SPECIFICATIONS

TRANSMITTER SECTION

Power Input To Final RF Amplifier:	Approximately 5 watts.
Frequency Control:	8 mc to 8.22 mc quartz crystal. Pin spacing .500". Pin diameter .093". FT-241 or FT-243 crystal holder.
Modulation:	AM plate modulation, automatically limited to not more than 100%.
Output Impedance:	50 or 72 Ω.

RECEIVER SECTION

Receiver Type:	Superregenerative detector preceded by RF pre-amplifier stage.
Sensitivity:	Usable with signals as low as 1 microvolt at the antenna terminals.
Speaker Size:	3-1/2" round.
Audio Power Output:	Approximately 1 watt (undistorted).
Tuning Range:	143.0 mc to 149.0 mc.

POWER SUPPLY

Power Rectifier:	Two silicon diodes in full-wave voltage doubler circuit.
Power Requirements:	With built-in supply: 105-125 volts 50/60 cycle AC 45 watts. With external supply: 6 volt operation - 6 volts at 2.35 amps, 260 volts DC at 90 ma. 12 volt operation - 12 volts at 1.2 amps, 260 volts DC at 90 ma.

ACCESSORIES

Microphone:	Ceramic element type, plastic case. Suitable for either hand or desk operation.
Connecting Cables:	Two supplied, one for 105-125 volt AC operation and one for 6 or 12 volt external DC power supply use. Power circuits are automatically switched for internal or external power supply use when cable is plugged in.

GENERAL

Tube Complement:.	1 - 6BA8: Oscillator/Tripler (Pentode Section) Tripler (Triode Section) 1 - 6BA8: Doubler (Triode Section) Final RF Amplifier (Pentode Section) 1 - 6BS8: Receiver Preamplifier and Detector. 1 - 12AX7: Speech Amplifier and First Audio Amplifier. 1 - 6AQ5: Audio Output and Modulator
Cabinet Dimensions:.	8" high (including handle). 8" deep (including knobs). 9-3/4" wide (including license holder).
Net Weight:.	6-1/2 lbs.
Shipping Weight:.	10 lbs.

Minor variations from these specifications may be encountered in kit-assembled equipment. Such factors as exact lead placement, component variations and normal variations in tube characteristics are possible sources of deviations. Such variables will ordinarily have no significant effect on overall performance.

INTRODUCTION

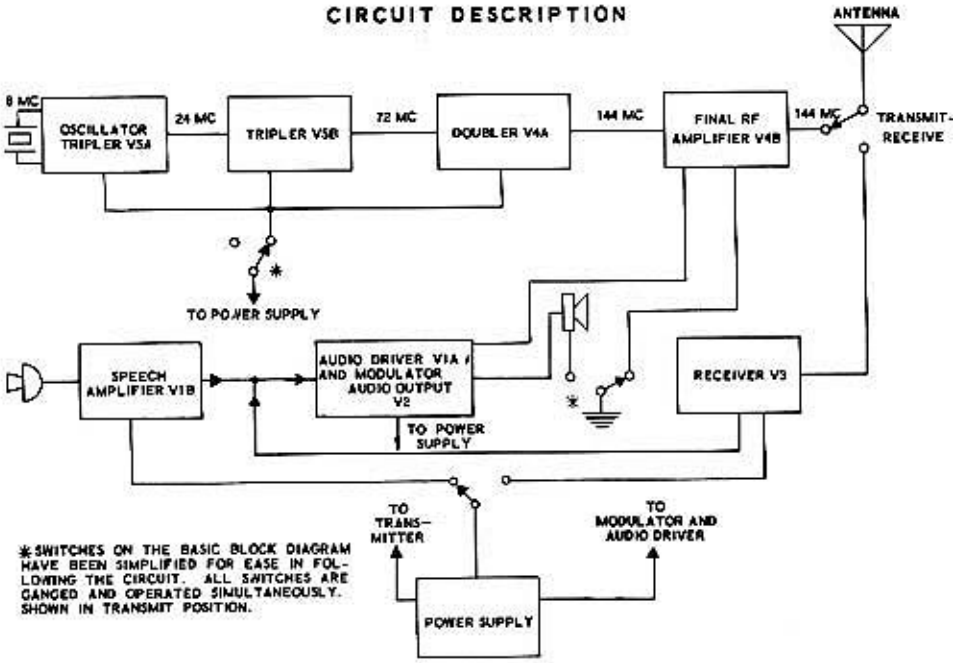
The HEATHKIT Model HW-30 Transceiver is a combination transmitter and receiver for use in the 2-meter amateur radiotelephone service.

Extensive procfbuilding and field testing over a period of several months have provided conclusive evidence that the HW-30 Transceiver will provide highly reliable service in its intended application, if assembled, wired and adjusted in accordance with the instructions outlined in this manual. It is, therefore, recommended that you follow the instructions carefully and make full use of the Circuit Description, Block Diagrams, Schematic Diagram, Installation Information, etc., in the interest of acquiring a good understanding of the transceiver and its capabilities.

The HW-30 Transceiver has a self-contained power supply for operation from a 117 volt 50/60 cycle AC power line, or can be operated from either a 6 volt or a 12 volt battery by using an external power supply having a rating of 260 volts B+ at 90 ma.

The HW-30 can be used with a wide variety of antenna types; an antenna should be selected for the transceiver on the basis of the application involved. See Page 37 for a discussion of suitable antenna types.

CIRCUIT DESCRIPTION



TRANSMITTER SECTION

The basic signal from which the final transmitter output is obtained (8 mc) is generated at 1/18 of the final output frequency in tube section V5A. This circuit is crystal controlled providing excellent frequency stability and is known as an "electron coupled" Pierce oscillator. "Three times" frequency multiplication is obtained in the plate circuit by tuning the output to 24 mc. This signal is coupled to the following stage through C6.

Tube section V5B multiplies the 24 mc signal again by three, providing a 72 mc signal which is coupled to the following stage through C8. Stage V4A is a frequency doubler which provides an output at 144 mc to drive the final amplifier grid.

V4B is the final amplifier and operates "straight through;" i.e., the input and output circuits are tuned to the same frequency. RF output is coupled to the antenna, through C17 and the transmit-receive switch contact, from a tap approximately 1/2 turn from the "cold" end o the final tank coil L4. The actual tap point is no critical and can be adjusted for optimum couplin if deemed necessary. Since most antenna fee lines will be in the vicinity of 50-75 ohms, th suggested tap point will provide near optimu coupling for most typical situations.

At the rear antenna terminal, there is pro vided a rather unique power output detecto circuit consisting of diode D1, resistor R and capacitor C18 and C19. This system, use in conjunction with an external voltmeter, sup plies a convenient means of tuning the fina tank circuit for maximum power into the anten na transmission line. As the power consume by this device is negligible, the meter may b left in the circuit at all times to indicate prope operation of the transmitter. The meter jac for this purpose is a three circuit standar phone jack and the reading is made with th plug inserted approximately halfway into th jack, such that the tip of the meter plug con tacts only the first terminal in the jack.

If the metering plug is inserted all the way into the jack, the meter will read final amplifier cathode current, typically in the order of 20-25 ma. The meter plug must be withdrawn from this position for normal operation once proper tuneup has been accomplished. The meter plug in this fully inserted position overrides the normal functioning of the transmit-receive switch and allows final amplifier plate current to flow regardless of switch position.

With a key plug inserted all the way in the meter jack, the transmitter may be used on CW if desired, although considerable "back wave" may result due to the fact that previous transmitter stages are running constantly.

For phone operation, modulation is accomplished by causing the plate and screen voltage source for V4B to vary at the audio frequency rate determined by the signal being passed through the combination modulation-output transformer (see AUDIO SECTION description).

RECEIVER SECTION

The incoming signal received by the antenna and arriving at the antenna connector via the transmission line is supplied to an impedance matching tap on coil L5, through capacitor C20. The resultant signal appearing across the broadly tuned circuit consisting of L5 and C21 is fed to the input of the RF amplifier stage V3A. The output circuit of the RF amplifier is "impedance coupled" to the cathode circuit of the superregenerative detector V3B through capacitor C24. This arrangement provides considerable gain in the RF stage, which does not require neutralization as the feed point in the detector circuit is relatively low impedance.

This means of coupling these two stages eliminates the most trying problem in most superregenerative detectors in that a condition referred to as "suck-out" can occur where a tuned circuit is not properly isolated from the detector. In other instances where a tuned circuit (it may be a coil and capacitor combination or reflected antenna tuning) is closely coupled, the detector will drop out of oscillation as detector tuning passes the resonant frequency of the interfering tuned circuit. In addition to solving the above problem and providing gain, the RF amplifier also isolates the antenna from the oscillating detector, minimizing re-radiation from the detector into the antenna.

The type of detector used is one which provides the most sensitivity for the number of components required and is superregenerative. In a straight regenerative detector, considerable sensitivity is achieved by adjusting the signal feedback of the detector for a near oscillating condition. In the regenerative circuit, the more feedback that can be employed with stable operation short of the detector actually going into oscillation, the greater will be the gain.

The superregenerative detector employed here carries the regenerative principle one step further in that the detector actually goes in and out of oscillation at a controlled rate. In doing such, the detector periodically passes through the point of maximum gain (just prior to oscillation) and therefore provides optimum gain from its circuit. This periodic rate, referred to as the "quench" frequency, is controlled by the value of RFC5, and associated components, and is in the vicinity of 20,000 cycles per second; therefore, the quench frequency is inaudible. The detector circuit is essentially a Colpitts type of oscillator circuit in which interelectrode tube and stray capacities form the normal feedback path. The detector cathode and heater are placed above RF ground by RF chokes RFC3 and RFC4. The plate circuit is bypassed for RF by C29.

The rear apron mounted 250 KΩ linear potentiometer R11 is adjusted for maximum sensitivity by setting the value of B+ voltage at the detector plate. The receiver configuration is one of very good sensitivity. Three microvolts input will produce near complete quieting with usable signals extending down to 1/2 microvolt.

AUDIO SECTION

The detected audio signal passes through C30 to the 1 megohm volume control R13. Signal flow proceeds through the audio mixing resistor R22 to the grid of the audio driver V1A which is coupled to the power output stage V2 by capacitor C35. The combination modulation-output transformer T2 provides proper impedance matching to the speaker with the unit operating as a receiver. With the transmit-receive switch in the receive position, no loading of the audio output occurs at the primary modulation tap because the cathode circuit of the transmitter final amplifier is open. During receive, tubes V5, V4 and section V1B are inoperative.

During transmit conditions, only tube V3 is switched out of the circuit, with all other circuits operating. B+ is supplied to V5, V4A and V1B while the cathode of the final amplifier V4B is returned to ground. With B+ removed from the receiver section V3, no audio voltage appears across the volume control R13 and only the signal which is amplified by the microphone preamplifier V1B reaches the grid of the audio driver stage V1A.

External radio frequency energy is prevented from re-entering the audio circuitry via the microphone cable through the use of RF choke RFC6 and capacitor C41 in the microphone input circuit. In transmit, the volume control will have negligible effect on the amount of audio impressed on the RF carrier, the volume control being isolated by resistor R22. It will be found that fixed gain in the microphone audio circuit is adequate for all normal transmit conditions.

POWER SUPPLY SECTION

The internal power supply provides the voltages necessary for proper operation from any 105-125 volt 50/60 cycle source. The B+ voltage is produced in a full-wave voltage doubler circuit consisting of D2, D3, C31 and C32. This DC voltage is then filtered by C33A and C33D, and distributed to the proper circuit points. Approximate B+ requirements are 260 volts 45 ma during receive and 90 ma during transmit.

The power connector on the chassis rear apron permits operation from any external source offering the proper voltages. The filament wiring is so arranged that the tubes are connected for either 6 or 12 volt operation, depending upon which power cable is in use. For 117 V AC operation, the power transformer provides 6.3 V AC for parallel wired filaments.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the REPLACEMENT section and supply the information called for therein. Include all inspection slips in your letter to us.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started:

1. Lay out all parts so that they are readily available.
2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.

Refer to Parts Pictorial on fold-out from page 11.

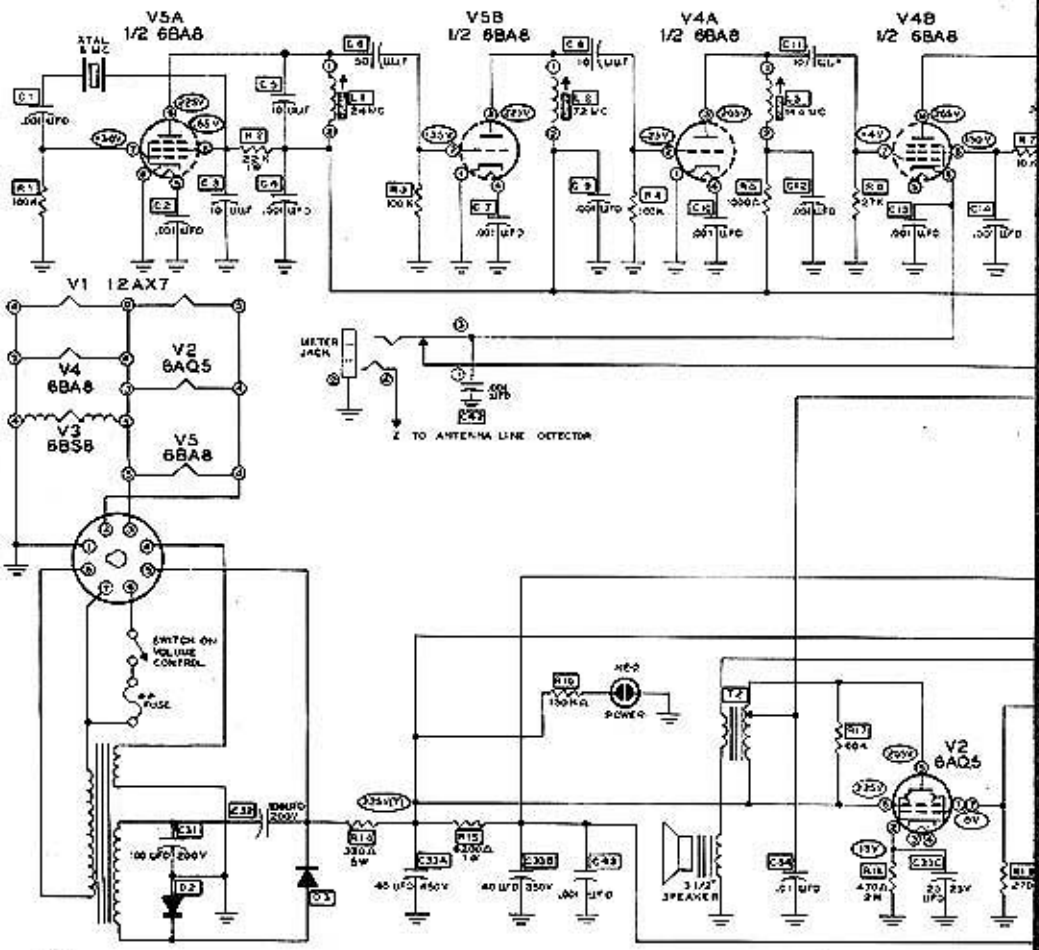
PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-9	1	1000 Ω 1/2 watt (brown-black-red)
1-14	2	3300 Ω 1/2 watt (orange-orange-red)
1-23	1	27 KΩ 1/2 watt (red-violet-orange)
1-26	3	100 KΩ 1/2 watt (brown-black-yellow)
1-27	2	150 KΩ 1/2 watt (brown-green-yellow)
1-29	1	220 KΩ 1/2 watt (red-red-yellow)
1-30	2	270 KΩ 1/2 watt (red-violet-yellow)
1-33	2	470 KΩ 1/2 watt (yellow-violet-yellow)
1-40	2	10 megohm 1/2 watt (brown-black-blue)
1-42	1	270 Ω 1/2 watt (red-violet-brown)
1-60	2	68 KΩ 1/2 watt (blue-gray-orange)
1-66	1	150 Ω 1/2 watt (brown-green-brown)
1A-4	1	8200 Ω 1 watt (gray-red-red)
1A-5	1	22 KΩ 1 watt (red-red-orange)
1A-9	1	10 KΩ 1 watt (brown-black-orange)
1B-12	1	470 Ω 2 watt (yellow-violet-brown)
3E-19	1	330 Ω 5 watt

PART No.	PARTS Per Kit	DESCRIPTION
Capacitors		
20-52	1	7.5 μμf silver mica
20-97	2	50 μμf silver mica
20-99	1	22 μμf silver mica
21-14	24	.001 μfd disc ceramic
21-16	1	.01 μfd disc ceramic
21-28	5	10 μμf tubular ceramic
21-29	1	4.7 μμf tubular ceramic
21-59	1	.001 μfd ceramic feed-through, 1000 V
21-70	1	.01 μfd 1400 volt disc ceramic
25-57	2	100 μfd 200 volt electrolytic
25-86	1	40-40-25-25 μfd at 450-350-25-25 volt electrolytic
26-71	1	3 μμf variable tuning capacitor
31-7	1	2.5 to 6 μμf trimmer
Transformers-Coils		
51-94	1	Combination modulation and output transformer
54-87	1	Power transformer
141-9	1	Coil set
Consisting of:		
40-186	1	Oscillator plate coil
40-332	1	Tripler coil
40-333	2	Detector and doubler coil
40-334	1	Antenna coil
40-335	1	Final tank coil
45-37	5	RF choke
45-48	1	RF choke

PART No.	PARTS Per Kit	DESCRIPTION
Terminal Strips-Sockets-Plugs		
431-1	1	1-lug terminal strip
431-5	1	4-lug terminal strip
431-10	1	3-lug terminal strip (large)
431-14	1	2-lug terminal strip
431-38	2	3-lug terminal strip (small)
431-40	2	4-lug terminal strip
432-1	1	Microphone connector (cable)
432-3	1	Microphone connector (chassis)
434-4	2	Octal socket
434-15	1	7-pin socket
434-38	1	Crystal socket
434-42	1	Phono socket
434-75	3	9-pin ceramic socket
434-77	1	9-pin wafer socket
435-1	1	Octal socket ring
436-6	1	3-circuit phone jack
438-3	1	Phone plug
438-4	2	Phono plug
438-22	1	Octal plug
440-1	2	Octal plug cap
Controls-Switches		
10-59	1	250 KΩ linear (REGENERATION)
19-27	1	1 megohm audio with SPST switch (VOLUME-ON-OFF)
63-210	1	3-position, 4-circuit, TRANSMIT-RECEIVE switch
Diodes-Tubes-Lamps		
56-4	1	Crystal diode
57-27	2	Silicon diode
411-26	1	12AX7 tube
411-60	1	6AQ5 tube
411-98	2	6BA8 tube
411-121	1	6BS8 tube
412-1	1	#47 pilot lamp
412-12	1	Neon pilot lamp (clear)
412-13	1	Neon pilot lamp (red)
Metal Parts		
90-111	1	Cabinet
200-M280F398	1	Chassis
203-181F397	1	Front panel
205-M167F	1	Speaker baffle plate
209-25	1	Speaker grill

PART No.	PARTS Per Kit	DESCRIPTION
Wire		
340-3	1	Length #16 bare wire
344-1	1	Length #22 hookup wire
344-2	1	Length #18 stranded black wire
344-3	1	Length #18 stranded red wire
346-1	1	Length sleeving
347-9	1	Length 3-conductor shielded cable
Hardware		
250-10	4	6-32 x 1/2" screw
250-26	1	6-32 x 5/8" screw
250-49	8	3-48 x 1/4" screw
250-51	2	#10 x 3/8" sheet metal screw
250-56	7	6-32 x 1/4" screw
250-89	12	6-32 x 3/8" screw
250-136	1	3-48 x 1/2" screw
250-172	2	3-48 x 3/8" screw
252-1	11	3-48 nut
252-3	20	6-32 nut
252-7	4	Control nut
252-22	4	#6 speednut
252-23	1	6-32 thumbnut
252-32	2	Speednut
253-10	5	Flat control washer
253-21	6	Flat washer
254-1	24	#6 lockwasher
254-4	5	Control lockwasher
254-7	12	#3 lockwasher
259-1	3	#6 solder lug
259-11	3	#6 spade terminal
Miscellaneous		
73-1	2	3/8" rubber grommet
73-4	1	5/16" rubber grommet
89-1	1	Line cord
211-16	1	Plastic handle
261-9	4	Rubber feet
391-5	1	Nameplate
401-21	1	Speaker
421-1	1	1-1/2 ampere fuse
421-4	1	8 ampere fuse
423-1	1	Fuse holder
462-85	2	Knob w/gold insert and indicator dot
462-86	1	Knob lever type w/gold insert and indicator line
480-8	1	Microphone
481-1	1	4-prong capacitor mounting wafer
331-6		Solder
595-364	1	Manual



NOTE:

ALL RESISTANCES IN OHMS K = 1000.
ALL RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED.
ALL VOLTAGES MEASURED WITH RESPECT TO CHASSIS GROUND.
VOLTAGES TAKEN WITH AN 11 MEGOHM VTVM.
ALL VOLTAGES POSITIVE UNLESS OTHERWISE SPECIFIED.

VOLTAGE READINGS TAKEN WITH UNIT OPERATING FROM NOMINAL 117 VOLT AC LINE WITH DUMMY LOAD PLUGGED IN AND CONTROLS SET AS FOLLOWS:

VOLUME CONTROL	-	ANT POSITION - ON
TUNING CAPACITOR	-	ANT POSITION
REGENERATION	-	ADJUSTED FOR NORMAL RECEPTION
MICROPHONE	-	DISCONNECTED

READINGS ON V1, V2, V4 AND V5 WITH SWITCH IN TRANSMIT.
READINGS ON V3 WITH SWITCH IN RECEIVE.

PRESENCE OF METER PROBE IN TRANSMITTER SECTION WILL CAUSE DE-TUNING IN MANY CASES. VALUES SHOWN ARE APPROXIMATE ONLY AND DEPENDENT UPON TUNING AND CRYSTAL ACTIVITY.

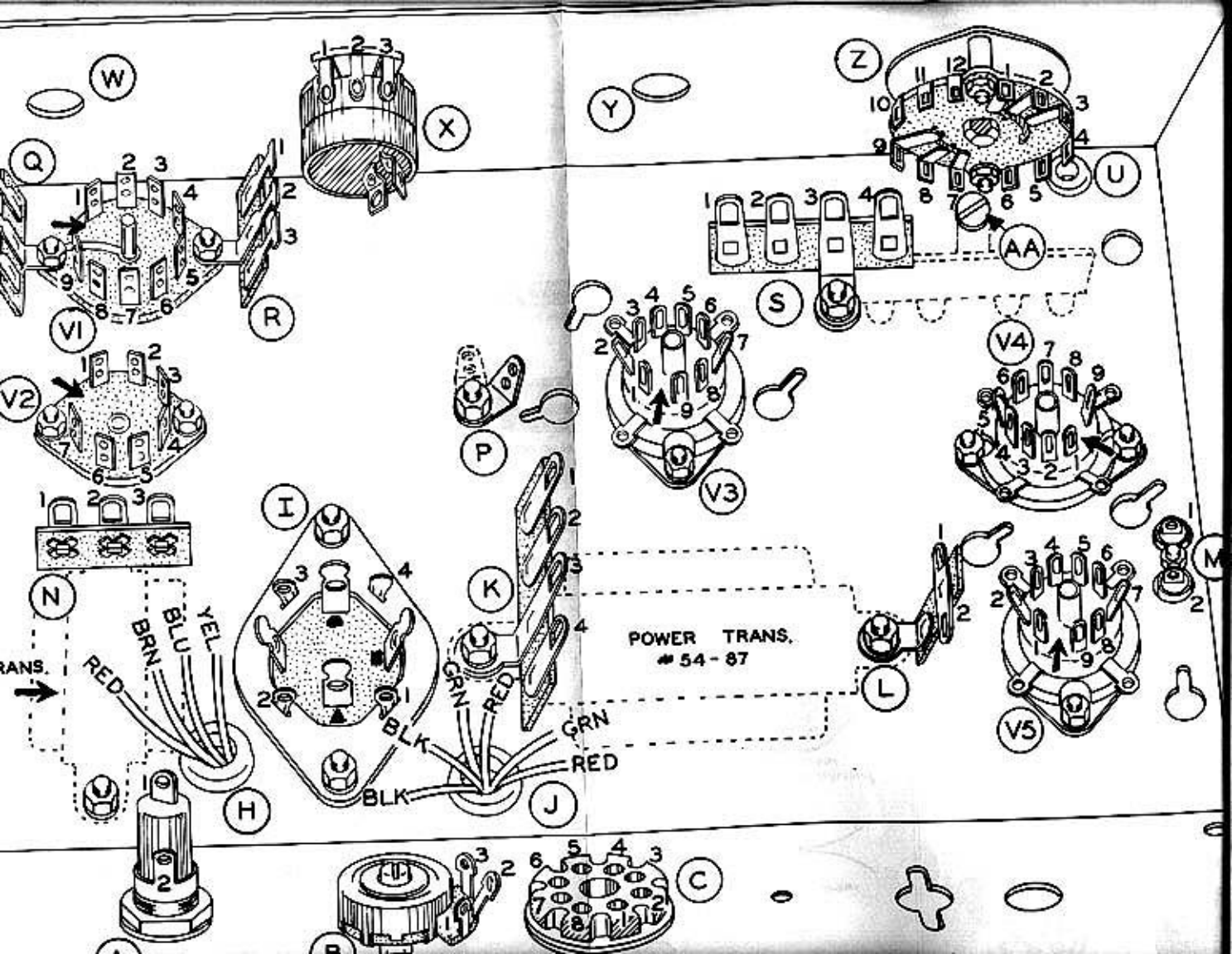
* VARIES WITH TUNING AND R15 SETTING.

** 1-1/2 AMP FOR AC OPERATION.
3 AMP FOR EXTERNAL POWER SUPPLY OPERATION.

117 VAC
POWER CORD

2 METER AMA
MO

TROUBLESHOOTING CHART	
1. Receiver section dead.	a. Faulty tubes - check V1, V2 and V3 voltages. b. Wiring error - recheck wiring. c. Faulty speaker or speaker ground - check speaker voice coil.
2. Receiver section weak.	a. Faulty tube - check V1, V2 and V3 voltages. b. Regeneration control not sufficiently advanced. c. RF or detector coils misaligned. d. Faulty antenna or connecting cable.
3. Transmitter appears dead.	a. Faulty tubes - check V4 and V5 voltages. b. Wiring error - recheck wiring. c. Transmitter section coils mistuned - recheck tuning. d. Dummy load shorted or open - recheck. e. Antenna mismatch - recheck antenna installation.
4. Power input to final amplifier too high (over 6 watts), or too low (less than 4 watts).	a. Faulty tube - check V4 and V5 voltages. b. Wiring error - recheck wiring. c. Transmitter section misaligned - recheck tuning procedure. d. Faulty meters - recheck meter readings. e. High or low activity crystal - substitute another crystal for comparison check. f. B+ voltage too high or low - check power supply voltages. Check for leaky capacitors, open or shorted resistors, at the power supply. Check transformer voltages.
5. Strong signal from transmitter but no modulation.	a. Faulty microphone or connections - recheck. b. Faulty tubes - check V1 and V2 voltages. c. Wiring error - recheck V2 and V2 wiring. d. Shorted RFC6 to ground at mike connector - center in connector opening.
6. Weak transmitted signal.	a. Faulty antenna - check. b. Shorted or open connecting cable - check. c. Poor antenna location.
7. Low power supply voltages.	a. Low line voltage - check. b. Leaky filter capacitors - check. c. Error in dropping resistor values or wiring - check. d. Faulty transformer - check voltages.
8. Modulation hum.	a. Power supply filter capacitor ground connection ungrounded - resolder. b. Faulty tubes - check V1 and V2. c. Open grid circuit connection - check wiring and soldering of V1 and V2.
9. Cathode current of final amplifier higher than normal.	a. Check the tuning of all transmitter coils for proper resonance and alignment.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POWER TRANS.
54-87
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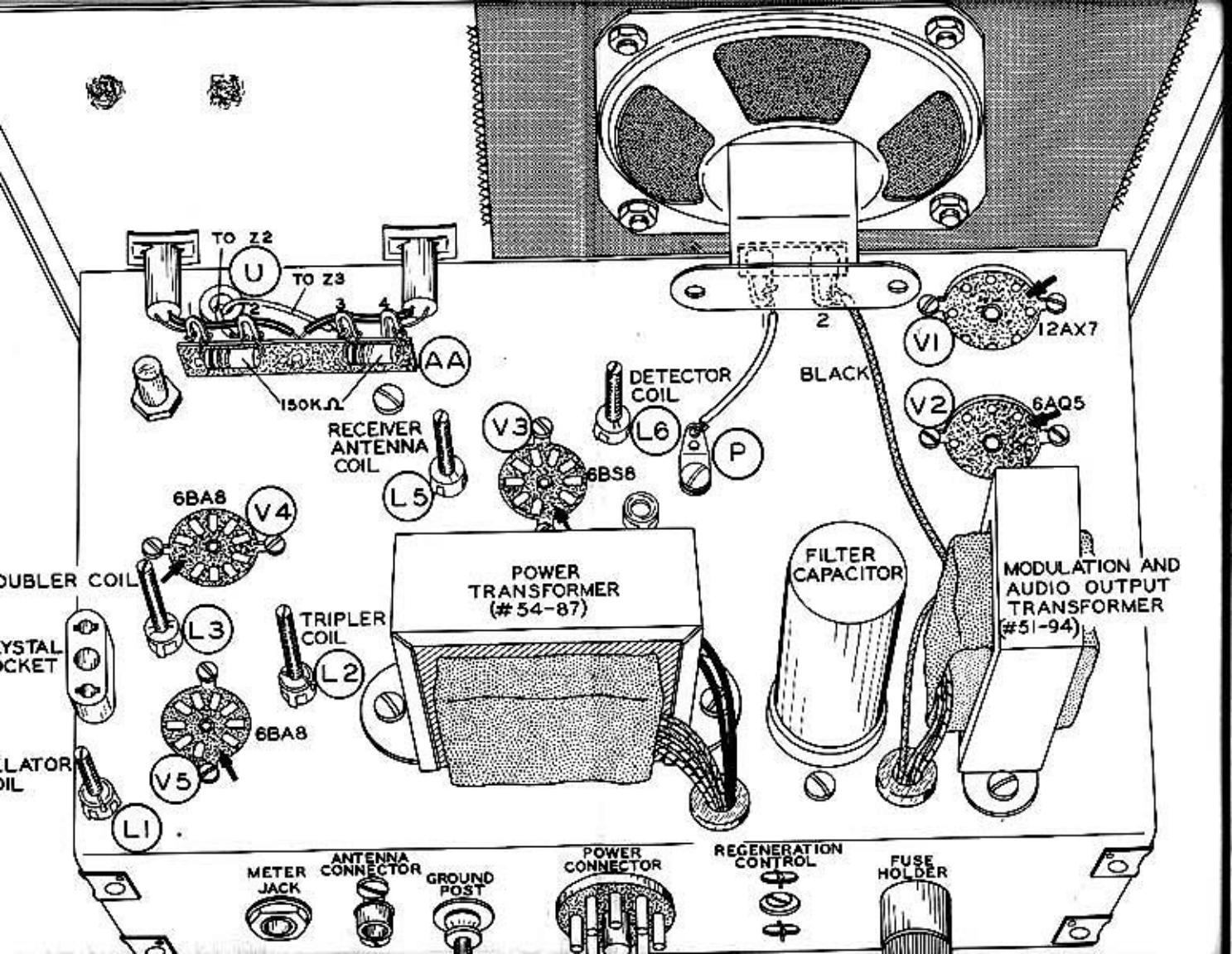
TO Z2
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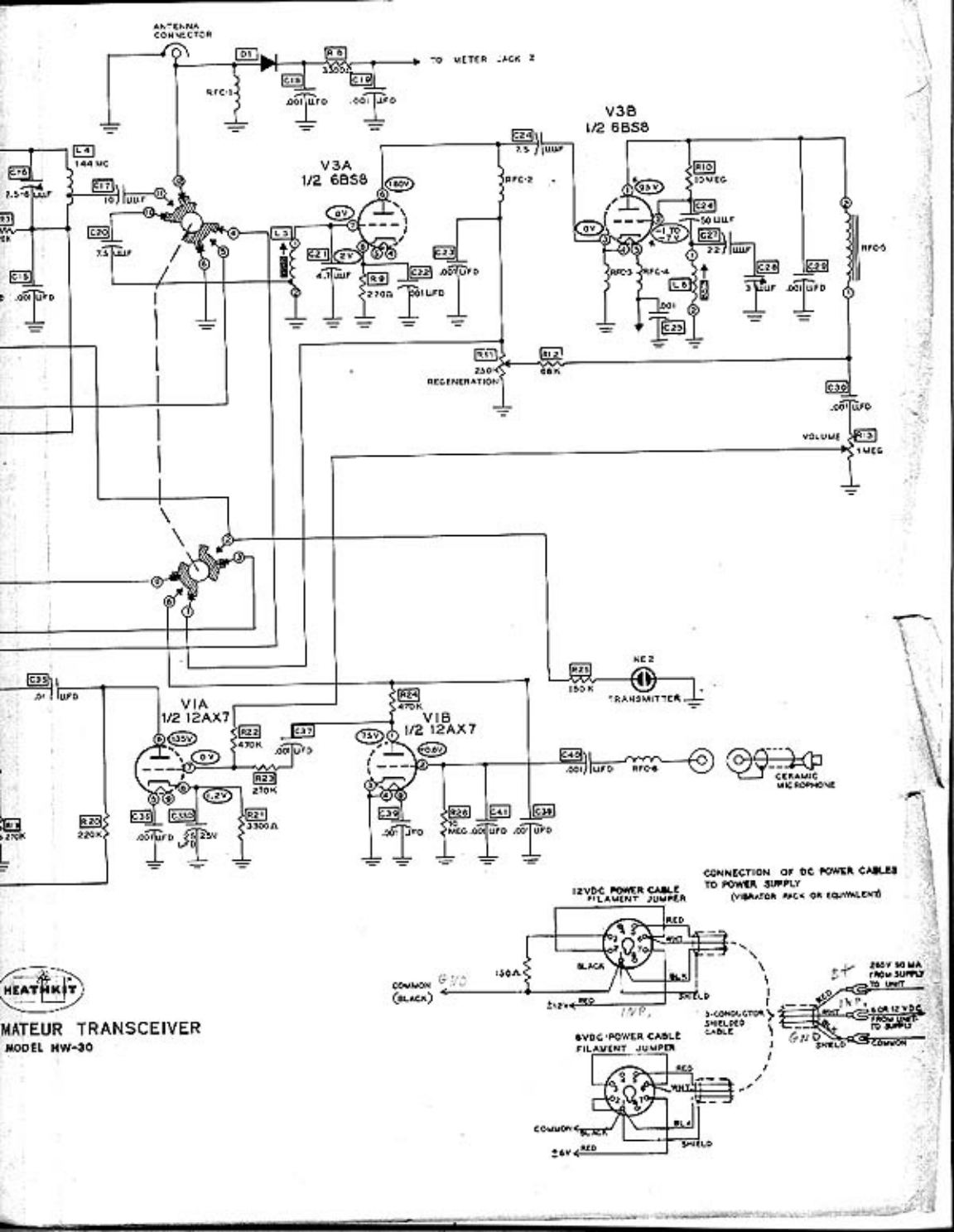
L5
V3
6BS8
DETECTOR COIL
L6
P
2
BLACK
V1
12AX7
V2
6AQ5
6BA8
V4
DUBLER COIL
L3
TRIPLER COIL
L2
POWER TRANSFORMER (#54-87)
FILTER CAPACITOR
MODULATION AND AUDIO OUTPUT TRANSFORMER (#51-94)
YSTAL OCKET
6BA8
V5
LLATOR OIL
L1
METER JACK
ANTENNA CONNECTOR
GROUND POST
POWER CONNECTOR
REGENERATION CONTROL
FUSE HOLDER



HEATHKIT

AMATEUR TRANSCEIVER

MODEL HW-30