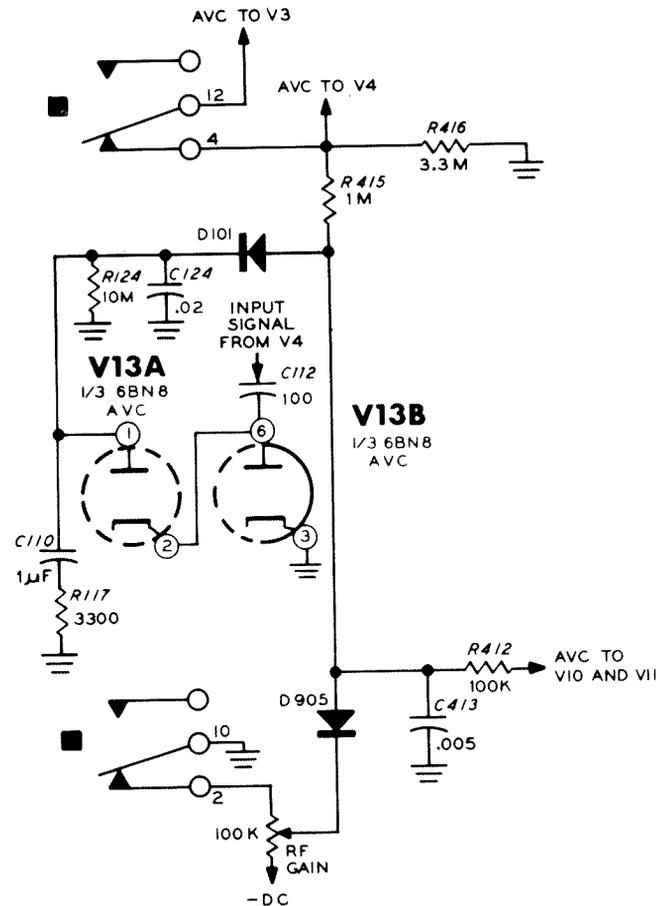


Figure 2-24

PRODUCT DETECTOR (Figure 2-25)

The 3.395 MHz signal from IF amplifier V4 is coupled to the grid of product detector tube V13C. At the same time, the signal from carrier oscillator V16 is fed to the cathode of V13C (3.3936 MHz for the lower sideband, or 3.3964 MHz for the upper sideband and CW).

These two signals are then mixed together in V13C, resulting in an audio output signal which is the difference frequency between these two signals. Capacitors C119 and C121, and resistor R119 are connected in a filter network that bypasses any RF signal coming from V13C to ground, but permits the audio signal to pass through to audio amplifier V14A.

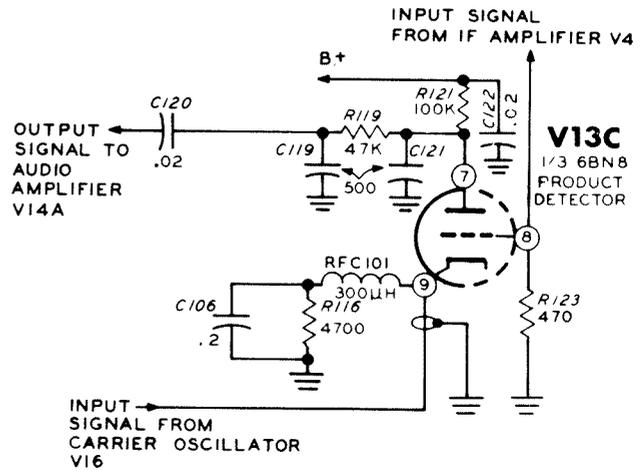


Figure 2-25

Two outputs are provided by the secondary of transformer T301: a headphone output and an 8 Ω speaker output. Audio power to the 8 Ω speaker jack is rated at 2 watts maximum.

An audio signal is also supplied to the anti-trip network from the plate of V14B.

AUDIO AND POWER AMPLIFIER (Figure 2-26)

The signal from the product detector is applied to the AF Gain control to determine the amount of signal that will be coupled through capacitor C308 to the grid of audio amplifier V14A. The audio signal is amplified in V14A and then coupled to power amplifier V14B. Tube V14B amplifies the signal further and supplies the audio power through output transformer T301 to the output connectors. Capacitor C912 couples a portion of the output back to the cathode of V14B as negative feedback for less distortion.

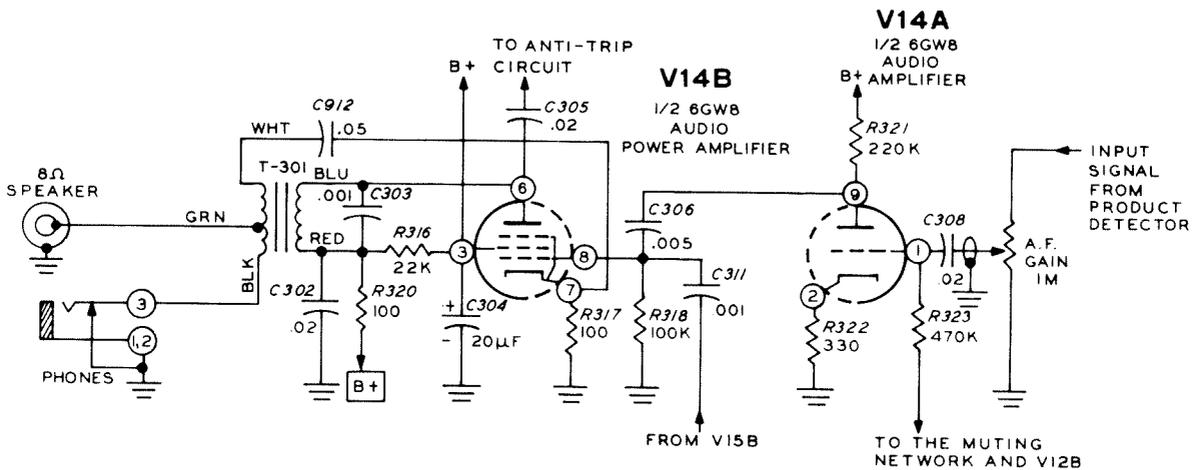


Figure 2-26

CRYSTAL CALIBRATOR (Figure 2-27)

Crystal calibrator stage V17B is connected as a Pierce crystal oscillator. When the Function switch is placed in the Calibrate position, the cathode of V17B is grounded, and an accurate 100 kHz signal is connected through capacitor C218 and diode CR201 to the antenna input of the receiver. The harmonics of this signal are then used for dial calibration checks.

Capacitor C220 may be adjusted to set the crystal calibrator to exactly 100 kHz using some standard such as WWV.

The Calibrate position of the Function switch also connects the grid of VOX amplifier V17A to ground to avoid accidental energizing of the transmitter when using the crystal calibrator.

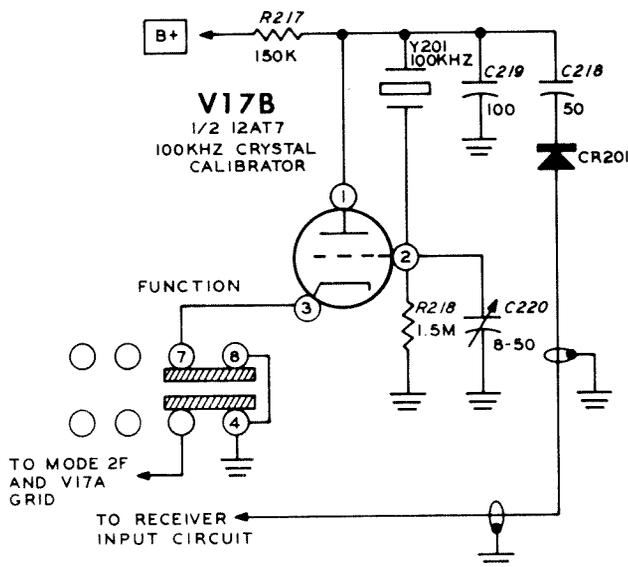


Figure 2-27

METERING CIRCUITS

Refer to Figure 2-28.

For the transmitting mode of operation, there are three different settings of the Meter switch: Final Power Amplifier cathode current, ALC voltage, and Relative Power output. In the ALC position, in the receive mode, the meter operates as an S-Meter.

To measure power amplifier cathode current, the meter is connected between the cathodes of the finals and ground, in parallel with the cathode resistor. To read cathode current on the meter, consider that each of the figures on the meter scale (3, 6, 9, 20, 40 and 60) represents 50 mA of current. For example, if the meter needle is at the figure 9, it shows 150 mA of cathode current (three 50 mA units), and the full scale reading at 60 represents 300 mA of final cathode current (six 50 mA units).

To measure ALC voltage, the meter is connected between the cathode and screen circuits of IF amplifier V3. When V3 receives a signal, the resulting current fluctuations in the cathode are indicated on the meter. Since the ALC voltage at the grid controls the gain of V3, the cathode current of V3 gives a relative indication of the ALC voltage level.

For Relative Power measurements, a small portion of the transmitter output signal is developed across resistor R912, rectified by diode CR901, and filtered by capacitor C933. The resulting DC voltage is then indicated by the meter.

When the Transceiver is in the receive condition, and the Meter switch is at ALC, the meter indicates the relative strength of the received signal in S-units. The circuit operates just as it does when it measures ALC voltage, except that the current in V3 is now controlled by the AVC voltage at the grid of V3.

The meter Zero Adj control is adjusted for a zero indication on the meter with the antenna disconnected and RF Gain control at the full clockwise position. The decrease in plate current (due to a larger AVC voltage) that occurs when a signal is received by tube V3 then appears as indications on the S-Meter.

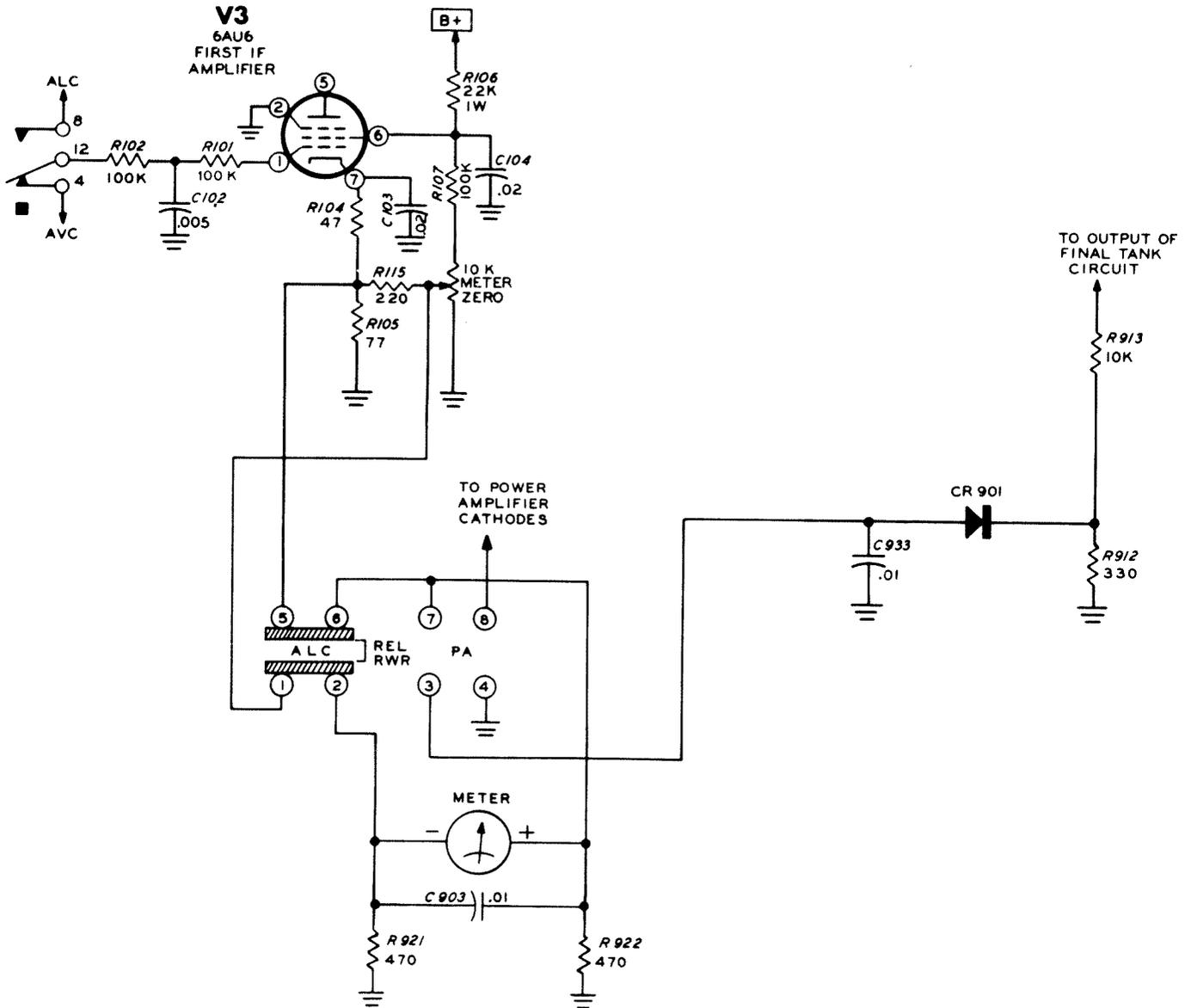
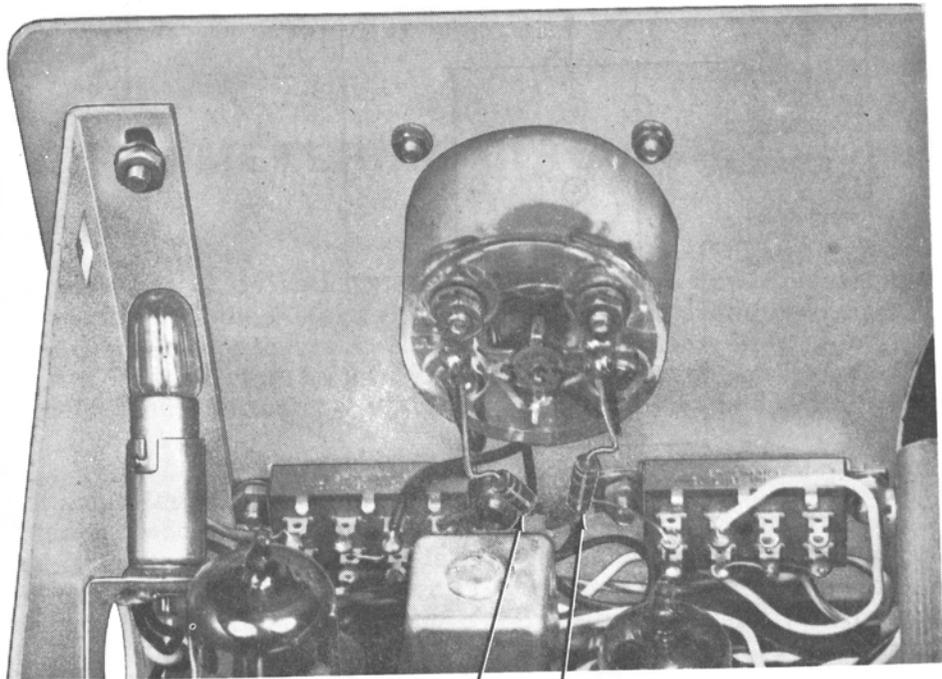
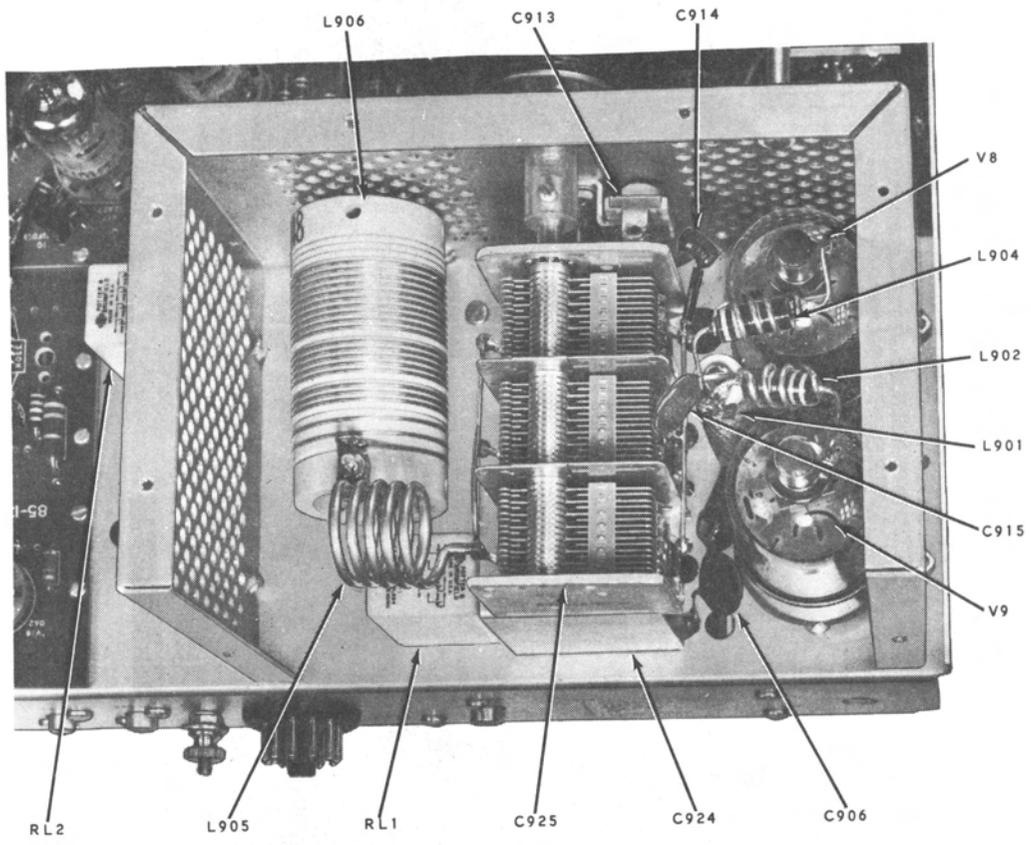


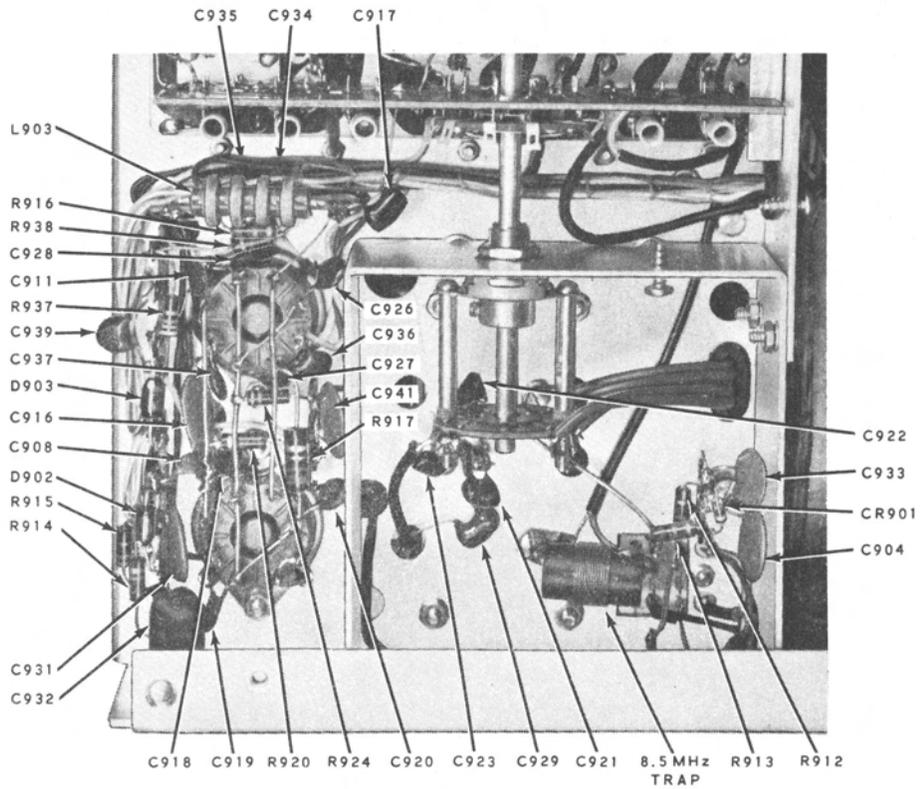
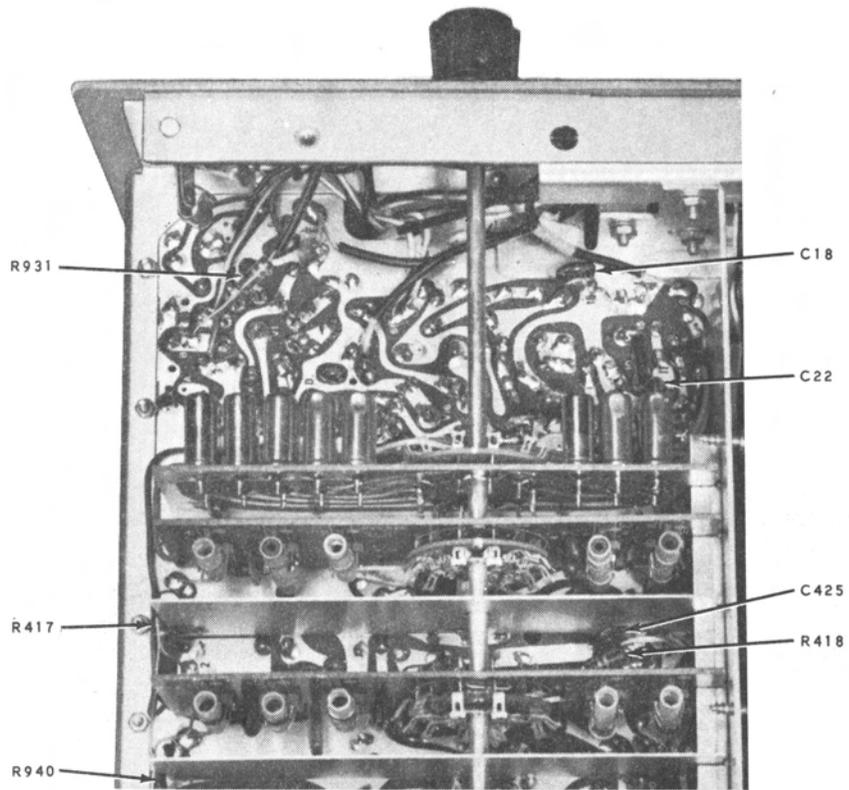
Figure 2-28

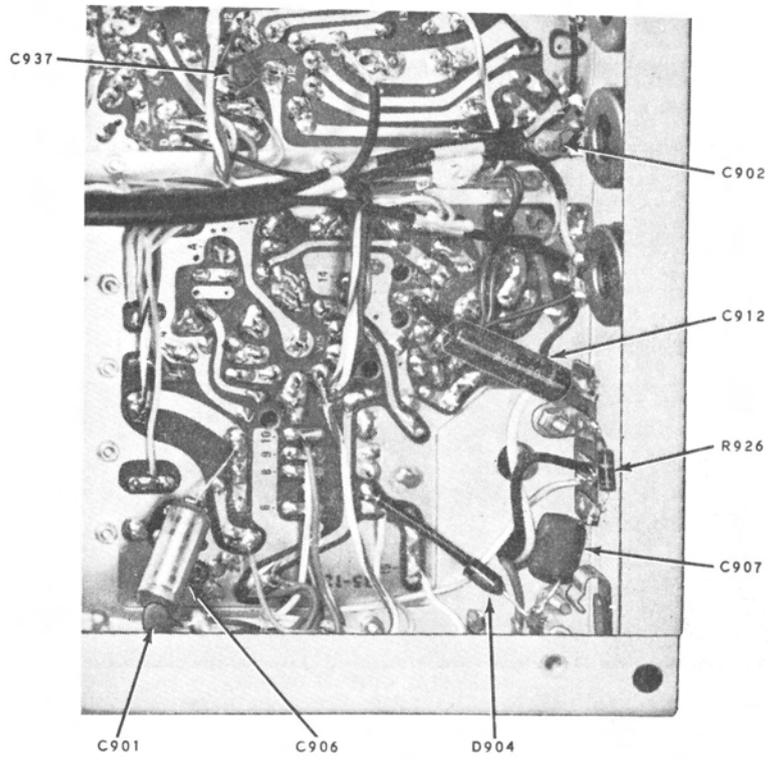
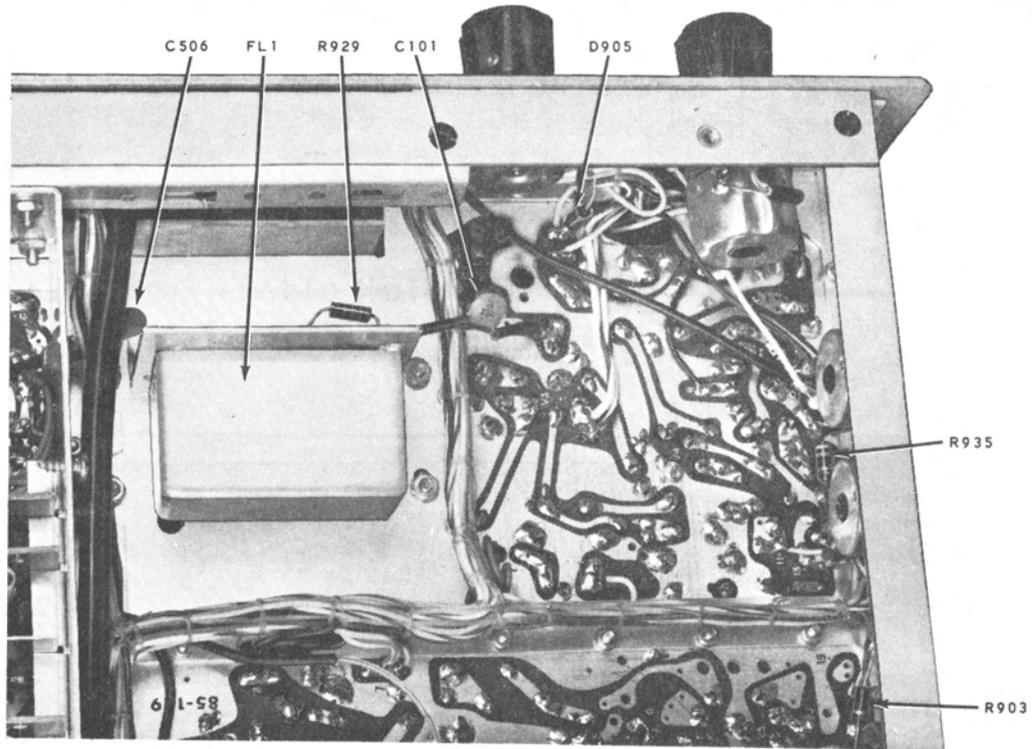
CHASSIS PHOTOGRAPHS



R922 R921

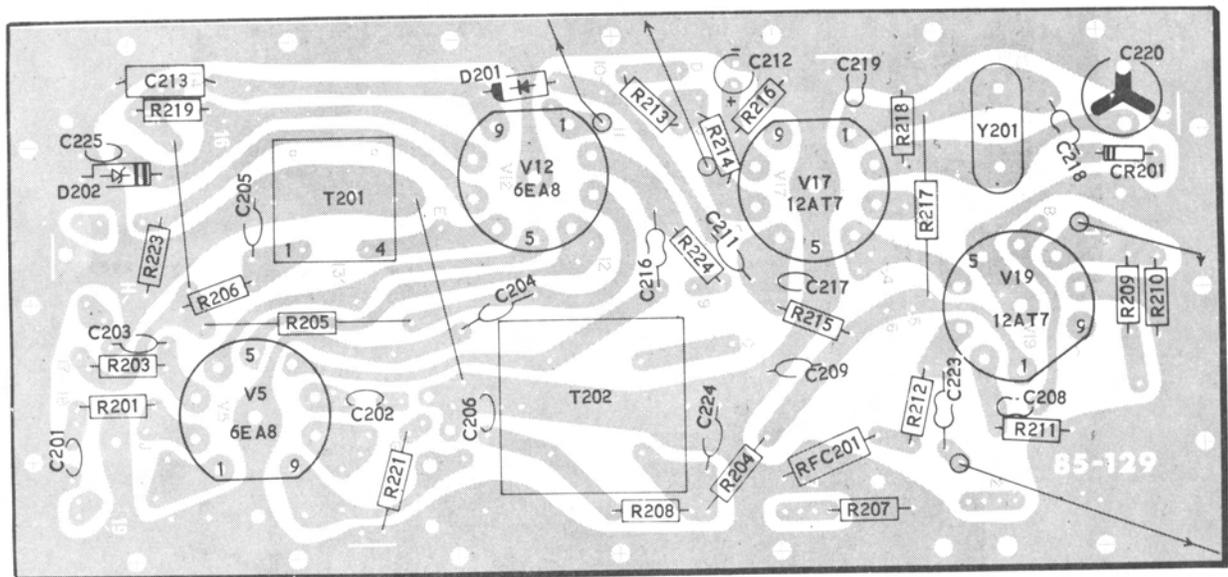




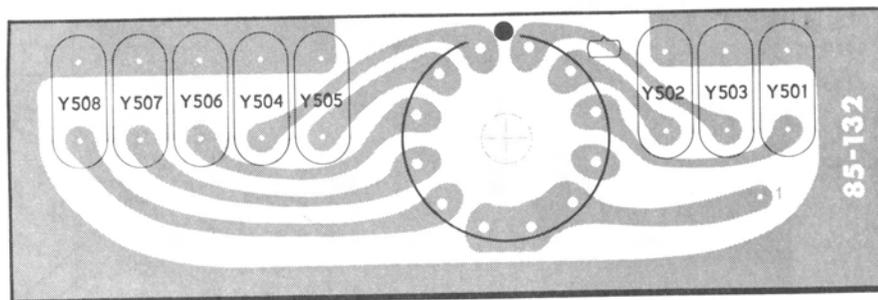


CIRCUIT BOARD X-RAY VIEWS

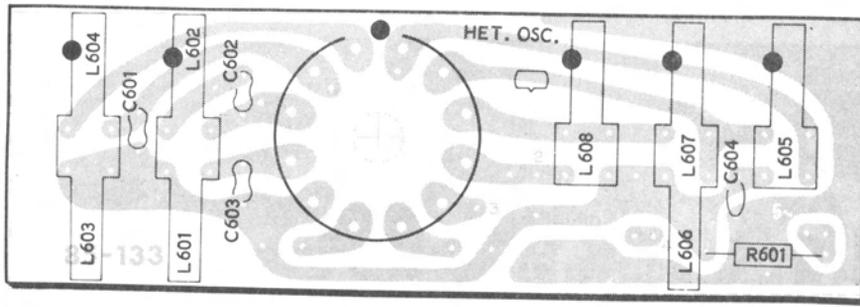
(viewed from foil side)



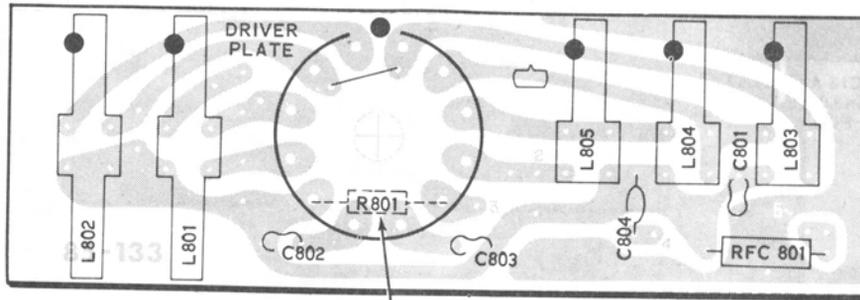
BANDPASS CIRCUIT BOARD



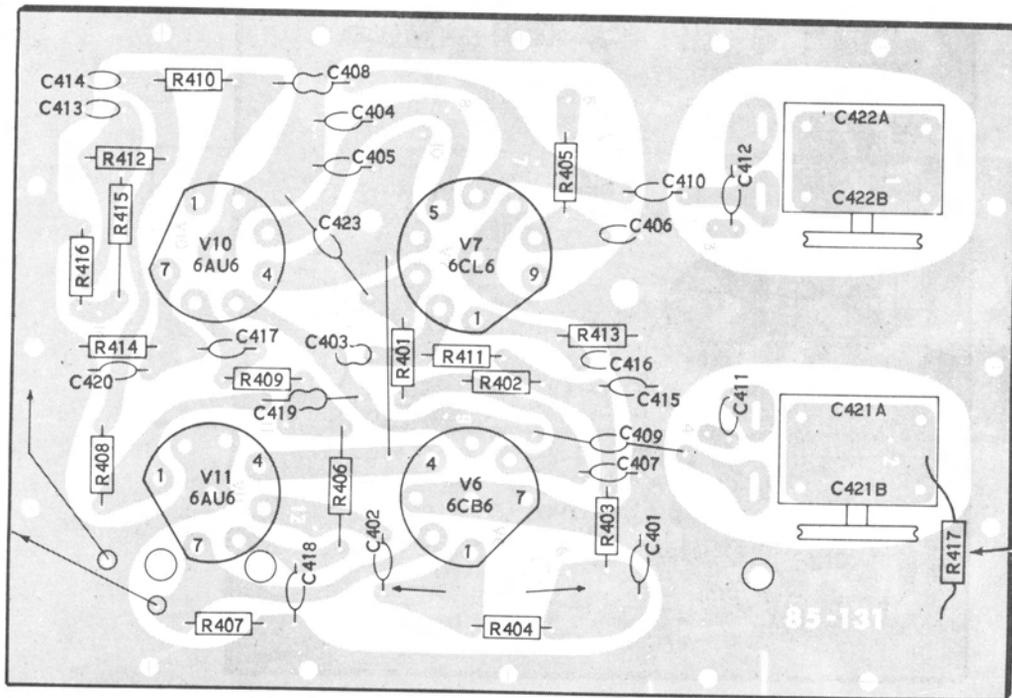
CRYSTAL CIRCUIT BOARD



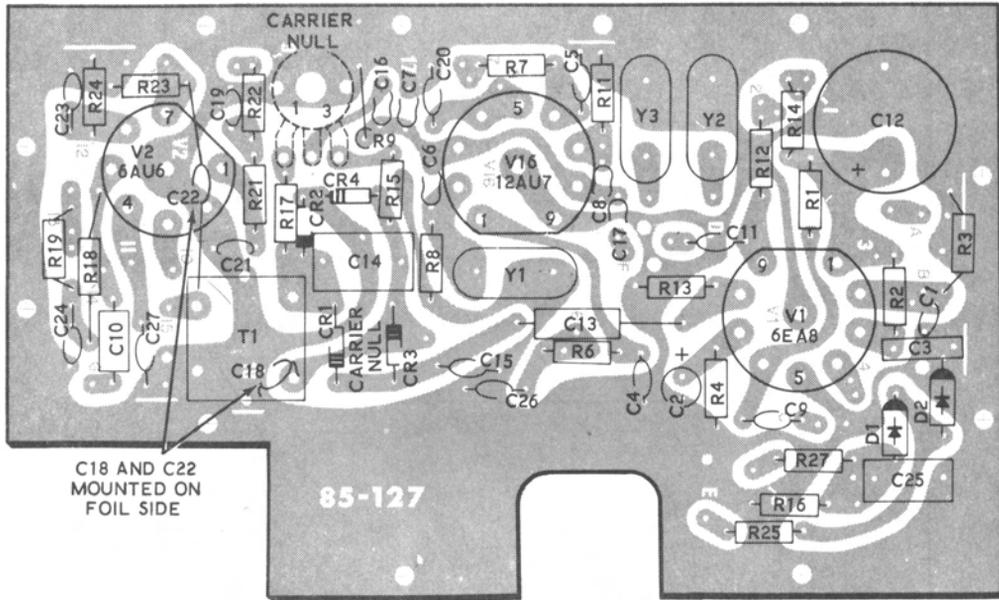
HETERODYNE OSCILLATOR
CIRCUIT BOARD



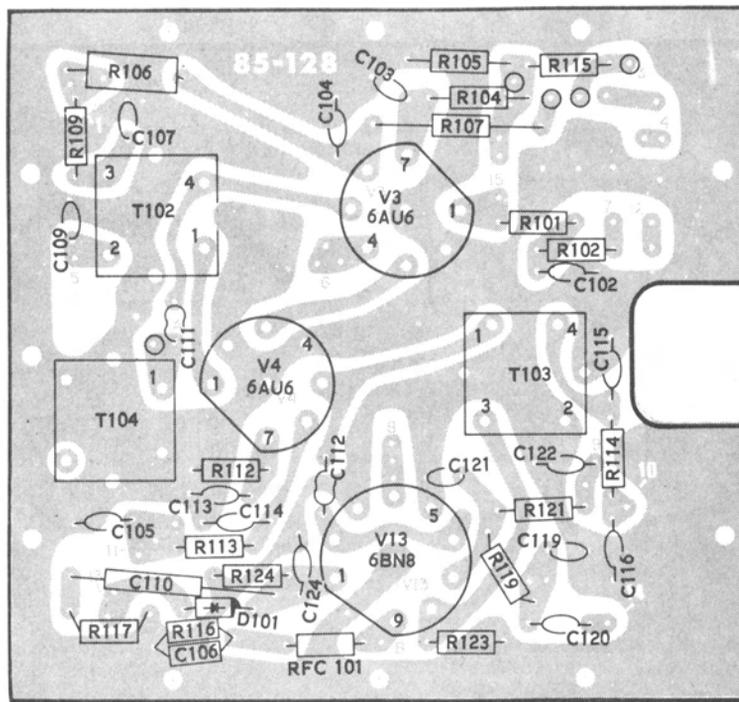
THIS RESISTOR LOCATED
ON SWITCH WAFER
DRIVER PLATE CIRCUIT BOARD



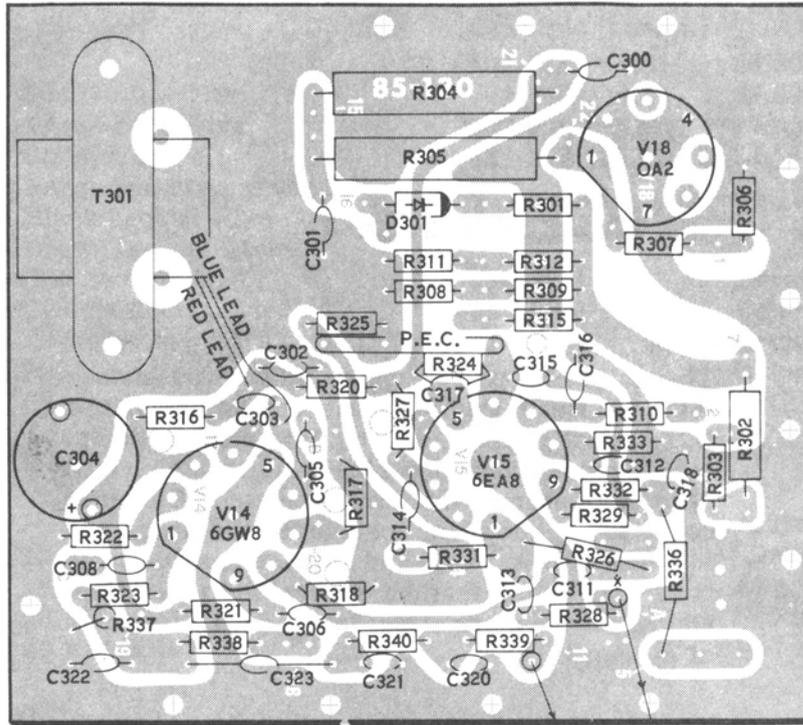
RF DRIVER CIRCUIT BOARD



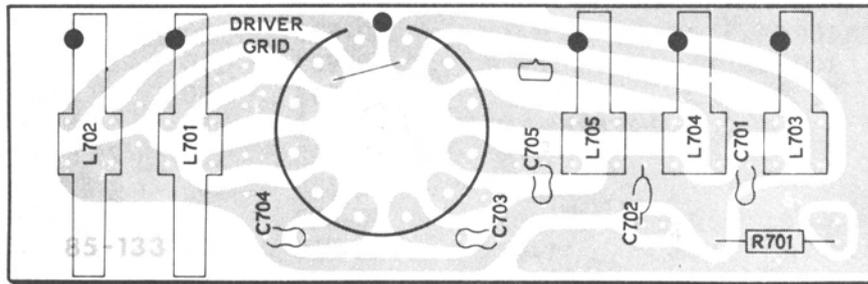
MODULATOR CIRCUIT BOARD



IF CIRCUIT BOARD



AUDIO CIRCUIT BOARD



DRIVER GRID CIRCUIT BOARD

REPLACEMENT PARTS PRICE LIST

The following prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from an authorized Service Center or Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates of exchange.

SWITCH BOARDS

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

RESISTORS-1/2 Watt

1-3	.10	100 Ω
1-9	.10	1000 Ω
1-22	.10	22 k Ω

CAPACITORS

Mica

20-130	.15	12 pF
20-77	.15	24 pF
20-96	.15	36 pF
20-97	.15	50 pF
20-102	.15	100 pF
20-105	.20	180 pF
20-107	.40	680 pF

Disc

21-14	.10	.001 μ F
21-16	.10	.01 μ F

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

COILS AND CHOKES

40-686	.50	7 MHz
40-687	.50	14/21 MHz
40-693	.80	28 MHz
40-688	.50	29 MHz
40-692	.80	29.5 MHz
40-685	.65	3.5 MHz
40-689	.95	3.5/7 MHz
40-690	.65	14/21 MHz
40-691	.95	28.5/29 MHz
45-51	.25	15 μ H RF choke

SWITCHES

63-396	.90	Rotary wafer (red dot)
63-397	.85	Rotary wafer (yellow dot)



PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

HARNESS-WIRE-SLEEVING

340-2	.05/ft	Small bare wire
340-3	.05/ft	Large bare wire
343-7	.05/ft	Coaxial cable
344-21	.05/ft	Large red hookup wire
344-50	.05/ft	Black hookup wire
344-51	.05/ft	Brown hookup wire
344-52	.05/ft	Red hookup wire
344-53	.05/ft	Orange hookup wire
344-59	.05/ft	White hookup wire
346-1	.05/ft	Small black sleeving
346-2	.05/ft	Clear sleeving
346-5	.05/ft	Large black sleeving

CRYSTALS

404-207	4.35	12.395 MHz
404-208	4.35	15.895 MHz
404-209	4.35	22.895 MHz
404-210	4.35	29.895 MHz

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

Crystals (cont'd.)

404-211	4.35	36.895 MHz
404-212	4.35	37.395 MHz
404-213	4.35	37.895 MHz
404-214	4.35	38.395 MHz

CIRCUIT BOARDS

85-132-1	.85	Crystal switch
85-133-1	.85	Heterodyne oscillator
85-133-2	.85	Driver grid
85-133-3	.85	Driver plate

MISCELLANEOUS

331-6	.10	Solder
390-147	.10	"Danger High Voltage" label
490-1	.10	Alignment tool
490-5	.10	Nut starter
595-904	2.00	Manual

MODULATOR CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

RESISTORS-1/2 Watt

1-45	.10	220 Ω
1-6	.10	470 Ω
1-9	.10	1000 Ω
1-90	.10	2000 Ω
1-16	.10	4700 Ω
1-24	.10	33 k Ω
1-25	.10	47 k Ω
1-26	.10	100 k Ω
1-27	.10	150 k Ω
1-35	.10	1 megohm

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

CAPACITORS

Mica		
20-130	.15	12 pF
20-77	.15	24 pF
20-96	.15	36 pF
20-97	.15	50 pF
20-102	.15	100 pF
Disc		
21-13	.10	500 pF
21-14	.10	.001 μ F
21-27	.10	.005 μ F
21-16	.10	.01 μ F
21-31	.10	.02 μ F



PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
Other Capacitors			DIODES		
21-29	.15	4.7 pF ceramic tubular	56-26-1	.35	Crystal
26-94	1.85	13 pF differential	57-27	.60	Silicon
27-34	.25	.2 μ F Mylar	MISCELLANEOUS		
25-115	.45	10 μ F electrolytic	10-147	.75	200 Ω control
25-135	.75	20 μ F electrolytic	52-79	.80	IF transformer
CRYSTALS			434-129	.15	7-pin socket
404-205	5.00	3393.6 kHz	434-130	.15	9-pin socket
404-206	5.00	3396.4 kHz	85-127-2	2.15	Circuit board
404-215	4.50	3395.4 kHz			

IF CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
RESISTORS			Disc		
1/2 Watt			21-13	.10	500 pF
1-1	.10	47 Ω	21-14	.10	.001 μ F
1-45	.10	220 Ω	21-27	.10	.005 μ F
1-6	.10	470 Ω	21-31	.10	.02 μ F
1-9	.10	1000 Ω	Other Capacitors		
1-14	.10	3300 Ω	27-34	.25	.2 μ F Mylar
1-16	.10	4700 Ω	27-19	1.50	1 μ F tubular (shape may vary)
1-25	.10	47 k Ω	COILS-TRANSFORMERS		
1-26	.10	100 k Ω	40-487	.20	300 μ H coil
1-40	.10	10 megohm	40-587	1.25	6.8 MHz trap coil
1 Watt			52-73	1.35	3.395 MHz IF transformer
1-5-1	.10	22 k Ω	52-79	.80	3.395 MHz transformer
CAPACITORS			MISCELLANEOUS		
Mica			57-27	.60	Silicon diode
20-97	.15	50 pF	85-128-3	1.55	IF circuit board
20-102	.15	100 pF	434-129	.15	7-pin socket
			434-130	.15	9-pin socket

BANDPASS CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

RESISTORS-1/2 Watt

1-1	.10	47 Ω
1-45	.10	220 Ω
1-4	.10	330 Ω
1-9	.10	1000 Ω
1-16	.10	4700 Ω
1-20	.10	10 k Ω
1-25	.10	47 k Ω
1-26	.10	100 k Ω
1-27	.10	150 k Ω
1-33	.10	470 k Ω
1-36	.10	1.5 megohm

CAPACITORS

Mica

20-97	.15	50 pF
20-102	.15	100 pF

Disc

21-14	.10	.001 μ F
21-27	.10	.005 μ F
21-31	.10	.02 μ F

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

Other Capacitors

25-115	.45	10 μ F electrolytic
27-34	.25	.2 μ F Mylar
31-36	.85	8-50 pF trimmer

COILS-TRANSFORMERS

45-51	.25	15 μ H RF choke
52-65	5.90	Bandpass transformer
52-79	.80	Transformer

DIODES

56-25	3.00	Zener, 15 volt
56-26-1	.35	Crystal
57-27	.60	Silicon

MISCELLANEOUS

404-43	5.00	100 kHz crystal
434-130	.15	9-pin socket
85-129-3	2.00	Bandpass circuit board

AUDIO CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

RESISTORS

1/2 Watt

1-3	.10	100 Ω
1-4	.10	330 Ω
1-9	.10	1000 Ω
1-16	.10	4700 Ω
1-22	.10	22 k Ω
1-25	.10	47 k Ω
1-26	.10	100 k Ω
1-29	.10	220 k Ω
1-31	.10	330 k Ω
1-33	.10	470 k Ω
1-34	.10	680 k Ω
1-35	.10	1 megohm
1-37	.10	2.2 megohm
1-38	.10	3.3 megohm

PART No.	PRICE Each	DESCRIPTION
----------	------------	-------------

1 Watt

1-3-1	.10	3300 Ω
-------	-----	---------------

7 Watt

3-15-7	.15	1000 Ω
3-16-7	.15	2500 Ω

CAPACITORS

Disc

21-13	.10	500 pF
21-14	.10	.001 μ F
21-27	.10	.005 μ F
21-16	.10	.01 μ F
21-31	.10	.02 μ F



<u>PART No.</u>	<u>PRICE Each</u>	<u>DESCRIPTION</u>
-----------------	-------------------	--------------------

Electrolytic

25-135	.75	20 μ F
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DIODES

57-27	.60	Silicon
-------	-----	---------

<u>PART No.</u>	<u>PRICE Each</u>	<u>DESCRIPTION</u>
-----------------	-------------------	--------------------

SOCKETS

434-129	.15	7-pin
434-130	.15	9-pin

MISCELLANEOUS

84-22	.60	Phase shift network
85-130-2	1.70	Audio circuit board

RF DRIVER CIRCUIT BOARD

<u>PART No.</u>	<u>PRICE Each</u>	<u>DESCRIPTION</u>
-----------------	-------------------	--------------------

RESISTORS**1/2 Watt**

1-111	.10	150 Ω
1-45	.10	220 Ω
1-4	.10	330 Ω
1-16	.10	4700 Ω
1-20	.10	10 k Ω
1-22	.10	22 k Ω
1-26	.10	100 k Ω
1-27	.10	150 k Ω
1-33	.10	470 k Ω
1-35	.10	1 megohm
1-38	.10	3.3 megohm

<u>PART No.</u>	<u>PRICE Each</u>	<u>DESCRIPTION</u>
-----------------	-------------------	--------------------

CAPACITORS

20-77	.15	24 pF mica
20-105	.20	180 pF mica
21-14	.10	.001 μ F disc
21-27	.10	.005 μ F disc
21-31	.10	.02 μ F disc
26-122	2.05	2-section variable

SOCKETS

434-129	.15	7-pin
434-130	.15	9-pin

MISCELLANEOUS

85-131-3	2.10	RF driver circuit board
----------	------	-------------------------

PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
#4 Hardware			OTHER HARDWARE		
252-15	.05	4-40 x 3/16" nut	252-7	.05	Control nut
254-9	.05	#4 lockwasher	253-10	.05	Control washer
253-80	.05	#4 flat washer	254-5	.05	Control lockwasher
#6 Hardware			259-10	.05	Control solder lug
250-8	.05	#6 x 3/8" sheet metal screw	253-36	.05	Spring brass washer
250-56	.05	6-32 x 1/4" screw	258-5	.10	Spring clip
250-170	.05	#6 x 1/4" sheet metal screw	255-59	.15	Black spacer
250-89	.05	6-32 x 3/8" screw	MISCELLANEOUS		
250-276	.05	6-32 x 3/8" flat head screw	51-123	2.05	Output transformer
250-284	.05	#6 x 1/2" sheet metal screw	69-35	5.80	Relay
250-26	.05	6-32 x 5/8" screw	74-6	.25	Masking tape
250-40	.05	6-32 x 1-1/2" screw	75-53	.25	Nylon insert
252-3	.05	6-32 nut	134-163	6.25	Wiring harness
252-22	.05	#6 speednut	207-22	.10	Cable clamp
253-1	.05	#6 flat fiber washer	253-49	.10	Nylon washer
253-2	.05	#6 shoulder fiber washer	255-42	.30	3/4" phenolic spacer
253-60	.05	#6 flat washer	261-9	.05	Rubber foot
254-1	.05	#6 lockwasher	268-7	.25	Rubber belt
259-1	.05	#6 solder lug	352-13	.15	Silicone grease cup
259-6	.05	#6 small solder lug	404-328	17.45	Crystal filter
#8 Hardware			407-99	7.95	Meter
250-43	.05	8-32 x 1/4" setscrew			
250-72	.05	8-32 x 3/4" screw			
252-4	.05	8-32 nut			
252-28	.10	8-32 knurled nut			
253-45	.05	#8 flat washer			
254-2	.05	#8 lockwasher			

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155

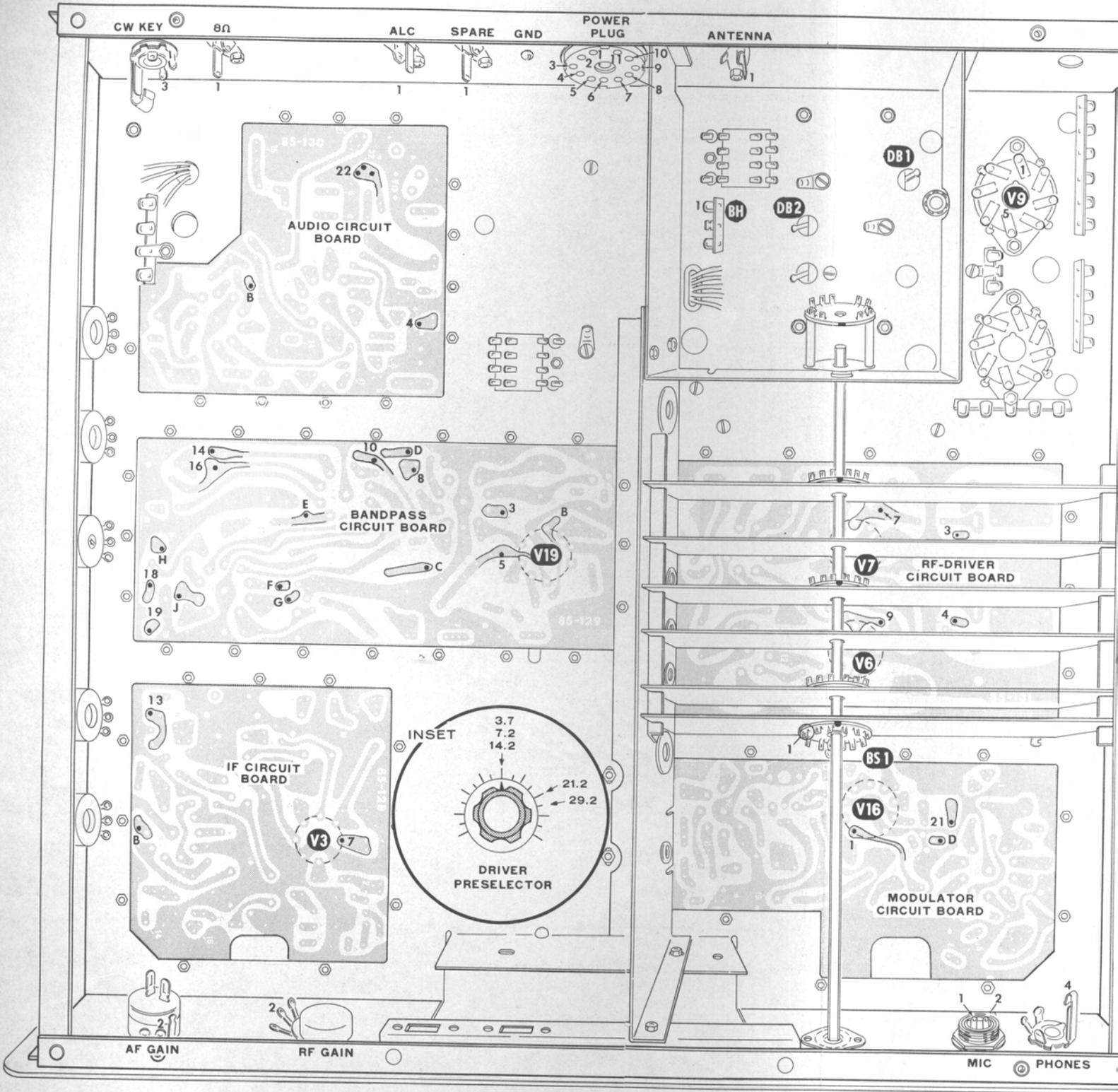
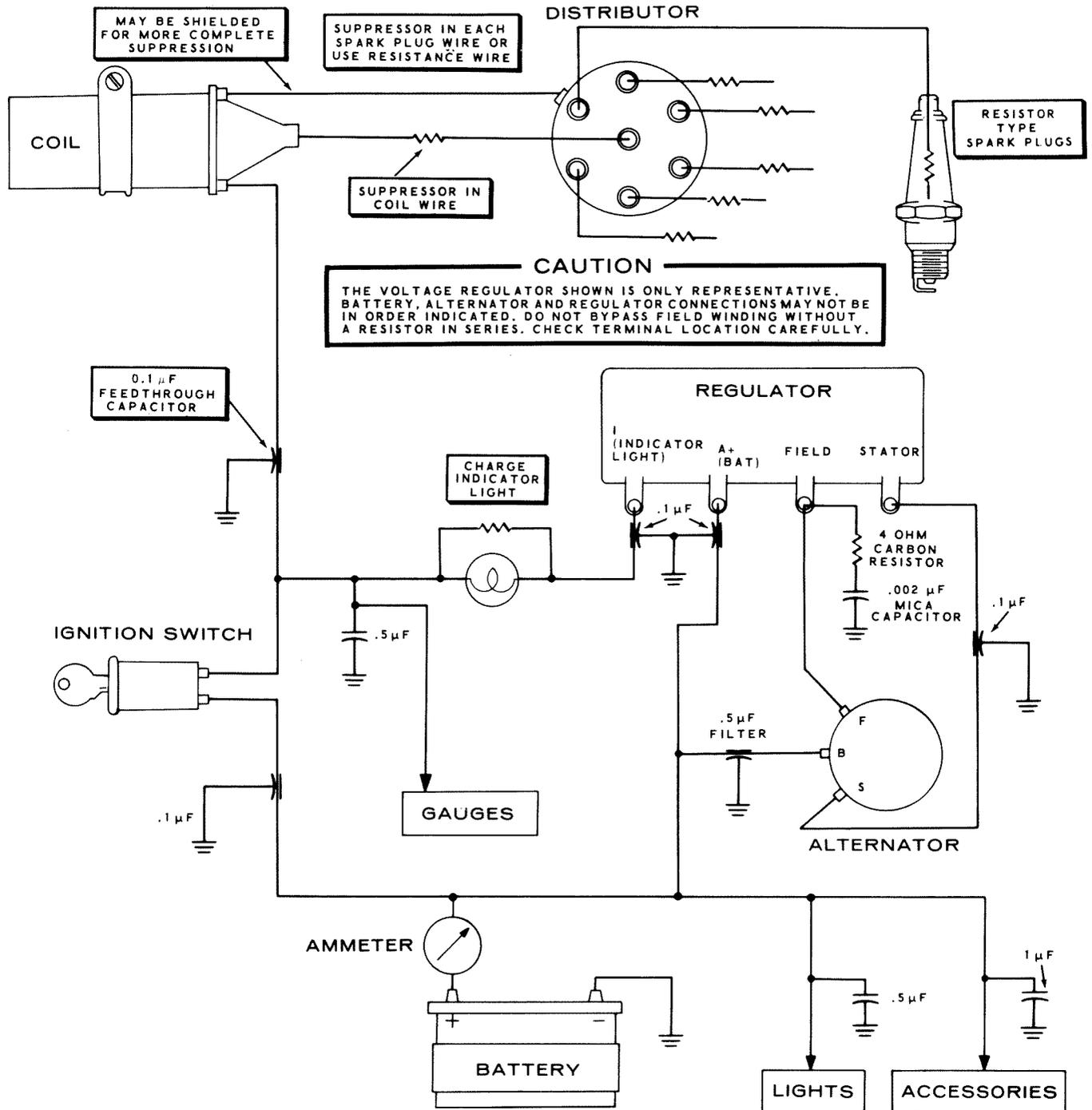


FIGURE 1-3



VALUE OF SUPPRESSOR	MANUFACTURER AND REPRESENTATIVE TYPE
10K OHM	ERIE TYPE L7VR-10ME
5K OHM	ERIE TYPE L7VR-5ME
.5 μF FEEDTHROUGH	SPRAGUE 48P18 (40 AMP), BRACKET MOUNT
.1 μF FEEDTHROUGH	SPRAGUE 80P3 (20 AMP), BULKHEAD MOUNT
	SPRAGUE 48P9 (20 AMP), BRACKET MOUNT
.5 μF	MALLORY AG-451
1 μF	MALLORY AG-452

NOTE: ALL GROUND CONNECTIONS SHOULD BE MADE TO THE COMPONENT BEING BYPASSED, PREFERABLY BY MOUNTING THE SUPPRESSOR DIRECTLY ON THE COMPONENT.

FIGURE 1-15

RECEIVER VOLTAGE CHART NOTES

DC VOLTAGES

1. POWER SUPPLY AND 8 Ω SPEAKER CONNECTED.
2. ANTENNA NOT CONNECTED.
3. BAND SWITCH IN 3.5 POSITION.
4. MODE SWITCH IN LSB POSITION.
5. FUNCTION SWITCH IN PTT POSITION.
6. RF GAIN MAXIMUM CLOCKWISE.
7. AF GAIN AT 9 O'CLOCK POSITION.
8. FILAMENT VOLTAGES NOT SHOWN: -
BROWN - 6.3 V AC/DC
WHITE/BROWN - 12.6 V AC/DC
9. BIAS AT 50 MA PLATE CURRENT.

 MEASURED WITH 11 MEGOHM INPUT ELECTRONIC VM.

 RF VOLTAGES - NO SIGNAL (USE RF PROBE WITH ELECTRONIC VM).

SIGNAL VOLTAGES

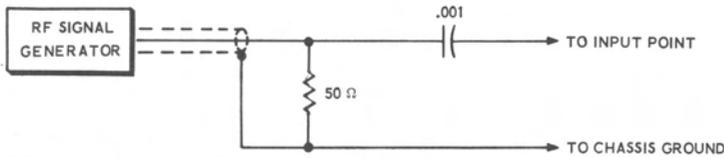
(Refer to Receiver DC Voltage Chart for Test Points)

CONTROL AND SWITCH SETTINGS AS IN DC VOLTAGE CHART EXCEPT AS FOLLOWS:

1. DIAL FREQUENCY - 3,900 MHz
2. MODE SWITCH - LSB OR USB.
3. AF GAIN - SET TO HEAR SIGNAL WITH APPROXIMATELY 1000 Hz TONE.
4. METER SWITCH IN ALC POSITION.

 SIGNAL INPUT POINTS.

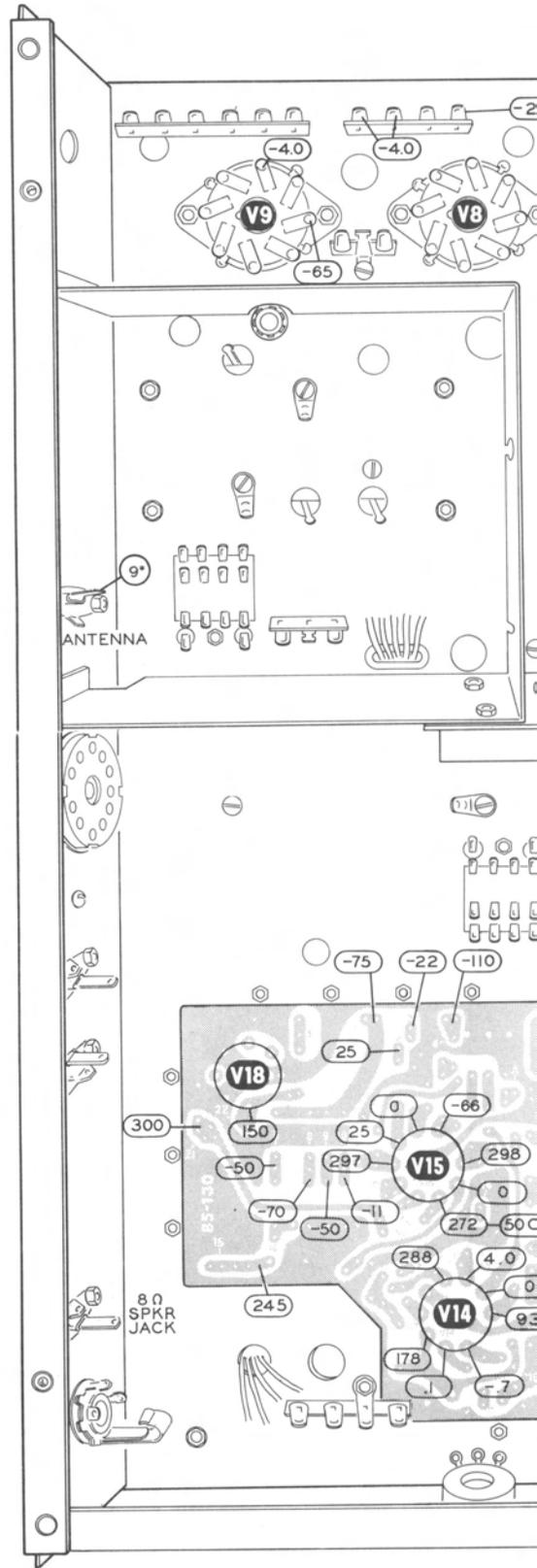
SIGNAL GENERATOR TERMINATION



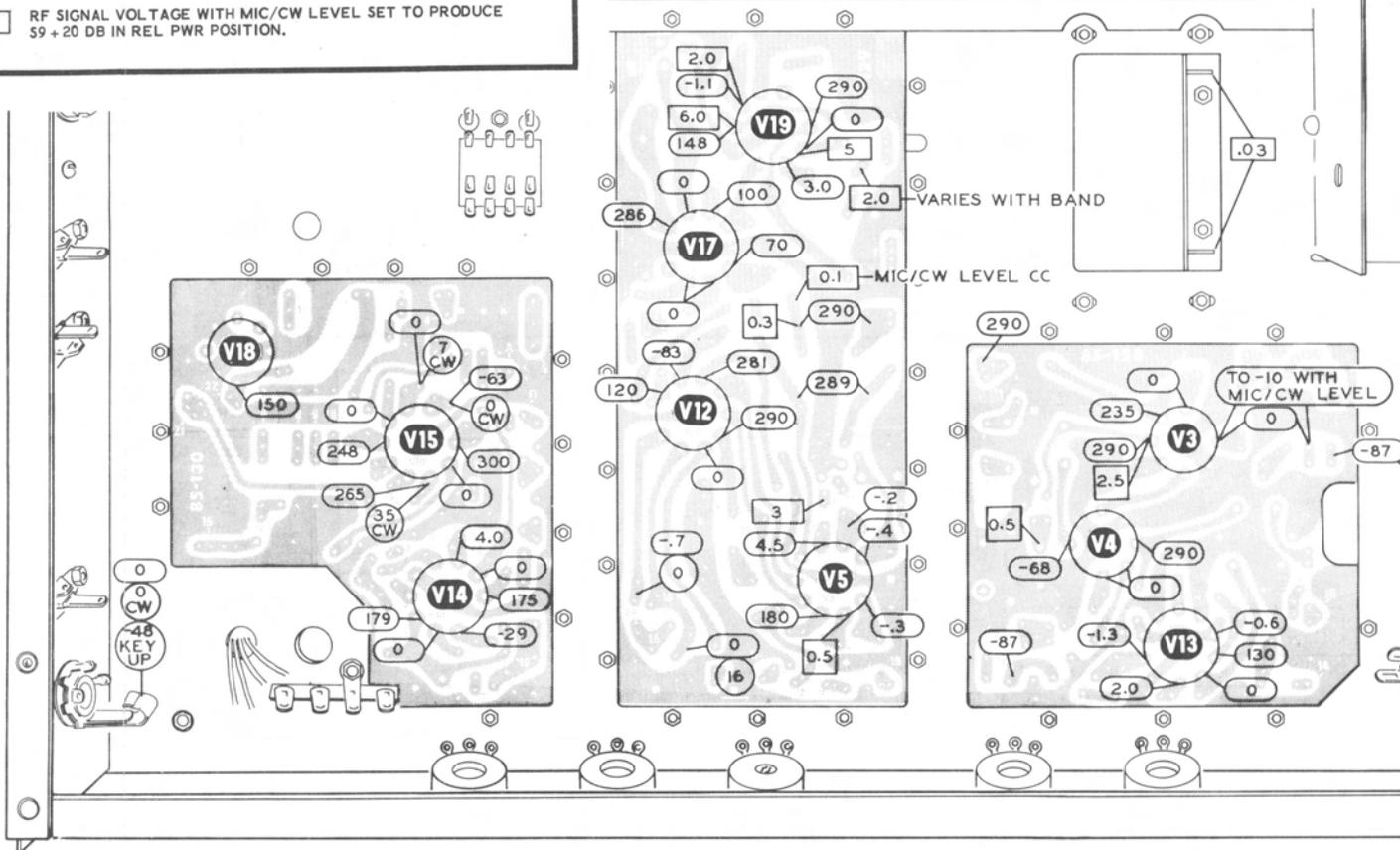
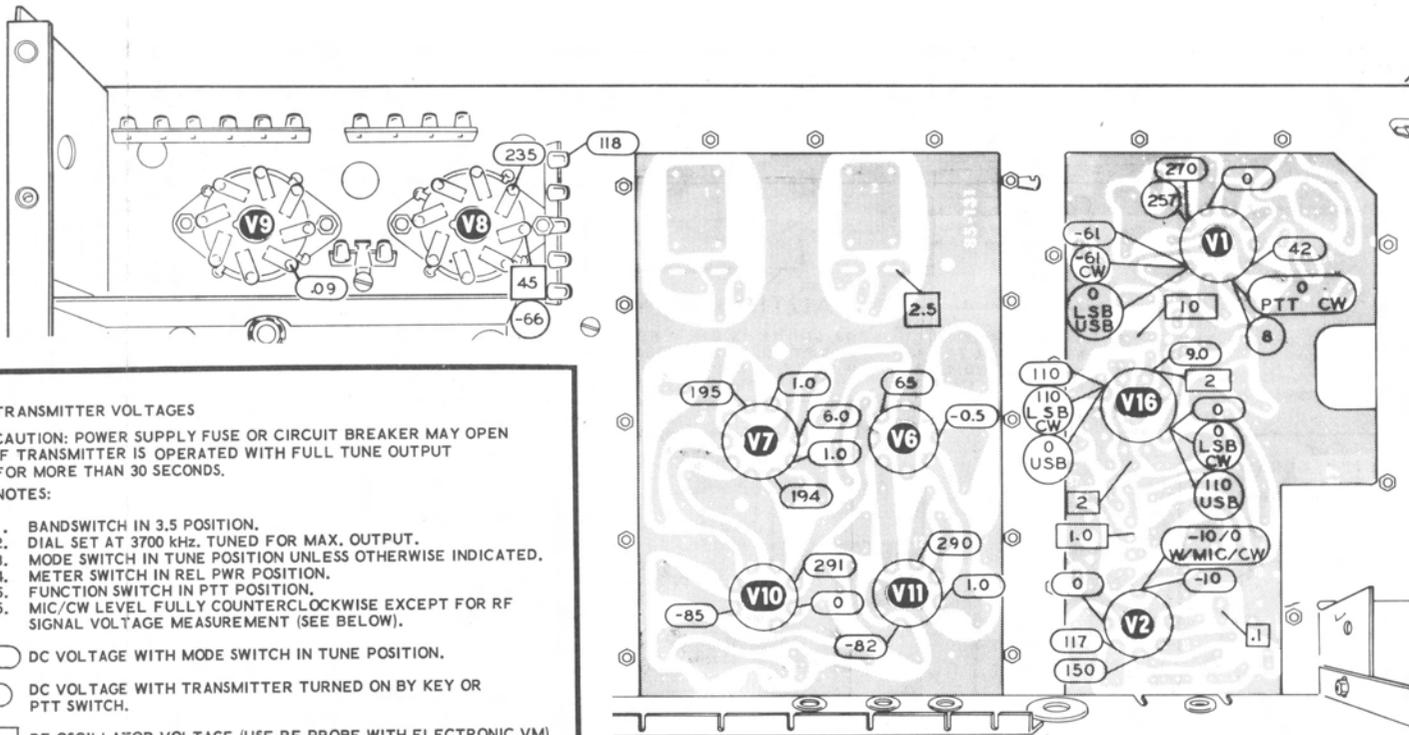
IMPORTANT: The crystal filter is quite narrow and the signal generator must be very carefully adjusted for the strongest signal indication at the Input Frequency listed in the chart below.

INPUT POINT	INPUT FREQUENCY	INPUT LEVEL	ELECTRONIC VM OR S-METER READING
1	3.395 MHz	20 mV	(AF GAIN MAX. CLOCKWISE) 4 V RMS AT 8 Ω JACK
2	"	10 mV	S-4
3	"	10 mV	S-9 + 60 DB.
4	"	10 mV	S-9 + 60 DB.
5	"	10 mV	S-9 + 10 DB.
6	8.5 MHz	10 mV	S-9 + 40 DB.
7	3,900 MHz	10 mV	S-9 + 20 DB.
8	3,900 MHz.	10 mV	S-9 + 40 DB PEAK DRIVER PRESELECTOR
XTAL CAL ON	3,900 MHz		S-9 + 20 DB PEAK DRIVER PRE SELECTOR
9 *	3,900 MHz	30 μV	S-9 APPROXIMATELY

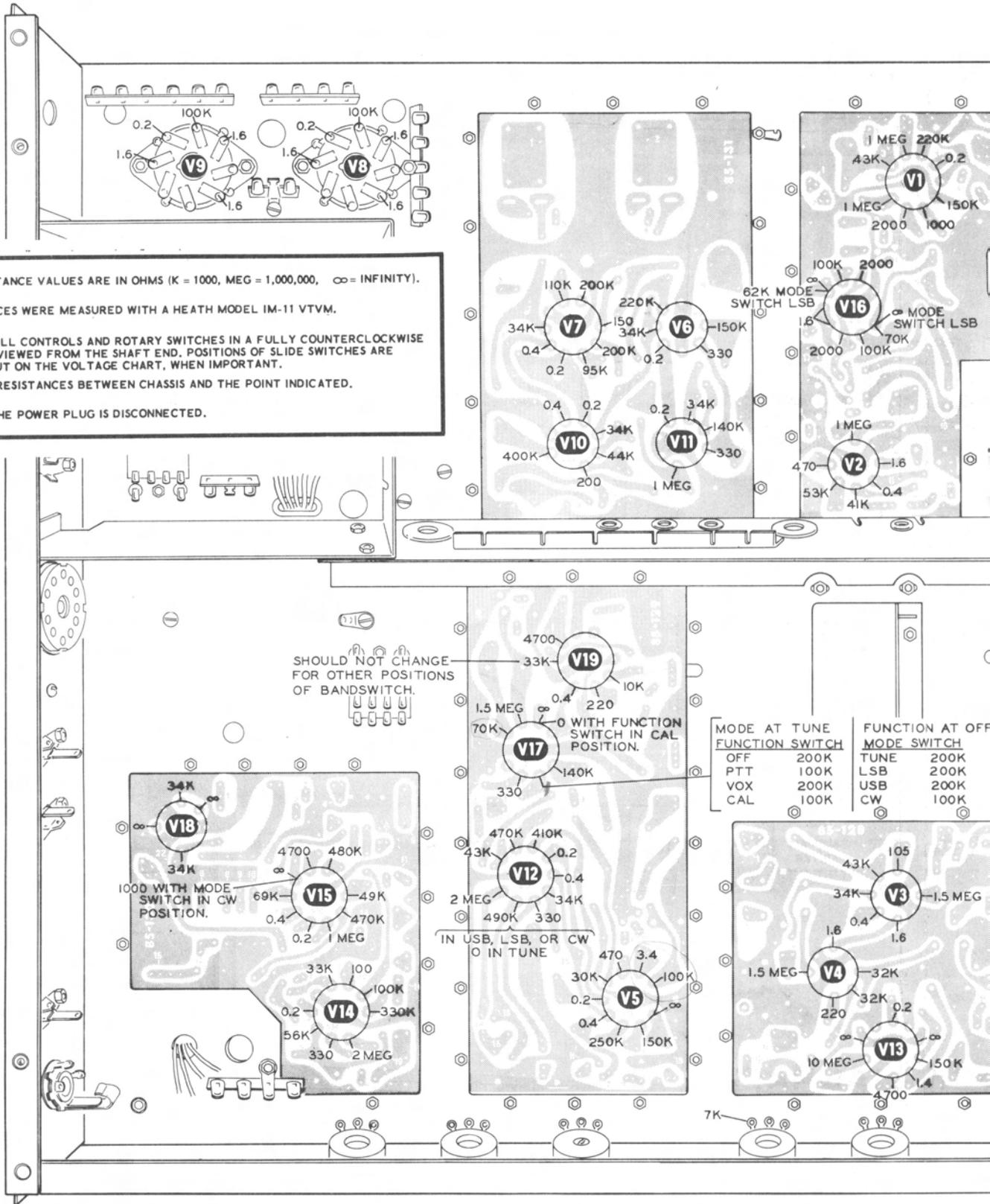
* GENERATOR CONNECTED DIRECTLY- NO TERMINATION.



RECEIVE



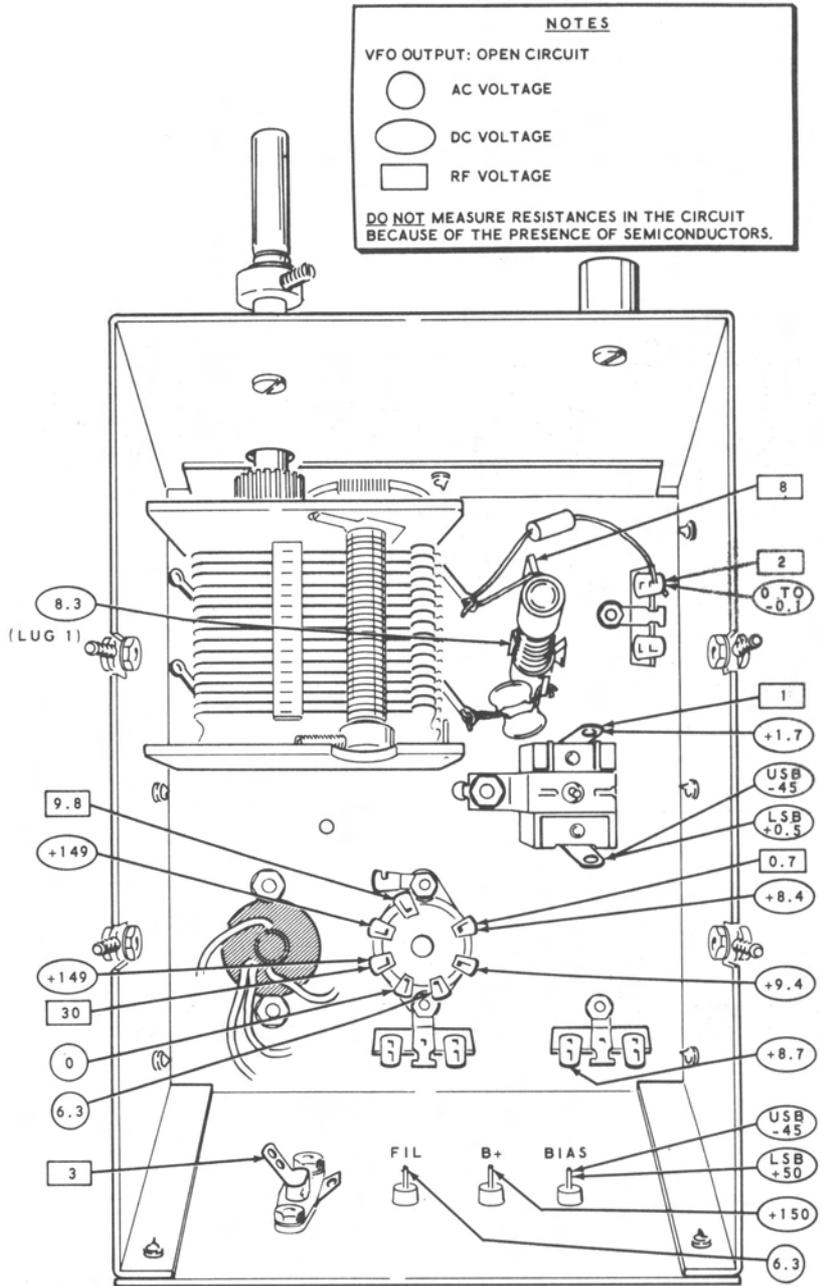
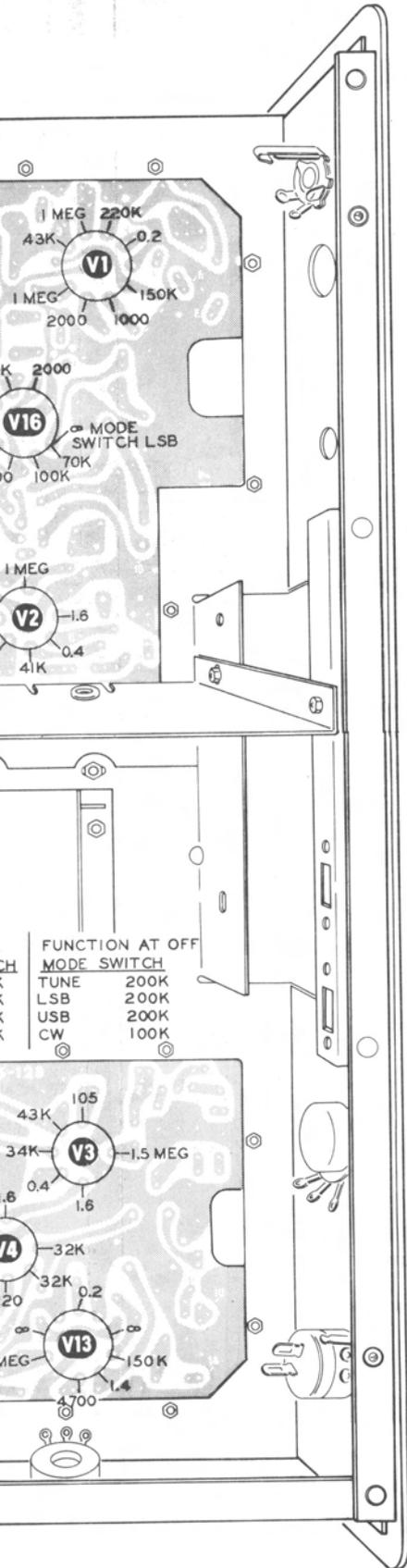
TRANSMITTER VOLTAGE CHART
FIGURE 1-19



1. ALL RESISTANCE VALUES ARE IN OHMS (K = 1000, MEG = 1,000,000, ∞ = INFINITY).
2. RESISTANCES WERE MEASURED WITH A HEATH MODEL IM-11 VTVM.
3. POSITION ALL CONTROLS AND ROTARY SWITCHES IN A FULLY COUNTERCLOCKWISE POSITION, VIEWED FROM THE SHAFT END. POSITIONS OF SLIDE SWITCHES ARE CALLED OUT ON THE VOLTAGE CHART, WHEN IMPORTANT.
4. MEASURE RESISTANCES BETWEEN CHASSIS AND THE POINT INDICATED.
5. BE SURE THE POWER PLUG IS DISCONNECTED.

	MODE AT TUNE FUNCTION SWITCH	FUNCTION AT OFF MODE SWITCH
OFF	200K	200K
PTT	100K	200K
VOX	200K	200K
CAL	100K	100K

**RESISTANCE CHART
FIGURE 1-20**



**VFO VOLTAGE CHART
FIGURE 1-21**

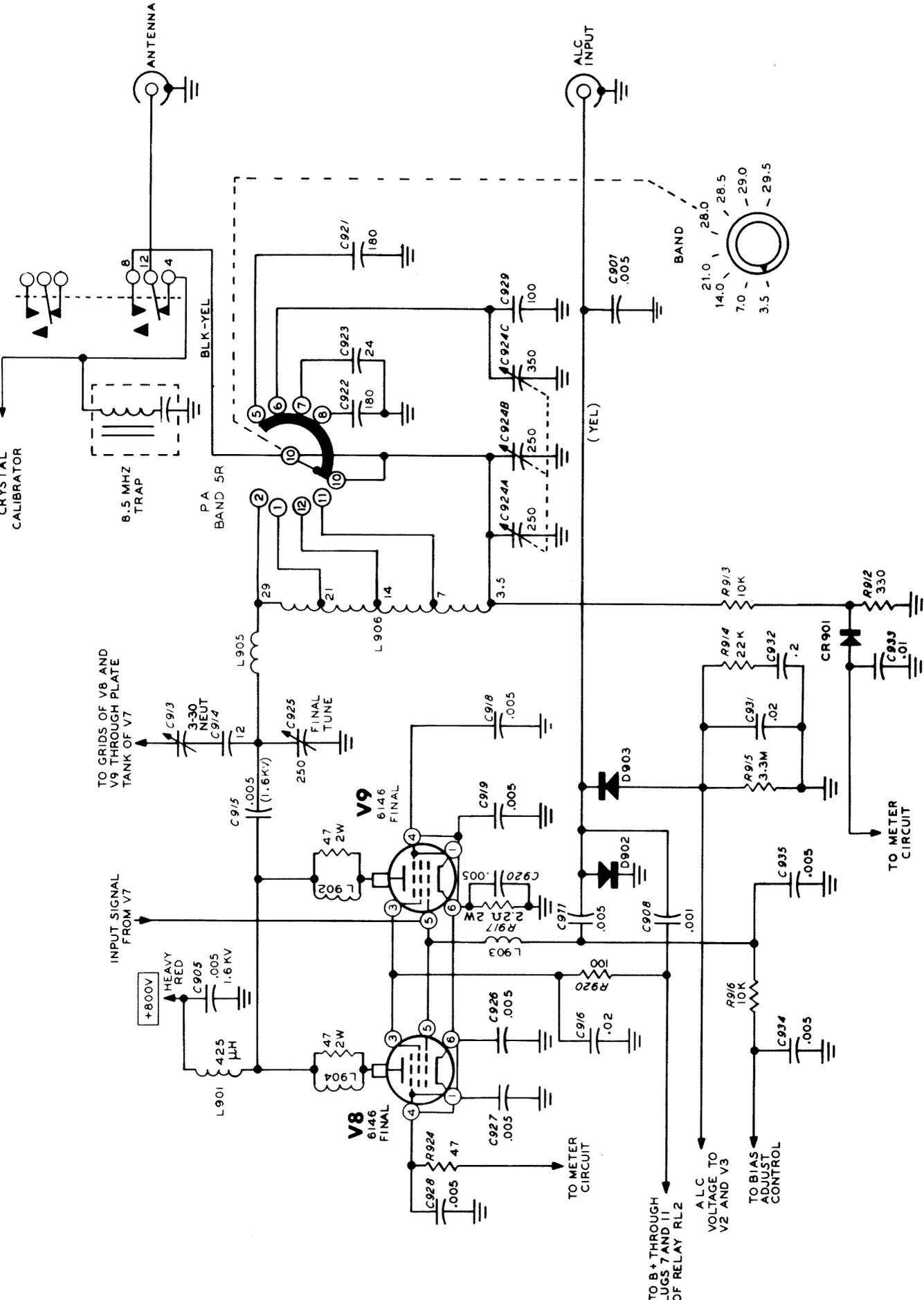


FIGURE 2-17

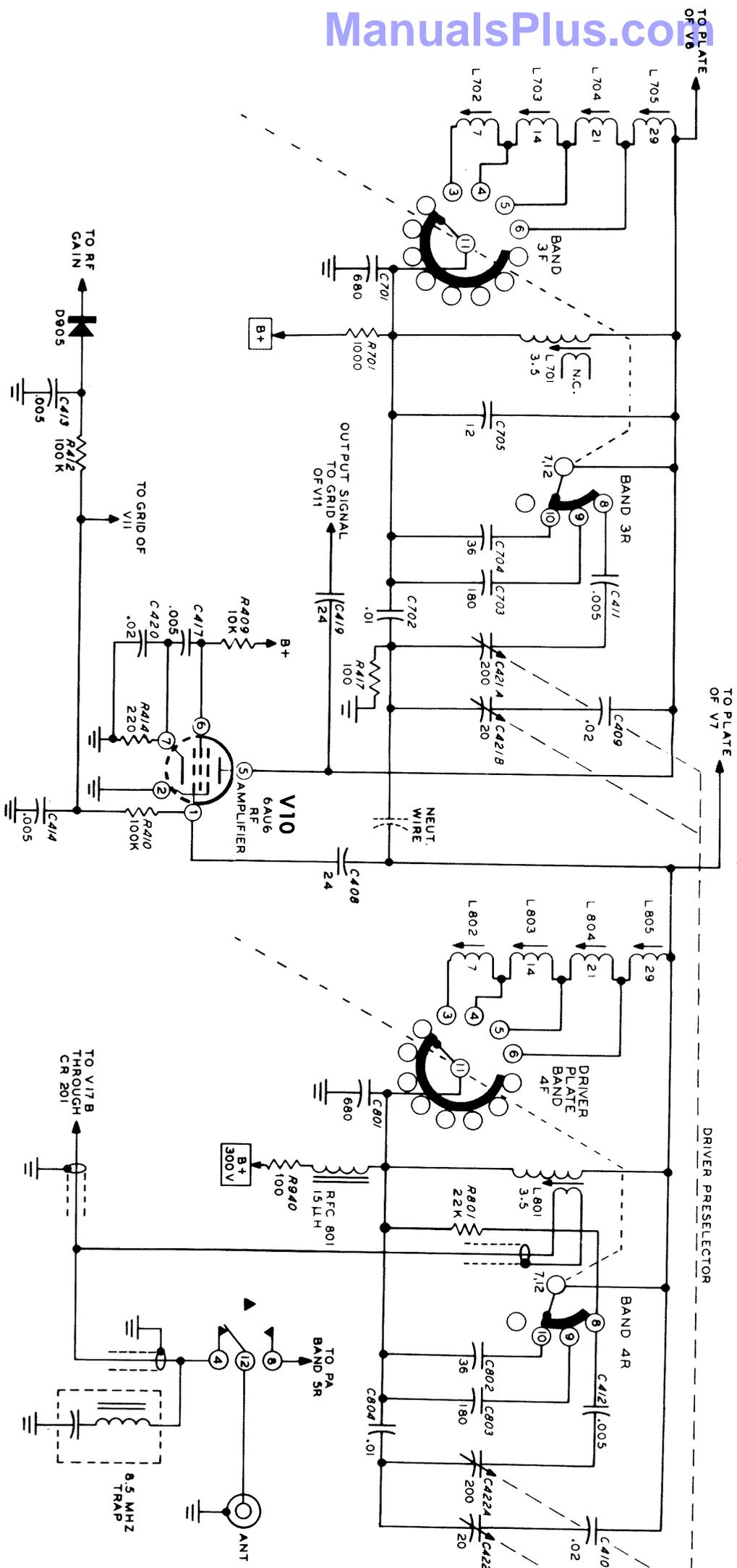


FIGURE 2-21

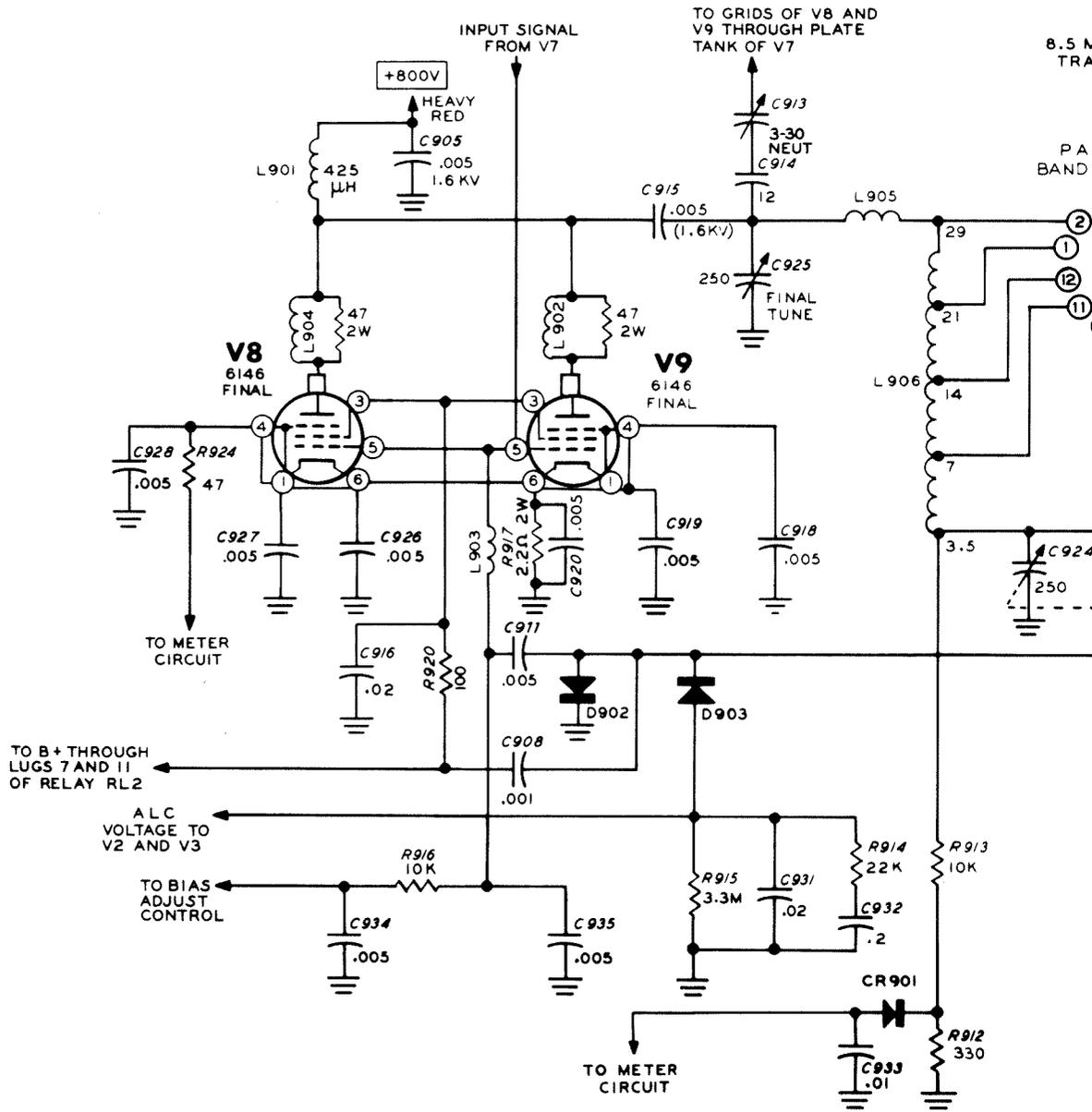


FIGURE 2-17

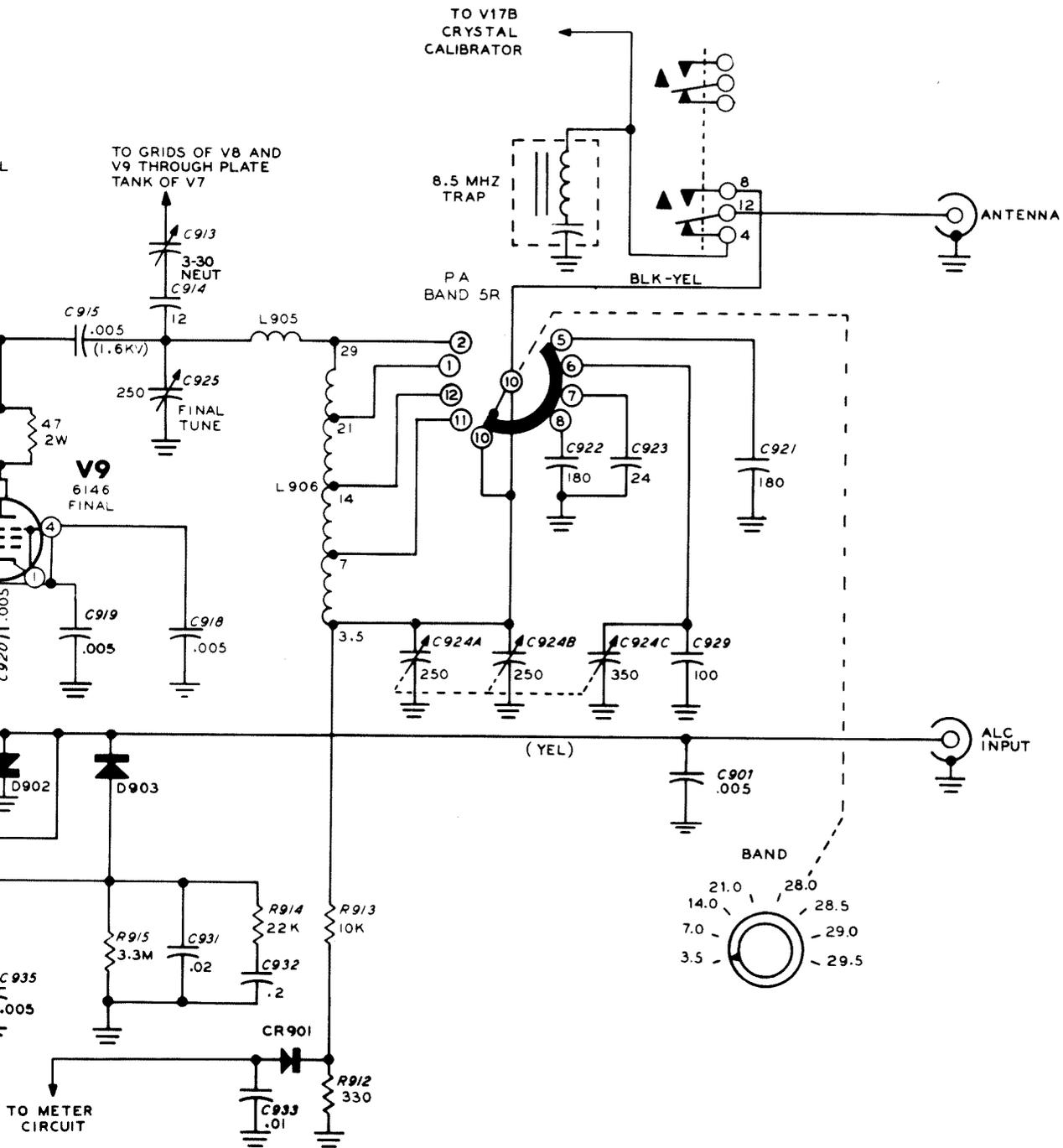


FIGURE 2-17

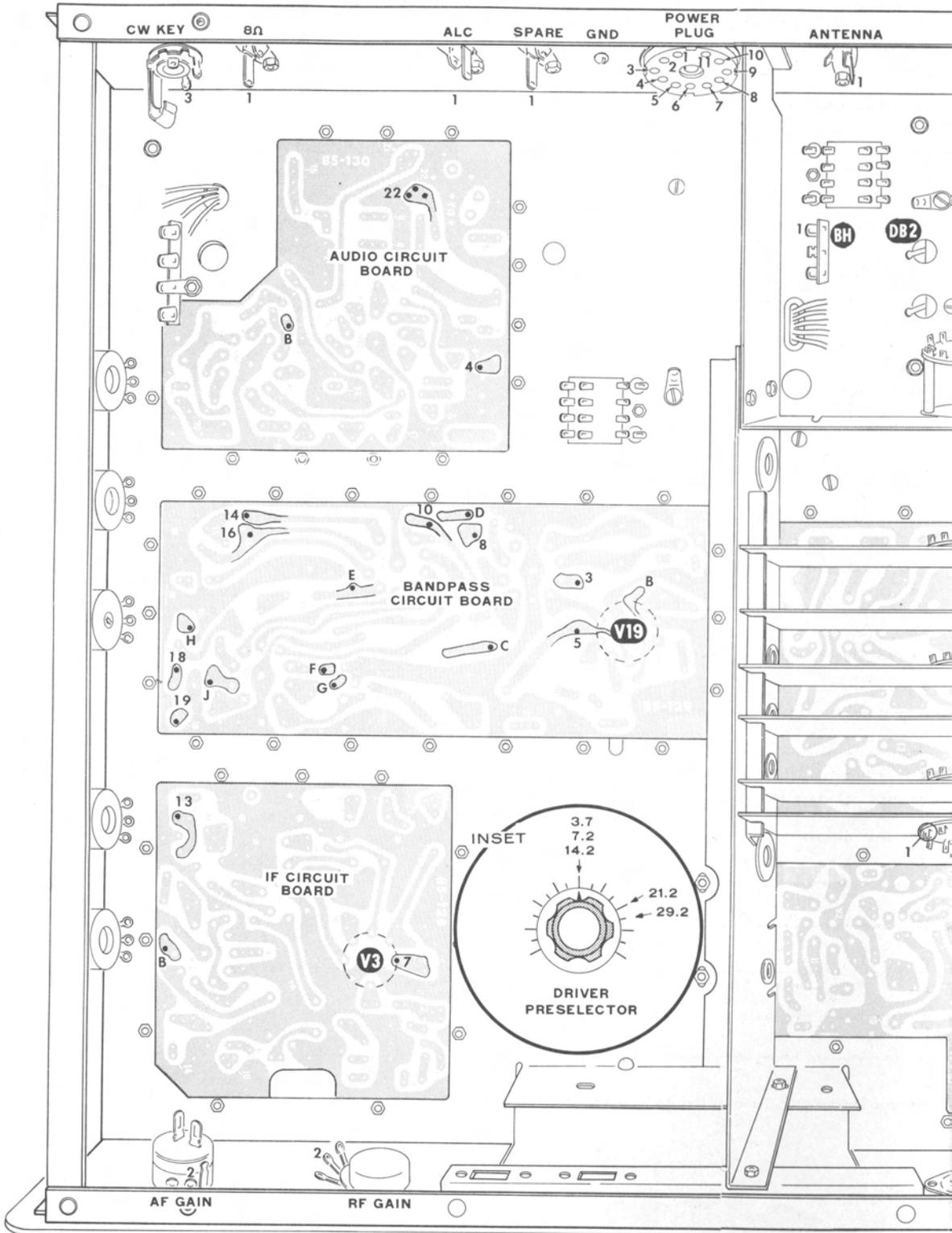


FIGURE 1-3

