

## CAUTION

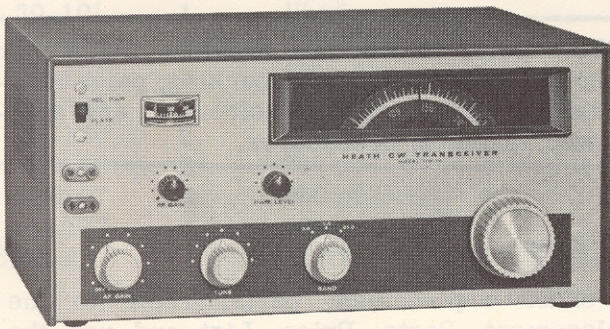
USE EXTREME CARE DURING INITIAL TESTING AND ALL SUBSEQUENT OPERATION OF THIS CW TRANSCEIVER. WHILE THE HW-16 IS DESIGNED FOR MAXIMUM SAFETY, NEVER LOSE RESPECT FOR THE HIGH VOLTAGE PRESENT IN THIS UNIT. ALWAYS PROTECT YOURSELF AGAINST LETHAL OR SEVERE ELECTRIC SHOCK.

Assembly  
and  
Operation  
of the



# CW TRANSCEIVER

MODEL HW-16



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HEATH COMPANY

BENTON HARBOR, MICHIGAN 49022



# INTRODUCTION

The Heathkit Model HW-16 CW Transceiver is a high performance and economical amateur radio receiver and transmitter. Although it is designed with the Novice Class operator in mind, this Transceiver is also an excellent piece of equipment for the General Class operator. The Transceiver provides full break-in CW communications in the lower 250 kHz segments of the 80-, 40-, and 15-meter bands.

The transmitter is crystal-controlled, using 80-meter crystals on 80- or 40-meter bands, and 40-meter crystals on 40- or 15-meter bands. The Transceiver also has provisions for an external VFO.

Input power to the final stage is adjustable for 50 to 90 watts input. A 75 watt marker on the meter, which indicates plate current, represents maximum power for Novice Class operation. All three stages of the transmitter are grid-block keyed. The only tuning required when changing bands or frequency is adjusting the final Tune capacitor.

The receiver uses dual conversion for excellent image rejection and the receiver's front end is

crystal controlled for excellent stability. For high selectivity, the receiver uses a 500 Hz crystal filter. The receiver is automatically muted each time the key is depressed, providing full break-in operation. No external antenna relay is required, as antenna switching is accomplished within the Transceiver.

The following equipment will be necessary for the initial test and alignment of the Transceiver.

1. An 11 megohm input VTVM (a 20 K $\Omega$ /V VOM may also be used).
2. A 50  $\Omega$  nonreactive dummy load that is capable of 100 watts dissipation, such as the Heathkit Cantenna, Model HN-31.
3. Crystals:
  - 7.030 MHz or slightly higher frequency.
  - 3500 kHz or slightly higher frequency.
  - 3750 kHz or slightly lower frequency.

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

# PARTS LIST

NOTE: The numbers in parentheses in the Parts List are keyed to the numbers on the Parts Pictorial (fold-out from Page 5) to aid in parts identification.

To order replacement parts, refer to the Replacement Parts Price List and use the Parts Order Form furnished with this kit.

| PART No.         | PARTS Per Kit | DESCRIPTION                          |
|------------------|---------------|--------------------------------------|
| <b>RESISTORS</b> |               |                                      |
| <b>1/2 Watt</b>  |               |                                      |
| (1) 1-41         | 3             | 10 $\Omega$ (brown-black-black)      |
| 1-54             | 1             | 15 $\Omega$ (brown-green-black)      |
| 1-66             | 2             | 150 $\Omega$ (brown-green-brown)     |
| 1-42             | 1             | 270 $\Omega$ (red-violet-brown)      |
| 1-6              | 1             | 470 $\Omega$ (yellow-violet-brown)   |
| 1-9              | 4             | 1000 $\Omega$ (brown-black-red)      |
| 1-13             | 1             | 2700 $\Omega$ (red-violet-red)       |
| 1-14             | 4             | 3300 $\Omega$ (orange-orange-red)    |
| 1-18             | 2             | 5600 $\Omega$ (green-blue-red)       |
| 1-20             | 4             | 10 K $\Omega$ (brown-black-orange)   |
| 1-21             | 1             | 15 K $\Omega$ (brown-green-orange)   |
| 1-22             | 3             | 22 K $\Omega$ (red-red-orange)       |
| 1-25             | 5             | 47 K $\Omega$ (yellow-violet-orange) |
| 1-60             | 1             | 68 K $\Omega$ (blue-gray-orange)     |
| 1-26             | 5             | 100 K $\Omega$ (brown-black-yellow)  |

| PART No.                              | PARTS Per Kit | DESCRIPTION                           |
|---------------------------------------|---------------|---------------------------------------|
| <b>Resistors (1/2 Watt) (cont'd.)</b> |               |                                       |
| 1-121                                 | 1             | 120 K $\Omega$ (brown-red-yellow)     |
| 1-29                                  | 2             | 220 K $\Omega$ (red-red-yellow)       |
| 1-99                                  | 2             | 240 K $\Omega$ (red-yellow-yellow)    |
| 1-31                                  | 1             | 330 K $\Omega$ (orange-orange-yellow) |
| 1-33                                  | 1             | 470 K $\Omega$ (yellow-violet-yellow) |
| 1-35                                  | 2             | 1 megohm (brown-black-green)          |
| 1-36                                  | 3             | 1.5 megohm (brown-green-green)        |
| <b>1 Watt</b>                         |               |                                       |
| (2) 1-2-1                             | 1             | 1000 $\Omega$ (brown-black-red)       |
| 1-5-1                                 | 1             | 22 K $\Omega$ (red-red-orange)        |
| 1-7-1                                 | 3             | 47 K $\Omega$ (yellow-violet-orange)  |
| 1-8-1                                 | 1             | 68 K $\Omega$ (blue-gray-orange)      |

| PART No.               | PARTS Per Kit | DESCRIPTION                          | PART No.  | PARTS Per Kit | DESCRIPTION   |
|------------------------|---------------|--------------------------------------|---|---------------|---|
| <b>2 Watt</b>          |               |                                      | <b>Other Capacitors</b>   |               |   |
| (3)1-13-2              | 1             | 220 $\Omega$ (red-red-brown)         | (11)21-29   | 1             | 4.7 pf tubular  |
| 1-17-2                 | 1             | 6800 $\Omega$ (blue-gray-red)        | (12)31-31   | 1             | 3-12 pf trimmer   |
| 1-11-2                 | 2             | 22 K $\Omega$ (red-red-orange)       | (13)26-113  | 2             | 54 pf variable  |
| 1-18-2                 | 2             | 33 K $\Omega$ (orange-orange-orange) | <b>COILS</b>  |               |   |
| 1-10-2                 | 1             | 47 K $\Omega$ (yellow-violet-orange) | NOTE: Do not remove coils from their envelopes until they are called for in the assembly steps. |               |   |
| 1-24-2                 | 2             | 100 K $\Omega$ (brown-black-yellow)  | (14)40-79   | 1             | 40-meter oscillator coil                                      |
| <b>Other Resistors</b> |               |                                      | (15)40-360  | 1             | 15-meter heterodyne oscillator coil                           |
| (4)3-19-5              | 1             | 330 $\Omega$ 5 watt                  | 40-363  | 1             | 15-meter RF coil  |
| 3-9-7                  | 1             | 100 $\Omega$ 7 watt                  | 40-795  | 1             | 80-meter RF coil  |
| <b>CAPACITORS</b>      |               |                                      | 40-796  | 1             | 40-meter RF coil  |
| <b>Resin</b>           |               |                                      | 40-797  | 2             | 40/80-meter heterodyne oscillator coil                        |
| (5)20-130              | 2             | 12 pf                                | (16)40-798  | 1             | 80/40/15-meter final coil                                     |
| 20-99                  | 1             | 22 pf                                | (17)40-799  | 1             | VFO shielded coil   |
| 20-96                  | 2             | 36 pf                                | 40-801  | 1             | 80-meter driver coil (shielded)                               |
| 20-101                 | 1             | 47 pf                                | 40-802  | 1             | 40-meter driver coil (shielded)                               |
| 20-110                 | 2             | 75 pf                                | 40-803  | 1             | 15-meter driver coil (shielded)                               |
| 20-102                 | 5             | 100 pf                               | (18)40-800  | 1             | Crystal filter coil (shielded)                                |
| 20-104                 | 1             | 130 pf                               | <b>CHOKES</b>   |               |   |
| 20-108                 | 2             | 200 pf                               | (19)45-30   | 3             | .5 mH RF choke  |
| 20-106                 | 2             | 390 pf                               | (20)45-3  | 1             | 1 mH RF choke   |
| 20-107                 | 2             | 680 pf                               | (21)45-19   | 1             | Parasitic RF choke (wound on 47 $\Omega$ yellow-violet-black) |
| 20-122                 | 3             | 1000 pf                              | <b>TRANSFORMERS</b>   |               |   |
| (6)27-47               | 1             | .1 $\mu$ fd                          | 51-55   | 1             | AF output transformer   |
| <b>Disc</b>            |               |                                      | (22)52-71   | 1             | IF transformer  |
| (7)21-3                | 4             | 10 pf                                | (23)52-102  | 1             | Bandpass coupler transformer                                  |
| 21-7                   | 1             | 33 pf                                | 54-179  | 1             | Power transformer   |
| 21-49                  | 1             | 68 pf 4KV                            | <b>DIODES-TRANSISTOR</b>  |               |   |
| 21-139                 | 1             | 150 pf 2KV or 4KV                    | 56-26   | 1             | 1N191 crystal diode (brown-white-brown)                       |
| 21-56                  | 2             | 470 pf                               | (25)57-27   | 6             | Silicon diode   |
| 21-14                  | 6             | .001 $\mu$ fd                        | (26)417-150   | 1             | 2N1274 transistor   |
| 21-71                  | 2             | .001 $\mu$ fd 1.4 KV                 |   |               |   |
| 21-36                  | 1             | .002 $\mu$ fd                        |   |               |   |
| 21-57                  | 33            | .005 $\mu$ fd                        |   |               |   |
| 21-35                  | 1             | .005 $\mu$ fd 1.6 KV                 |   |               |   |
| 21-31                  | 8             | .02 $\mu$ fd                         |   |               |   |
| <b>Electrolytic</b>    |               |                                      |   |               |   |
| (8)25-54               | 1             | 10 $\mu$ fd                          |   |               |   |
| (9)25-206              | 1             | 20-20 $\mu$ fd                       |   |               |   |
| (10)25-179             | 1             | 50-40-80-80 $\mu$ fd                 |   |               |   |
| 25-17                  | 2             | 50 $\mu$ fd                          |   |               |   |

| PART No.                   | PARTS Per Kit | DESCRIPTION   | PART No.                             | PARTS Per Kit | DESCRIPTION                            |
|----------------------------|---------------|---|--------------------------------------|---------------|--|
| <b>TUBES</b>               |               |   | <b>Sockets-Jacks-Plugs (cont'd.)</b> |               |  |
| 411-26                     | 1             | 12AX7   | (41)434-112                          | 2             | 7-pin circuit board type tube socket   |
| 411-63                     | 2             | 6CL6  | (42)434-121                          | 1             | 12-pin compactron tube socket          |
| 411-124                    | 2             | 6EA8  | (43)436-4                            | 2             | Phone jack                             |
| 411-170                    | 2             | 6EW6  | (44)438-3                            | 1             | Phone plug                             |
| 411-171                    | 1             | 6HF8  | (45)438-4                            | 3             | Phono plug                             |
| 411-185                    | 1             | 6GE5  | (46)431-10                           | 2             | 3-lug terminal strip                   |
| <b>CRYSTALS</b>            |               |   | 431-11                               | 1             | 5-lug terminal strip                   |
| (27)404-206                | 1             | 3396.4 kHz product detector                             | 431-12                               | 3             | 4-lug terminal strip                   |
| 404-301                    | 1             | 9.045 MHz   | 431-16                               | 2             | 2-lug terminal strip                   |
| 404-302                    | 1             | 12.545 MHz  | 431-55                               | 1             | 6-lug terminal strip                   |
| 404-303                    | 1             | 26.545 MHz  | (47)481-1                            | 1             | 4-prong metal capacitor mounting wafer |
| 404-305                    |               | Matched set of crystals consisting of the following:    | (48)481-4                            | 2             | 3-prong fiber capacitor mounting wafer |
| 404-241                    | 1             | 3395.150 kHz  | (49)206-54                           | 2             | Tube shield                            |
| 404-242                    | 1             | 3395.450 kHz  |                                      |               |  |
| <b>LAMPS</b>               |               |   | <b>COAXIAL CABLE-WIRE-SLEEVING</b>   |               |  |
| 412-1                      | 2             | 6 volt incandescent                                     | 343-7                                | 1             | Coaxial cable                          |
| (28)412-34                 | 1             | Neon  | 344-50                               | 1             | Black hookup wire                      |
| <b>CONTROLS-SWITCHES</b>   |               |   | 344-51                               | 1             | Brown hookup wire                      |
| (29)10-33                  | 1             | 200 $\Omega$ control (RF Gain)                          | 344-52                               | 1             | Red hookup wire                        |
| 11-78                      | 1             | 15 K $\Omega$ control (Power-Level)                     | 344-54                               | 1             | Yellow hookup wire                     |
| (30)19-72                  | 1             | 500 K $\Omega$ control with switch (AF Gain and Off-On) | 344-55                               | 1             | Green hookup wire                      |
| (31)60-4                   | 1             | SPDT slide switch (Rel-Pwr-Plate)                       | 344-56                               | 1             | Blue hookup wire                       |
| (32)63-436                 | 1             | 4-section band switch                                   | 344-59                               | 1             | White hookup wire                      |
| (33)65-10                  | 1             | 3 ampere circuit breaker                                | 340-3                                | 1             | Large bare wire                        |
| <b>SOCKETS-JACKS-PLUGS</b> |               |   | 340-8                                | 1             | Small bare wire                        |
| (34)434-2                  | 1             | Octal tube socket                                       | 346-4                                | 1             | Sleeving                               |
| (35)434-38                 | 1             | Large crystal socket                                    | <b>HARDWARE</b>                      |               |  |
| (36)434-42                 | 3             | Phono socket  | <b>#3 Hardware</b>                   |               |  |
| (37)434-43                 | 2             | 9-pin, shielded tube socket                             | (50)250-49                           | 26            | 3-48 x 1/4" screw                      |
| (38)434-74                 | 1             | Small crystal socket                                    | (51)254-7                            | 29            | #3 lockwasher                          |
| (39)434-79                 | 4             | 9-pin circuit board type tube socket                    | (52)252-1                            | 26            | 3-48 x 3/16" nut                       |
| (40)434-90                 | 2             | Miniature pilot lamp socket with bracket                | <b>#4 Hardware</b>                   |               |  |
|                            |               |   | (53)250-34                           | 2             | 4-40 x 1/2" screw (retain in envelope) |
|                            |               |   | (54)252-15                           | 2             | 4-40 x 3/16" nut (retain in envelope)  |

| PART No. | PARTS Per Kit | DESCRIPTION |
|----------|---------------|-------------|
|----------|---------------|-------------|

| PART No. | PARTS Per Kit | DESCRIPTION |
|----------|---------------|-------------|
|----------|---------------|-------------|

**#6 Hardware**

|              |    |                         |
|--------------|----|-------------------------|
| (55) 250-138 | 8  | 6-32 x 3/16" screw      |
| (56) 250-56  | 36 | 6-32 x 1/4" screw       |
| (57) 250-116 | 4  | 6-32 x 1/4" black screw |
| (58) 250-8   | 10 | #6 sheet metal screw    |
| (59) 250-162 | 4  | 6-32 x 1/2" screw       |
| (60) 254-1   | 59 | #6 lockwasher           |
| (61) 252-3   | 44 | 6-32 x 1/4" nut         |
| (62) 252-22  | 4  | 6-32 speednut           |
| (63) 259-1   | 3  | #6 solder lug           |
| (64) 259-6   | 3  | #6 small solder lug     |

**METAL PARTS**

|              |   |                       |
|--------------|---|-----------------------|
| 90-358       | 1 | Top cover             |
| (81) 100-43  | 1 | Dial hub assembly     |
| 200-485-1    | 1 | Chassis               |
| 203-479-1    | 1 | Front panel           |
| (82) 204-102 | 1 | Shield bracket        |
| 205-260      | 1 | Plate, chassis bottom |
| (83) 206-334 | 1 | Small shield plate    |
| (84) 206-335 | 1 | Large shield plate    |
| (85) 206-336 | 1 | RF shield             |

**MISCELLANEOUS**

|              |   |   |
|--------------|---|---|
| 73-1         | 1 | 3/8" rubber grommet                       |
| 73-4         | 1 | 5/16" rubber grommet                      |
| 75-24        | 1 | Line cord strain relief                   |
| 89-1         | 1 | Line cord                                 |
| 85-173-1     | 1 | Circuit board                             |
| (86) 100-624 | 1 | Dial drive assembly                       |
| (87) 407-121 | 1 | Meter                                     |
| 464-29-5     | 1 | Dial                                      |
| 453-39       | 1 | Shaft, 5-13/16" long                      |
| 462-122      | 3 | Gray knob with skirt and pointer          |
| 462-258      | 2 | Dark green knob                           |
| 462-189      | 1 | 2" gray knob                              |
| 446-59       | 1 | Escutcheon                                |
| (88) 346-25  | 1 | Black tubing                              |
| (89) 260-7   | 4 | IF transformer clip                       |
| 261-9        | 4 | Rubber foot                               |
| 489-1        | 1 | Sandpaper                                 |
| 490-5        | 1 | Nut starter                               |
| 490-1        | 1 | Alignment tool                            |
| 391-34       | 1 | Identification label                      |
| 597-260      | 1 | Parts Order Form                          |
| 597-308      | 1 | Kit Builders Guide                        |
|              | 1 | Manual (See front cover for part number.) |
|              |   | Solder                                    |

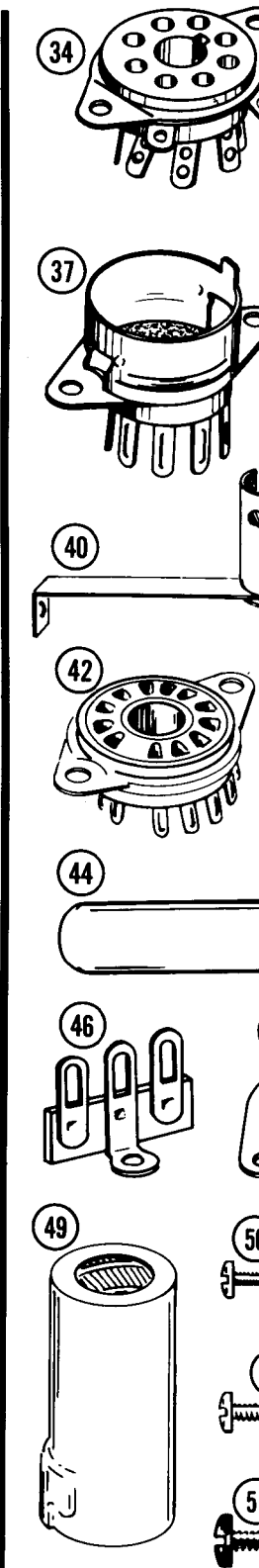
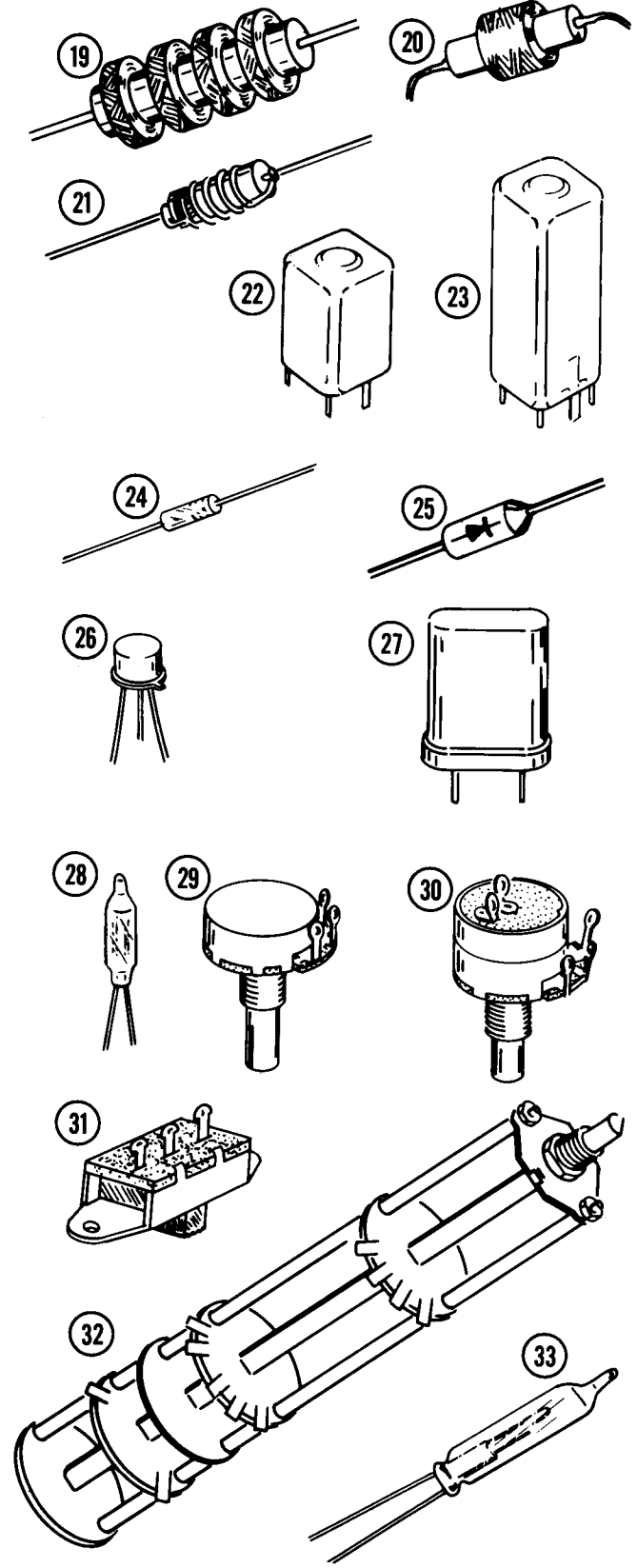
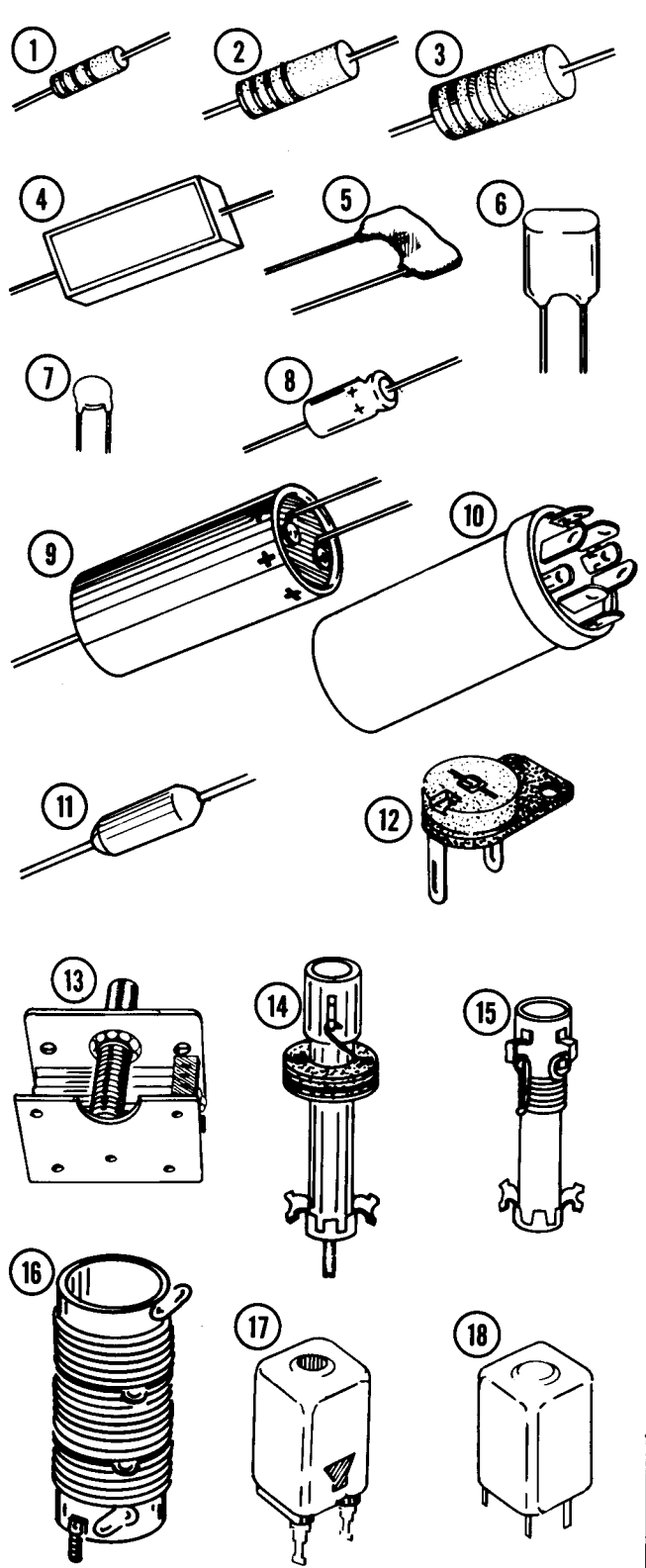
**#8 Hardware**

|             |   |                       |
|-------------|---|-----------------------|
| (65) 250-16 | 1 | 8-32 x 3/16" setscrew |
| (66) 250-92 | 1 | 8-32 x 5/8" screw     |
| (67) 253-9  | 4 | #8 small flat washer  |
| (68) 253-45 | 2 | #8 large flat washer  |
| (69) 254-2  | 5 | #8 lockwasher         |
| (70) 252-4  | 5 | 8-32 nut              |
| (71) 252-28 | 1 | 8-32 knurled nut      |
| (72) 259-24 | 4 | #8 wire lug           |

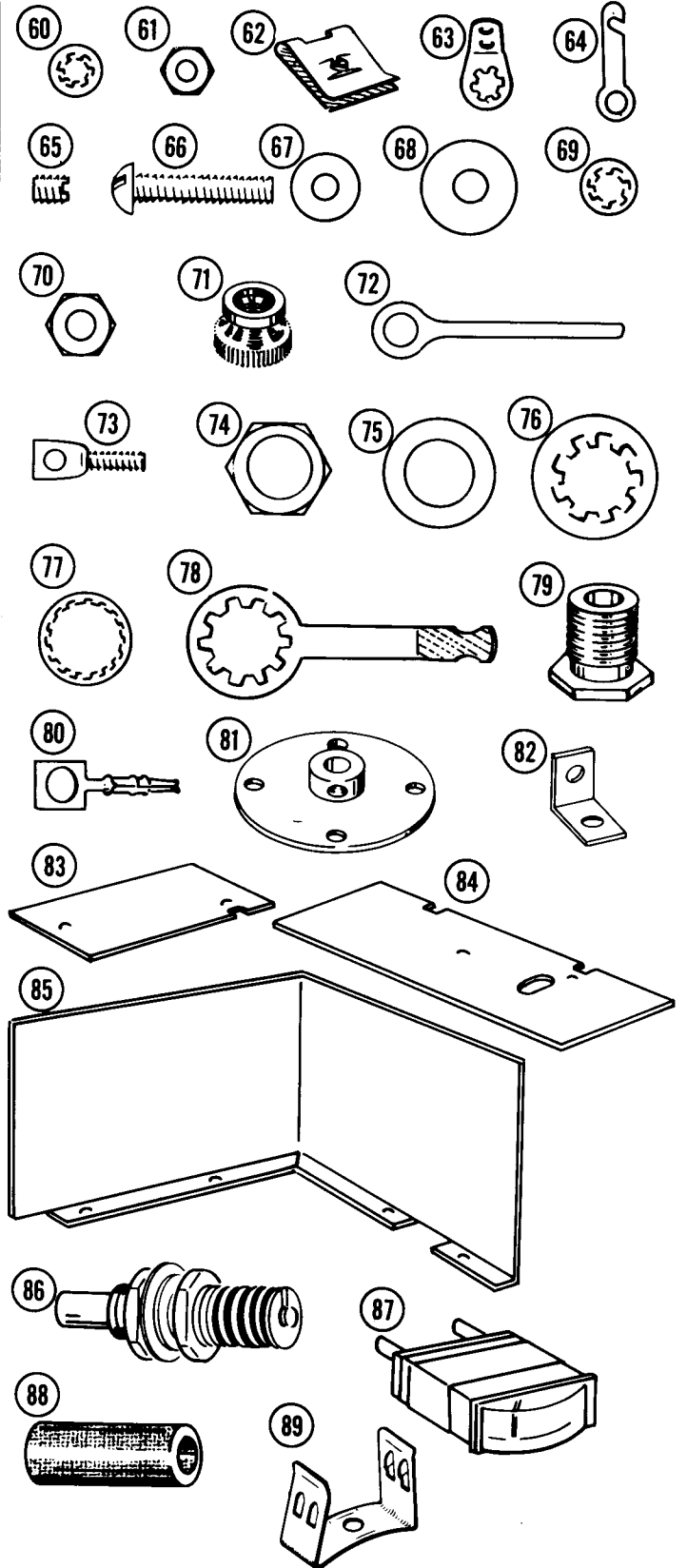
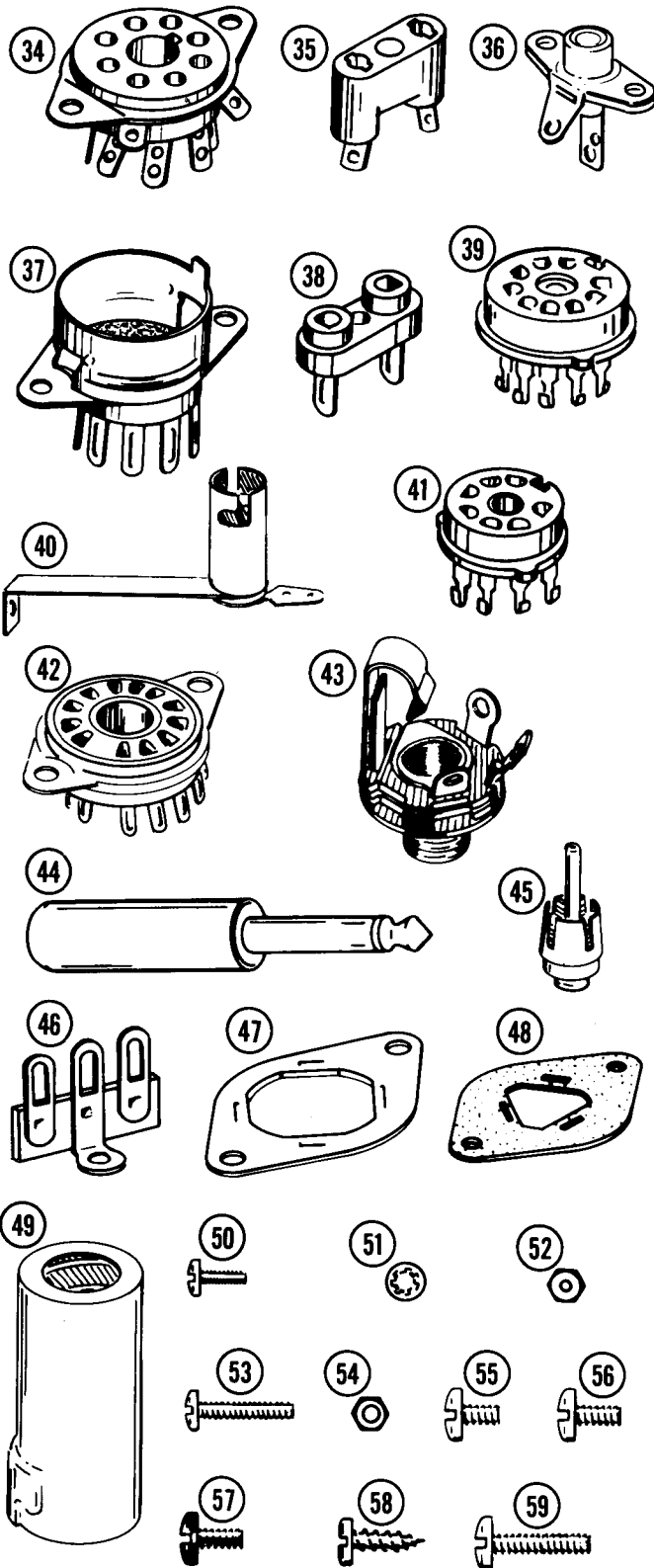
**Other Hardware**

|             |   |                         |
|-------------|---|-------------------------|
| (73) 251-1  | 3 | 6-32 spade bolt         |
| (74) 252-7  | 7 | Control nut             |
| (75) 253-10 | 8 | Control flat washer     |
| (76) 254-4  | 6 | Control lockwasher      |
| (77) 254-5  | 1 | Thin control lockwasher |
| (78) 259-10 | 1 | Control solder lug      |
| (79) 455-9  | 1 | Bushing                 |
| (80) 259-20 | 1 | Terminal pin            |

# PARTS PICTORIAL



# PARTS PICTORIAL





## STEP-BY-STEP ASSEMBLY

### CIRCUIT BOARD ASSEMBLY

Before you start the circuit board assembly be sure to read the Circuit Board Parts Mounting and the Soldering sections (Pages 11, 12, and 13) of the Kit Builders Guide.

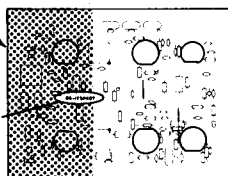
Use 1/2 watt resistors unless the step directs otherwise. All resistors will be called out by only the resistance value (in  $\Omega$ ,  $K\Omega$ , or megohms) and the color code. Capacitors will be called by only the capacitance and type. Use hookup wire of

the color specified when wire is called for in a step. Cut the wires to the proper length and remove insulation from each end as directed. Position each wire as shown.

Refer to Pictorial 1. Position the circuit board on your work surface as shown in Pictorial 1. Due to its large size, only a small portion of the circuit board is shown in each of the next three Pictorials; the complete board is shown in Pictorial 4.

Complete each step on Pictorials 1, 2, 3, and 4.

The steps performed in this Pictorial are in this area of the circuit board.



START

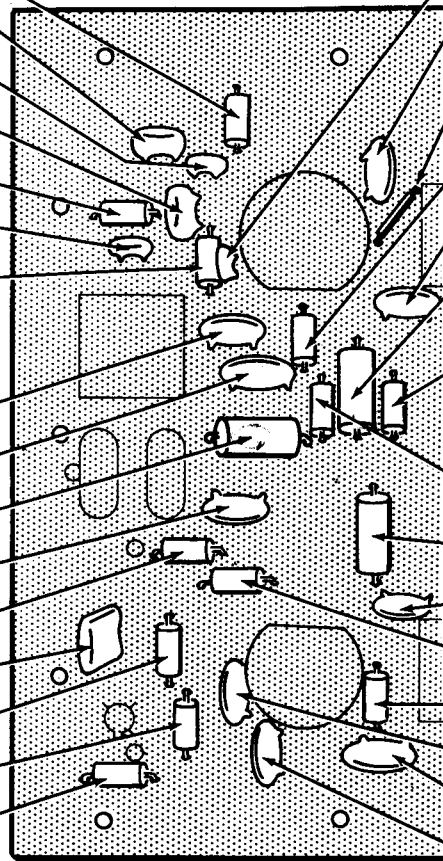


PART NUMBER

CONTINUE



- ( ) 1000  $\Omega$  (brown-black-red).
- ( ) 1000 pf resin.
- ( ) 680 pf resin.
- ( ) 1000 pf resin.
- ( ) 1000  $\Omega$  (brown-black-red).
- ( ) 100 pf resin.
- ( ) 100 K $\Omega$  (brown-black-yellow).
- ( ) Solder all leads to the foil and cut off the excess lead lengths.
- ( ) .005  $\mu$ fd disc.
- ( ) .02  $\mu$ fd disc.
- ( ) 47 K $\Omega$  1 watt (yellow-violet-orange).
- ( ) .005  $\mu$ fd disc.
- ( ) 22 K $\Omega$  (red-red-orange).
- ( ) .1  $\mu$ fd Mylar.
- ( ) 220 K $\Omega$  (red-red-yellow).
- ( ) 120 K $\Omega$  (brown-red-yellow).
- ( ) 10 K $\Omega$  (brown-black-orange).
- ( ) Solder all leads to the foil and cut off the excess lead lengths.



- ( ) 100 pf resin.
- ( ) .005  $\mu$ fd disc.
- ( ) 1-1/2" wire. Use yellow hookup wire with 1/2" of insulation removed from each end.
- ( ) 3300  $\Omega$  (orange-orange-red).
- ( ) .005  $\mu$ fd disc.
- ( ) 47 K $\Omega$  1 watt (yellow-violet-orange).
- ( ) 1.5 megohm (brown-green-green).
- ( ) Solder all leads to the foil and cut off the excess lead lengths.
- ( ) 47 K $\Omega$  (yellow-violet-orange).
- ( ) 68 K $\Omega$  1 watt (blue-gray orange).
- ( ) .005  $\mu$ fd disc.
- ( ) 3300  $\Omega$  (orange-orange-red).
- ( ) 5600  $\Omega$  (green-blue-red).
- ( ) .005  $\mu$ fd disc.
- ( ) .02  $\mu$ fd disc.
- ( ) .005  $\mu$ fd disc.
- ( ) Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 1

PROCEED TO PICTORIAL 2.

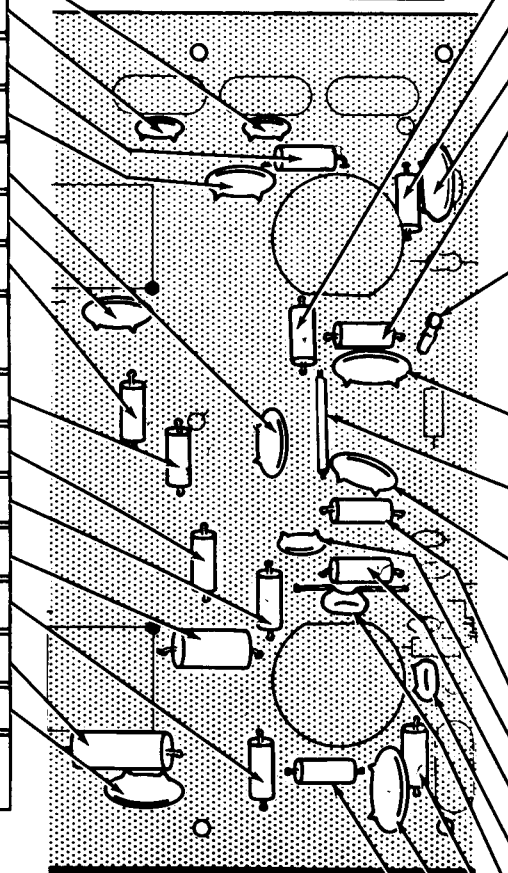
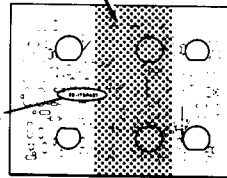
The steps performed in this Pictorial are in this area of the circuit board.

**START** ↓

**CONTINUE** ↓

- ( ) 10 pf disc.
- ( ) 10 pf disc.
- ( ) 1000 Ω (brown-black-red).
- (✓) .005 μfd disc.
- (✓) .005 μfd disc.
- (✓) .005 μfd disc.
- ( ) 100 KΩ (brown-black-yellow).
- ( ) Solder all leads to the foil and cut off the excess lead lengths.
- ( ) 10 Ω (brown-black-black).
- ( ) 150 Ω (brown-green-brown).
- ( ) 3300 Ω (orange-orange-red).
- ( ) 4.7 pf tubular.
- ( ) 3300 Ω (orange-orange-red).
- (✓) 22 KΩ 1 watt (red-red-orange).
- ( ) .02 μfd disc.
- (✓) Solder all leads to the foil and cut off the excess lead lengths.

PART NUMBER



- (✓) 1 megohm (brown-black-green).
  - ( ) 10 KΩ (brown-black-orange).
  - (✓) .005 μfd disc.
  - ( ) 240 KΩ (red-yellow-yellow).
  - (✓) Install terminal pin (#259-20) at "test point" location on circuit board.
- 
- ( ) .02 μfd disc.
  - (✓) 1-3/4" wire. Use yellow hook-up wire with 1/2" of insulation removed from each end.
  - (✓) .005 μfd disc.
  - ( ) Solder all leads to the foil and cut off the excess lead lengths.
  - (✓) 240 KΩ (red-yellow-yellow).
  - ( ) 470 pf disc.
  - (✓) 47 KΩ (yellow-violet-orange).
  - ( ) 36 pf resin.
  - ( ) 200 pf resin.
  - (✓) 47 KΩ (yellow-violet-orange).
  - ( ) .02 μfd disc.
  - (✓) 68 KΩ (blue-gray-orange).
  - (✓) Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 2

PROCEED TO PICTORIAL 3.

The steps performed in this Pictorial are in this area of the circuit board.

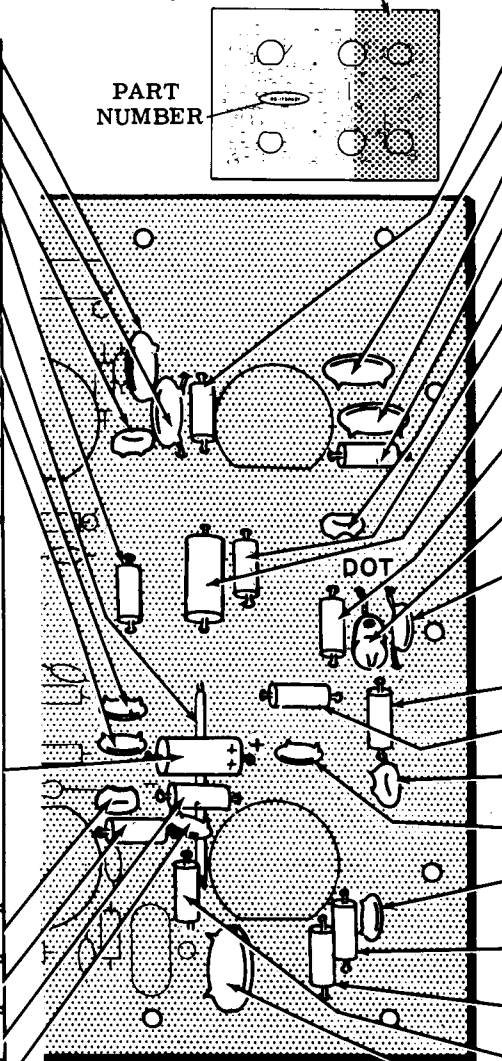
START



CONTINUE



- (.) .005  $\mu$ fd disc.
  - (.) .005  $\mu$ fd disc.
  - (.) 22 pf resin.
  - (.) 1 megohm (brown-black-green).
  - (.) 2-1/4" wire. Use yellow hookup wire with 1/2" of insulation removed from each end.
  - (.) .001  $\mu$ fd disc.
  - (.) 470 pf disc.
  - (.) Solder all leads to the foil and cut off the excess lead lengths.
  - (.) 10  $\mu$ fd electrolytic. NOTE: When mounting electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.
- POSITIVE (+) END
- (.) 100 pf resin.
  - (.) 2700  $\Omega$  (red-violet red).
  - (.) 270  $\Omega$  (red-violet-brown).
  - (.) .001  $\mu$ fd disc.
  - (.) Solder all leads to the foil and cut off the excess lead lengths.



- (.) 47 K $\Omega$  (yellow-violet orange).
- (.) .005  $\mu$ fd disc.
- (.) .005  $\mu$ fd disc.
- (.) 100 K $\Omega$  (brown-black yellow).
- (.) 100 pf resin.
- (.) 10  $\Omega$  (brown-black-black).
- (.) 47 K $\Omega$  1 watt (yellow-violet-orange).
- (.) 1.5 megohm (brown-green-green).
- (.) Neon lamp. Align red dot of neon lamp to red dot on circuit board.
- (.) .002  $\mu$ fd disc.
- (.) Solder all leads to the foil and cut off the excess lead lengths.
- (.) 470 K $\Omega$  (yellow-violet-yellow).
- (.) 100 K $\Omega$  (brown-black-yellow).
- (.) 390 pf resin.
- (.) .001  $\mu$ fd disc.
- (.) .001  $\mu$ fd disc.
- (.) 1.5 megohm (brown-green-green).
- (.) 470  $\Omega$  (yellow-violet-brown).
- (.) 330 K $\Omega$  (orange-orange yellow).
- (.) .005  $\mu$ fd 1.6 KV disc.
- (.) Solder all leads to the foil and cut off the excess lead lengths.

PROCEED TO PICTORIAL 4.

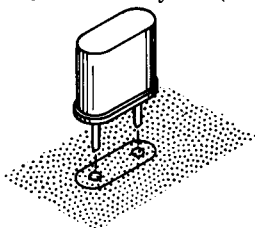
PICTORIAL 3

**START**

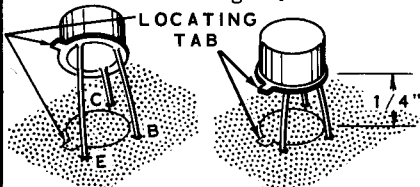


NOTE: Solder the pins of each part as it is installed. Do not bend or cut off the crystal pins after soldering.

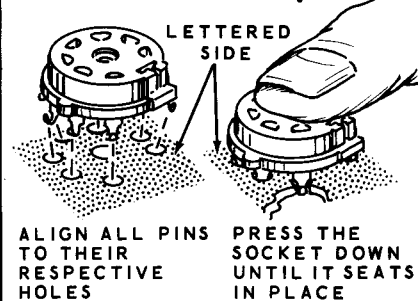
(.) 3395,150 kHz crystal (#404-241).



(.) Install the transistor in the following manner, as shown: First, line up the locating tab of the transistor with the outline of the tab on the circuit board. Then insert the transistor ends into their correct holes, which are indicated by C, B, and E. Position the transistor 1/4" away from the circuit board. Solder each lead to foil and cut off the excess lead lengths.

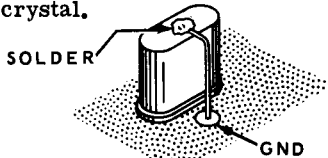


(.) Mount 7-pin circuit board tube sockets at V1 and V4.



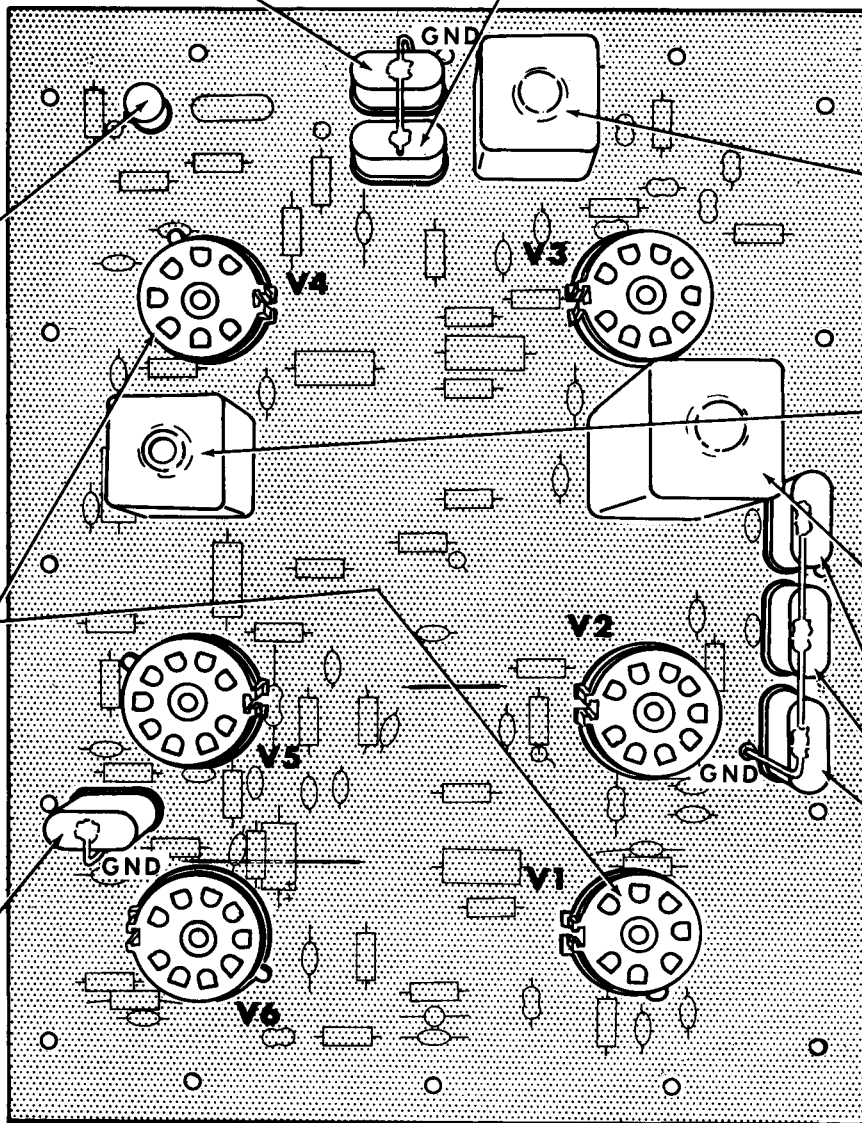
(.) 3396,4 kHz crystal (#404-206).

(.) 1-3/4" small bare wire. Bend wire 90 degrees 1/4" from end. Insert 1-1/2" portion into GND hole in circuit board. Solder wire to crystal. Be careful, excessive heat can damage the crystal.



(.) Turn circuit board over, solder wire to foil, and cut off excess lead.

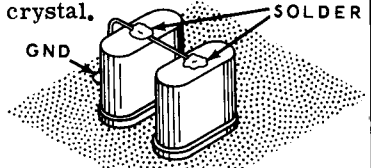
(.) Install 9-pin circuit board tube sockets at V2, V3, V5, and V6.



**PICTORIAL 4**

( ) 3395.450 kHz crystal (#404-242).

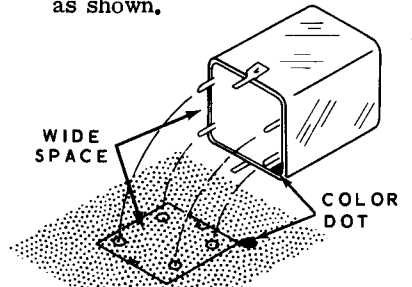
( ) 2-1/2" small bare wire. Bend wire 90 degrees 1" from end. Insert 1-1/2" portion into GND hole in circuit board. Solder wire to each crystal. Be careful, excessive heat can damage the crystal.



( ) Turn circuit board over, solder wire to foil, and cut off excess lead.

( ) Crystal filter coil (#40-800).

( ) 3.395 MHz IF transformer (#52-71). Position the color dots as shown.



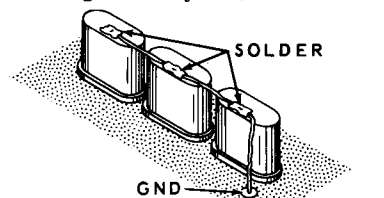
( ) Bandpass transformer (#52-102). Position the transformer color dot over the circuit board color dot.

( ) 9.045 MHz crystal (#404-301).

( ) 12.545 MHz crystal (#404-302).

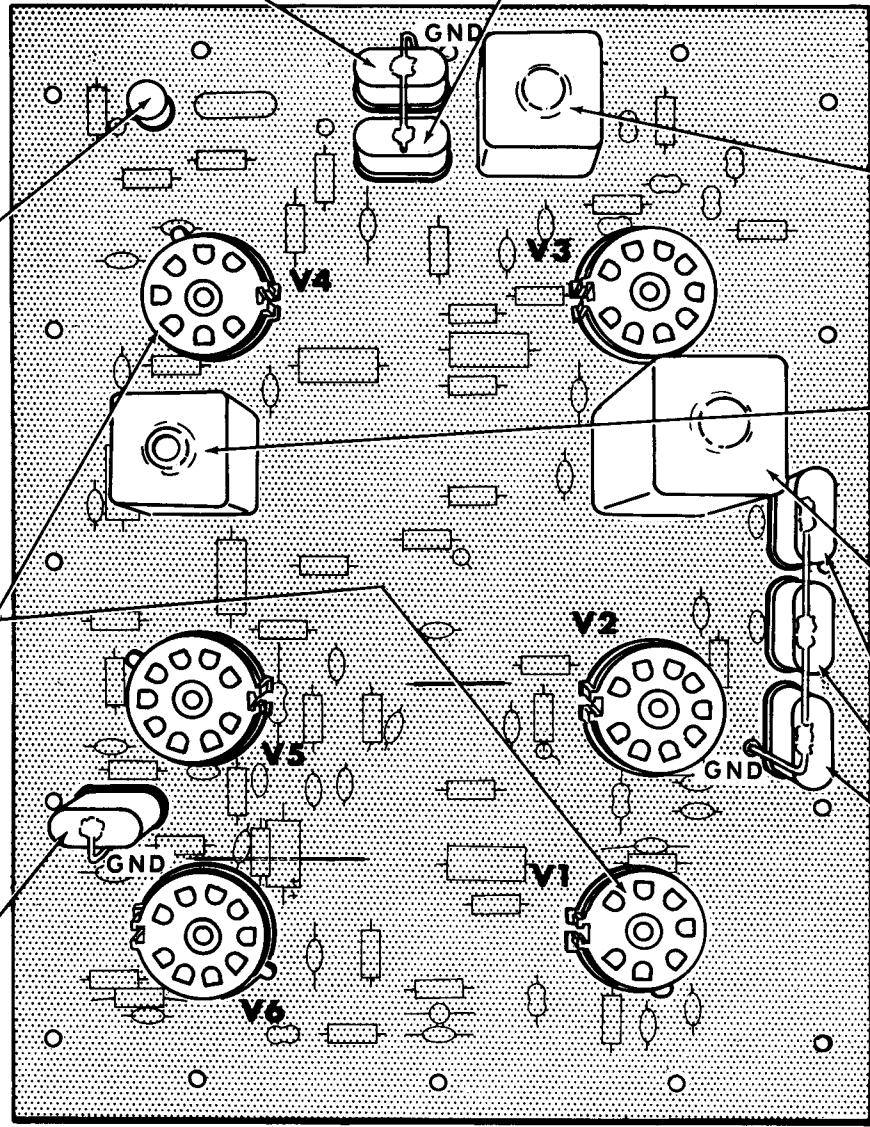
( ) 26.545 MHz crystal (#404-303).

( ) 3-1/2" small bare wire. Bend wire 90 degrees 1-1/2" from end. Insert 1-1/2" portion into GND hole in circuit board. Solder the wire to each crystal. Be careful, excessive heat can damage the crystal.

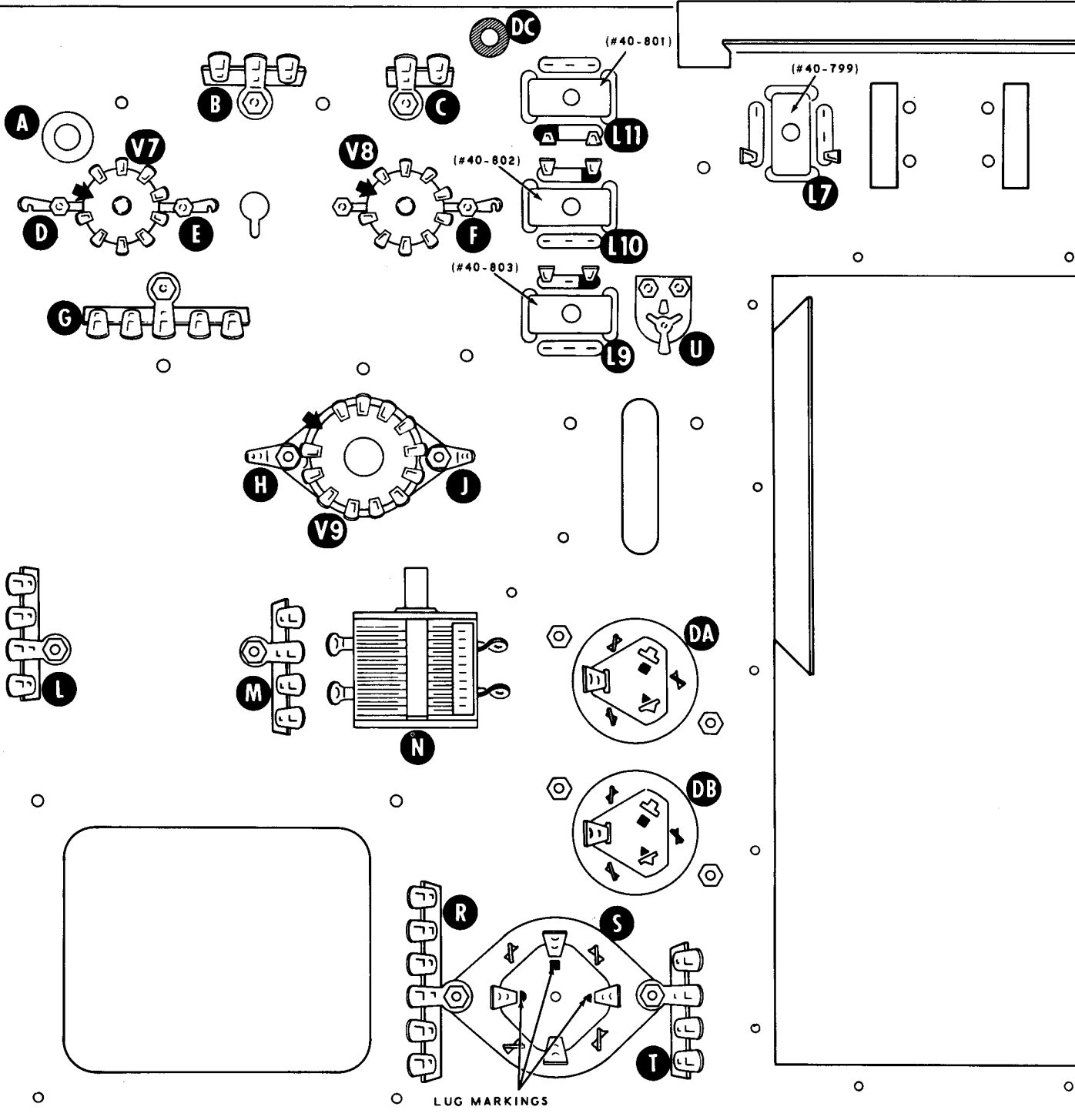


( ) Turn circuit board over, solder wire to foil, and cut off excess lead.

( ) Carefully inspect the foil side of the circuit board and solder any connections that might have been missed. Then set the circuit board aside temporarily.



PICTORIAL 4



**PICTORIAL 5**

## CHASSIS PARTS MOUNTING

NOTE: When hardware is called for in a step, only the screw size will be given. For instance, if 3-48 x 1/4" hardware is called for, it means that a 3-48 x 1/4" screw, one or more #3 lockwashers, and a 3-48 nut should be used. The Detail referred to in the step will show the proper number of lockwashers to use.

Refer to Pictorial 5 for the following steps.

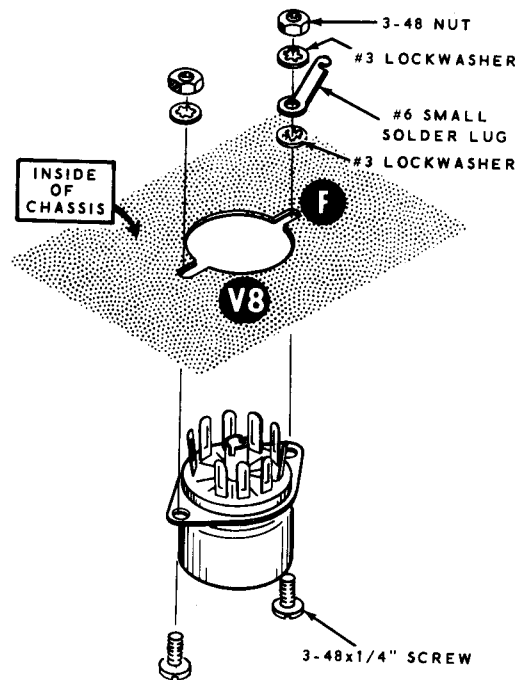
- ( ) Place the chassis bottom side up, as shown in the Pictorial.
- ( ) Install a 3/8" grommet at A.
- ( ) Install a 5/16" grommet at DC.

NOTE: When mounting the tube sockets, position the blank space of each socket as shown by the large arrows in the Pictorial.

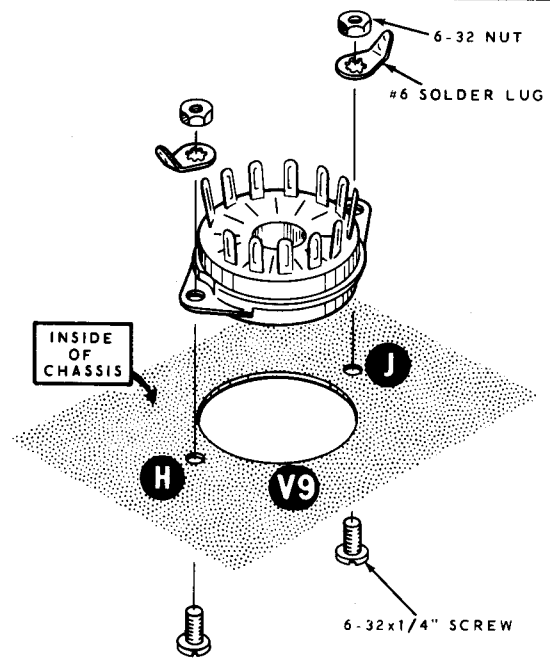
Refer to Detail 5A for the following steps.

NOTE: The Heath Company has provided a plastic nut starter with this kit. Use this nut starter to start 6-32 and 3-48 nuts on screws. Refer to Page 3 of the Kit Builders Guide for further information.

- ( ) Mount a 9-pin tube socket at V8 with one #6 small solder lug at F. Use 3-48 x 1/4" hardware. Bend the solder lug up.
- ( ) Mount a 9-pin tube socket at V7 with two #6 small solder lugs. Locate one solder lug at D and one solder lug at E. Use 3-48 x 1/4" hardware. Bend the solder lugs up.
- ( ) Refer to Detail 5B and mount the 12-pin tube socket at V9 with two #6 solder lugs. Locate one solder lug at H and one solder lug at J. Use 6-32 x 1/4" hardware.

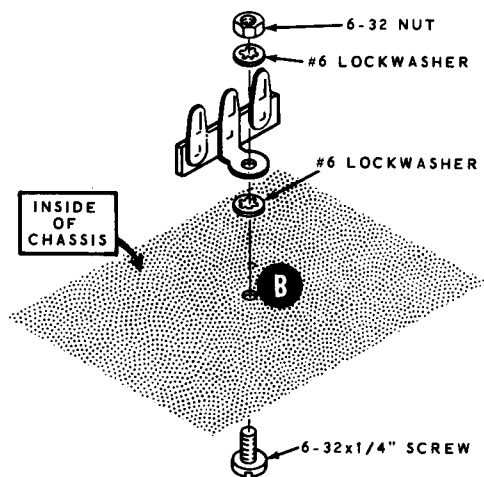


Detail 5A



Detail 5B

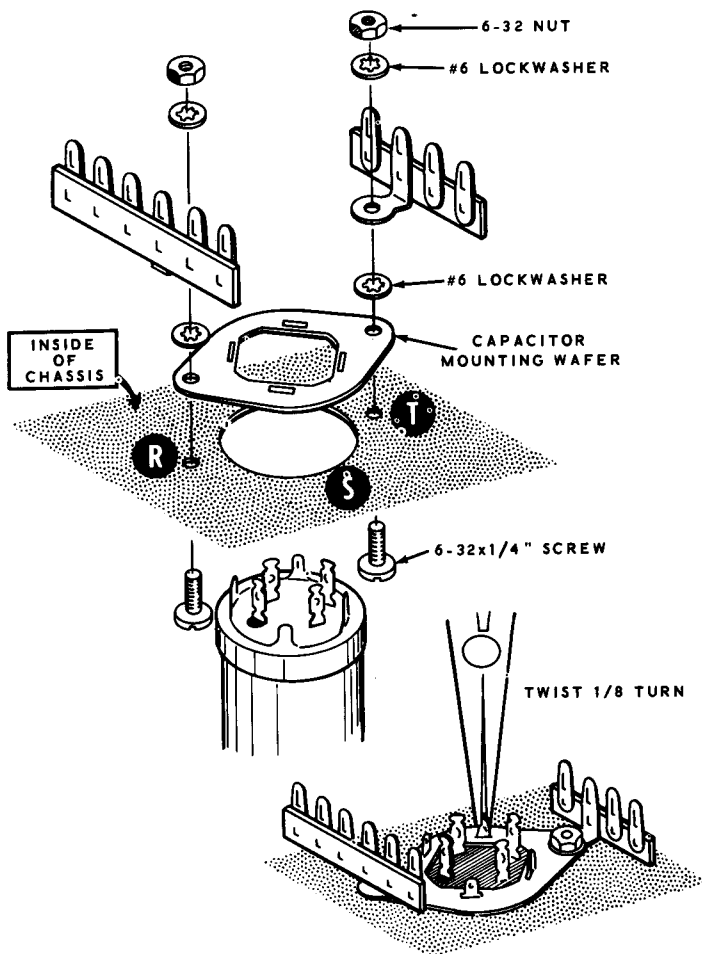




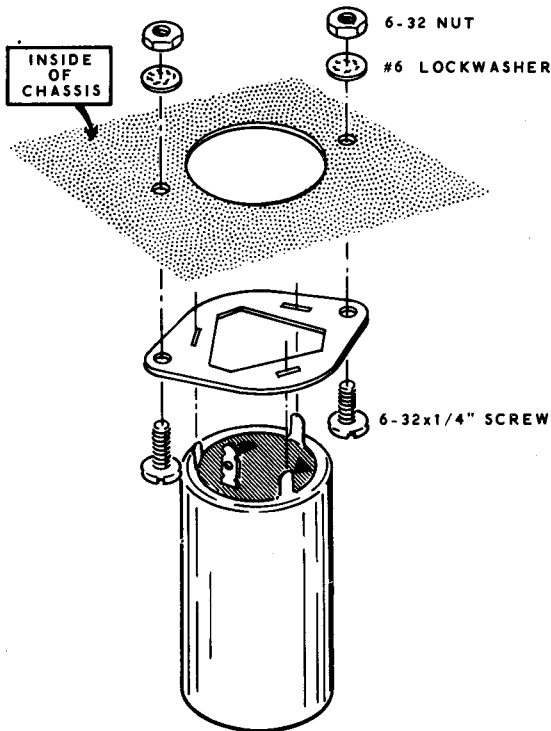
Detail 5C

NOTE: Refer to Detail 5C for mounting terminal strips. Position each terminal strip as shown in the Pictorial.

- ( ) Mount a 3-lug terminal strip at B. Use 6-32 x 1/4" hardware.
- ( ) Mount a 5-lug terminal strip at G. Use 6-32 x 1/4" hardware.
- ( ) Mount two 4-lug terminal strips, one terminal strip at L and one terminal strip at M. Use 6-32 x 1/4" hardware.
- ( ) Mount a 2-lug terminal strip at C. Use 6-32 x 1/4" hardware.
- ( ) Refer to Detail 5D and mount the 4-prong metal capacitor mounting wafer at S with a 6-lug terminal strip at R and a 4-lug terminal strip at T. Use 6-32 x 1/4" hardware.
- ( ) Mount the 50-40-80-80  $\mu$ fd electrolytic capacitor to capacitor wafer S. Twist each mounting lug 1/8 turn. Be sure to position the capacitor lug markings as shown in the Pictorial.

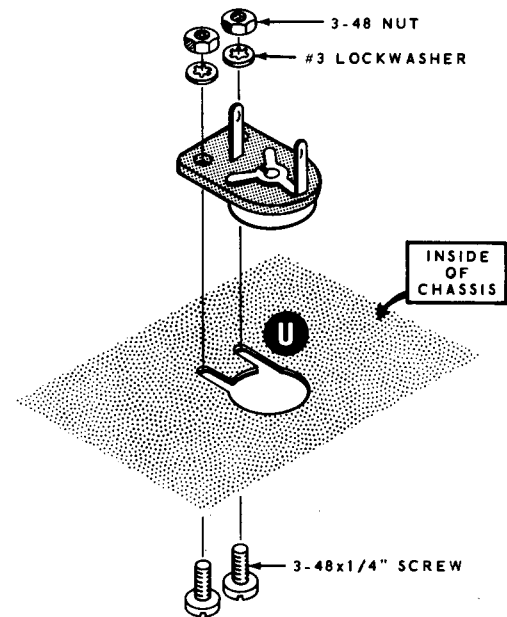


Detail 5D



Detail 5E

- (L) Refer to Detail 5E and mount two 3-prong fiber capacitor mounting wafers, one at DA and the other at DB. Use 6-32 x 1/4" hardware. Be sure to position the wafers as shown in the Pictorial.
- (L) Mount two 50  $\mu$ fd electrolytic capacitors; one mounts to capacitor wafer DA, and the other mounts to capacitor wafer DB. Twist the mounting lugs 1/8 turn each. Be sure to position the capacitor lug markings as shown in the Pictorial.

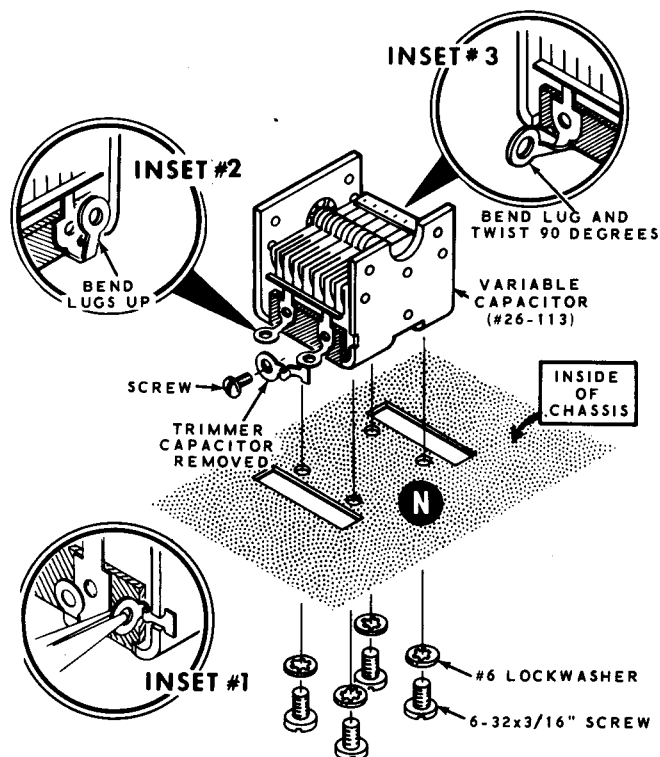


Detail 5F

- (L) Refer to Detail 5F. Mount the ceramic trimmer capacitor at U. Use 3-48 x 1/4" hardware.

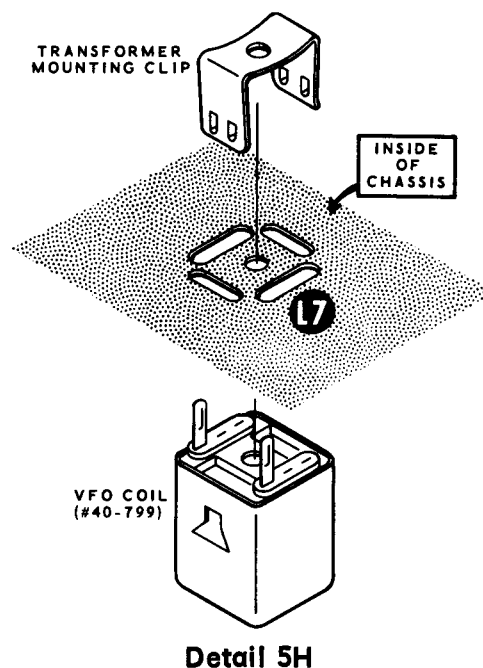
**CAUTION:** In the following steps, keep the plates of the variable capacitor completely meshed to avoid damaging them. Refer to Detail 5G for the following steps.

- (L) Remove the screw from the trimmer capacitor on the side of a variable capacitor (#26-113). Grasp the trimmer capacitor with a pair of pliers and pull it off the frame of the variable capacitor as shown in inset drawing #1 of Detail 5G.



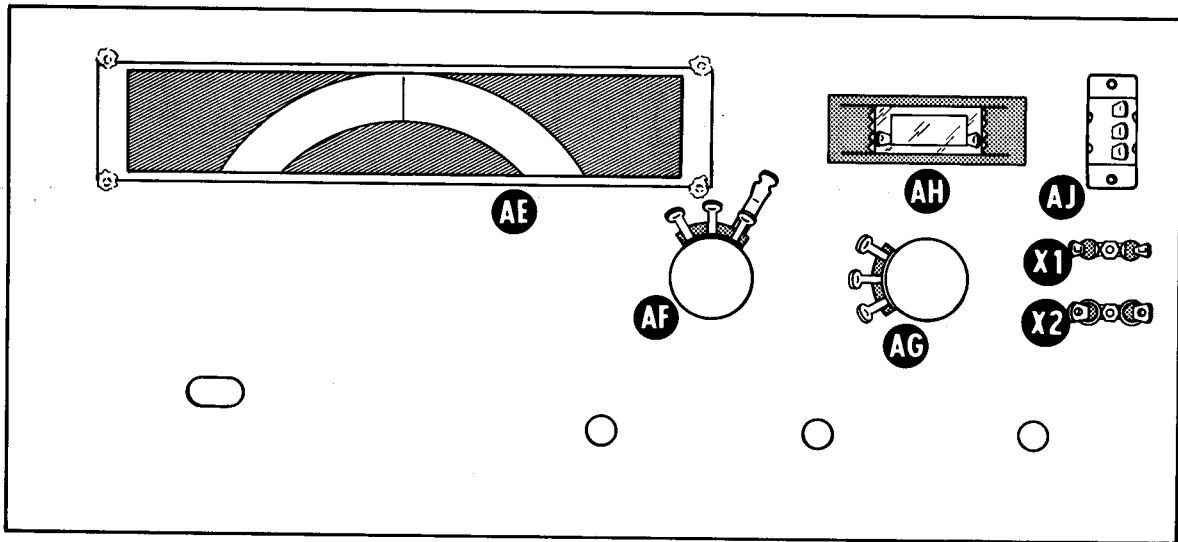
Detail 5G

- ( ) On this same side, bend the lugs up as far as possible as shown in inset drawing #2 of Detail 5G.
- ( ) Bend and twist the lugs on the other side of this variable capacitor as shown in inset drawing #3.
- ( ) Position and mount this variable capacitor at N as shown. Use four 6-32 x 3/16" screws and four #6 lockwashers.



Detail 5H

- ( ) Refer to Detail 5H and mount a VFO coil (#40-799) at L7. Use an IF transformer clip. Place the coil lugs in the position indicated in the Pictorial. Be sure the clip snaps firmly in place.
- ( ) Refer to Detail 5H and mount the 80-meter driver coil (#40-801) at L11. Use an IF transformer clip. Be sure to place each lug as shown in the Pictorial.
- ( ) In a like manner, mount the 40-meter driver coil (#40-802) at L10. Position the coil as shown in the Pictorial.
- ( ) In a like manner, mount the 15-meter coil (#40-803) at L9. Position the coil as shown in the Pictorial.



PICTORIAL 6

Refer to Pictorial 6 for the following steps.

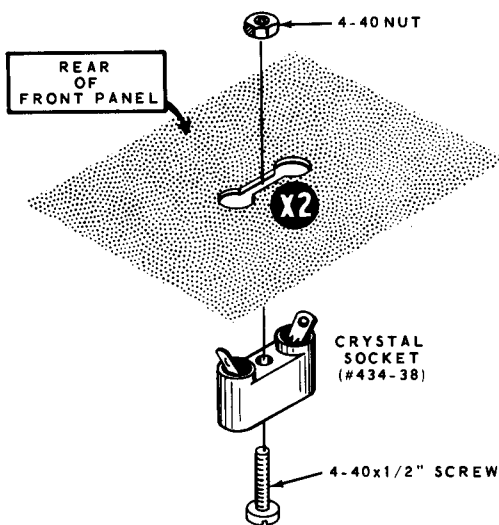
- ( ) Position the front panel as shown in the Pictorial.

NOTE: The 4-40 hardware for mounting the crystal sockets is packed in a separate envelope.

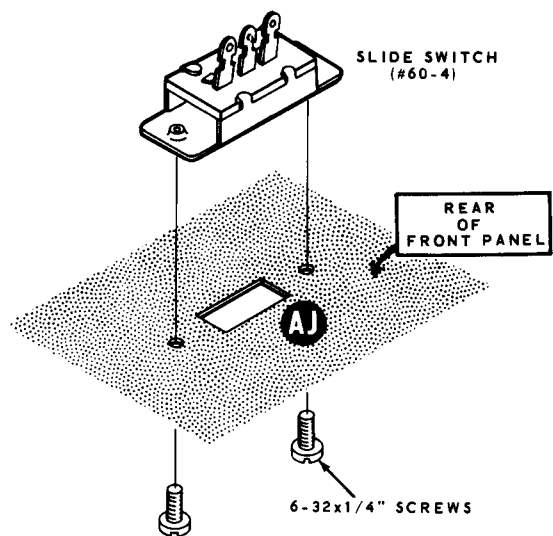
- ( ) Refer to Detail 6A and mount the large crystal socket (#434-38) from the front of the front panel at X2. Use a 4-40 x 1/2" screw and a 4-40 nut. Do not overtighten.

- ( ) Similarly, mount the small crystal socket (#434-74) at X1. Use a 4-40 x 1/2" screw and 4-40 nut.

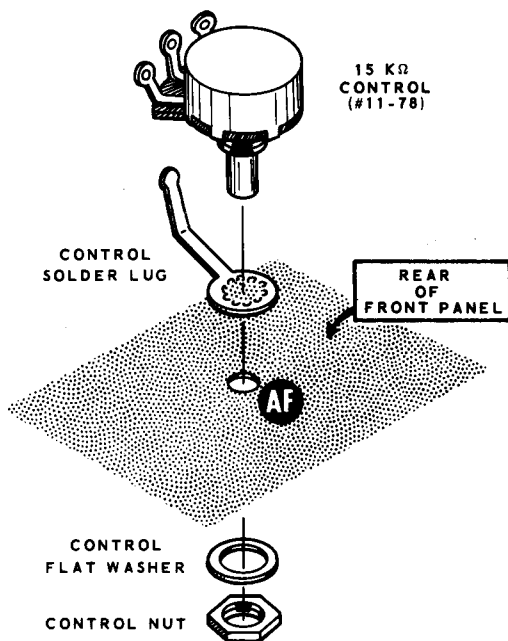
- ( ) Refer to Detail 6B and mount the slide switch (#60-4) at AJ. Use 6-32 x 1/4" screws. Position the lugs as shown in the Pictorial.



Detail 6A



Detail 6B



Detail 6C

NOTE: Scrape away any excess paint around hole AF on the rear of the front panel before you mount the control in the next step.

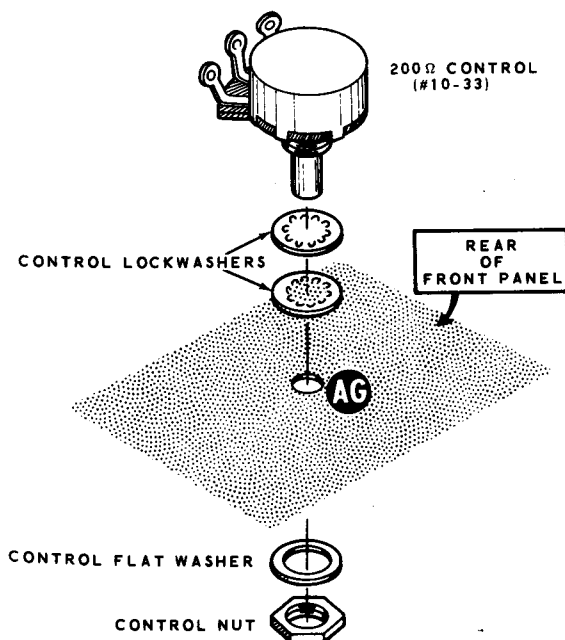
- (L) Refer to Detail 6C and mount the 15 K $\Omega$  control (#11-78) at AF. Use a control solder lug, a control flat washer, and a control nut. Position the control and the control solder lug as shown in the Pictorial.

NOTE: Do not use the thin control lockwasher until it is specifically called for in a step.

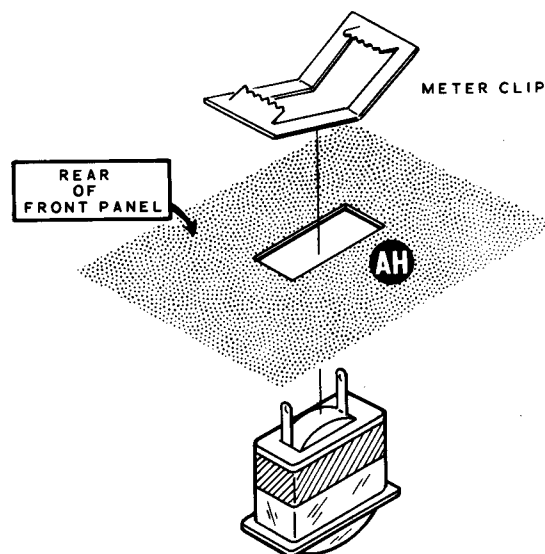
- (L) Refer to Detail 6D and mount the 200  $\Omega$  control (#10-33) at AG. Use two control lockwashers, one control flat washer, and one control nut. Position the control as shown.

- ( ) Refer to Detail 6E and use the meter clip to mount the meter at AH. Be sure the meter is positioned right-side up on the front panel.

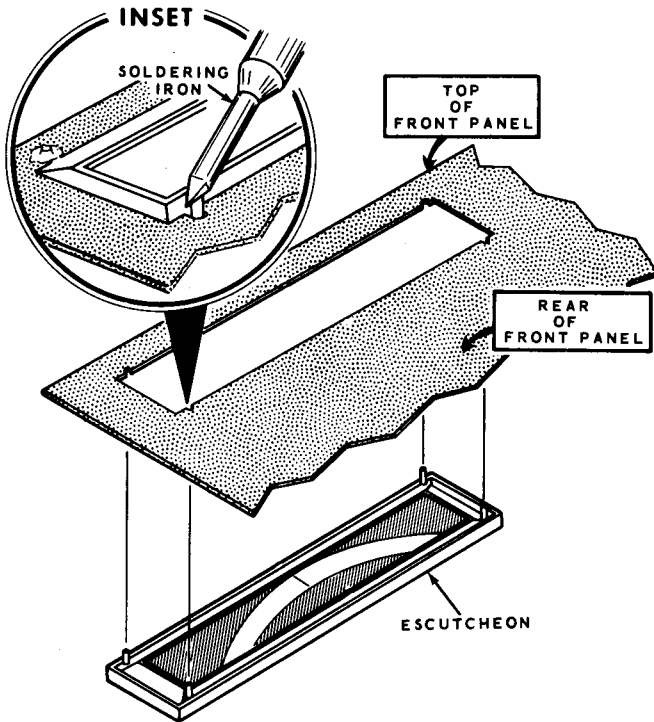
- ( ) Remove any wire between the meter terminals.



Detail 6D



Detail 6E

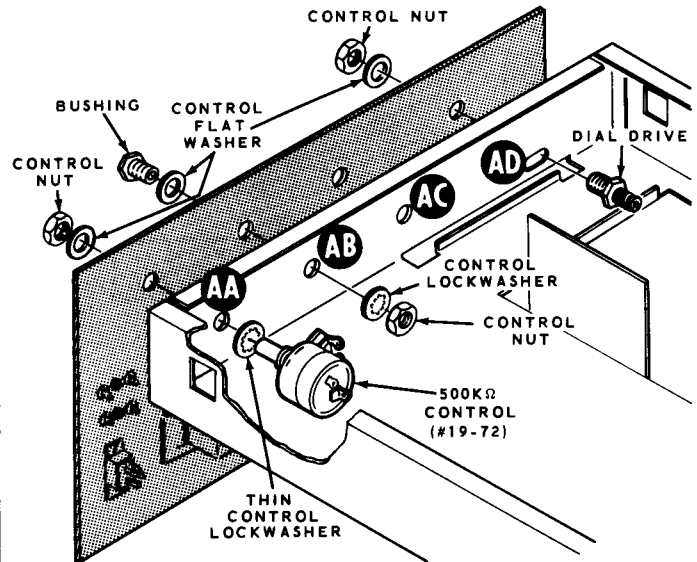


Detail 6F

- ( ) Refer to Detail 6F and mount the escutcheon at AE. Be sure to position escutcheon as shown in the Pictorial.
- ( ) Heat the escutcheon studs with a soldering iron flattening each stud so that it holds the escutcheon securely on the front panel.

Refer to Pictorial 7 for the following steps.

- ( ) Mount the front panel to the chassis. Use a bushing, a control flat washer, a control lockwasher, and a control nut at AB. Do not tighten the control nut; it will be tightened later.



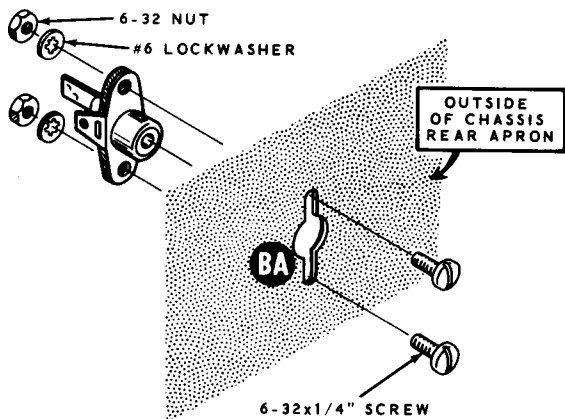
PICTORIAL 7

- ( ) Mount the dial drive at AD. Use a control flat washer and the control nut furnished with the dial drive. Do not tighten the control nut; it will be tightened later.
- ( ) Mount a 500 K $\Omega$  control with an On-Off switch (#19-72) at AA. Use a thin control lockwasher, a control flat washer, and a control nut. Position the control as shown.
- ( ) Locate circuit board (#85-173-1) and lightly sandpaper the foil around the circuit board mounting holes to remove any substance which may impede grounding the circuit board foil to the chassis.
- ( ) Position the circuit board on the chassis so that tube sockets V3 and V4 are closest to the front panel.

- ( ) Refer to Pictorial 8 and mount the circuit board (#85-173-1) on the chassis. Mount two wire lugs, one wire lug at X and the other wire lug at Y. Use 3-48 x 1/4" hardware. Bend both wire lugs 90 degrees at 1" from the end, as shown in the Pictorial.

Refer to Pictorial 9 (fold-out from Page 19) for the following steps.

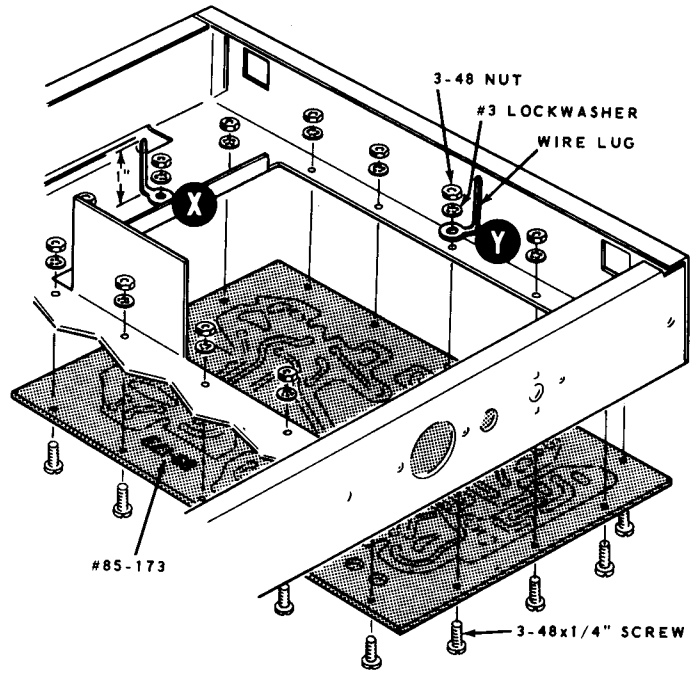
- ( ) Refer to Detail 9A and mount a phono socket inside the chassis at BA. Use 6-32 x 1/4" hardware. Position the socket as shown in the Pictorial.



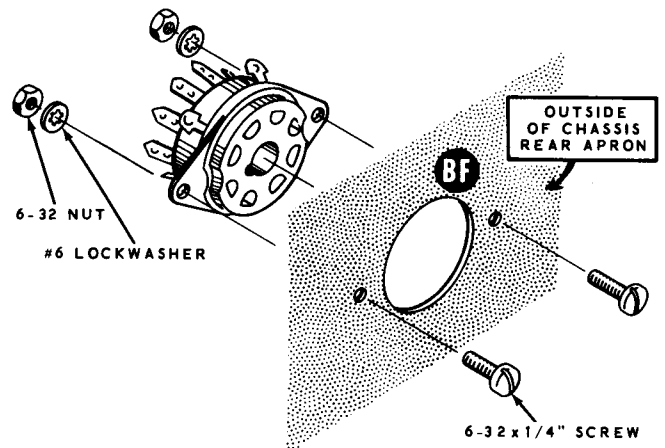
Detail 9A

- ( ) Mount phono sockets at BC and BH. Use 6-32 x 1/4" hardware. Position as shown in the Pictorial.

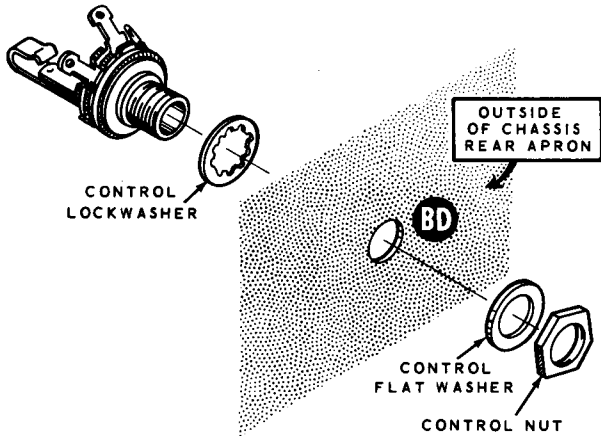
- ( ) Refer to Detail 9B and mount an octal socket at BF. Position the keyway of the socket as shown by the large arrow in the Pictorial. Use 6-32 x 1/4" hardware.



PICTORIAL 8

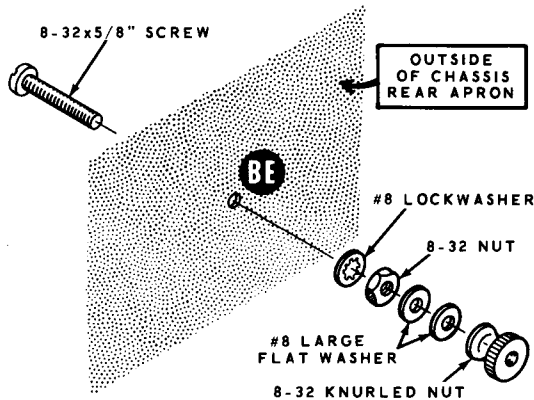


Detail 9B

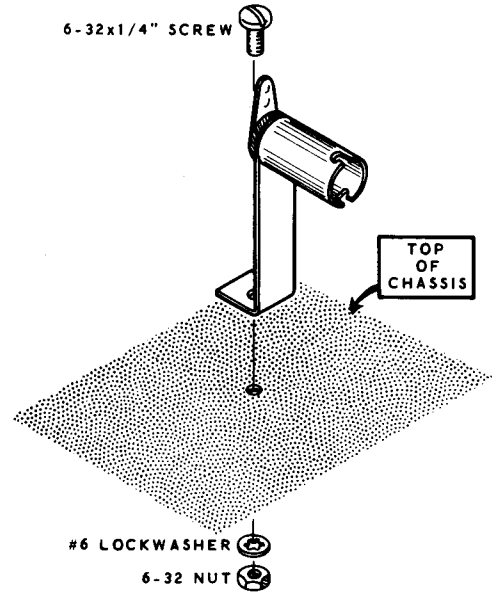


Detail 9C

- ( ) Refer to Detail 9C and mount a 3-lug phone jack at BD. Use a control lockwasher, a control flat washer, and a control nut. Position jack as shown in the Pictorial.
- ( ) In a like manner, mount a 3-lug phone jack at BG. Use a control lockwasher, a control flat washer, and a control nut.
- ( ) Refer to Detail 9D and insert an 8-32 x 5/8" screw through the back panel from the inside at BE. Install it with one #8 lockwasher, one 8-32 nut, two #8 large flat washers, and one 8-32 knurled nut.



Detail 9D

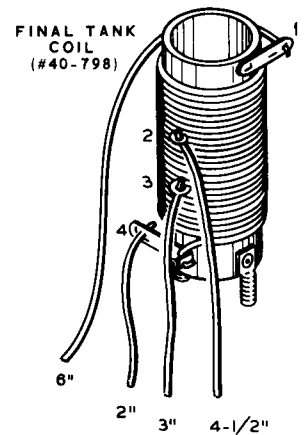


Detail 10A

Refer to Pictorial 10 (fold-out from page 19) for the following steps.

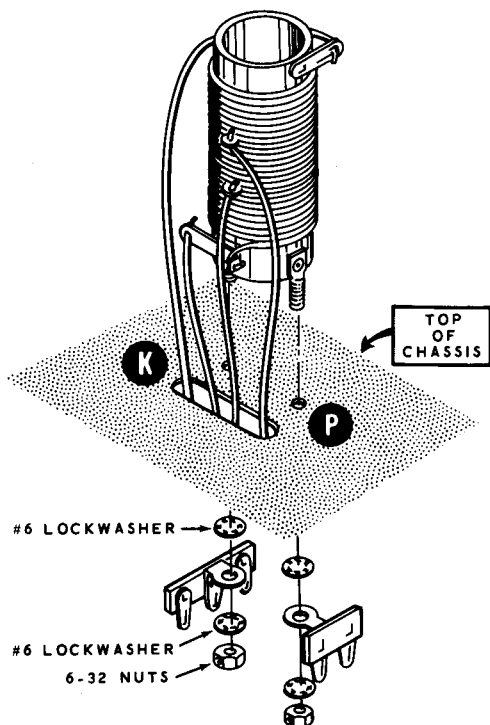
- ( ) Refer to Detail 10A and mount two pilot lamp sockets with brackets (#434-90), one at CB and one at CC. Use 6-32 x 1/4" hardware.
- ( ) Locate final tank coil (#40-798). Prepare the following lengths of large bare wire and connect one end of each to the coil as shown in Detail 10B. Position the wires as shown.

| WIRE LENGTH | COIL LUG |
|-------------|----------|
| ( ) 6"      | 1 (S-1)  |
| ( ) 4-1/2"  | 2 (S-1)  |
| ( ) 3"      | 3 (S-1)  |
| ( ) 2"      | 4 (S-1)  |



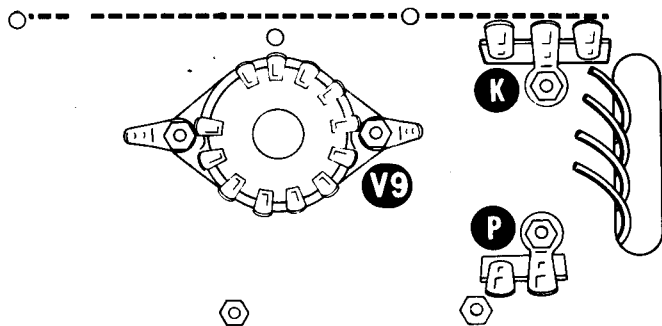
Detail 10B



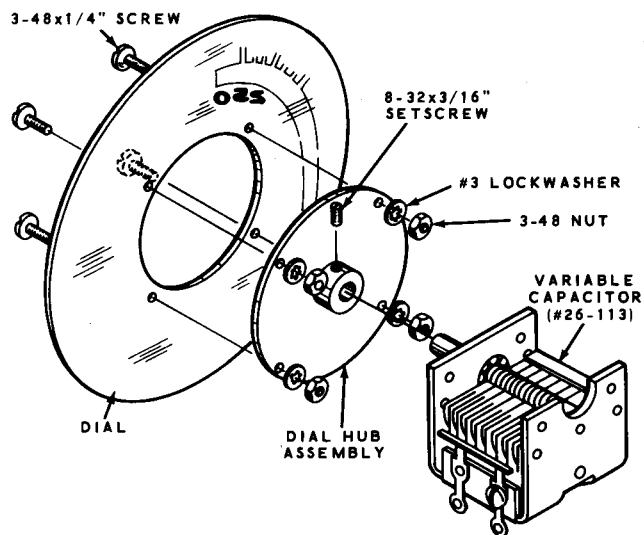


Detail 10C

- ( ) Refer to Detail 10C and mount the final tank coil to the chassis by inserting the spade bolts through the chassis holes at L12 and the four coil wires through the large oblong hole.
- ( ) From the bottom of the chassis, install a 3-lug terminal strip on coil spade bolt K and a 2-lug terminal strip on coil spade bolt P. Use four #6 lockwashers and two 6-32 nuts. Refer to Detail 10D to position the terminal strips.



Detail 10D



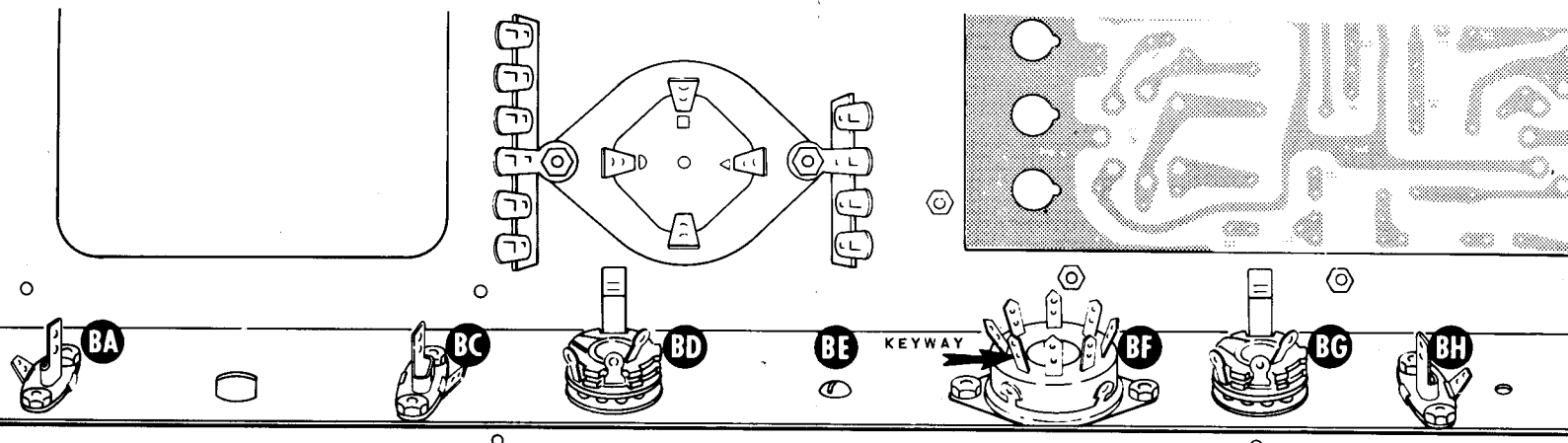
Detail 10E

- ( ) Refer to Detail 10E and mount dial hub assembly (#100-43) to the dial (#464-29-5). Align the dial number 250 with the dial hub setscrew as shown. Use 3-48 x 1/4" hardware. Install the 8-32 x 3/16" setscrew into the dial drive hub, but do not allow it to extend into the shaft mounting hole.

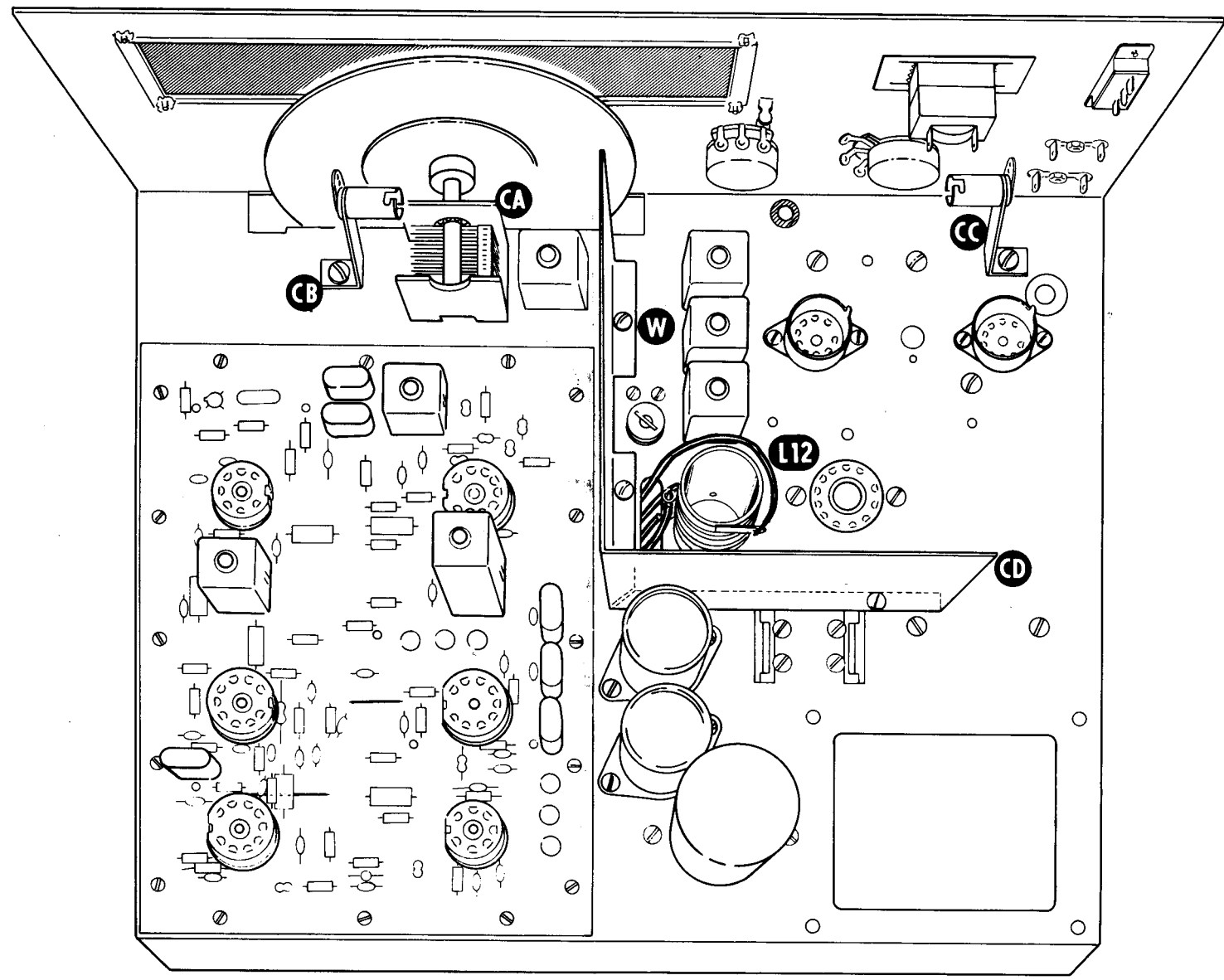
**CAUTION** Be sure the variable capacitor plates are completely meshed before proceeding with the following steps.

- ( ) Insert the shaft of a variable capacitor (#26-113) into the dial drive hub. Do not tighten the setscrew.

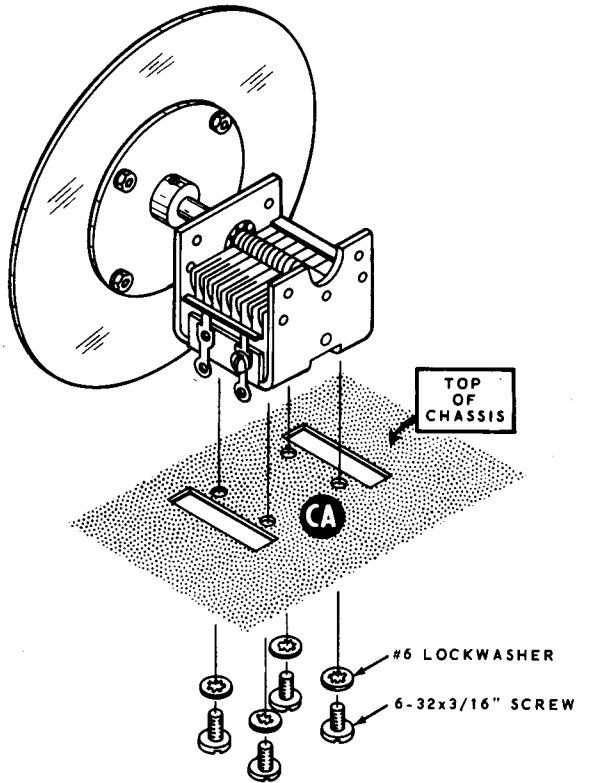
**NOTE:** Be sure the dial drive assembly at AD is at the end of the slot away from the center of the chassis. Refer back to Pictorial 7.



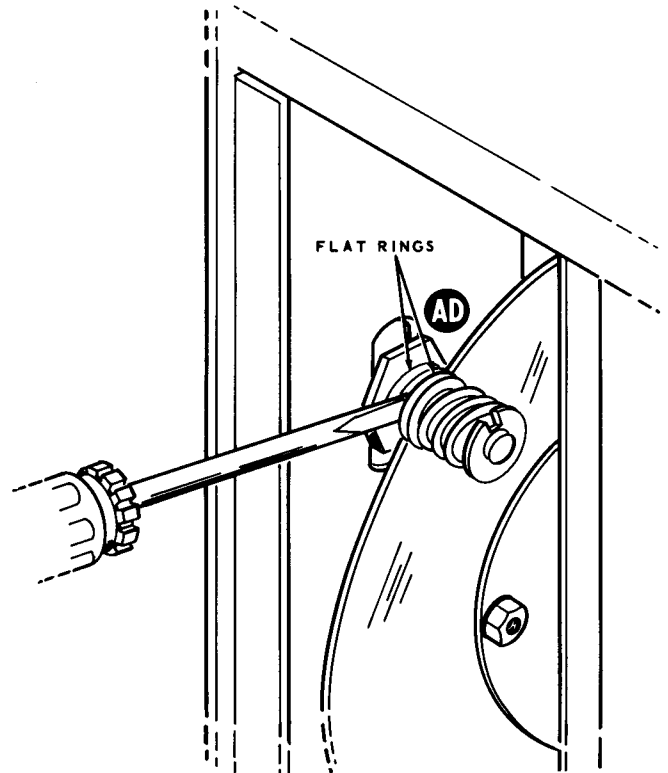
**PICTORIAL 9**



**PICTORIAL 10**



Detail 10F



Detail 10G

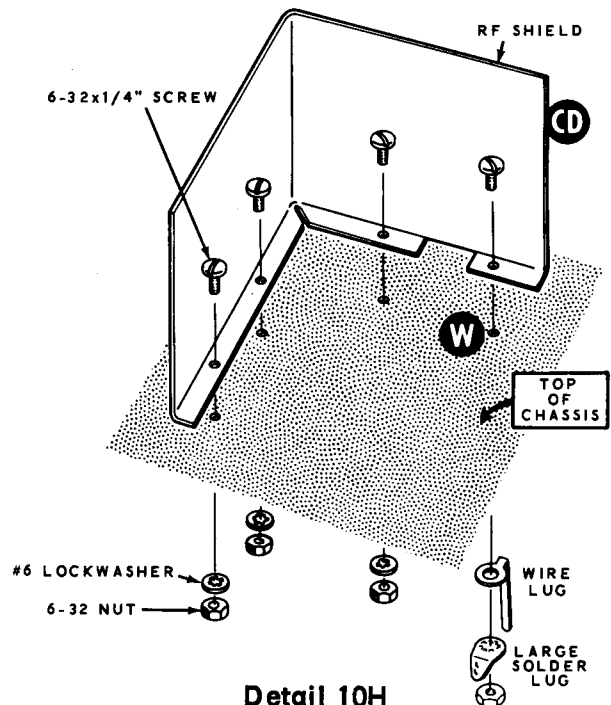
( ) Refer to Detail 10F and mount the dial and variable capacitor assembly to the chassis at CA. Use four #6 lockwashers and four 6-32 x 3/16" screws.

( ) Refer to Detail 10G and perform the following operations to engage the dial into the dial drive.

- A. Use the blade of a screwdriver to separate the two flat rings of the dial drive.
- B. Move the dial drive closer to the dial and guide the edge of the dial into the separation made by the screwdriver.
- C. Hold the dial drive in place and remove the screwdriver.
- D. Tighten the control nut on the dial drive.

( ) Tighten the control nuts at AA and AB. Refer to Pictorial 7 (Page 16).

( ) Refer to Detail 10H and Pictorial 12. Then mount RF shield (#206-336) on top of the chassis at CD with a wire lug and large solder lug at W on the bottom of the chassis. Use 6-32 x 1/4" hardware.



Detail 10H



## WIRING CHASSIS TOP

Refer to Pictorial 11 (fold-out from this page) for the following steps. Route wires as indicated. Review the Kit Builders Guide, Pages 9 and 10, before proceeding.

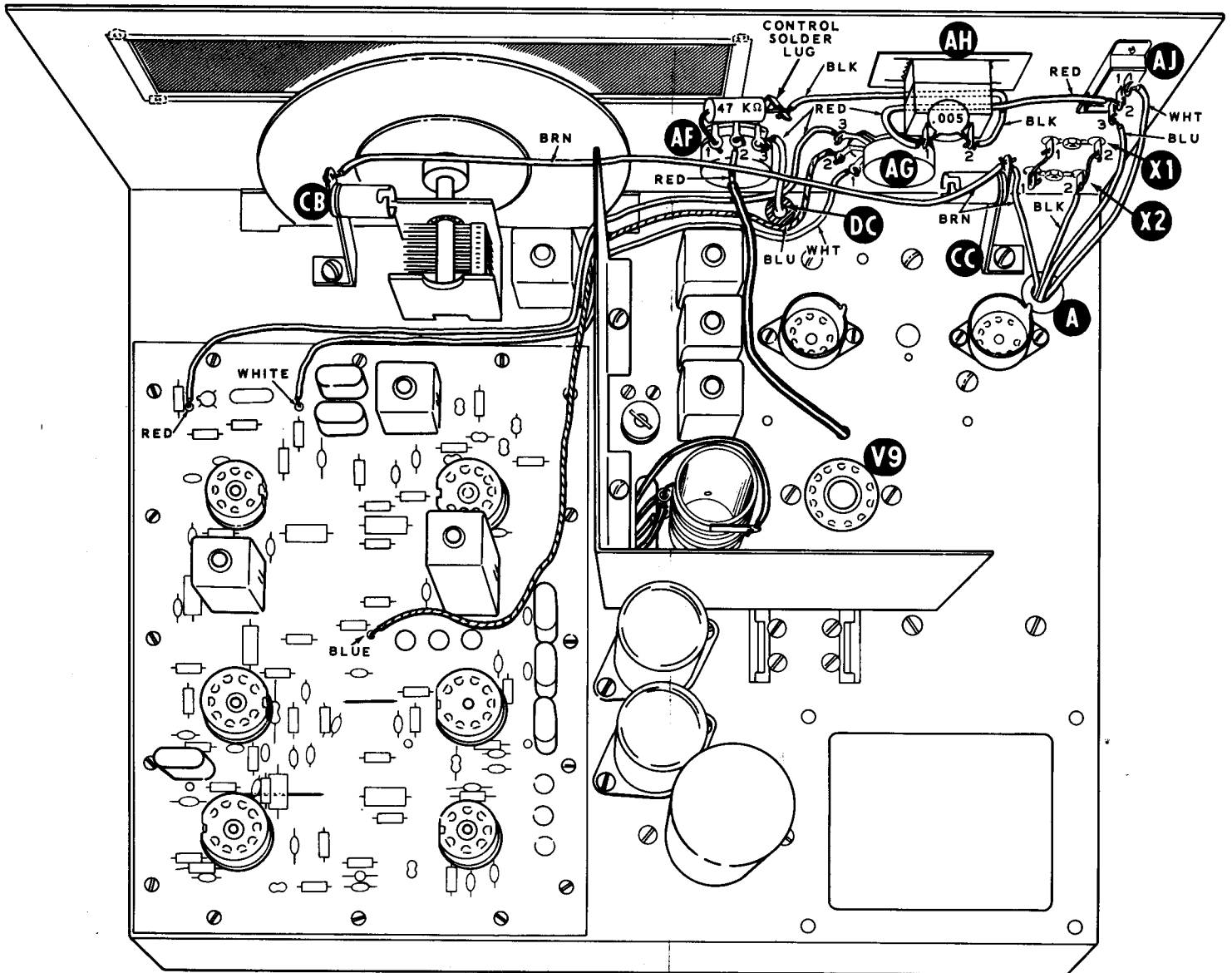
NOTE: When wiring this kit you may find it easier to prepare the lengths of hookup wire ahead of time as in the following step. To prepare a wire, cut it to the indicated length and strip 1/4" of insulation from each end. The wires are listed in the order in which they will be used. Use hookup wire of the color specified.

- ( ) Prepare the following lengths of hookup wire:

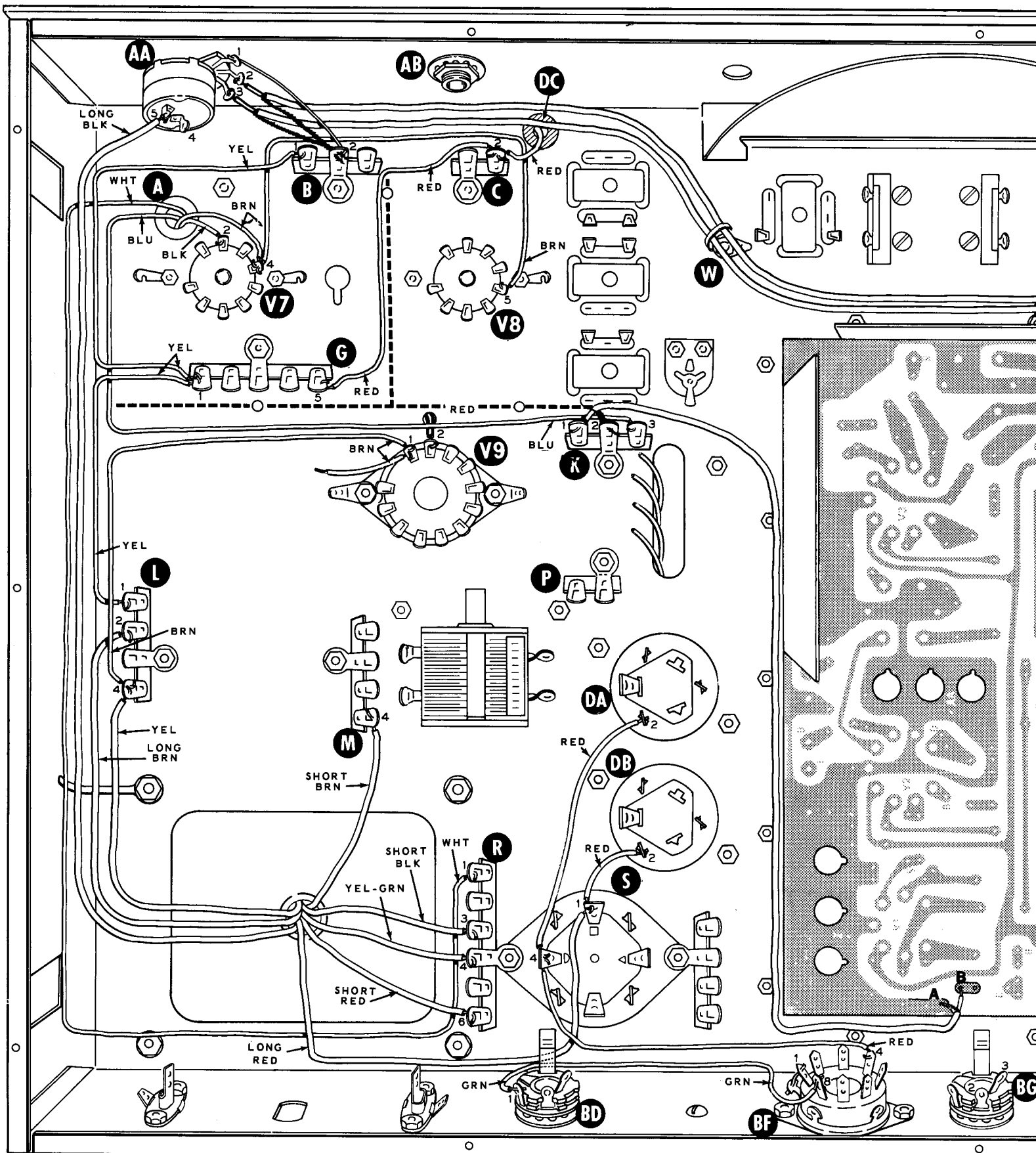
|            |              |
|------------|--------------|
| 10" white  | 4" red       |
| 12" blue   | 4" black     |
| 12" red    | 12" blue     |
| 3-1/2" red | 20" white    |
| 6" red     | 4-1/2" brown |
| 5" black   | 10" brown    |

NOTE: Identification Photographs of the assembled chassis are provided at the rear of the Manual. Refer to these photos from time to time as you wire the Kit. They show actual positions of wires and components.

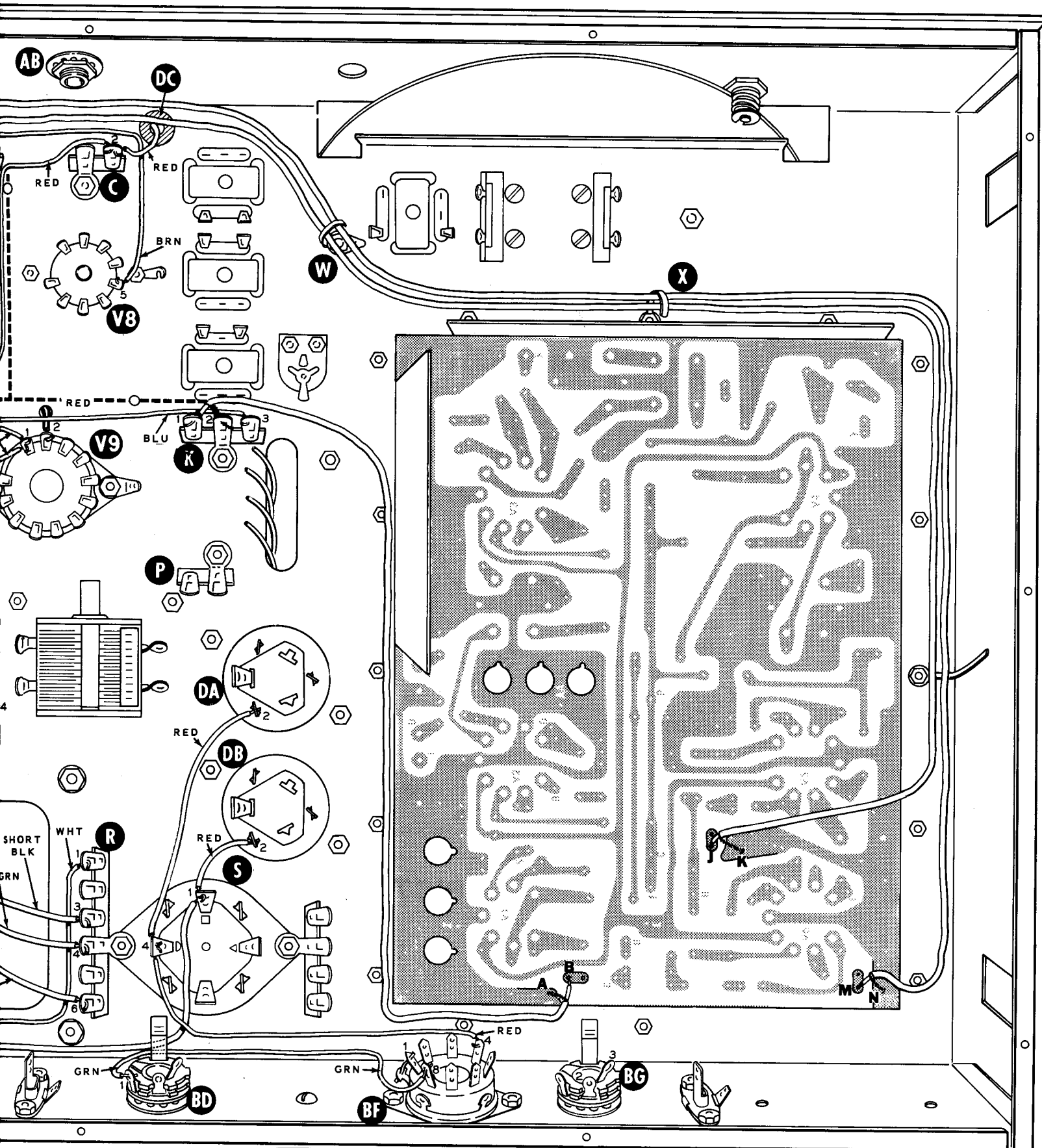
- ( ) Connect a 10" white wire from lug 1 of control AG (S-1) to the circuit board hole marked WHITE (S-1).
- ( ) Connect a 12" blue wire from lug 2 of control AG (S-1) to the circuit board hole marked BLUE (S-1).
- ( ) Connect a 12" red wire from lug 3 of control AG (S-1) to the circuit board hole marked RED (S-1).
- ( ) Connect one end of a 3-1/2" red wire to lug 3 of control AF (S-1). Insert the free end of the wire through grommet DC to be connected later.
- ( ) Connect one end of a 6" red wire to lug 2 of control AF (S-1). Cut a 5" length of sleeving, place it over the red wire and insert the free end of this wire and its sleeving through the hole closest to tube socket V9 (to be connected later).
- ( ) Connect a 5" black wire from the control solder lug of control AF (NS) to lug 2 of meter AH (NS).
- ( ) Connect a 4" red wire from lug 1 of meter AH (NS) to lug 2 of slide switch AJ (S-1).
- NOTE: Where a wire passes through a terminal and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection.
- ( ) Remove an additional 3/4" of insulation from one end of a 4" black wire. Feed the 1" bared end of this black wire through lug 2 of large crystal socket X2 (S-2) and connect it to lug 2 of small crystal socket X1 (S-1). Insert the free end of this wire through grommet A to be connected later.
- ( ) Connect a 1" small bare wire from lug 1 of small crystal socket X1 (S-1) to lug 1 of large crystal socket X2 (NS).
- ( ) Connect one end of a 12" blue wire to lug 3 of slide switch AJ (S-1). Insert the free end through grommet A to be connected later.
- ( ) Connect one end of a 20" white wire to lug 1 of slide switch AJ (S-1). Insert the free end through grommet A to be connected later.
- ( ) Connect one end of a 4-1/2" brown wire to the lug of pilot lamp socket CC (NS). Insert the free end through grommet A to be connected later.
- ( ) Connect a 10" brown wire from the lug of pilot lamp CC (S-2) to the lug of pilot lamp CB (S-1).
- ( ) Connect a 47 K $\Omega$  (yellow-violet-orange) 2 watt resistor between lug 1 (S-1) and control solder lug (S-2) of control AF.
- ( ) Connect a .005  $\mu$ fd disc capacitor between lug 1 (S-2) and lug 2 (S-2) of meter AH.



**PICTORIAL 11**



PICTORIAL 12



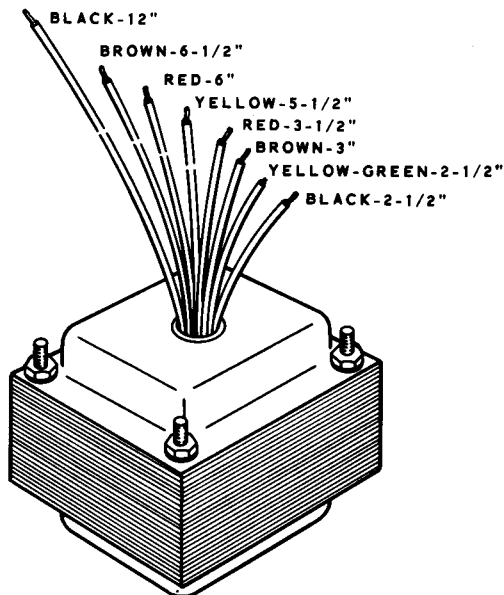
PICTORIAL 12

## WIRING CHASSIS BOTTOM

**NOTE:** Route all wires as shown in the following Pictorials. Do not route wires across dotted areas because other pieces of hardware will be mounted in the dotted areas.

Refer to Pictorial 12 for the following steps.

- ( ) Cut the leads of the power transformer to the lengths indicated in Detail 12A. Measure the leads from where they come out of the transformer.

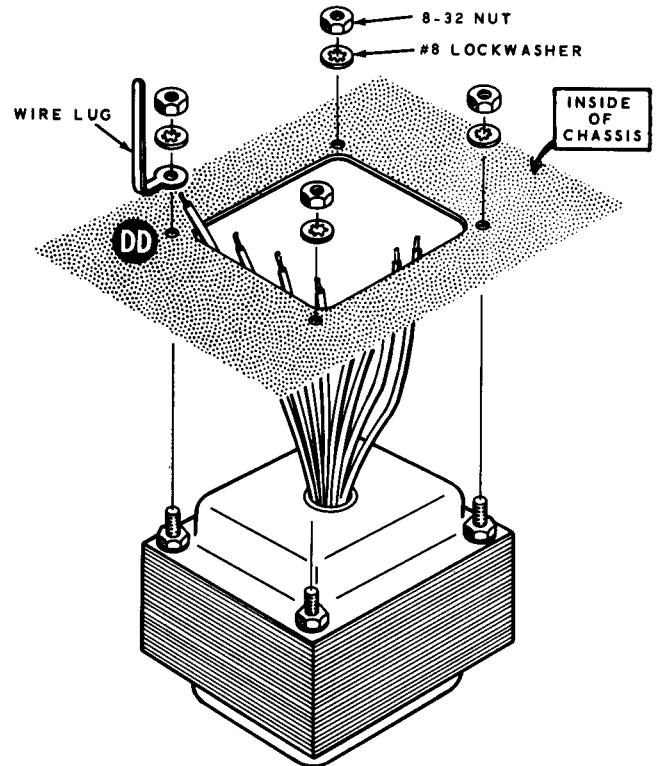


**Detail 12A**

- ( ) Remove 1/4" of insulation from the end of each transformer lead. Twist together the small strands of wire at the end of each lead; then melt a small amount of solder on each exposed lead end to hold the small wire strands together.

**NOTE:** The power transformer mounts from the top of the chassis with the nuts, lockwashers, and wire lug on the bottom of the chassis.

- ( ) Refer to Detail 12B and the Pictorial and mount the power transformer and wire lug to the chassis. Use four 8-32 nuts and four #8 lockwashers.



**Detail 12B**

Connect the power transformer leads as follows:

- ( ) Long black to lug 5 of control AA (S-1).  
 ( ) Long brown to lug 2 of terminal strip L (NS).  
 ( ) Yellow to lug 4 of terminal strip L (NS).  
 ( ) Short brown to lug 4 of terminal strip M (NS).  
 ( ) Short black to lug 3 of terminal strip R (NS).  
 ( ) Yellow-green to lug 4 of terminal strip R (NS).  
 ( ) Long red to lug 1 of electrolytic capacitor S (NS).  
 ( ) Short red to lug 6 of terminal strip R (NS).





- ( / ) Connect the red wire extending through grommet DC to lug 2 of terminal strip C (NS).
- ( / ) Connect the black wire extending through grommet A to lug 2 of tube socket V7 (NS).
- ( ) Connect the brown wire extending through grommet A to lug 4 of tube socket V7 (NS).
- ( ) Connect the blue wire extending through grommet A to lug 3 of terminal strip K (NS).
- ( - ) Connect the white wire extending through grommet A to lug 1 of terminal strip R (NS).
- ( / ) Connect a 5" red wire from lug 5 of terminal strip G (NS) to lug 2 of terminal strip C (NS).
- ( ) Connect a 6" brown wire from lug 1 of tube socket V9 (NS) to lug 4 of terminal strip L (NS).
- ( ) Connect a 3" brown wire to lug 1 of tube socket V9 (NS) and leave the other end free.
- ( ) Connect a 5-1/2" green wire from lug 1 of phone jack BD (NS) to lug 8 of octal socket BF (NS).

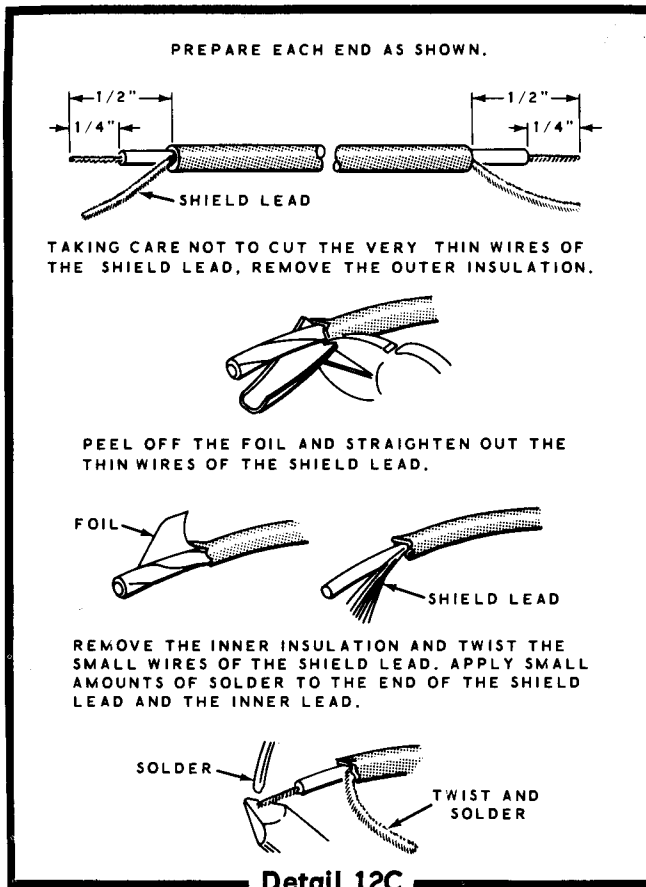
NOTE: Do not loop the end of the red wire around lug 2 of tube socket V9, because this wire will be disconnected during the alignment procedures.

- ( ) Connect the free end of the red wire extending through the hole at tube socket V9 to lug 2 of tube socket V9 (NS). Check that the sleeving on the wire extends through the hole.
- ( ) Prepare the following lengths of hookup wire:
 

|               |                 |
|---------------|-----------------|
| 5-1/2" yellow | 5-1/2" green    |
| 4" yellow     | 6" red          |
| 7" brown      | 3-1/2" red      |
| 5" red        | 1-1/2" red      |
| 6" brown      | 1" bare (small) |
| 3" brown      |                 |
- ( ) Connect a 6" red wire from lug 4 of electrolytic capacitor S (NS) to lug 4 of octal socket BF (NS).
- ( ) Connect a 3-1/2" red wire from lug 4 of electrolytic capacitor S (NS) to mounting lug 2 of electrolytic capacitor DA (S-1).
- ( ) Connect a 1-1/2" red wire from lug 1 of electrolytic capacitor S (NS) to mounting lug 2 of electrolytic capacitor DB (S-1).
- ( ) Connect a 1" small bare wire between lug 1 (S-1) and the ground lug nearest lug 1 (S-1) of octal socket BF.

- ( ) Connect a 5-1/2" yellow wire from lug 1 of terminal strip B (NS) to lug 1 of terminal strip G (NS).
- ( ) Connect a 4" yellow wire from lug 1 of terminal strip G (NS) to lug 1 of terminal strip L (NS).
- ( ) Connect a 7" brown wire from lug 4 of tube socket V7 (NS) to lug 5 of tube socket V8 (NS).

CAUTION: The insulation on the inner leads of the coaxial cables melts quite easily; therefore, the connections should be soldered as quickly as possible to prevent the cables from shorting. When soldering the shields, it is advisable to use a pair of long-nose pliers as a heat sink. Grip the shield between the connection and the cable. This will prevent the heat from reaching the insulation of the inner lead. A rubber band around the handles of the pliers will keep them in place to free both hands for soldering.



- ( ) Refer to Detail 12C and prepare two 21" coaxial cables.
- ( ) At one end of one of these coaxial cables, connect the inner lead to hole J (S-1) and the shield to hole K (S-1) of the circuit board.
- ( ) At the other end of this coaxial cable, connect the inner lead to lug 3 of control AA (S-1) and the shield to lug 2 on terminal strip B (NS).
- ( ) At one end of the other 21" coaxial cable, connect the inner lead to hole M (S-1) and the shield to hole N (S-1) of the circuit board.

- ( ) At the other end of this coaxial cable, connect the inner lead to lug 2 of control AA (S-1) and the shield to lug 2 of terminal strip B (NS).
- ( ) Route the cables and bend the two #8 wire lugs at X and W around the cables to hold the cables in place. See Pictorial 12.
- ( ) Connect a 1" bare wire from lug 1 of control AA (S-1) to lug 2 of terminal strip B (NS).
- ( ) Prepare a 12" coaxial cable as shown in Detail 12C.
- ( ) At one end of this 12" cable, connect the inner lead to hole B (S-1) and the shield to hole A (S-1) of the circuit board.
- ( ) At the other end of this 12" cable, connect the inner lead to lug 1 of terminal strip K (NS) and the shield to lug 2 of terminal strip K (NS).

Refer to Pictorial 13 (fold-out from Page 25) for the following steps.

- ( ) Prepare the following lengths of hookup wire.

|           |                 |
|-----------|-----------------|
| 15" green | 17" red         |
| 9" red    | 14" green       |
| 8" red    | 3" bare (small) |
| 4" brown  | 3" bare (large) |
| 17" white | 13" brown       |
| 4" green  |                 |

- ( ) Connect a 15" green wire from circuit board hole Y (S-1) to lug 8 of octal socket BF (NS).
- ( ) Route the cables and wires as shown, and bend the #8 wire lug at Y around the three cables to hold them in place.
- ( ) Connect a 9" red wire from circuit board hole H (S-1) to lug 3 of electrolytic capacitor S (NS).

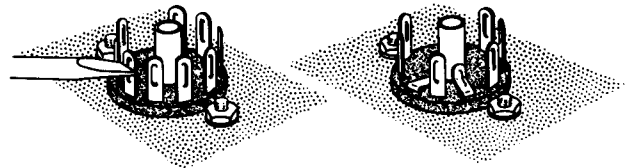
- ( ) Connect an 8" red wire from circuit board hole F (S-1) to lug 2 of electrolytic capacitor S (NS).
- ( ) Connect a 4" brown wire from circuit board hole E (S-1) to lug 2 of octal socket BF (NS).
- ( ) Connect a 17" white wire from circuit board hole D (S-1) to lug 2 of terminal strip L (NS).
- ( ) Connect a 4" green wire from circuit board hole C (S-1) to lug 8 of octal socket BF (S-3).
- ( ) Connect a 17" red wire from lug 5 of terminal strip G (NS) to lug 2 of electrolytic capacitor S (NS).
- ( ) Connect a 14" green wire from lug 2 of terminal strip G (NS) to lug 1 of phone jack BD (NS).
- ( ) Connect a 3" small bare wire to lug 1 of trimmer capacitor U (S-1).
- ( ) Insert the other end of this wire through lug 1 of 15-meter coil L9 (S-2), through lug 1 of 40-meter coil L10 (NS), and to lug 1 of 80-meter coil L11 (NS).
- ( ) Insert one end of a 3" large bare wire through lug 1 of variable capacitor CA (S-2) to lug 1 at coil L7 (NS). Connect the free end of the wire to circuit board hole X (S-1). This wire must not touch the chassis.
- ( ) Connect a 13" brown wire from lug 4 of terminal strip L (S-3) to lug 2 of octal socket BF (S-2).
- ( ) Refer to Detail 12C and prepare a 10" length of coaxial cable.

- ( ) At one end of this 10" cable, connect the inner lead to lug 9 of tube socket V7 (NS) and the shield to solder lug D (S-1).
- ( ) At the other end of this cable, connect the inner lead to lug 2 of phono socket BA (S-1) and the shield to lug 1 of phono socket BA (S-1).

Refer to Detail 13A and then bend and solder the following lugs to the center post of tube socket V7.

- ( ) Lug 1 (S-1).
- ( ) Lug 5 (S-1).
- ( ) Lug 7 (S-1).

BEND LUG DOWN AGAINST CENTER POST

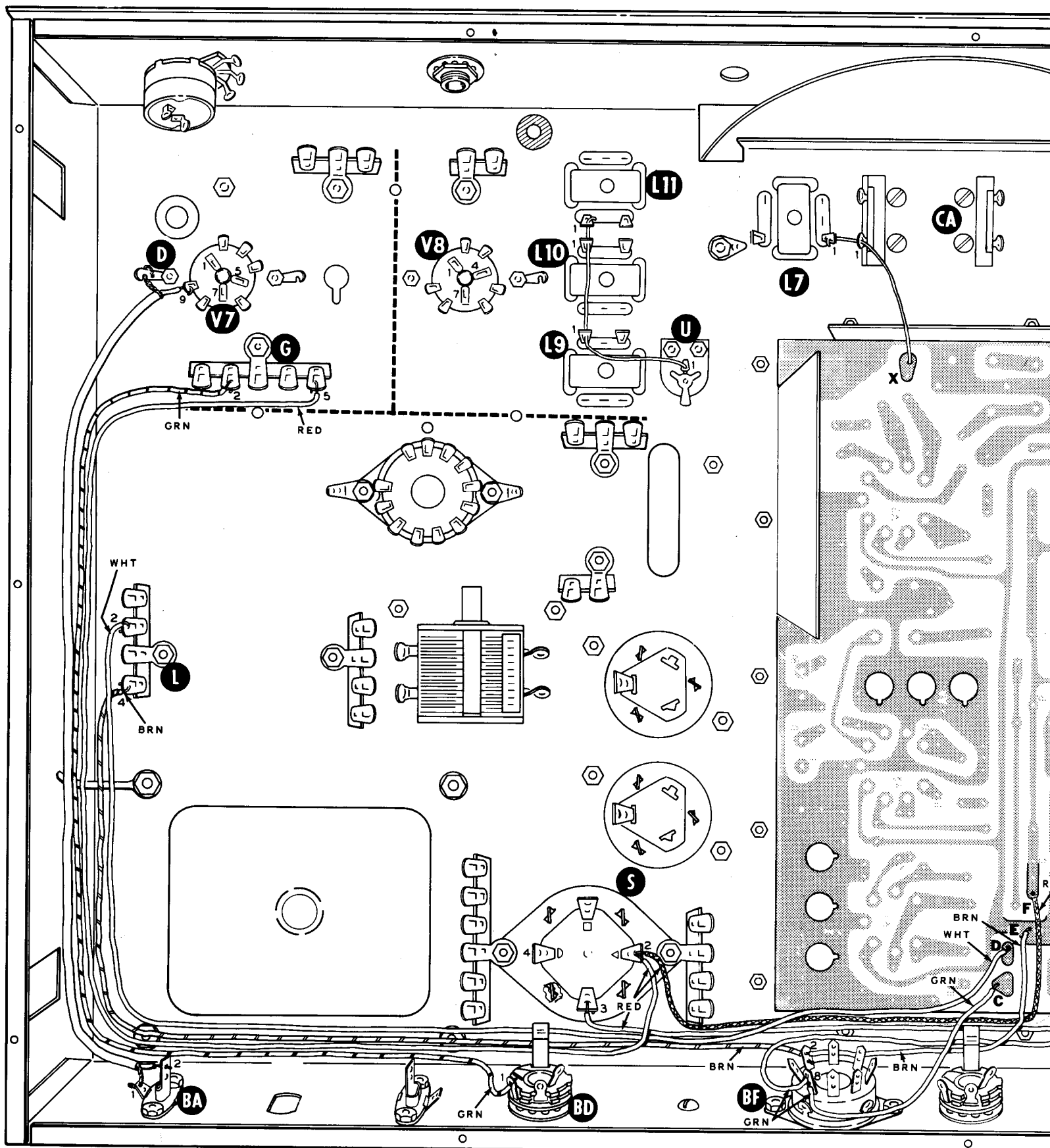


Detail 13A

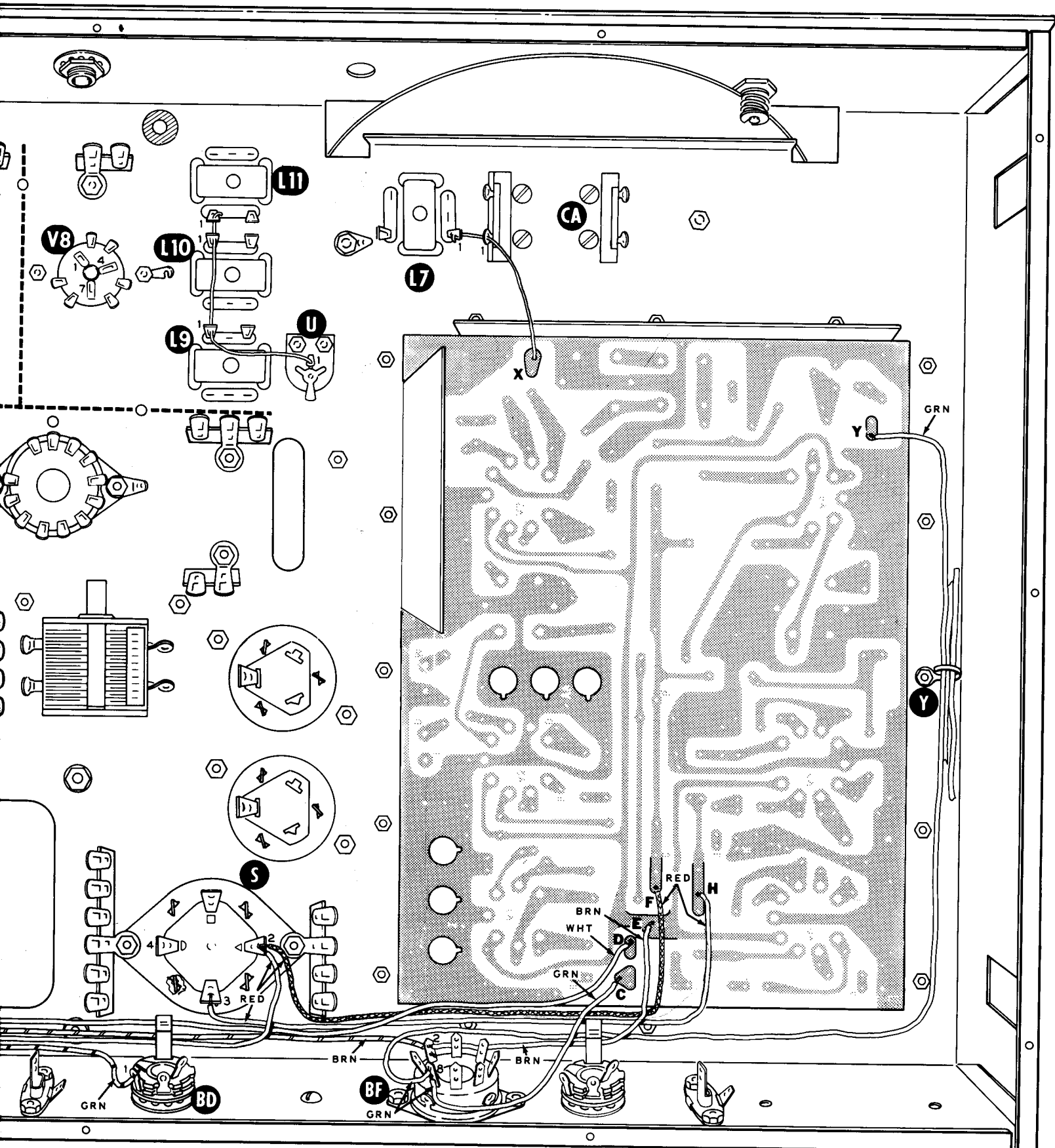
In a like manner, bend the following lugs to the center post of tube socket V8.

- ( ) Lug 1 (S-1).
- ( ) Lug 4 (S-1).
- ( ) Lug 7 (S-1).
- ( ) On electrolytic capacitor S, solder the mounting lug located between lug 3 and lug 4 to the capacitor mounting wafer.

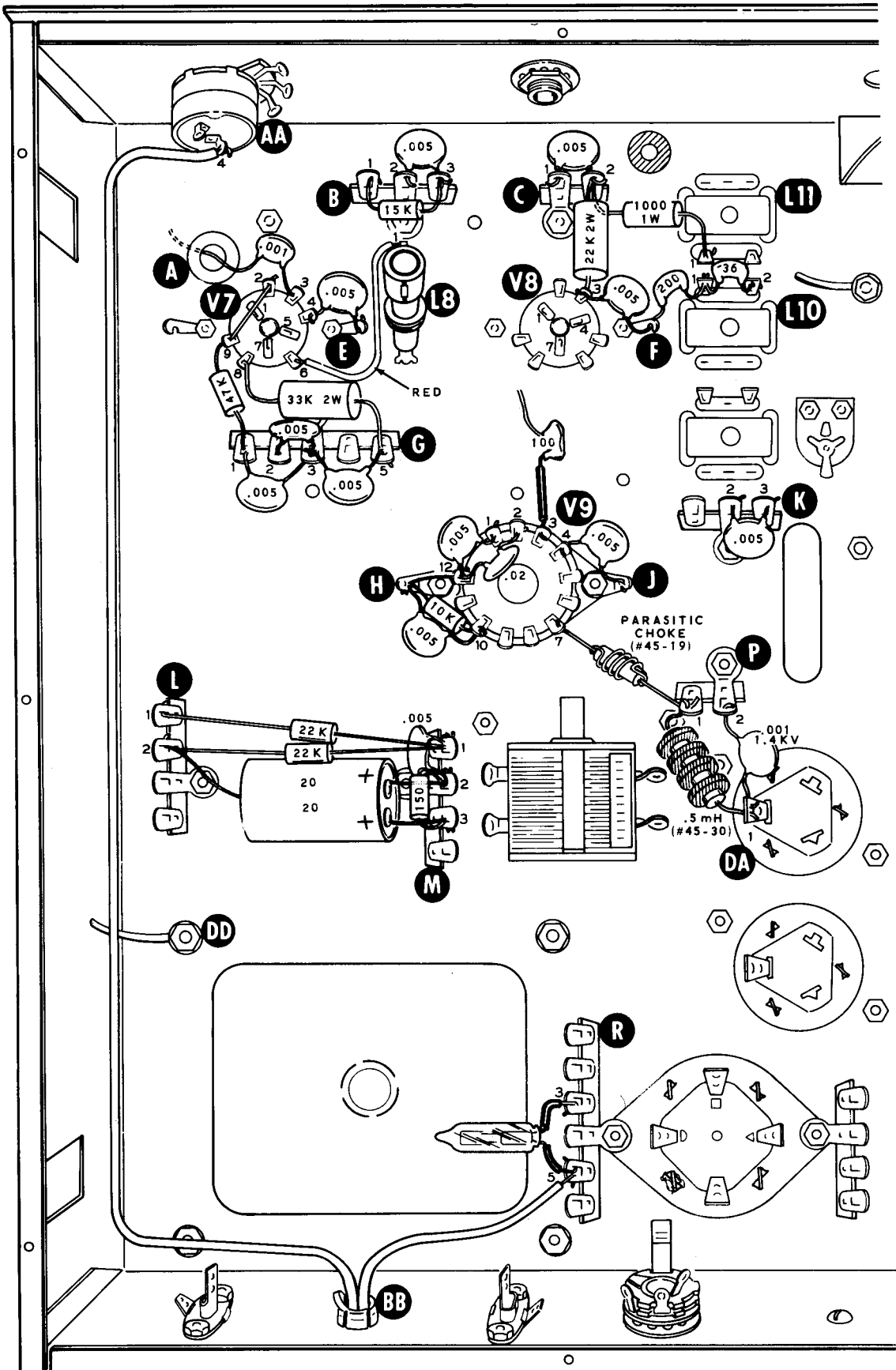
NOTE: The leads of a component should be cut to the proper length before the component is installed. Review Kit Builders Guide Pages 9 and 10 and refer to the Chassis Photographs on Pages 57 and 58, which show a typically well-assembled Transceiver.



PICTORIAL 13



PICTORIAL 13

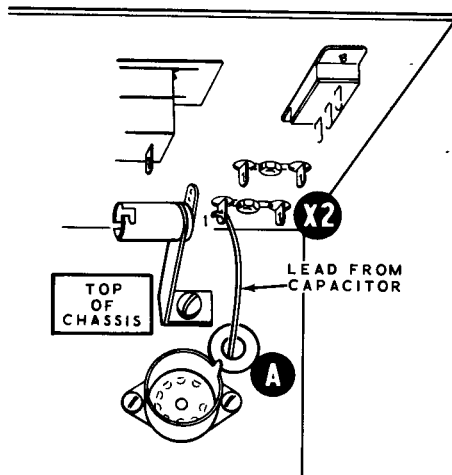


PICTORIAL 14

Refer to Pictorial 14 for the following steps.

NOTE: The .001  $\mu$ fd disc capacitor being connected in the next two steps has one lead connected from the bottom of the chassis and one lead connected from the top. Be sure the lead connected to the tube socket is long enough so that the capacitor can be placed near the grommet.

- ( ) Cut one lead of a .001  $\mu$ fd disc capacitor to 1". Connect this lead to lug 3 of tube socket V7 (S-1).
- ( ) Refer to Detail 14A and insert the other lead of the .001  $\mu$ fd disc capacitor through grommet A. From the top of the chassis, connect this capacitor lead to lug 1 of crystal socket X2 (S-2).



Detail 14A

- ( ) Connect a .005  $\mu$ fd disc capacitor from lug 4 of tube socket V7 (S-3) to solder lug E (NS).

NOTE: When resistors are installed, use only 1/2 watt resistors unless higher wattage resistors are specifically called for.

- ( ) Insert one lead of a 47 K $\Omega$  (yellow-violet-orange) resistor through lug 9 (S-3) to lug 2 (S-2) of tube socket V7. Connect the other lead to lug 1 of terminal strip G (NS).

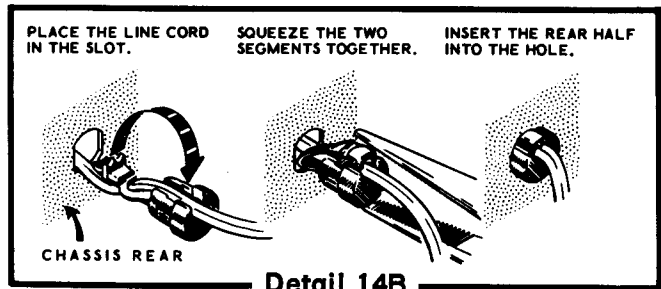
- ( ) Connect a .005  $\mu$ fd disc capacitor between lug 1 (NS) and lug 3 (NS) of terminal strip G.
- ( ) Connect a .005  $\mu$ fd disc capacitor between lug 2 (NS) and lug 3 (NS) of terminal strip G.
- ( ) Connect a .005  $\mu$ fd disc capacitor between lug 3 (NS) and lug 5 (NS) of terminal strip G.
- ( ) Connect a 33 K $\Omega$  (orange-orange-orange) 2 watt resistor from lug 8 of tube socket V7 (S-1) to lug 5 of terminal strip G (NS).
- ( ) Connect a .005  $\mu$ fd disc capacitor between lug 2 (S-4) and lug 3 (NS) of terminal strip B.
- ( ) Connect a 15 K $\Omega$  (brown-green-orange) resistor between lug 1 (S-2) and lug 3 (NS) of terminal strip B.
- ( ) Connect a 22 K $\Omega$  (red-red-orange) resistor from lug 1 of terminal strip L (S-2) to lug 1 of terminal strip M (NS).
- ( ) Connect a 22 K $\Omega$  (red-red-orange) resistor from lug 2 of terminal strip L (NS) to lug 1 of terminal strip M (NS).
- ( ) Connect a .005  $\mu$ fd disc capacitor between lug 1 (NS) and lug 2 (NS) of terminal strip M.
- ( ) Connect a 150  $\Omega$  (brown-green-brown) resistor between lug 2 (NS) and lug 3 (NS) of terminal strip M.
- ( ) Locate a 20-20  $\mu$ fd 200 V electrolytic capacitor. Place it between terminal strips M and L with the two leads at the end of the capacitor marked positive (+) toward terminal strip M. Connect one of these positive leads to lug 2 of terminal strip M (S-3) and the other positive (+) lead to lug 3 of terminal strip M (NS).
- ( ) Connect the negative (-) lead of this capacitor to lug 2 of terminal strip L (S-4).

- (+) Connect a 10 K $\Omega$  (brown-black-orange) resistor from lug 10 of tube socket V9 (NS) to solder lug H (NS).
- ( ) Connect a .005  $\mu$ fd disc capacitor from lug 10 of tube socket V9 (S-2) to lug H (NS).
- (+) Connect a .005  $\mu$ fd disc capacitor from lug 12 (NS) to lug 1 (S-3) of tube socket V9.
- ( ) Insert one lead of a .02  $\mu$ fd disc capacitor through lug 12 of tube socket V9 (S-3) to solder lug H (S-3). Connect the other lead to lug 2 of tube socket V9 (S-2).
- (+) Cut one 1" length of sleeving and cut one lead of a 100 pf resin capacitor to 1-1/4". Place the 1" sleeving on the 1-1/4" capacitor lead and connect this lead to lug 3 of tube socket V9 (NS). Leave the other end free.
- ( ) Connect a .005  $\mu$ fd disc capacitor from lug 4 of tube socket V9 (NS) to solder lug J (S-1).
- ( ) Connect a parasitic RF choke (#45-19) from lug 7 of tube socket V9 (S-1) to lug 1 of terminal strip P (NS).
- (+) Connect a 1000  $\Omega$  (brown-black-red) 1 watt resistor from lug 2 of terminal strip C (NS) to lug 1 of 80-meter coil L11 (S-2).
- ( ) Connect a 36 pf resin capacitor between lug 1 (NS) and lug 2 (NS) of 40-meter coil L10.
- ( ) Connect a 200 pf resin capacitor from lug 1 of 40-meter coil L10 (S-4) to solder lug F (NS).
- ( ) Connect a .005  $\mu$ fd disc capacitor from solder lug F (NS) to lug 3 of tube socket V8 (NS).
- ( ) Connect a 22 K $\Omega$  (red-red-orange) 2 watt resistor from lug 2 of terminal strip C (S-5) to lug 3 of tube socket V8 (S-2).
- ( ) Split a 12" section of the line cord, and then cut off 10" from one of the two line cord leads. Strip 1/4" insulation from both line cord leads.
- ( ) Insert the line cord through hole BB and connect the longer line cord lead to lug 4 of control AA (S-1). Connect the shorter line cord lead to lug 5 of terminal strip R (NS). Route the line cord along the sides of the chassis as shown.

- ( ) Install the line cord strain relief on the line cord from the rear of the chassis as shown in Detail 14B.

NOTE: In the next two steps, do not loop the ends of the .001  $\mu$ fd 1.4 KV disc capacitor and the .5 mH choke around lug 1 of electrolytic capacitor DA, because these leads will be disconnected during the alignment procedures.

- ( ) Connect a .001  $\mu$ fd 1.4 KV disc capacitor from lug 2 of terminal strip P (S-1) to lug 1 of electrolytic capacitor DA (NS).
- ( ) Connect a .5 mH choke (#45-30) from lug 1 of terminal strip P (NS) to lug 1 of electrolytic capacitor DA (NS).



- (+) Connect a .005  $\mu$ fd disc capacitor between lug 1 (S-1) and lug 2 (NS) of terminal strip C.
- ( ) Route the cables and wires as shown, and bend the #8 wire lug at DD around the 10 cables to hold them in place.

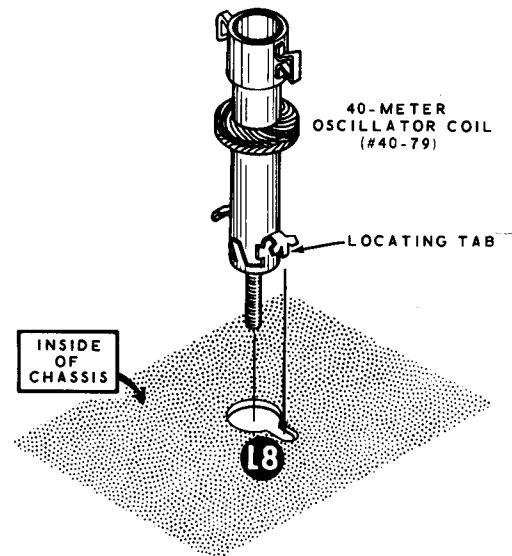
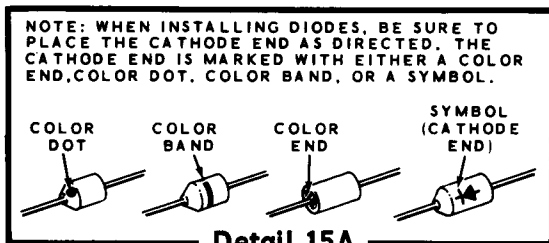


- ( ) Cut two 1/2" lengths of sleeving. Place one length of sleeving on each circuit breaker lead.
- ( ) Connect the circuit breaker between lug 3 (S-2) and lug 5 (S-2) of terminal strip R.
- ( ) Connect a .005  $\mu$ fd disc capacitor between lug 2 (NS) and lug 3 (NS) of terminal strip K.
- ( ) Refer to Detail 14C and mount the 40-meter oscillator coil (#40-79) to the chassis at L8. Press the coil firmly into the hole. When seated properly, the small tabs will snap out to lock the coil in place.
- ( ) Connect a 2" red wire between lug 6 of tube socket V7 (S-1) and lug 1 of 40-meter oscillator coil L8 (NS).

Refer to Pictorial 15 (fold-out from Page 29) for the following steps.

- ( ) Connect a 1000  $\Omega$  (brown-black-red) resistor between lug 1 (S-5) and lug 2 (NS) of terminal strip G.
- ( ) Connect a 220 K $\Omega$  (red-red-yellow) resistor between lug 2 (S-4) and lug 3 (S-4) of terminal strip G.
- ( ) Insert one lead of a .5 mH choke (#45-30) through lug 11 (S-2) to lug 3 (S-2) of tube socket V9. Connect the other lead to lug 1 of terminal strip M (S-4).

NOTE: Refer to Detail 15A before connecting the silicon diodes.



**Detail 14C**

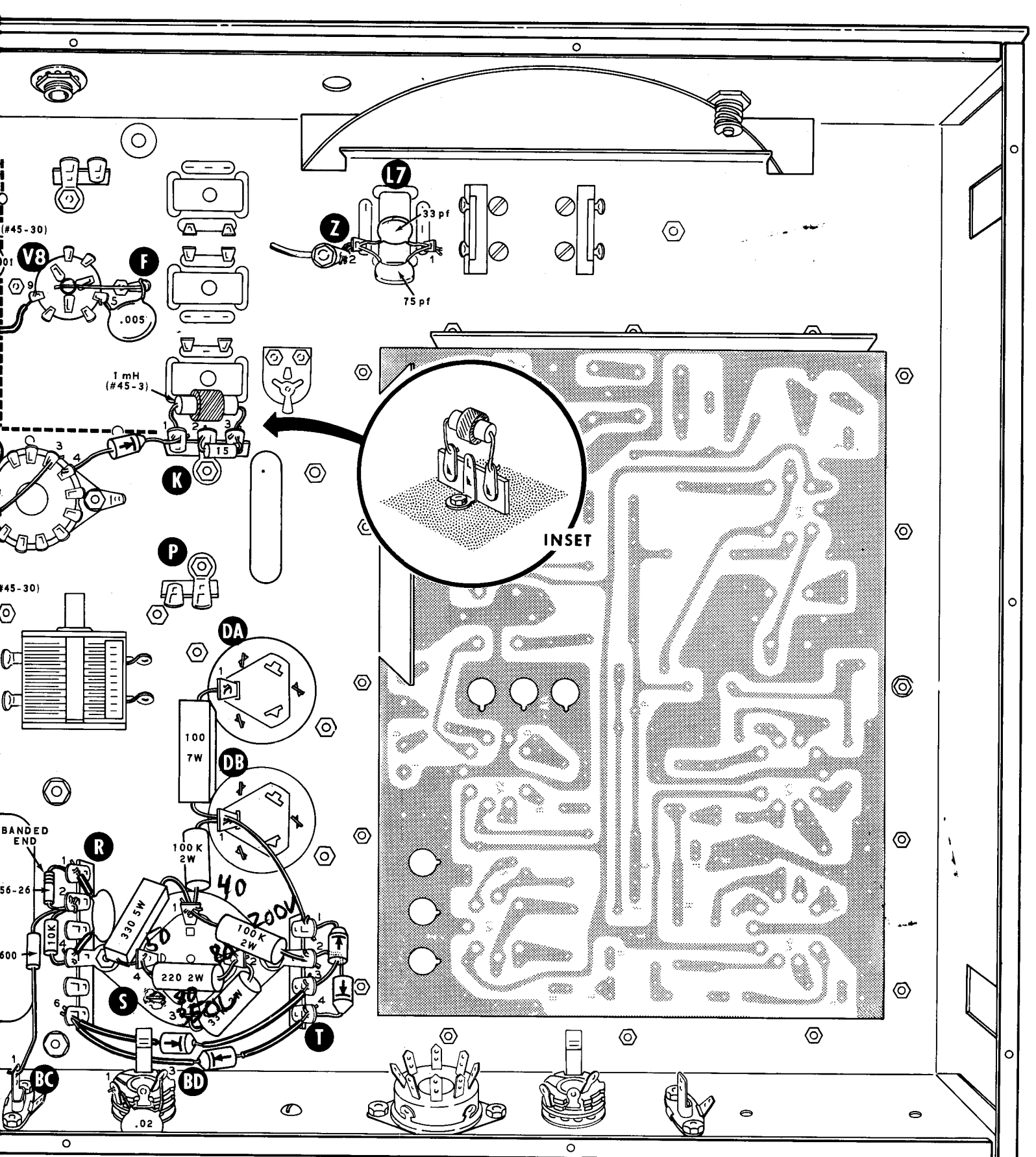
Connect each of the silicon diodes as follows:

- ( ) Cathode lead to lug 3 (S-3) and the other lead to lug 4 (S-2) of terminal strip M.
- ( ) Cathode lead to lug 1 of terminal strip K (NS) and the other lead to lug 4 of V9 (S-2).
- ( ) Cathode lead to lug 1 (NS) and the other lead to lug 3 (NS) of terminal strip T.
- ( ) Cathode lead to lug 4 (NS) and the other lead to lug 2 (NS) of terminal strip T.
- ( ) Place a 1" length of sleeving on each lead of a silicon diode. Connect the cathode lead of this silicon diode to lug 3 of terminal strip T (S-2) and connect the other lead to lug 6 of terminal strip R (NS).
- ( ) Place a 1" length of sleeving on each lead of a silicon diode. Connect the cathode lead of this silicon diode to lug 6 of terminal strip R (S-3) and connect the other lead to lug 4 of terminal strip T (S-2).
- ( ) Locate a #56-26 (brown-white-brown) germanium diode.

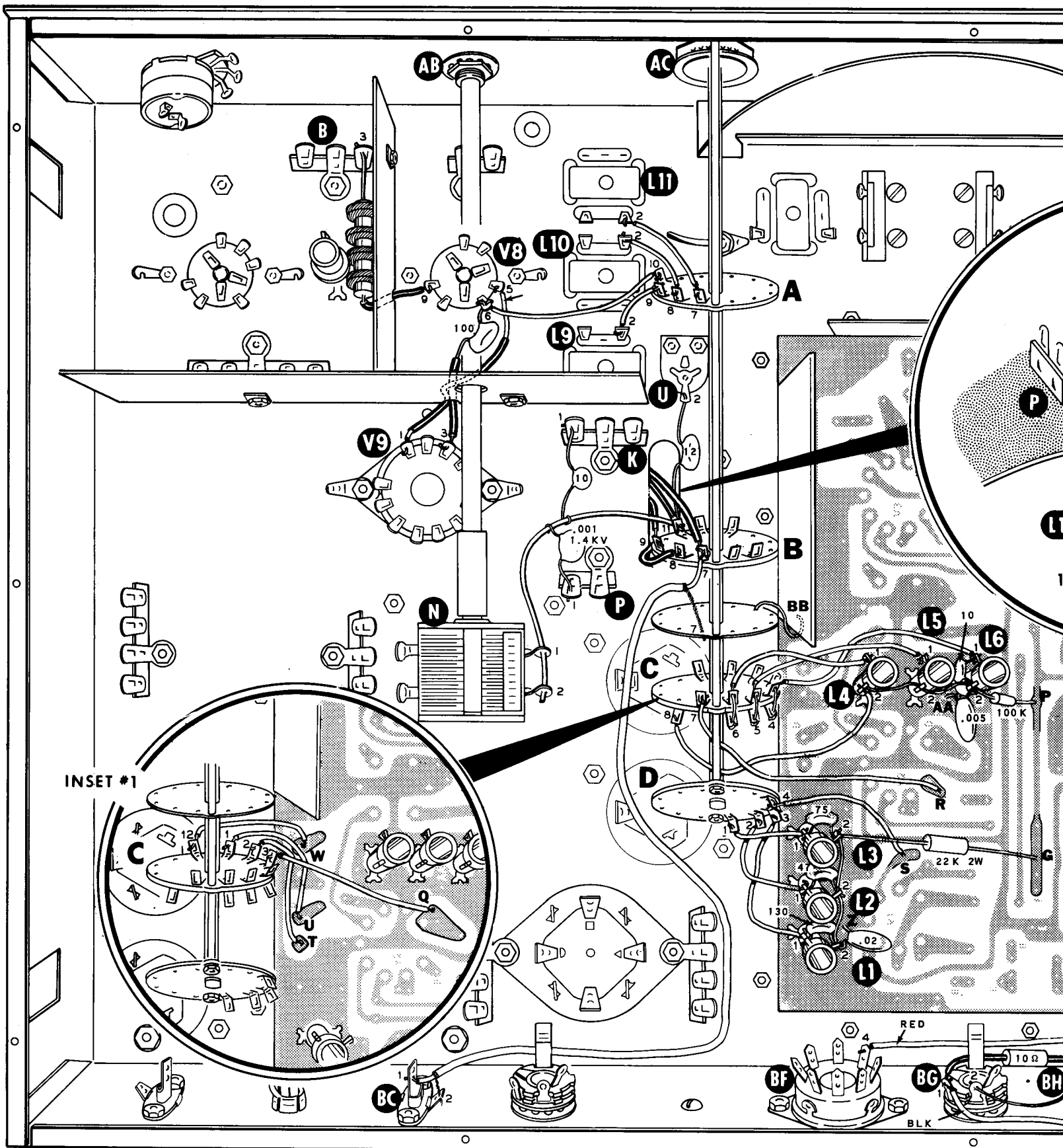


- ( ) Connect the lead from the banded end of this diode to lug 1 (NS) and the other lead to lug 2 (NS) of terminal strip R.
- ( ) Place a 1/2" length of sleeving on each lead of a .005  $\mu$ fd disc capacitor. Then connect this capacitor between lug 1 (S-3) and lug 4 (NS) of terminal strip R.
- ( ) Connect a 10 K $\Omega$  (brown-black-orange) resistor between lug 2 (NS) and lug 4 (S-3) of terminal strip R.
- ( ) Connect a 5600  $\Omega$  (green-blue-red) resistor from lug 2 of terminal strip R (S-3) to lug 1 of phono socket BC (NS).
- ( ) Connect a 33 K $\Omega$  (orange-orange-orange) 2 watt resistor between lug 2 (NS) and lug 3 (S-2) of electrolytic capacitor S.
- ( ) Connect a 220  $\Omega$  (red-red-brown) 2 watt resistor between lug 2 (S-4) and lug 4 (NS) of electrolytic capacitor S.
- ( ) Connect a 330  $\Omega$  5 watt resistor between lug 1 (NS) and lug 4 (S-4) of electrolytic capacitor S.
- ( ) Connect a 100 K $\Omega$  (brown-black-yellow) 2 watt resistor from lug 1 of electrolytic capacitor S (NS) to lug 1 of electrolytic capacitor DB (NS).
- ( ) Insert one lead of a 100  $\Omega$  7 watt resistor through lug 1 of electrolytic capacitor DB (S-3) to lug 1 of terminal strip T (S-2). Connect the other lead to lug 1 of electrolytic capacitor DA (S-3).
- ( ) Connect a 100 K $\Omega$  (brown-black-yellow) 2 watt resistor from lug 1 of electrolytic capacitor S (S-5) to lug 2 of terminal strip T (S-2).
- ( ) Connect a 15  $\Omega$  (brown-green-black) resistor between lug 2 (S-3) and lug 3 (NS) of terminal strip K.
- ( ) Connect a 1 mH choke (#45-3) between lug 1 (NS) and lug 3 (S-4) of terminal strip K. Position the choke above the terminal strip as it is shown in the inset drawing on Pictorial 15.
- ( ) Connect one lead of a .005  $\mu$ fd disc capacitor around solder lug F (S-4) to the center post of tube socket V8 (S-1). Connect the other lead to lug 5 of tube socket V8 (NS).
- ( ) Cut a 1" length of sleeving and place it on one lead of a .5 mH choke (#45-30) and connect this lead to lug 9 of tube socket V8 (S-1). Leave the other lead free and position the choke as shown in the Pictorial.
- ( ) Connect a .001  $\mu$ fd disc capacitor from lug 1 of 40-meter oscillator coil L8 (NS) to the lead of the RF choke that is connected to lug 9 of tube socket V8 (S-1). Make the connection near the choke body.
- ( ) Insert one lead of a .005  $\mu$ fd disc capacitor around solder lug E (S-3) to the center post of tube socket V7 (S-1). Connect the other lead to lug 2 of 40-meter oscillator coil L8 (NS).
- ( ) Connect a 12 pf resin capacitor between lug 1 (S-3) and lug 2 (NS) of 40-meter oscillator coil L8.
- ( ) Connect a 6800  $\Omega$  (blue-gray-red) 2 watt resistor from lug 5 of terminal strip G (S-5) to lug 2 of 40-meter oscillator coil L8 (S-3).
- ( ) Insert one lead of a 75 pf resin capacitor through lug 2 of coil L7 (NS) to solder lug Z (NS). Connect the other lead to lug 1 of coil L7 (NS).
- ( ) Insert one lead of a 33 pf disc capacitor through lug 2 of coil L7 (S-4) to solder lug Z (S-2). Connect the other lead to lug 1 of coil L7 (S-3).
- ( ) Connect a .02  $\mu$ fd disc capacitor from lug 1 (S-3) to lug 3 (S-1) of jack BD.

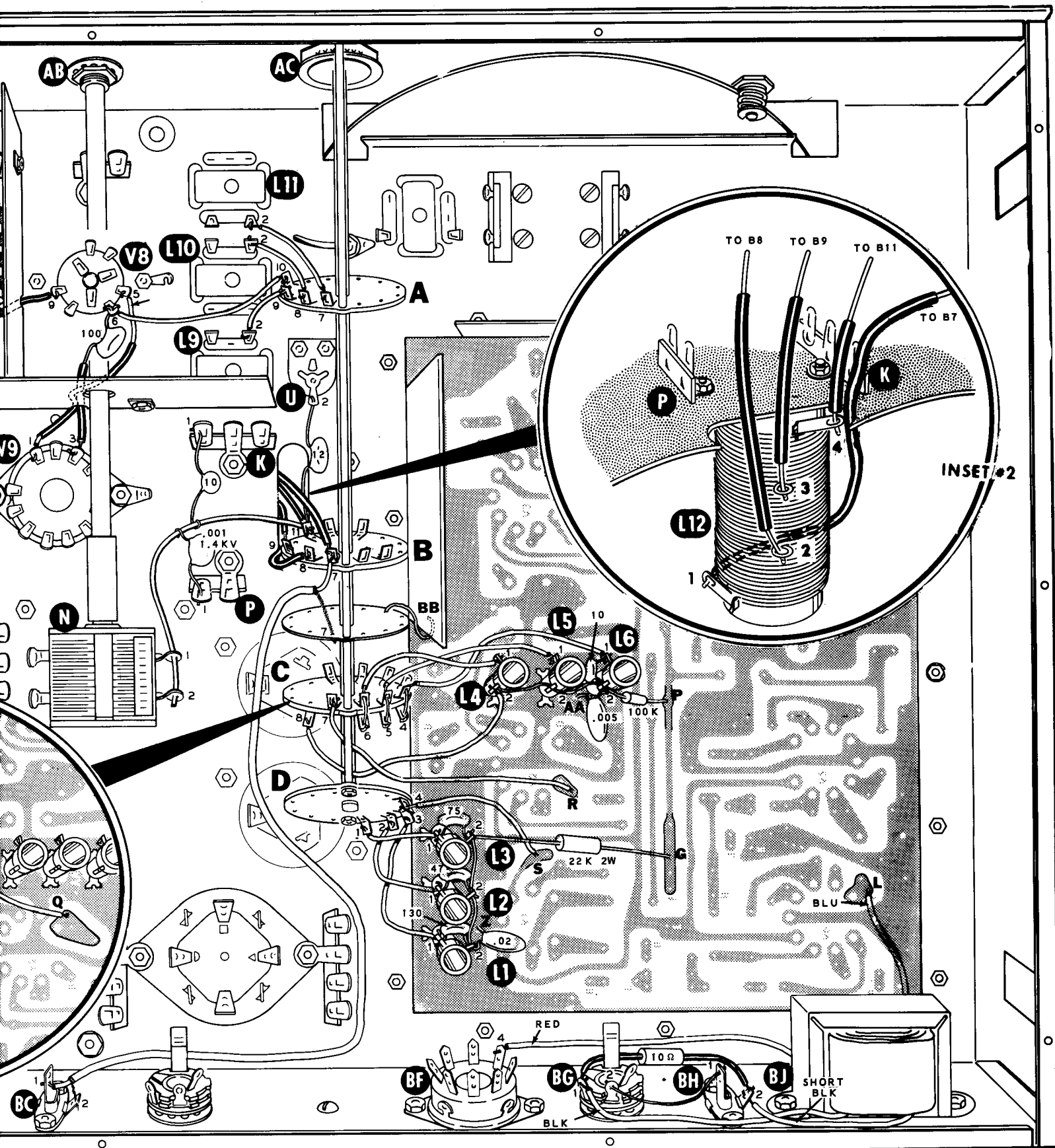




PICTORIAL 15



PICTORIAL 16

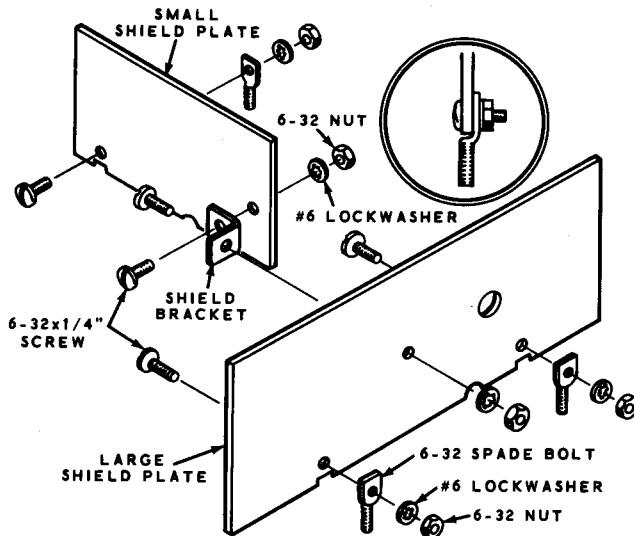


PICTORIAL 16

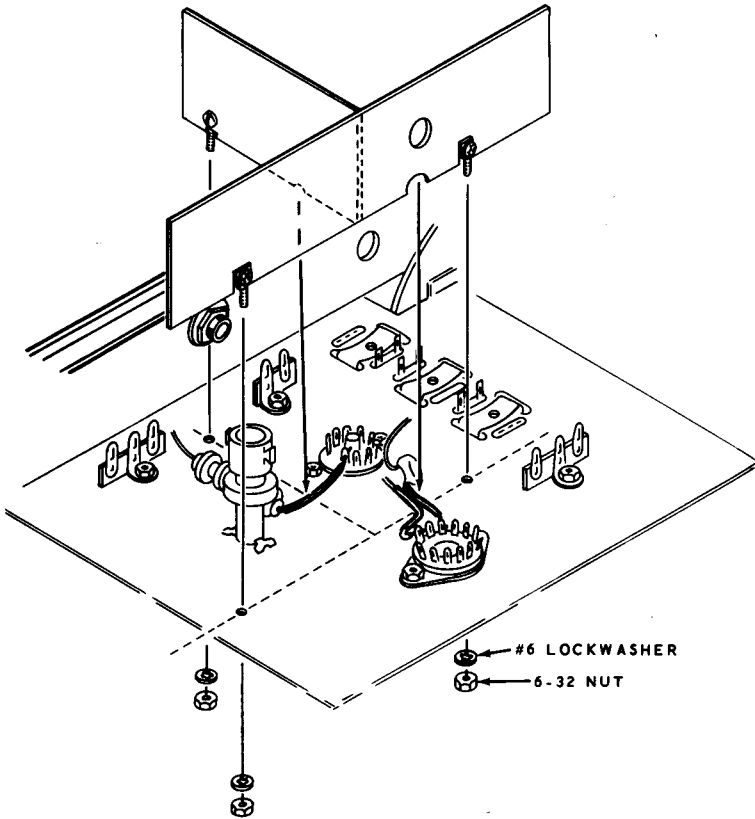
## FINAL WIRING

Refer to Pictorial 16 for the following steps.

- ( ) Refer to Detail 16A to assemble the oscillator-final amplifier shield.

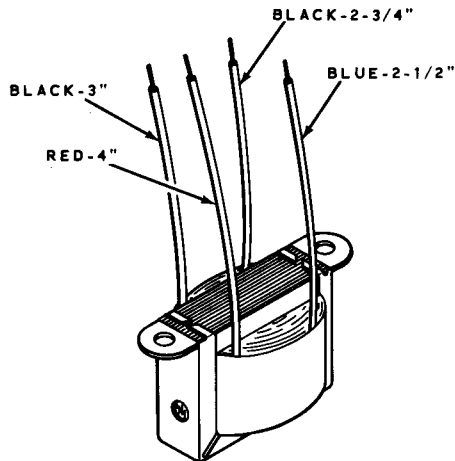


Detail 16A

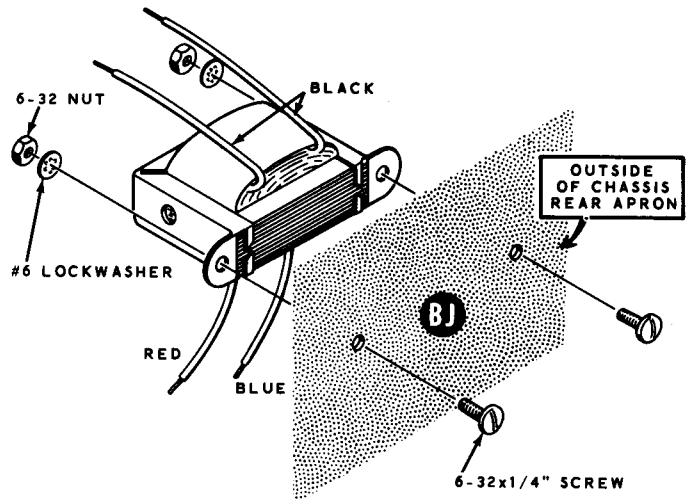


Detail 16B

- ( ) Locate a shield bracket (#204-102), a small shield plate (#206-334), and a large shield plate (#206-335).
- ( ) Place the shorter arm of the shield bracket against the small shield plate at the mounting hole as shown in Detail 16A. The folded edge of the shield bracket should be flush with the edge of the smaller shield plate. Use 6-32 x 1/4" hardware to mount the shield bracket to the smaller shield plate.
- ( ) Align the small hole near the center of the larger shield plate with the hole in the free arm of the shield bracket and mount the larger shield plate to the bracket. Use 6-32 x 1/4" hardware.
- ( ) Mount the three spade bolts to the assembled shield with 6-32 x 1/4" hardware. Position spade bolts as shown in the inset.
- ( ) Place a 2-1/2" length of sleeving on the brown wire coming from lug 1 of tube socket V9.
- ( ) Mount the bottom RF shield assembly to the chassis and route the wires as shown in Detail 16B. Use three #6 lockwashers and three 6-32 nuts. Be sure no wires are pinched under the shield before tightening the nuts.
- ( ) Locate the free end of the brown wire coming from lug 1 of tube socket V9. Connect this wire to lug 5 of tube socket V8 (S-3).



Detail 16C



Detail 16D

- ( ) Locate the free lead of the capacitor coming from lug 3 of tube socket V9. Connect this lead to lug 6 of tube socket V8 (NS).
- ( ) Locate the free lead of the choke coming from lug 9 of tube socket V8. Connect this lead to lug 3 of terminal strip B (S-3).
- ( ) Place a 1-1/4" length of sleeving on each lead of a 10 Ω (brown-black-black) resistor.
- ( ) Connect this 10 Ω resistor from lug 1 of phone jack BG (NS) to lug 2 of phono socket BH (NS).
- ( ) Connect a 1-1/2" bare wire from lug 1 of phono socket BH (S-1), to lug 2 of phone jack BG (S-1).
- ( ) Cut the leads of the AF output transformer (#51-55) to the lengths indicated in Detail 16C. Measure the leads from where they come out of the transformer.

**CAUTION:** Do not cut into the stranded wires when removing the insulation.

- ( ) Remove 1/4" of insulation from the end of each transformer lead. Twist together the small strands of wire at the end of each lead; then melt a small amount of solder on each exposed lead end.

**NOTE:** When mounting the AF output transformer, be sure the blue and red leads extend toward the circuit board.

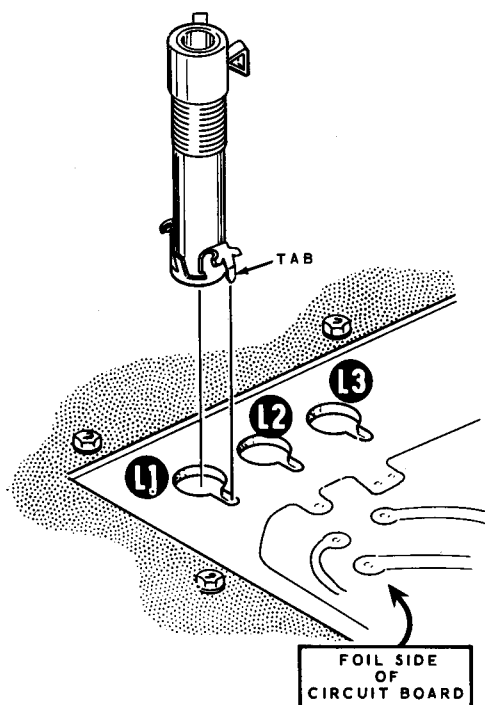
- ( ) Refer to Detail 16D and mount the AF output transformer at BJ. Use 6-32 x 1/4" hardware.

Connect the AF output transformer leads as follows:

| <u>LEAD COLOR</u> | <u>CONNECT TO</u>               |
|-------------------|---------------------------------|
| ( ) Long black    | lug 1 of phone jack BG (S-2).   |
| ( ) Short black   | lug 2 of phono socket BH (S-2). |
| ( ) Red           | lug 4 of octal socket BF (S-2). |
| ( ) Blue          | circuit board hole L (S-1).     |

**NOTE:** Position the blue lead of the AF output transformer up and away from the circuit board.





Detail 16E

Refer to Detail 16E for mounting six unshielded coils to the circuit board.

Mount the coils on the circuit board and connect the capacitors as follows:

- ( ) 15-meter RF coil (#40-363) at L1.
- ( ) 130 pf resin capacitor between lug 1 (NS) and lug 2 (NS) of coil L1.
- ( ) 40-meter RF coil (#40-796) at L2.
- ( ) 47 pf resin capacitor between lug 1 (NS) and lug 2 (NS) of coil L2.
- ( ) 80-meter RF coil (#40-795) at L3.
- ( ) 75 pf resin capacitor between lug 1 (NS) and lug 2 (NS) of coil L3.

- ( ) 40/80-meter heterodyne oscillator coil (#40-797) at L6.
- ( ) 10 pf disc capacitor between lug 1 (NS) and lug 2 (NS) of coil L6.
- ( ) 40/80-meter heterodyne oscillator coil (#40-797) at L5.
- ( ) 15-meter heterodyne oscillator coil (#40-360) at L4.
- ( ) Insert one lead of a .005  $\mu$ fd disc capacitor through lug 2 of coil L6 (NS), through lug 2 of coil L5 (S-2), to lug 2 of coil L4 (NS). Connect the other lead to circuit board hole AA (S-1).
- ( ) Connect a 100 K $\Omega$  (brown-black-yellow) resistor from lug 2 of coil L6 (S-4) to circuit board hole P (S-1).
- ( ) Insert one lead of a .02  $\mu$ fd disc capacitor through lug 2 of coil L1 (S-3) through lug 2 of coil L2 (S-3) to lug 2 of coil L3 (NS). Connect the other lead to circuit board hole Z (S-1).
- ( ) Connect a 22 K $\Omega$  (red-red-orange) 2 watt resistor from lug 2 of coil L3 (S-3) to circuit board hole G (S-1).

**NOTE:** The Band switch will be partially wired before installing it. To make it easier to locate the lugs, each lug position (hole), on each wafer, is assigned a number even though some holes do not have lugs. Each wafer of the 4-wafer switch is assigned a letter. Beginning with the front wafer, the wafers are identified as A, B, C, and D. Wafer C has lugs on the front of the wafer and also on the rear of the wafer. Since the lugs are electrically connected, the front and rear lugs have the same number and will be identified as F for front and R for rear in the following wiring instructions. See Details 16F and 16H. Also observe that a metal grounding wafer is located between wafers B and C.



NOTE: The following lengths of black hookup wire are listed in the sequence that they are wired.

( ) Prepare the following lengths of black hookup wire.

|        |        |
|--------|--------|
| 2"     | 2"     |
| 1-3/4" | 3-1/4" |
| 1-1/4" | 4-1/4" |
| 2-1/4" |        |

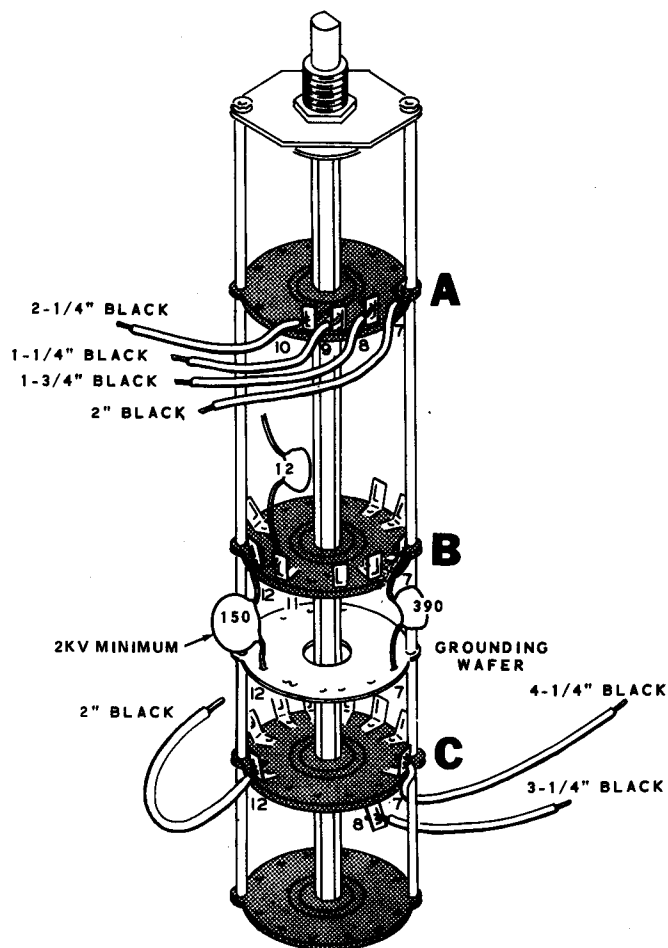
Refer to Detail 16F for the following steps.

Connect one end of the following black wires to the Band switch; leave the other end free:

WIRE LENGTH      BANDSWITCH LUG

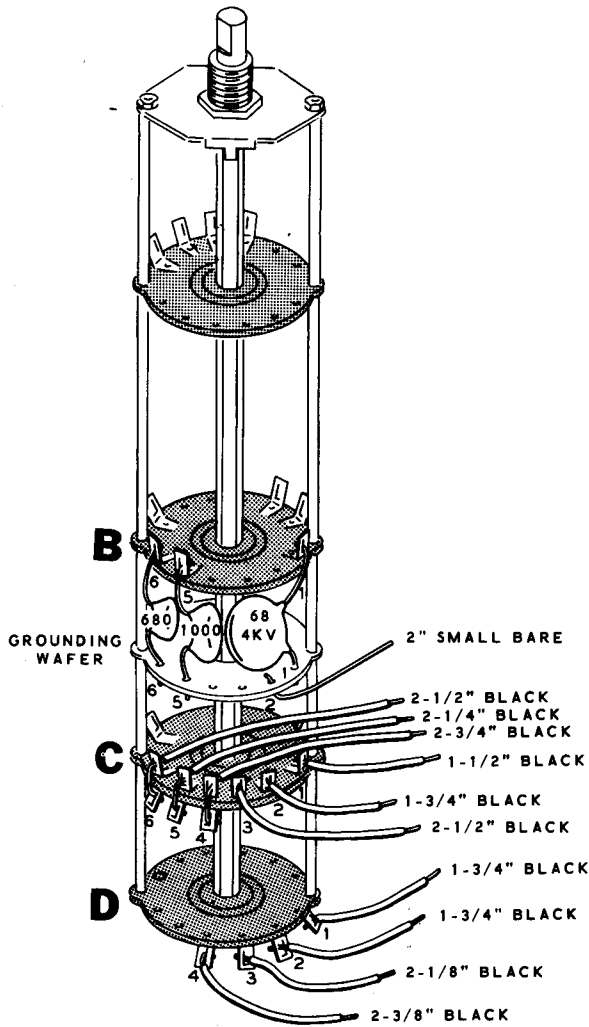
|            |            |
|------------|------------|
| ( ) 2"     | A7 (S-1).  |
| ( ) 1-3/4" | A8 (S-1).  |
| ( ) 1-1/4" | A9 (S-1).  |
| ( ) 2-1/4" | A10 (S-1). |
| ( ) 2"     | C12 (S-1). |
| ( ) 3-1/4" | C8 (S-1).  |
| ( ) 4-1/4" | C7 (S-1).  |

( / ) Connect a 150 pf (2KV or 4 KV) disc capacitor from Band switch lug B12 (S-1) to grounding wafer hole 12 (S-1).



Detail 16F

- ( / ) Cut one lead of a 12 pf resin capacitor to 1" length. Connect this lead to Band switch lug B11 (NS). Leave the other lead free.
- ( / ) Connect a 390 pf resin capacitor from Band switch lug B7 (NS) to grounding wafer hole 7 (NS).



Detail 16G

Refer to Detail 16G for the following steps:

- ( ) Connect a 680 pf resin capacitor from Band switch lug B6 (S-1) to grounding wafer hole 6 (S-1).
- ( ) Connect a 1000 pf resin capacitor from Band switch lug B5 (S-1) to grounding wafer hole 5 (S-1).
- ( ) Connect a 68 pf 4 KV disc capacitor from Band switch lug B1 (S-1) to grounding wafer hole 1 (S-1).
- ( ) Connect one end of a 2" length of small bare wire to grounding wafer hole 2 (S-1). Leave the other end free.

( ) Prepare the following lengths of black hook-up wire:

|        |        |
|--------|--------|
| 2-1/2" | 1-1/2" |
| 2-1/4" | 2-3/8" |
| 2-3/4" | 2-1/8" |
| 2-1/2" | 1-3/4" |
| 1-3/4" | 1-3/4" |

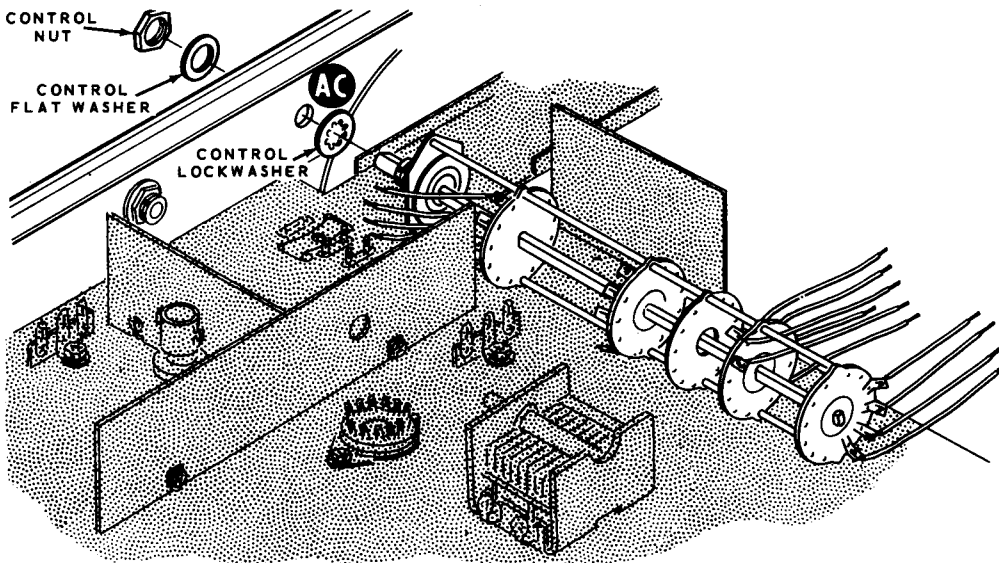
Connect one end of the following black wires to the Band switch; leave the other end free:

| <u>WIRE LENGTH</u> | <u>BAND SWITCH LUG</u> |
|--------------------|------------------------|
| ( ) 2-1/2"         | C6, F, and R (S-3).    |
| ( ) 2-1/4"         | C5, F, and R (S-3).    |
| ( ) 2-3/4"         | C4, F, and R (S-3).    |
| ( ) 2-1/2"         | C3 (S-1).              |
| ( ) 1-3/4"         | C2 (S-1).              |
| ( ) 1-1/2"         | C1 (S-1).              |
| ( ) 2-3/8"         | D4 (S-1).              |
| ( ) 2-1/8"         | D3 (S-1).              |
| ( ) 1-3/4"         | D2 (S-1).              |
| ( ) 1-3/4"         | D1 (S-1).              |

( ) Refer to Detail 16H and position the Band switch as shown. Mount the Band switch at AC. Use a control lockwasher, a control flat washer, and a control nut.

Refer to Pictorial 16 and connect the wires coming from Band switch AC as follows:

| <u>BAND SWITCH LUG</u> | <u>CONNECT TO</u>   |
|------------------------|---------------------|
| ( ) A7                 | lug 2 of L11 (S-1). |
| ( ) A8                 | lug 2 of L10 (S-2). |
| ( ) A9                 | lug 2 of L9 (S-1).  |
| ( ) A10                | lug 6 of V8 (S-2).  |



Detail 16H

BAND SWITCH LUG

CONNECT TO

( ) Cut sleeving to the following lengths:

|      |        |
|------|--------|
| 3/4" | 3"     |
| 2"   | 5-1/2" |

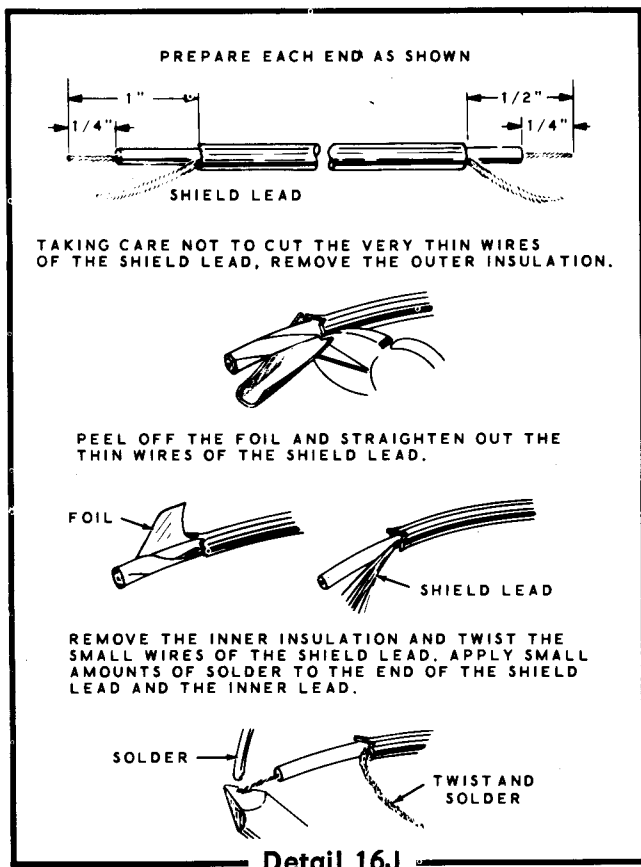
NOTE: Refer to inset drawing #1 on Pictorial 16 for the following four steps.

- ( ) C12 circuit board pin W (S-1).
- ( ) C1 circuit board pin U (S-1).
- (✓) C2 circuit board pin T (S-1).
- ( ) C3 circuit board hole Q (S-1).
- ( ) C6 lug 1 of L4 (S-1).
- ( ) C5 lug 1 of L5 (S-1).
- ( ) C4 lug 1 of L6 (S-2).
- ( ) C7 circuit board hole R (S-1).
- ( ) C8 lug 2 of L4 (S-2).
- ( ) D1 lug 1 of L3 (S-2).
- ( ) D2 lug 1 of L2 (S-2).
- ( ) D3 lug 1 of L1 (S-2).
- ( ) D4 circuit board hole S (S-1).

In the following steps, you will be directed to install sleeving and to connect the wires which have one end connected to final tank coil L12. Refer to inset drawing #2 on Pictorial 16.

(✓) Connect the free end of the bare wire coming from the ground wafer of the Band switch to crystal ground pin BB (S-1).

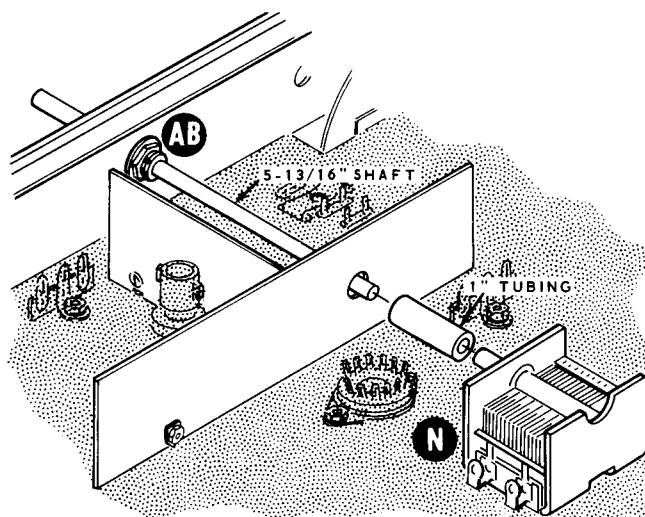
- (✓) Place a 3/4" length of sleeving on the bare wire coming from lug 4; connect this wire to Band switch lug B11 (NS). Cut off the excess lead length.
- (✓) Place a 2" length of sleeving on the bare wire coming from lug 3; connect this wire to Band switch lug B9 (S-1). Cut off the excess lead length.
- (✓) Place a 3" length of sleeving on the bare wire coming from lug 2; connect this wire to Band switch lug B8 (S-1). Cut off the excess lead length.
- (✓) Place a 5-1/2" length of sleeving on the bare wire coming from lug 1; connect this wire to Band switch lug B7 (NS). Cut off the excess lead length.
- (✓) Connect the free lead of the 12 pf resin capacitor coming from Band switch lug B11 to lug 2 of trimmer capacitor U (S-1).



- (✓) Refer to Detail 16J and prepare one 11-1/2" length of coaxial cable.
- (✓) Refer to Pictorial 16. Connect the 1" long end of the inner lead of this cable to lug B7 (S-3) and connect the shield at this end to ground wafer hole 7 of the Band switch (S-2).
- (✓) Connect the free end of the inner lead of the coaxial cable coming from the Band switch to lug 1 of phono socket BC (S-2). Connect the shield to lug 2 of phono socket BC (S-1).
- (✓) Insert a 3-1/2" length of large bare wire through lug 1 (S-2) to lug 2 (S-1) of variable capacitor N. The free end should be positioned between the chassis and parasitic choke. Connect the other end of the wire around the wires connected to lug B11 of the Band switch (S-3).

**CAUTION:** This large bare wire must not touch the chassis or parasitic choke.

- (✓) Connect a .001  $\mu$ fd 1.4 KV disc capacitor from lug 1 of terminal strip P (S-3) to the large bare wire coming from variable capacitor N (S-1).
- (✓) Connect a 10 pf disc capacitor from lug 1 of terminal strip K (S-4) to the large bare wire coming from variable capacitor N (S-1).
- (✓) Refer to Detail 16K and mount a 1" length of black tubing on the end of the shaft of variable capacitor N. From the front panel, insert a 5-13/16" shaft through bushing AB, through the hole in the oscillator shield, and into the open end of the 1" length of tubing on the shaft of variable capacitor N.



- ( ) Clip excess lengths of wires sticking up through the top of the circuit board.
- ( ) Check the two 2-watt resistors mounted on capacitor S and be sure that no wires nor leads touch phone jack BD.

This completes the wiring of your Heathkit Transceiver HW-16. Carefully inspect all connections for loose wire or unsoldered joints. Remove any wire clippings or solder splashes that may be lodged in the wiring. Be sure no solder bridges exist between the foils of the circuit board. Dress wires so that no ungrounded bare wire touches the chassis and that no bare wires touch other parts or connections.

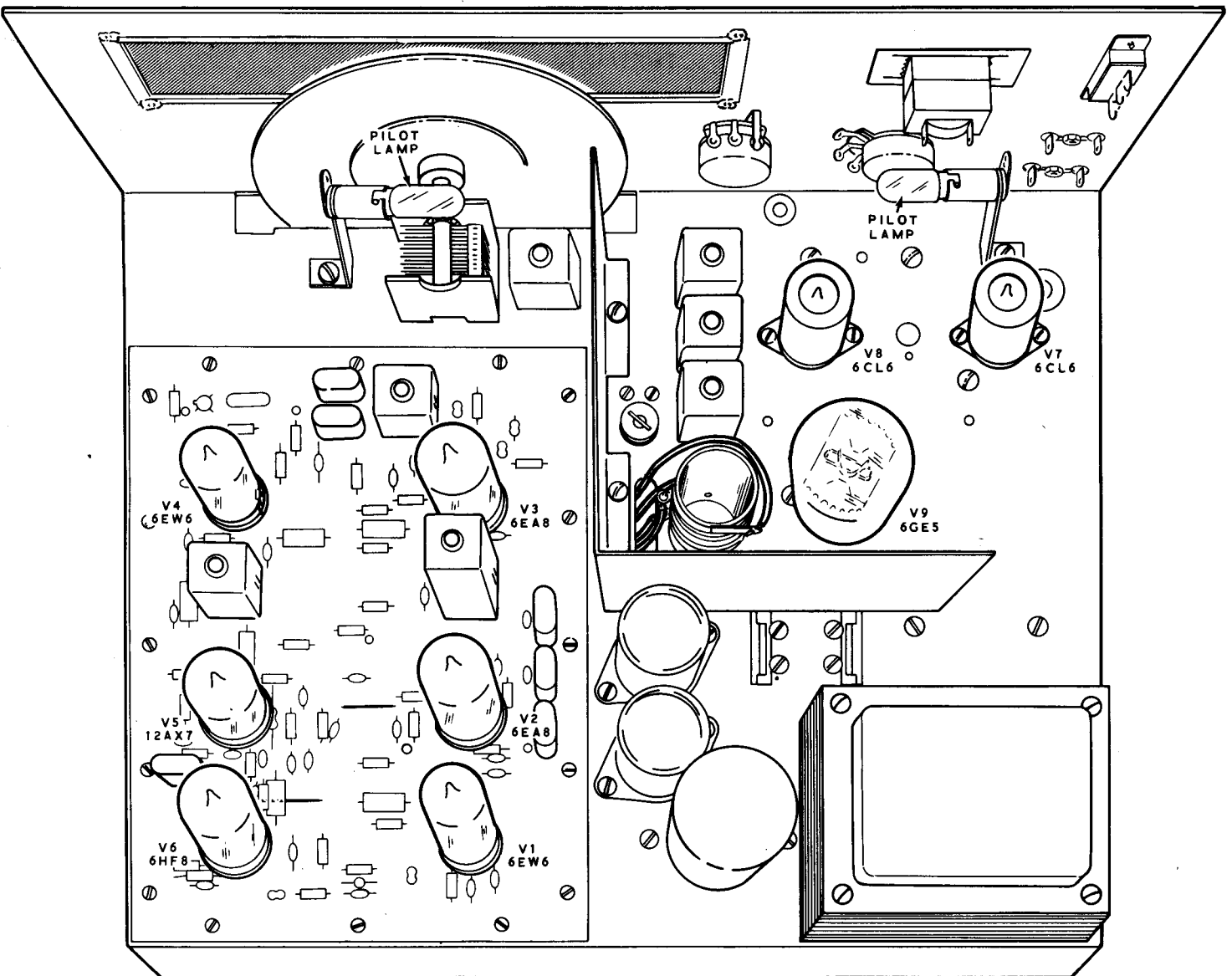
Refer to Pictorial 17 for the following steps.  
Install the tubes in the designated tube sockets  
as follows:

| TUBE      | SOCKET |
|-----------|--------|
| ( ) 6EW6  | V1     |
| ( ) 6EA8  | V2     |
| ( ) 6EA8  | V3     |
| ( ) 6EW6  | V4     |
| ( ) 12AX7 | V5     |

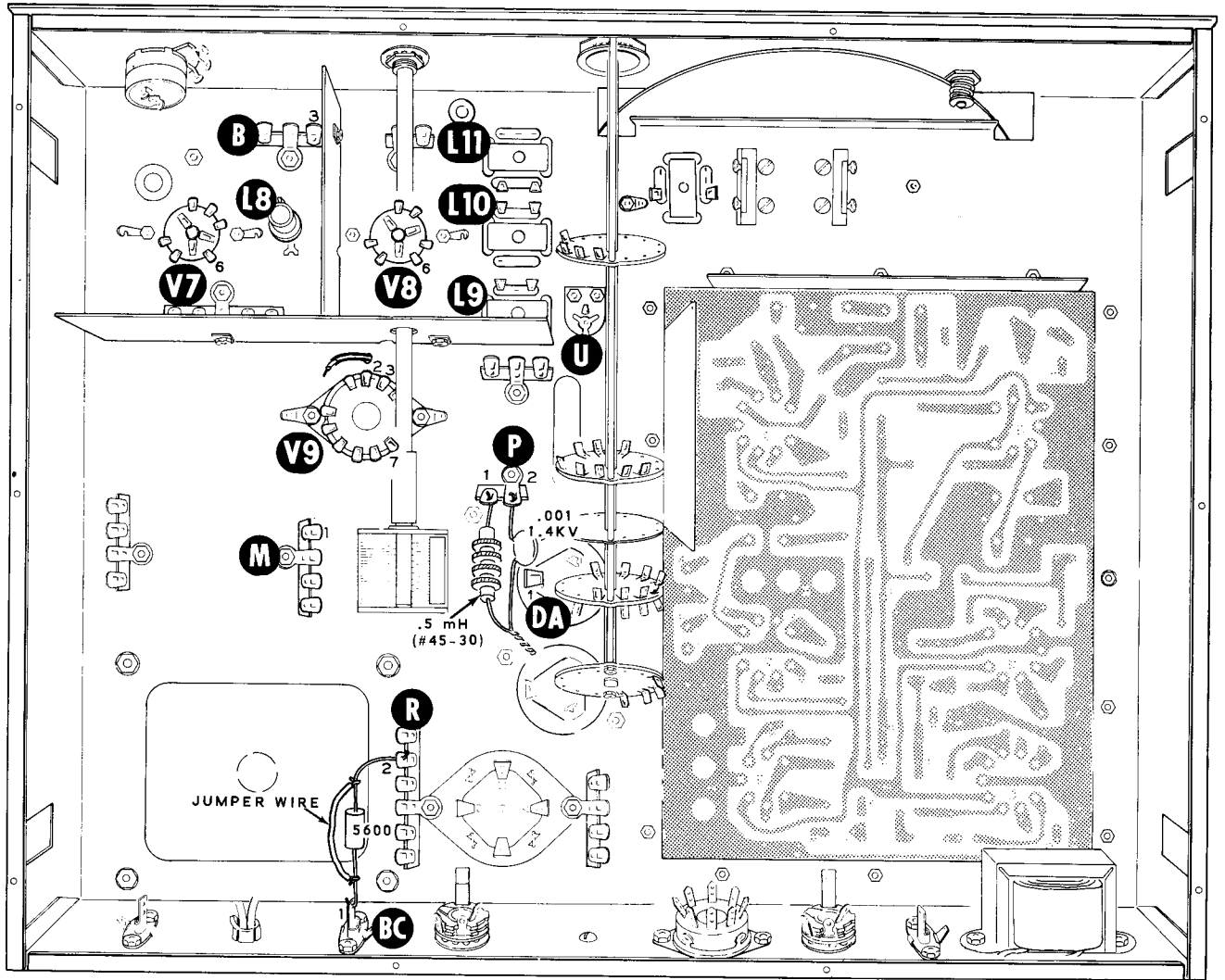
| TUBE     | SOCKET |
|----------|--------|
| ( ) 6HF8 | V6     |
| ( ) 6CL6 | V7     |
| ( ) 6CL6 | V8     |
| ( ) 6GE5 | V9     |

( ) Install two tube shields, one shield over tube V7 and one shield over tube V8.

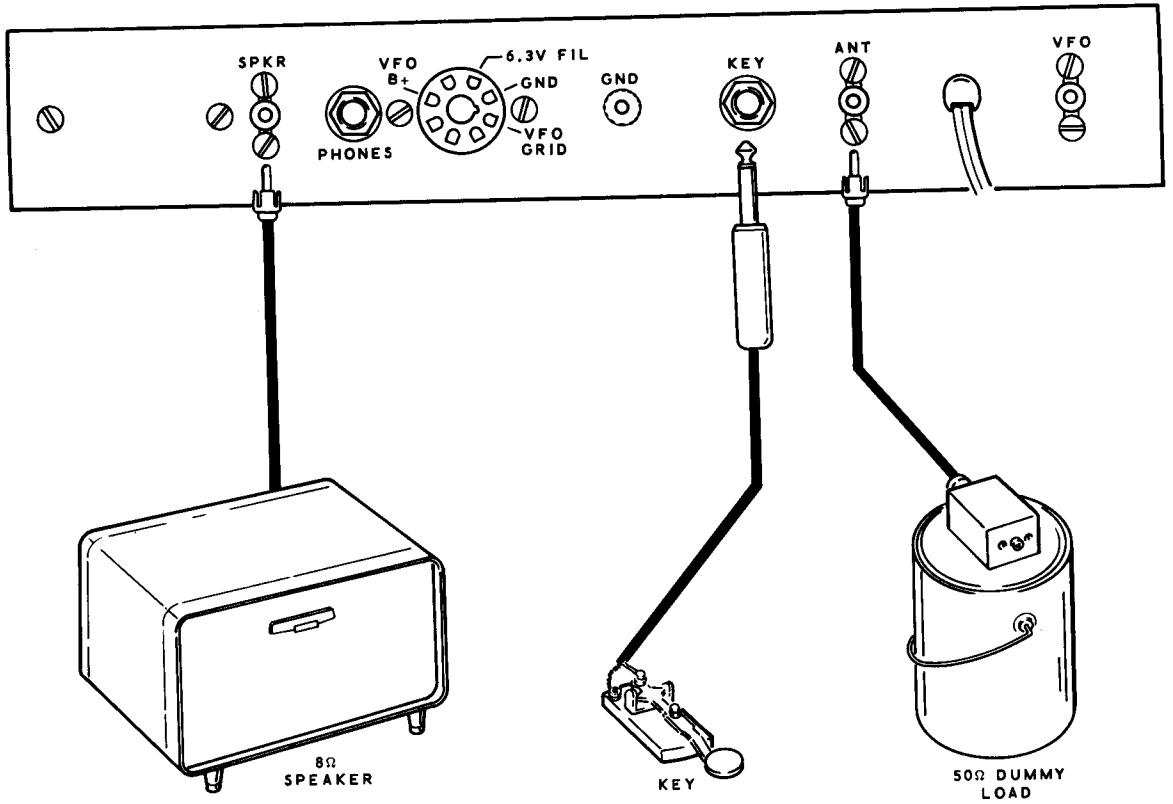
( ) Install the pilot lamps.



PICTORIAL 17

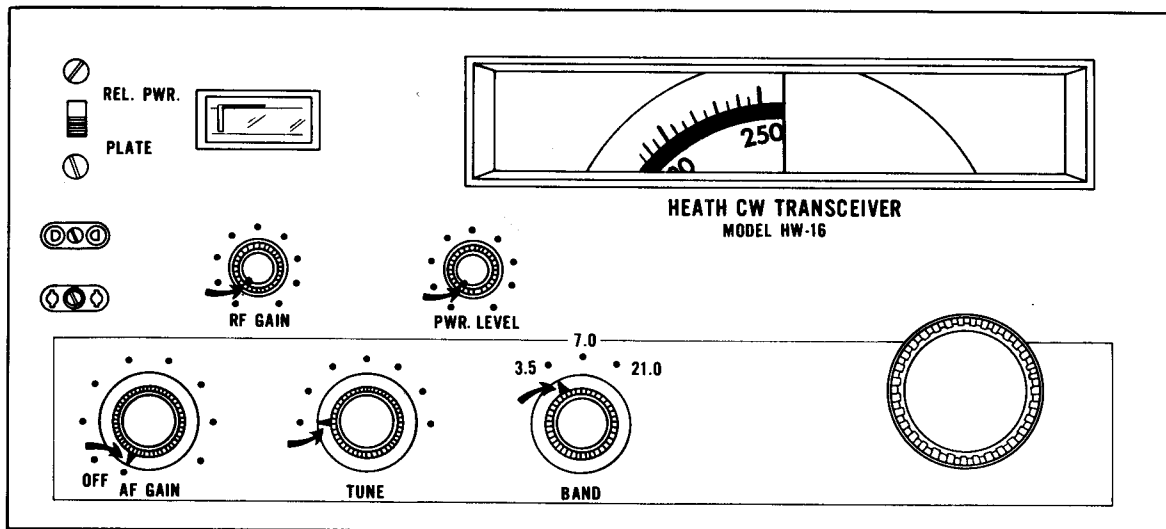


**FIGURE 1-1**



**FIGURE 1-2**





PICTORIAL 18

Refer to Pictorial 18 for the following steps.

Position the Transceiver so that the front panel faces you.

(1) Turn all switch and control shafts fully counterclockwise.

(2) Turn the two variable capacitor shafts so the plates of the capacitors are fully meshed (closed).

(3) Install two 1/2" diameter knobs; one knob on the shaft of the RF Gain control and one knob on the shaft of the Pwr Level control. Position the pointers on the knobs as indicated by the arrows in the Pictorial. Tighten the setscrews.

(4) Install three 1-1/8" diameter knobs; one knob on the shaft of the AF Gain control, one knob on the shaft of the Tune capacitor, and one knob on the shaft of the Band switch. Position the pointers on the knobs as indicated by the arrows in the Pictorial, and tighten the setscrews.

(5) Install the 2" diameter knob on the shaft of the Main Tuning Dial capacitor and tighten the setscrew.

**NOTE:** Be sure the dial hub assembly setscrew is loose enough to allow the Main Tuning Dial to turn without opening the plates of the variable capacitor.

(6) Turn the Main Tuning Dial knob clockwise until the number 250 appears. Continue turning the knob until the outermost edge of the base line beneath the numbers appears under the escutcheon index line; tighten the setscrew in the dial hub assembly.

(7) Turn the Main Tuning Dial knob counterclockwise until the plates of the variable capacitor are fully open. The outermost edge, nearest zero, should appear under the escutcheon index line.

This completes the basic assembly of your Heathkit HW-16 Transceiver. Proceed to the Initial Test. Attaching the bottom chassis plate, the feet, and the top cover will be accomplished in the Final Assembly.

# INITIAL TEST

Before applying power to the Transceiver, complete the preliminary resistance checks given in this section. Perform these checks to be sure there are no short circuits or open connections that would cause damage to the Transceiver components. During the Initial Test, checking the pilot lamps, tube filaments, and the tone oscillator circuit indicates that the power supply and receiver output stage are operating.

For initial testing and alignment of the Transceiver, the equipment listed below, or their equivalents, are necessary.

1. An 11 megohm input VTVM (a 20 K $\Omega$ /V VOM may also be used).
2. A 50  $\Omega$  nonreactive dummy load that is capable of 100 watts dissipation, such as the Heathkit Cantenna, Model HN-31.
3. Crystals:
  - 7.030 MHz or slightly higher frequency.
  - 3500 kHz or slightly higher frequency.
  - 3750 kHz or slightly lower frequency.

If the following resistances are taken with a VOM, the probes (polarity) may need to be reversed to obtain the proper resistance readings.

Check the following resistances. Wait for meter to reach full reading. If any of the resistance readings are lower than specified, refer to the In Case Of Difficulty section on Page 48. Refer to Figure 1-1 (fold-out from Page 38) for test and adjustment points.

- ( ) Pin 7 of tube socket V9 to ground - over 100 K $\Omega$ . *120k*
- ( ) Pin 3 of tube socket V9 to ground - over 20 K $\Omega$ . *21k*
- ( ) Pin 6 of tube socket V8 to ground - over 15 K $\Omega$ . *16k + 20k*
- ( ) Pin 6 of tube socket V7 to ground - over 15 K $\Omega$ . *11 18 k*

Figure 1-2 (fold-out from Page 38) shows the initial test setup.

- ( ) Cut the speaker wires to the length required for your installation. Refer to Figure 1-2A to attach a phono plug to the speaker wires.
- ( ) Connect an 8  $\Omega$  speaker, such as the Heathkit Communications Speaker, Model SB-600, or HS-24, to the SPKR phono socket on the rear of the chassis.
- ( ) Connect the 50  $\Omega$  dummy load to the ANT phono socket on the rear of the chassis. If necessary, refer to Figure 1-2A and attach a phono plug to the 50  $\Omega$  dummy load antenna.

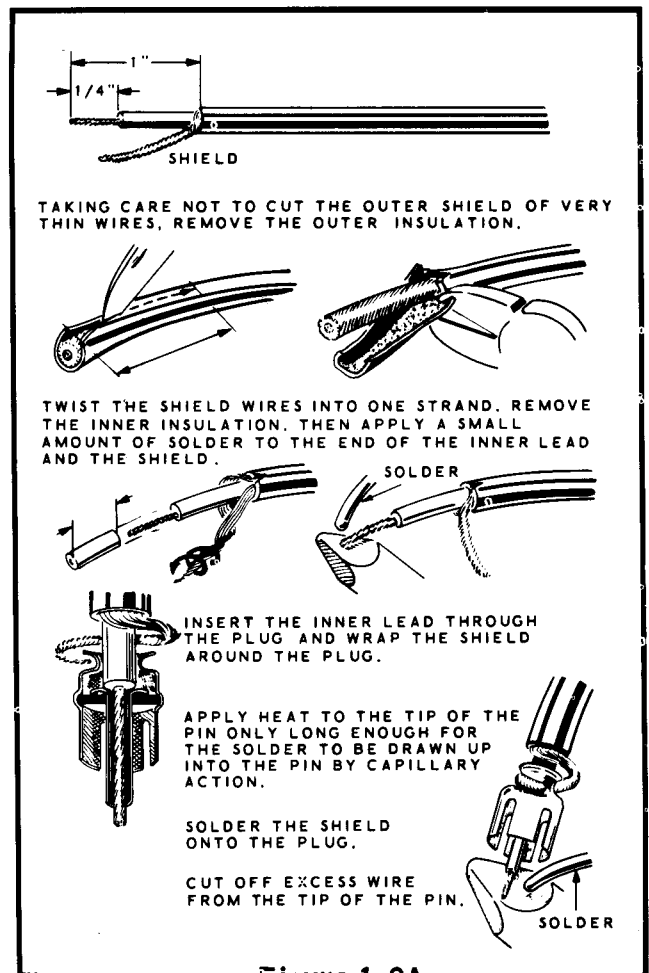


Figure 1-2A

**NOTE:** The Heathkit Electronic Keyer, Model HD-10, can be used with this Transceiver.

Be sure that your keyer has a phone plug that mates with the Key jack on the Transceiver or prepare a wire and phone plug assembly as follows:

- ( ) Cut a wire to the length required for your installation. Refer to Figure 1-2B and prepare the wire and phone plug assembly for connecting your key to the Transceiver KEY jack. Connect the other end of the wire to the terminals of your key.

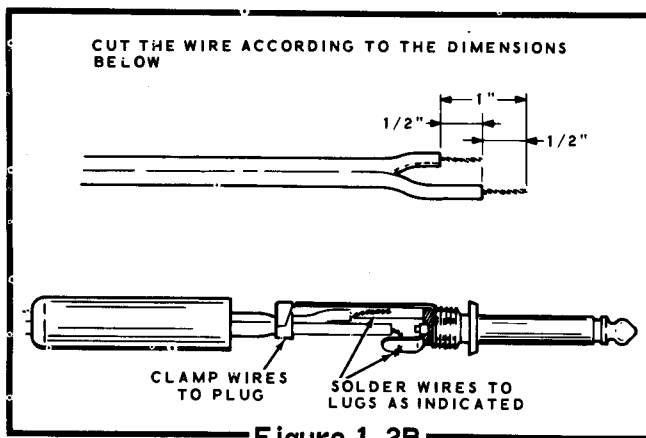


Figure 1-2B

- ( ) Connect your key to the Transceiver KEY jack. When the equipment is on and the key is open, there is about 80 V DC across the terminals.
- ( ) Be sure that the AF GAIN control is in the OFF position and connect the line cord to a 120 volt 50/60 Hz AC outlet.

**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.**

- ( ) Turn the AF GAIN control to the 12 o'clock position.
- ( ) Wait a few minutes to allow the tubes to warm up and then check all pilot lamps and tube filaments. All should be lit and the tube envelopes should begin to feel warm.

**CAUTION:** After the Transceiver has been operating for 1/2 hour or more, the tube envelopes may get hot enough to burn your fingers.

- ( ) When you close the key, a tone should be audible in the speaker. If no tone is heard, refer to the In Case Of Difficulty section of the Manual.

## ALIGNMENT

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

### TRANSMITTER ALIGNMENT

- ( ) Check that the 50  $\Omega$  dummy load is connected to the ANT socket and that the line cord is connected to the 120 volt AC outlet.

**NOTE:** Two crystal sockets are supplied in order to accommodate two different types of plug-in crystals. Only one crystal can be used at a time. Refer to the Operation section of this Manual for crystal information and the differences in the two sockets.

**CAUTION:** Never use a crystal with a VFO nor more than one crystal at the same time, because the Transceiver may transmit on two frequencies simultaneously.

- ( ) Plug a 40-meter crystal (7,030 MHz or slightly higher) into the proper crystal socket on the front panel.
- ( ) Set the front panel controls as follows:

AF GAIN - 12 o'clock position.  
 BAND - 21.0.  
 PWR LEVEL - fully counterclockwise.  
 REL PWR-PLATE - REL PWR.

If you do not get the results specified while you are performing the following steps, refer to the In Case Of Difficulty section of the Manual.

- (✓) Close the key and adjust the TUNE capacitor for a maximum meter reading.
- ( ) Set the REL PWR-PLATE switch to the PLATE position. The meter should read approximately 100, which indicates a V9 plate current flow of approximately 100 ma.
- ( ) Turn the PWR LEVEL control clockwise to check that the meter pointer moves up-scale.
- ( ) Turn the AF GAIN control OFF.
- ( ) Set the Transceiver on its side with the power transformer at the bottom.
- (✓) Turn the AF GAIN control to 12 o'clock position.

Refer to Figure 1-1 for the test and adjustment points.

- (✓) Set the VTVM to the -150 VDC scale. Hold the DC probe of the VTVM on lug 3 of terminal strip B and connect the common probe to the chassis.
- ( ) Close the key and, from the top of the chassis, adjust the slug in crystal oscillator coil L8 for a maximum reading on the VTVM. Then turn the slug clockwise one turn.

NOTE: Leave the negative (-) probe of the VTVM connected to the chassis until directed to remove it.

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

NOTE: The Heath Company has provided an alignment tool with this kit. Use this alignment tool to adjust the position of the slugs in all adjustable coils except crystal oscillator coil L8.

- (✓) Connect the DC probe of the VTVM to lug 1 of terminal strip M, close the key, and adjust the slug in 15-meter driver coil L9 for a maximum reading on the VTVM. Do not disconnect the DC probe of the VTVM from lug 1 of terminal strip M.

- ( ) Set the BAND switch to the 7.0 MHz position and check that the REL PWR-PLATE switch is in the REL PWR position.
  - ( ) Close the key and adjust the TUNE capacitor for a maximum REL PWR reading, then adjust the slug in 40-meter coil L10 for a maximum reading on the VTVM.
  - ( ) Set the BAND switch to the 3.5 MHz position.
  - ( ) Remove the 40-meter crystal and install an 80-meter crystal (3500 kHz or slightly higher frequency).
  - ( ) Close the key and adjust the TUNE capacitor for a maximum REL PWR reading, then adjust the slug in 80-meter driver coil L11 for a maximum reading on the VTVM.
  - ( ) Turn the AF GAIN control to the OFF position and disconnect the line cord from the 120 volt AC outlet.
  - ( ) Use a screwdriver with an insulated handle and short lug 1 of electrolytic capacitor DA to chassis.
  - ( ) Disconnect both probes of the VTVM from the Transceiver.
  - ( ) Disconnect the red wire which is protected with black sleeving, from lug 2 of tube socket V9, and then position the sleeving over the exposed end of the wire.
  - ( ) Remove the .001  $\mu$ fd 1.4 KV disc capacitor lead and the .5 mH choke lead from lug 1 of electrolytic capacitor DA and solder these two free leads to each other.
- CAUTION: The exposed ends of the wire and leads must not touch anything.
- ( ) Locate the 5600  $\Omega$  (green-blue-red) resistor which has one lead connected to the ANT jack; temporarily connect a jumper wire across this resistor.
  - ( ) Set the Transceiver on its side with the power transformer at the bottom.

- ( ) Set the REL PWR-PLATE switch to the REL PWR position.
- ( ) Set the BAND switch to the 21.0 position.
- ( ) Remove the 80-meter crystal and install the 40-meter crystal.
- ( ) Connect the Transceiver line cord to the 120 volt AC outlet and turn the AF GAIN control to the 12 o'clock position.
- ( ) Close the key and adjust the TUNE capacitor for a maximum reading on the meter.
- ( ) Use a screwdriver with an insulated handle and adjust neutralizing capacitor U from the top of the chassis for a minimum reading on the meter.
- ( ) Turn the AF GAIN control to the OFF position and disconnect the Transceiver line cord from the 120 volt AC outlet.
- ( ) Lay the Transceiver down with the bottom of the chassis up.
- ( ) Use a screwdriver with an insulated handle to short lug 1 of electrolytic capacitor DA to chassis.
- ( ) Remove the jumper wire that was temporarily connected across the 5600  $\Omega$  resistor. If the jumper wire was soldered to the resistor leads, check that the permanent resistor connections have not been disturbed.
- ( ) Reconnect the free end of the red wire to lug 2 of tube socket V9 (S-2) and reposition the sleeving on the wire so that the sleeving extends through the chassis hole.
- ( ) Separate the .001  $\mu$ fd 1.4 KV disc capacitor lead from the .5 mH choke lead and reconnect these two leads to lug 1 of electrolytic capacitor DA (S-3).
- ( ) Disconnect the 50  $\Omega$  dummy load.
- ( ) Disconnect the hand key and remove the crystal from the Transceiver.

This completes the Alignment of the Transmitter section.

## RECEIVER ALIGNMENT

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

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

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

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

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

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

- (✓) Adjust the slug in coil L6 for a maximum VTVM reading.
- ( ) Set the BAND switch to the 7.0 position and adjust the slug in L5 for a maximum VTVM reading.
- ( ) Set the BAND switch to the 21.0 position.
- (✓) From the top of coil L4, turn the slug counterclockwise as far as it will go. Do not remove the slug from the coil form. Then adjust the slug in L4 for a maximum VTVM reading by turning the slug clockwise.
- (✓) Set the BAND switch to the 3.5 position.
- (✓) Disconnect both probes of the VTVM from the Transceiver.
- ( ) Set the VTVM to the 1.5 VAC scale, and connect the VTVM AC probes across the speaker terminals.

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

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

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

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

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

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

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

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

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

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

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

( ) Return the BAND switch to the 3.5 position.

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

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

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

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

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

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

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

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

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

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

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

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

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

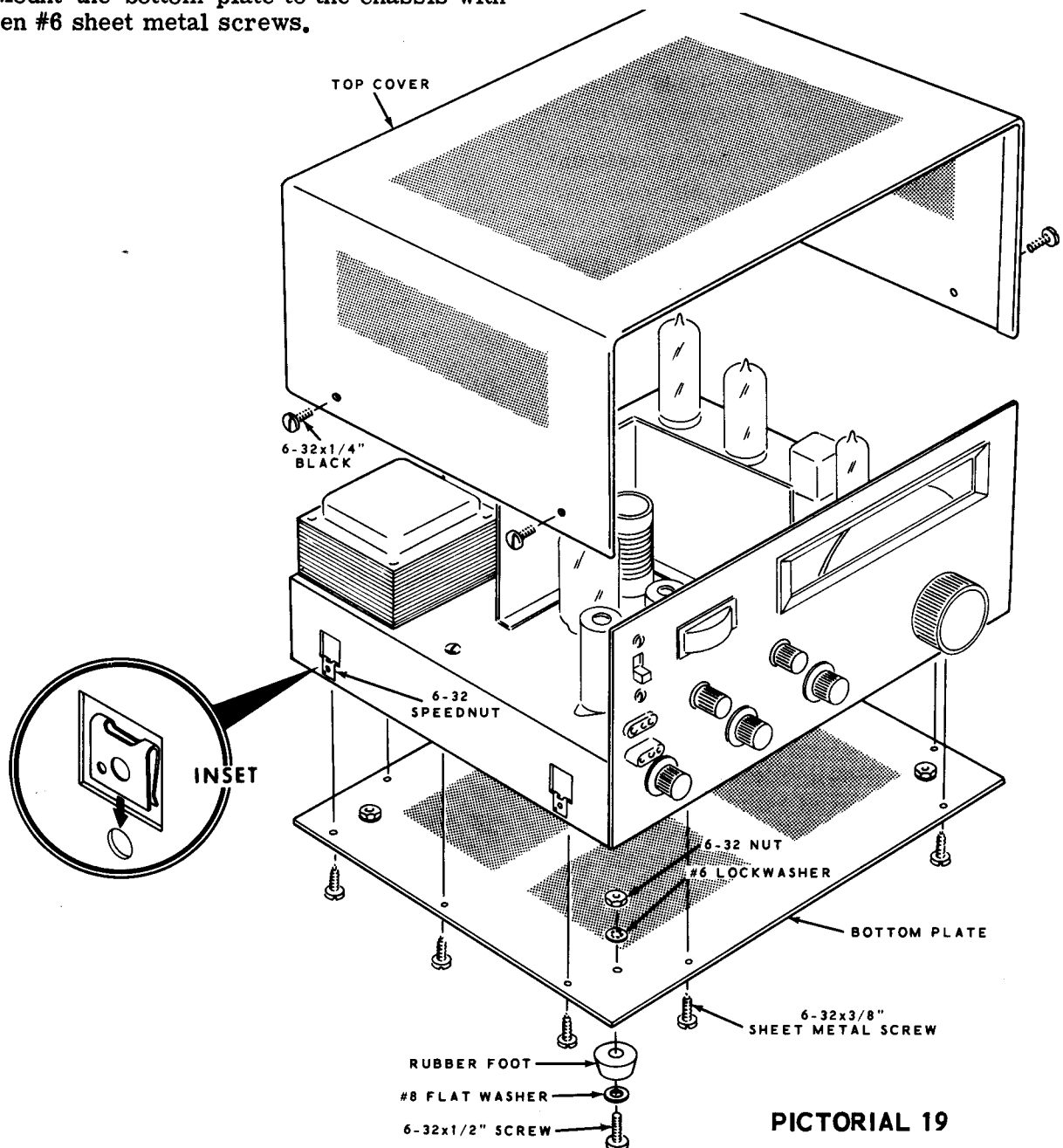
## FINAL ASSEMBLY

Refer to Pictorial 19 for the following steps.

- ( ) Install four 6-32 speednuts on the chassis. Be sure the flat surface of each speednut is on the outside of the chassis.
- ( ) Install four rubber feet on the bottom plate. Use four 6-32 x 1/2" screws, four #8 small flat washers, four #6 lockwashers, and four 6-32 nuts.
- ( ) Mount the bottom plate to the chassis with ten #6 sheet metal screws.

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

- ( ) Place the top cover over the chassis and secure it with two 6-32 x 1/4" black screws on each side.
- ( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear of the chassis between the two screws at the left of the SPKR jack.



PICTORIAL 19

# OPERATION

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

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

- ( ) Connect a true earth ground to the GND connector at the rear of the chassis. To create a true earth ground connection, drive a metal stake into the earth and route a wire from the stake to your Transceiver.
- ( ) Connect an 8 ohm speaker to the SPKR socket at the rear of the chassis.
- ( ) Connect a manual key or electronic key to the KEY jack at the rear of the chassis.
- ( ) Connect a 50 ohm antenna to the ANT socket. Refer to the section on Antennas.
- ( ) Connect the additional accessories you wish to use, such as headphones to the PHONES jack and a VFO to the VFO phono socket and to the VFO power socket.

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

## ANTENNAS

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

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

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

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

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

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

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

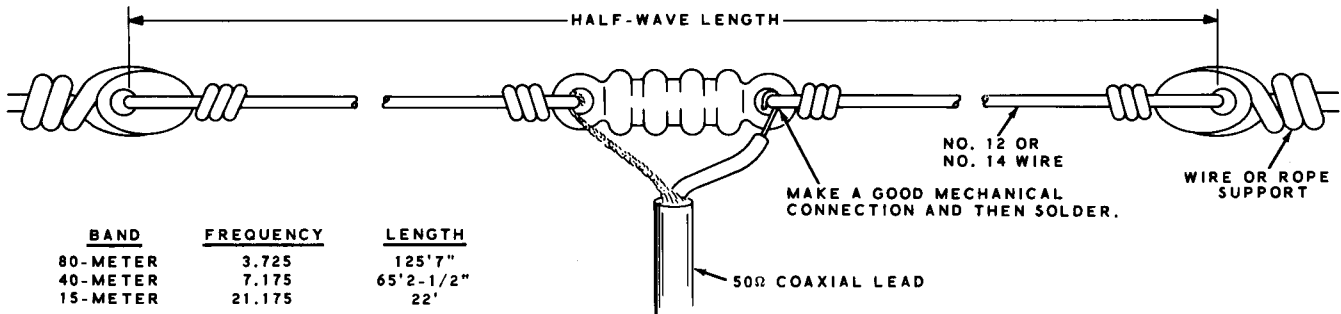


Figure 1-5



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

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

### OPERATION WITH CRYSTALS

The Transceiver may be operated satisfactorily using the following crystals:

| <u>BAND</u> | <u>FUNDAMENTAL CRYSTALS</u>                       |
|-------------|---|
| 80-meter    | 80-meter (3500-3750 kHz).                         |
| 40-meter    | 80- or 40-meter (3500-3625 kHz or 7000-7250 kHz). |
| 15-meter    | 40-meter (7000-7083 kHz).                         |

Crystal Information:

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

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

Novice operation imposes restrictions on operating frequencies as follows:

| <u>BAND</u> | <u>FREQUENCY kHz</u> | <u>USE CRYSTAL FREQUENCY kHz</u> |
|-------------|----------------------|----------------------------------|
| 80-meter    | 3700-3750            | 3700-3750                        |
| 40-meter    | 7150-7200            | 7150-7200 or<br>3575-3600        |
| 15-meter    | 21,100-21,250        | 7034-7083                        |

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

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

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

### OPERATION WITH VFO

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

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

### CONTROL FUNCTIONS

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

#### Rel Pwr-Plate

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

#### RF Gain

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



### Pwr Level

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

### AF Gain

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

### Tune

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

### Band

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

### Main Tuning

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

## TRANSCEIVER OPERATION

- ( ) Plug the line cord into a 120 volt 50/60 Hz AC outlet.
- ( ) Check the SPKR, ANT, KEY, and GND connections.
- ( ) Set the front panel controls as follows:

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

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

- ( ) Select a crystal and plug it into the proper crystal socket. If you desire to contact a specific station, select a crystal equal to or near the frequency of that station.
- ( ) Depress the key and adjust the TUNE control for a maximum REL PWR meter indication.
- ( ) Place the REL PWR-PLATE switch to the PLATE position and check the input current reading.

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

- ( ) Adjust the plate current to the desired level with the PWR LEVEL control.
- ( ) Place the REL PWR-PLATE switch to the REL PWR position and readjust the TUNE control for a maximum REL PWR meter readings.
- ( ) Return the REL PWR-PLATE switch to the PLATE position and check that the meter reading does not exceed the allowable limit.

The Transceiver is now ready to receive and transmit.

## OPERATING REMINDERS

1. Operation of the transmitter with an improperly tuned amplifier (not tuned to resonance) may result in component failure. Always retune after changing crystals or VFO frequency.
2. Operation of the transmitter without a proper antenna or a dummy load will result in component failure.
3. Use caution and observe rules of safety in taking voltage and current measurements.
4. Do not cover the cabinet ventilation holes.

## IN CASE OF DIFFICULTY

Review the Operation section of the Manual.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.
2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of the Kit Builders Guide.
3. Check to be sure that all tubes and cable connections are in their proper locations. Make sure that all tubes light up properly.
4. Check the tubes with a tube tester or by substitution of tubes of the same types that are known to be good.
5. Check the values of the parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.
6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.
7. If, after careful checks, the trouble is still not located and a voltmeter is available, check the voltage readings against those shown on the Schematic (fold-out from Page 63). All voltage readings were taken with an 11 megohm vacuum tube voltmeter. Voltages may vary as much as  $\pm 10\%$ .
8. A review of the Circuit Description will help you to know where to look for trouble.

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

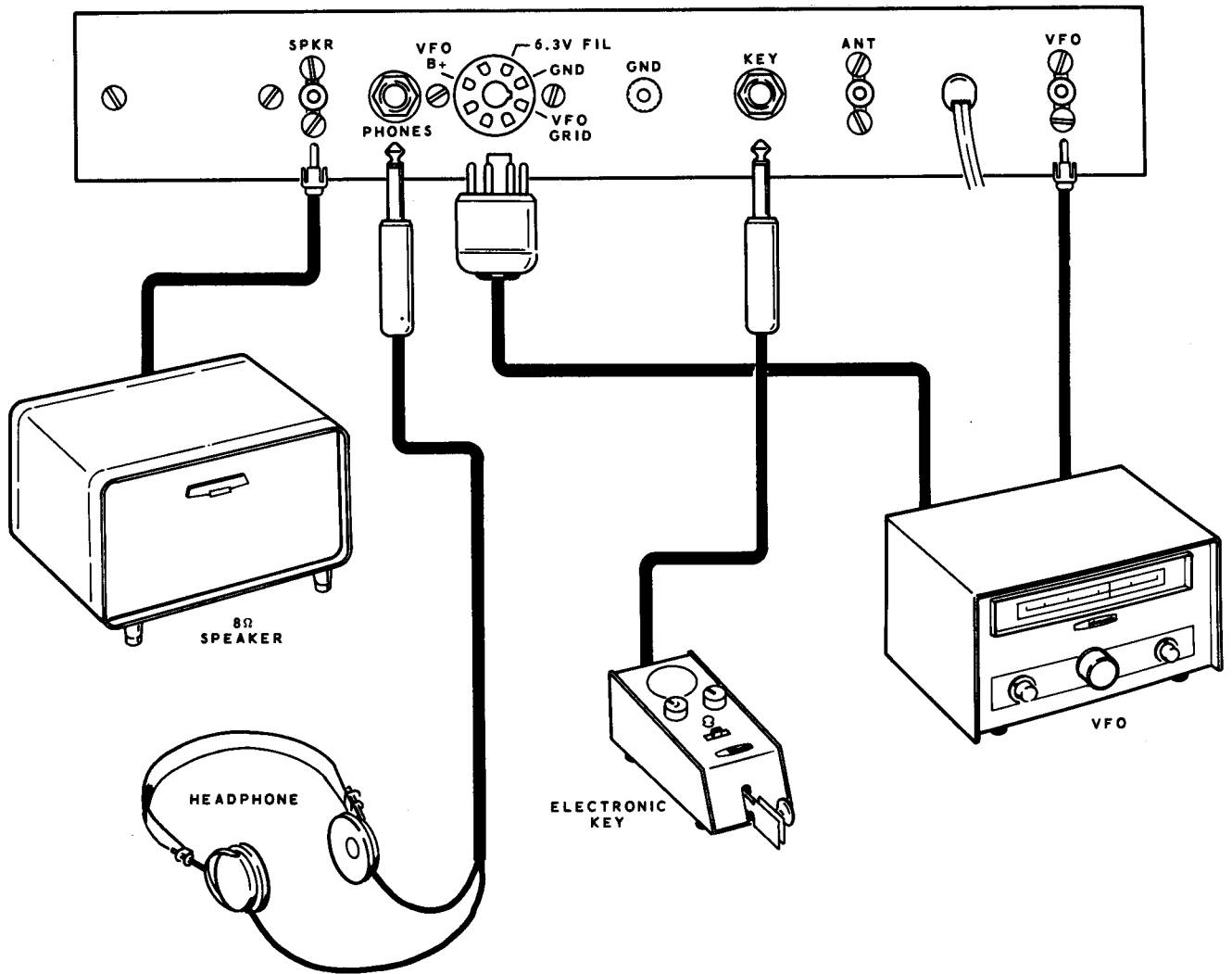
Breaks in the foil of the circuit board can be detected by placing a bright light under the foil side of the board and looking through the board from the lettered side. A break will appear as a hairline crack in the foil.

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

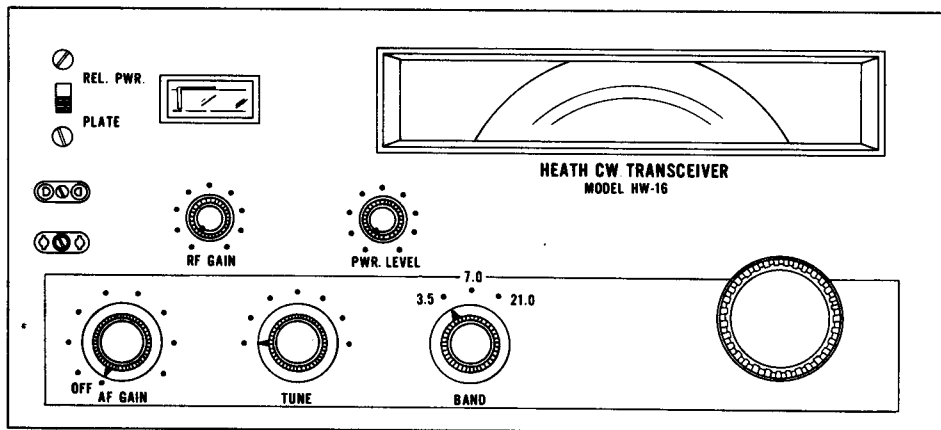
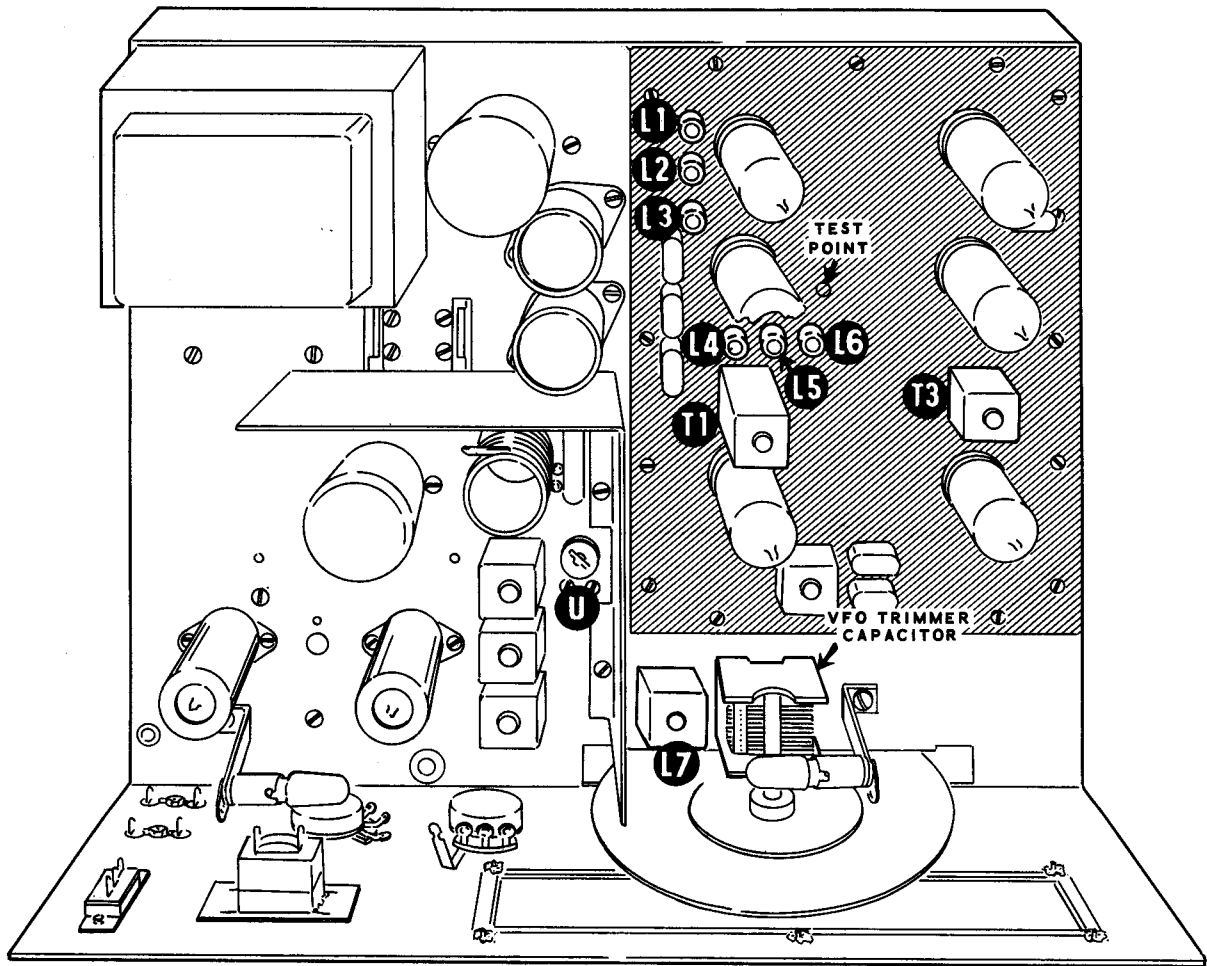
## TROUBLESHOOTING CHART

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

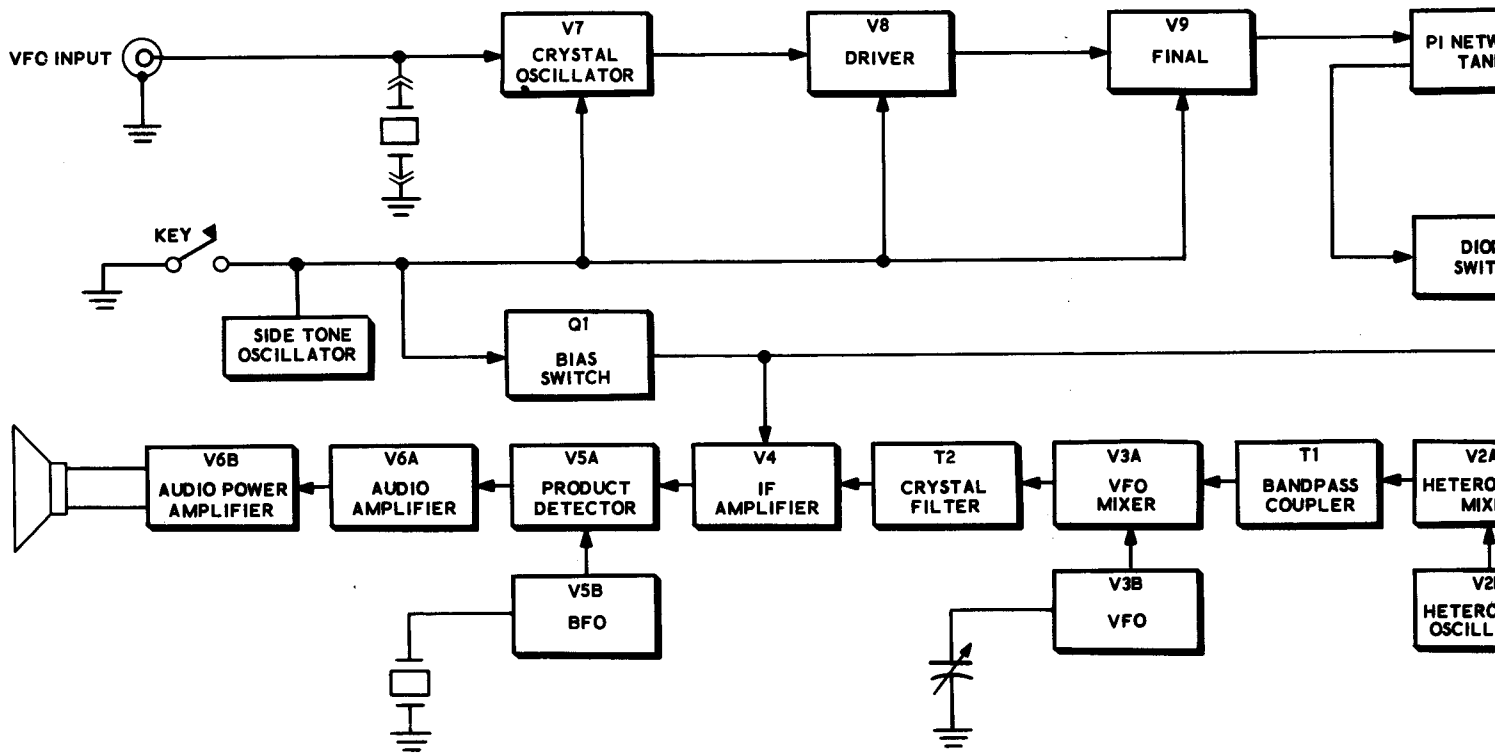
| SYMPTOMS   | POSSIBLE CAUSE  |
|--|---|
| 1. No power; pilot lamps and tube filaments do not light, no B+ or bias voltage. | A. AF GAIN control in OFF position.<br>B. Line cord disconnected from 120 VDC source.<br>C. Circuit breaker open.<br>D. Defective AC switch on AF GAIN control.<br>E. Black leads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



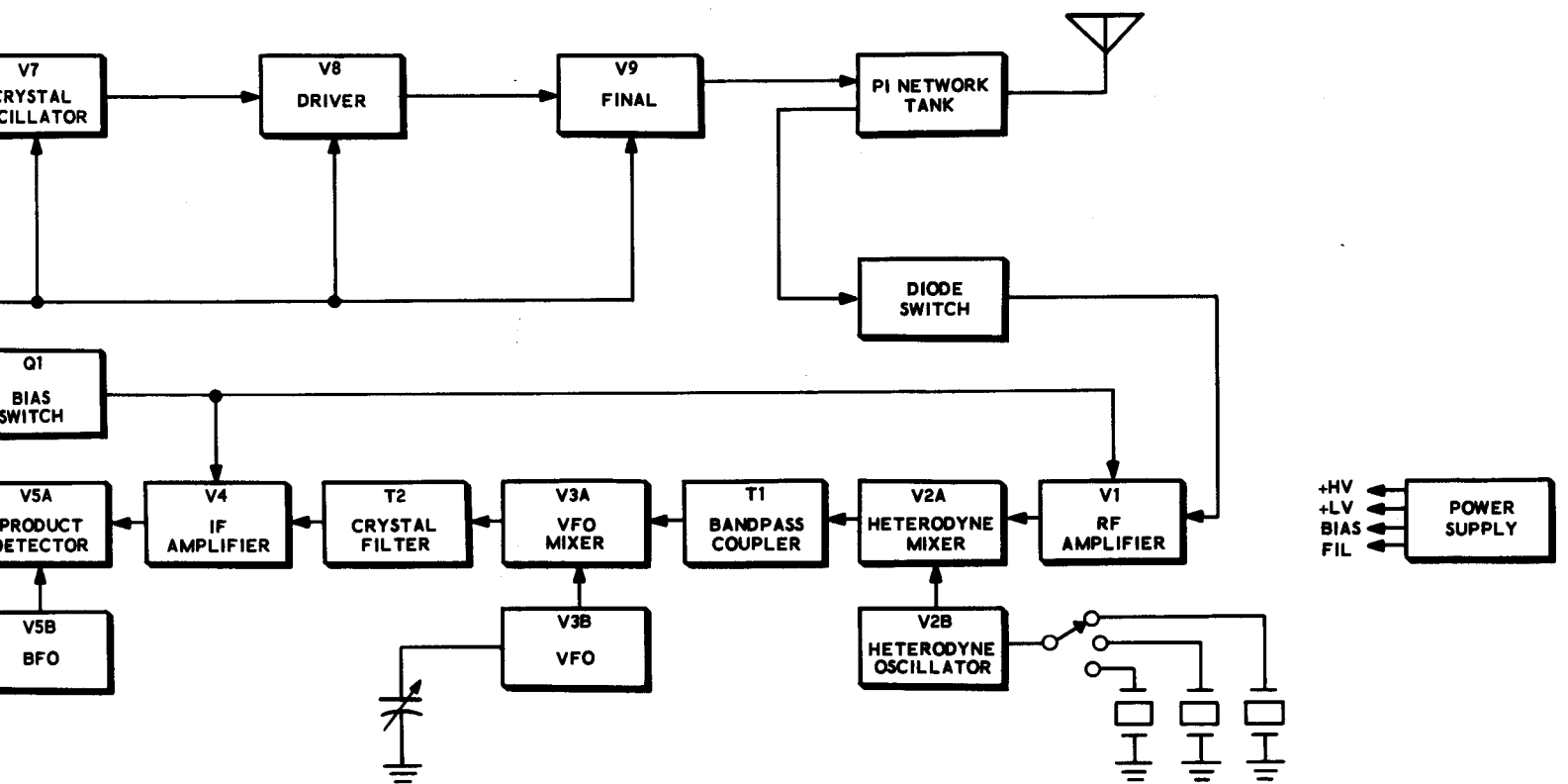
**FIGURE 1-4**



**FIGURE 1-3**



**BLOCK DIAGRAM**



**BLOCK DIAGRAM**



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

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



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

## SPECIFICATIONS

### TRANSMITTER

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

**RECEIVER**

|                                     |   |
|-------------------------------------|---|
| Sensitivity. . . . .                | Less than 1 microvolt for 10 db signal-plus-noise to noise ratio. |
| Selectivity. . . . .                | 500 Hz at 6 db down.  |
| Image Rejection. . . . .            | 70 dB or better.  |
| IF Rejection. . . . .               | 35 dB or better.  |
| Intermediate Frequency. . . . .     | 3396 kHz.   |
| Antenna Impedance. . . . .          | 50 $\Omega$ unbalanced.   |
| External Speaker Impedance. . . . . | 8 $\Omega$ .  |

**GENERAL**

|                                      |   |
|--------------------------------------|---|
| Frequency Coverage. . . . .          | 3.5 to 3.75 MHz.<br>7.0 to 7.25 MHz.<br>21.0 to 21.25 MHz.  |
| Power. . . . .                       | 120 VAC 50/60 Hz.   |
| Transmitter Tube Complement. . . . . | 6CL6 Crystal oscillator.<br>6CL6 Driver<br>6GE5 Final.  |
| Receiver Tube Complement. . . . .    | 6EW6 RF amplifier.<br>6EA8 Heterodyne mixer-oscillator.<br>6EA8 VFO mixer-oscillator.<br>6EW6 IF amplifier.<br>12AX7 Product detector-oscillator.<br>6HF8 1st audio and audio output. |
| Transistor Complement. . . . .       | 2N1274 muting circuit.  |
| Dimensions. . . . .                  | 13-3/4" wide x 11-1/2" deep x 6-1/2" high.  |
| Net Weight. . . . .                  | 20 lbs.   |

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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 50) and to the Schematic Diagram (fold-out from Page 63) while reading this Circuit Description.

Note that the receiver circuits are across the bottom and the transmitter circuits are across the top of the Schematic and Block Diagrams.

### TRANSMITTER

Tube V7 is a modified Pierce crystal oscillator which combines the functions of an oscillator and a buffer amplifier. It creates the basic signal which is amplified by tube V8, the driver stage. The driver stage also serves as a frequency tripler on the 15-meter band. The final amplifier, tube V9, increases the power sufficiently for transmission. Closing the key removes the cutoff bias from the grids of all three transmitter stages.

#### Crystal Oscillator

The screen grid of pentode V7 serves as the plate of a crystal-controlled triode oscillator. The oscillator operates at the fundamental frequency of an 80- or 40-meter crystal.

The complete pentode acts as an amplifier for the oscillator signal on the control grid. The plate load is a tuned tank circuit on 40-meter signals, but the coil acts as an RF choke on 80-meters. (Capacitor C7 couples the signal to the driver stage.)

#### Driver

Driver tube V8 operates as a straight amplifier on either 40 or 80 meters. On 15 meters, V8 acts as a frequency tripler. The proper broadband plate tank circuit is selected with the Band switch. The output signal is coupled through capacitor C15 to the final amplifier.

#### Final Amplifier

Final amplifier tube V9 operates as a neutralized amplifier with its input and output circuits tuned to the same frequency. It is necessary to cancel the plate-to-grid capacity by using capacitors C21 and C22 to pass a small amount of the output into the grid circuit as an out-of-phase neutralizing signal. A parasitic choke made up of coil L15 and resistor R11 is used in the plate circuit to suppress high frequency parasitic oscillations.

The Power Level control on the front panel adjusts the screen voltage of tube V9 to control the power output. When the Plate-Rel Pwr meter switch is in the Rel Pwr position, the meter measures a sample of RF voltage taken from voltage divider resistors R16 and R17 and rectified by diode D2. The meter reading is proportional to the RF output voltage at the antenna.

In the Plate position of the Plate-Rel Pwr meter switch, the meter indicates final cathode current (plate current and screen current) by measuring the voltage drop across resistor R15.

In the transmit condition, cathode current flows through resistor R15, coil L17, and diode D1 to the cathode of tube V9 (pins 4 and 10). This provides forward bias to D1 and allows any RF coupled from the pi network circuit via C23 to be bypassed to ground through diode D1 and capacitors C16 and C17. This prevents the transmitter output from reaching the receiver RF amplifier grid during transmit.

During receive operation, diode D1 has no bias. It is effectively an open circuit at the low signal voltages received. Signals are coupled through C23 to the grid of receiver RF amplifier tube V1. Diode D1 acts as an antenna relay.

#### Pi Network Output Circuit

The output network is used in both the transmit and receive modes. Different pi network configurations are switched into the output circuit by

the Band switch. On the 80-meter band, the entire coil L12 is used; capacitors C26 and C27 are paralleled with capacitor C28; and capacitors C29 and C31 are paralleled with capacitor C32, which is a fixed loading capacitor. On the 40-meter band, a few turns of coil L12 are shorted; the shunting capacitances are reduced by switching capacitors C27 and C29 out of the circuit. On the 15-meter band, most of coil L12 is shorted; the shunting capacitances are reduced further by switching capacitors C26 and C31 out of the circuit.

### Grid-Block Keying Circuits

With a key-up condition, a large negative voltage is placed on the grids of tubes V7, V8, and V9. This bias voltage cuts these tubes off, therefore the transmitter has no output.

The key-down condition shorts resistor R69, which removes the cutoff bias voltage from tubes V7 and V8. At the same time, the bias at V9 is reduced to an operating level.

## RECEIVER

The receiver employs one RF amplifier, a fixed-tuned heterodyne oscillator and heterodyne mixer, a manually-tuned VFO, a VFO mixer, an IF amplifier, a crystal controlled product detector, and two audio amplifiers. In addition, there is a transistor-type bias switch with a manual RF Gain control.

### RF Amplifier

The received signal from the antenna passes through the pi network and is amplified by RF amplifier tube V1. The plate load is a broadband tank circuit. All received signals in the selected band of frequencies are coupled through capacitor C42 to Heterodyne Oscillator-Mixer tube V2. The amount of RF amplification is controlled by the RF Gain control. It controls the amount of cathode bias on RF amplifier tube V1. The RF Gain control also affects IF amplifier V4.

### Heterodyne Oscillator-Mixer

The RF signal at the grid of heterodyne mixer tube V2A is mixed with a signal generated by heterodyne oscillator V2B. The Band switch selects the proper crystal and plate coil for the oscillator. The signal produced in the heterodyne oscillator is capacitively coupled to the heterodyne mixer within the tube. Here, all signals passed by the pi network and RF amplifier are mixed with the heterodyne oscillator signal. The output signal is coupled to the grid of the VFO mixer through T1, the bandpass coupler. This bandpass coupler passes desired signals in the range of frequencies from 5546 kHz to 5296 kHz.

### Variable Frequency Oscillator-Mixer

The signal input to V3A at the VFO mixer grid is mixed with the signal from VFO tube V3B. Capacitor C53 tunes the VFO from 1900 kHz to 2150 kHz. The VFO signal is coupled through C56 to the cathode of the VFO mixer where the bandpass signals from the preceding stage are mixed with the signal from the VFO. The resultant signal is an IF of 3396 kHz. A highly selective crystal filter couples the output of the VFO mixer to the grid of the IF amplifier.

### IF Amplifier-Product Detector And BFO

Amplifier V4 is a conventional IF stage which amplifies the 3396 kHz signal passed by the crystal filter. The amount of IF amplification is controlled by the RF Gain control, which controls the amount of cathode bias on V4. The RF Gain control also affects RF amplifier tube V1.

Coil T3, which is tuned to resonance by a small capacitor, serves as the plate load for IF amplifier V4. The signal from the plate of V4 is coupled through capacitor C73 to the grid of product detector stage V5A.

Tube V5B is a crystal-controlled BFO that produces a 3396.4 kHz signal. The BFO signal couples from the cathode of V5B to the cathode of V5A through capacitor C78. The product detector produces an audio signal equal to the

difference in frequency between the BFO and IF of the two input signals. The output of the product detector couples through the AF Gain control to audio amplifier V6A. The AF Gain control varies the volume of the output signal.

### AF Gain Control

AF Gain control R61 is connected in series with DC blocking capacitor C75 and resistor R53 as an audio (signal) voltage divider which shunts plate load resistor R54. Turning AF Gain control R61 in a clockwise direction increases the proportion of the audio signal being coupled to audio amplifier V6A. The greater the signal input to the audio amplifier, the greater the volume of the output signal.

### Audio Amplifier-Audio Power Amplifier

The cathode circuit of audio amplifier V6A is connected to a side-tone oscillator, neon lamp and capacitor C86. When the key is depressed, the sidetone oscillator provides an audio signal at the cathode of audio amplifier V6A. This is for monitoring purposes and allows you to monitor the message you are transmitting. The amplified signal from the plate of audio amplifier V6A is coupled through capacitor C85 to the grid of audio power amplifier V6B.

Audio power amplifier V6B couples through a transformer to either a speaker or headphones. The speaker is left connected at all times. When

the headphones are plugged in, their high impedance causes the speaker to be effectively muted. For operation with headphones only, a shorted phono plug must be inserted in SPKR Jack.

### Bias Switch

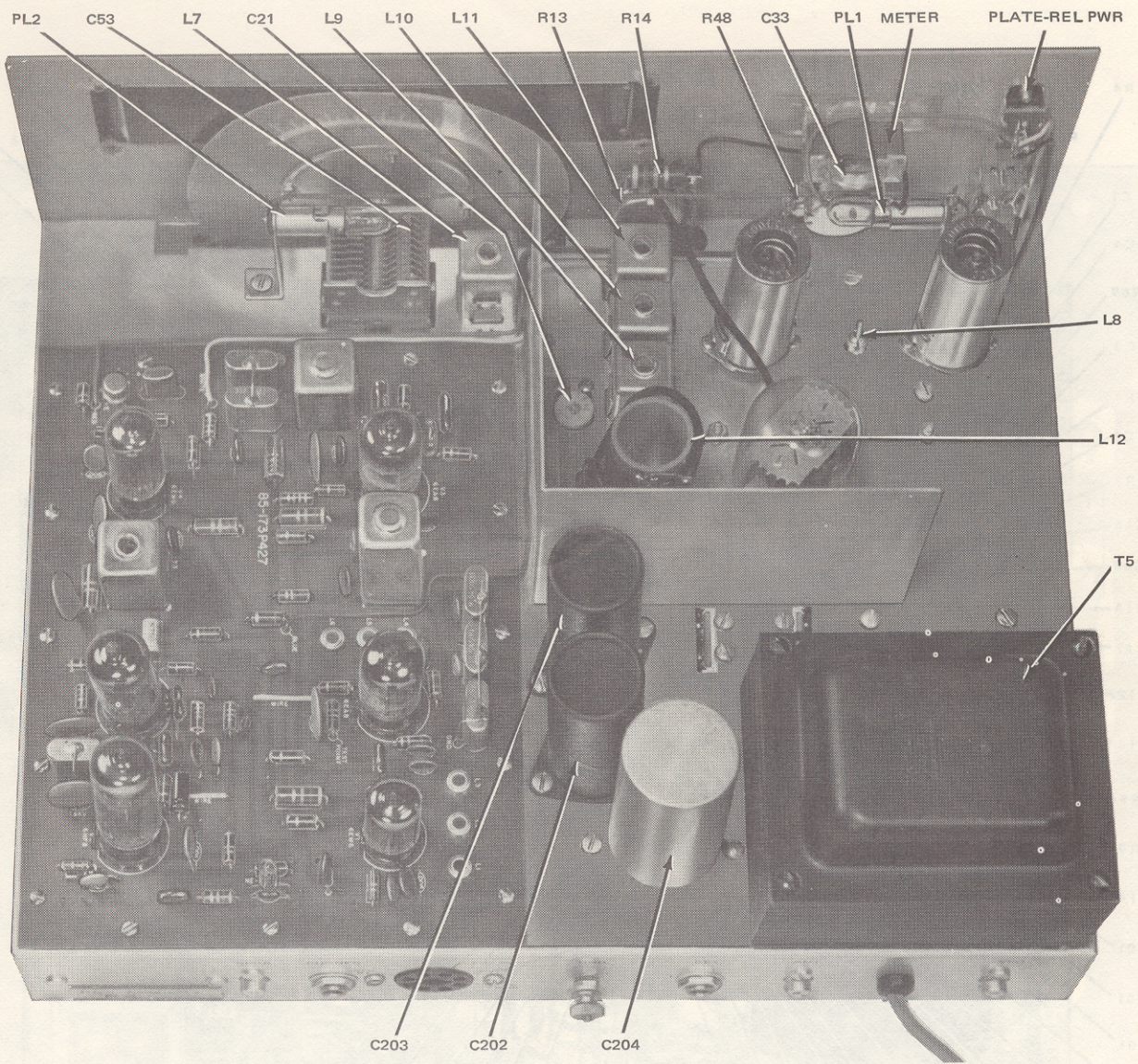
Transistor Q1 is a bias switch for receiver muting. When receiving, Q1 conducts and provides operating bias to the cathode of V1 and V4. Depressing the key causes the base-emitter junction of Q1 to become reverse biased and cut off. Because of this, the cathode voltage of V1 and V4 rises and cuts off the receiver RF and IF stages.

### POWER SUPPLY

The power supply consists of a half-wave rectifier, a voltage doubler and a filament supply. The half-wave rectifier produces -120 V DC for the grid-block keying bias. This is filtered by capacitor C201 and resistor R201. The voltage doubler circuit produces 600 V DC for the final amplifier plate and 300 V DC which is further filtered and dropped to supply low voltage B+ to the receiver and transmitter sections. Filament voltage is supplied directly by a low voltage winding on power transformer T5.

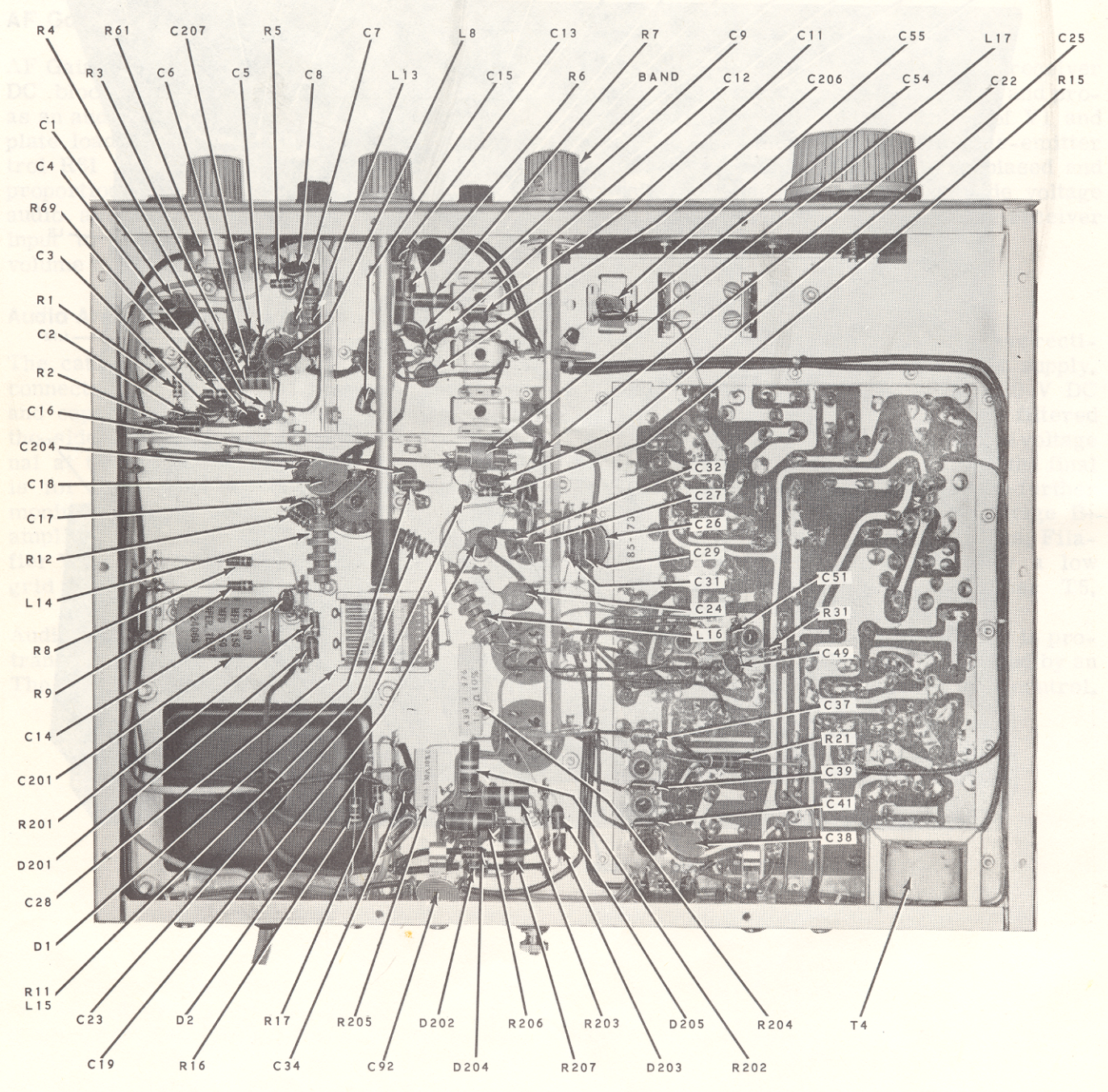
The primary of the power transformer is protected by a circuit breaker and controlled by an On-Off switch operated with the AF Gain control.

# CHASSIS PHOTOGRAPHS

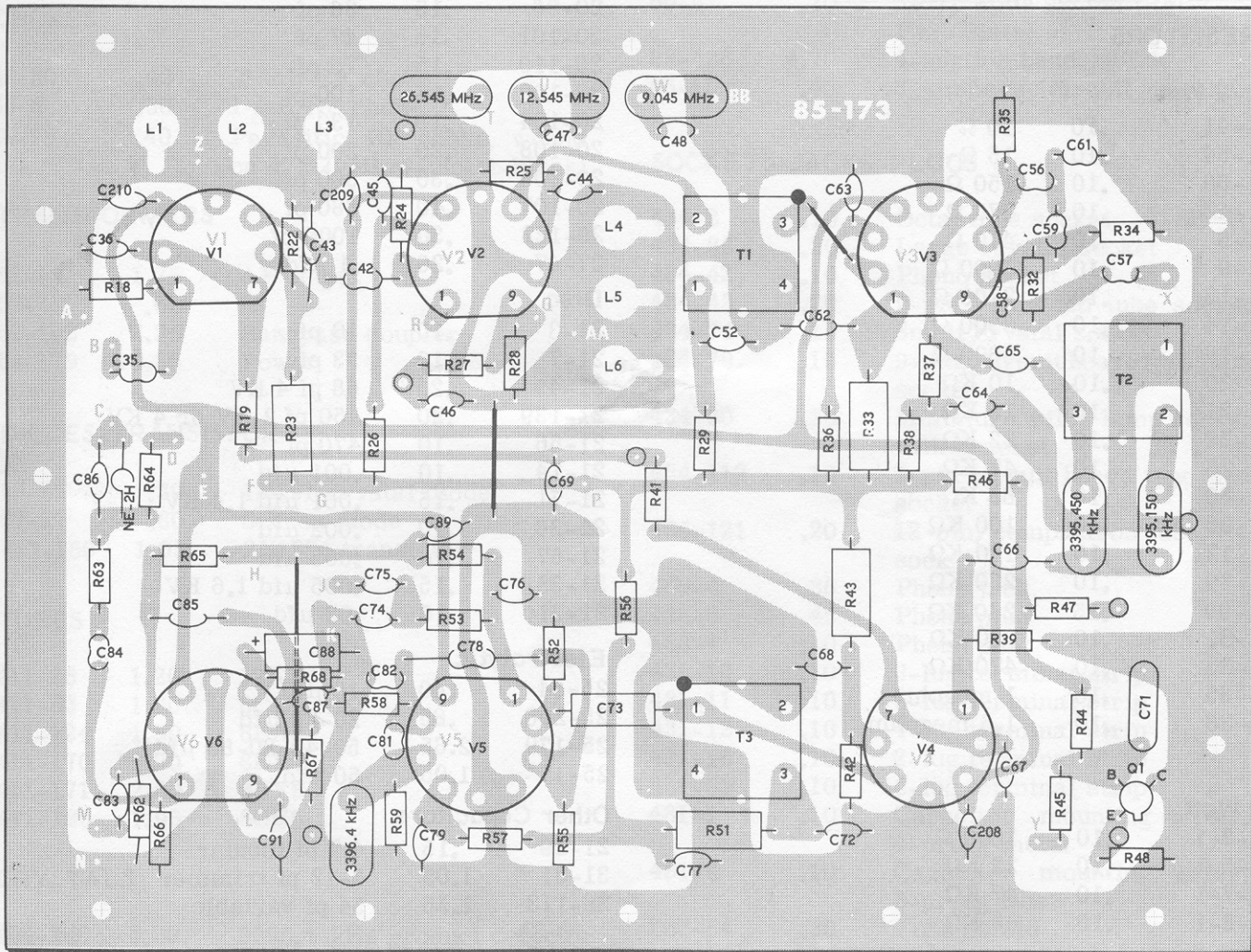




CHASSIS PHOTOGRAPHS  
The first of photographs showing the high level of accuracy of the Heathkit chassis is the chassis photograph showing the internal components of the chassis. The Heathkit chassis is a high level of accuracy and precision. The Heathkit chassis is a high level of accuracy and precision.



# CIRCUIT BOARD X-RAY VIEW (VIEWED FROM FOIL SIDE)



## REPLACEMENT PARTS PRICE LIST

To order parts, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to Replacement Parts in the Kit Builders Guide.

| PART<br>No. | PRICE<br>Each | DESCRIPTION |
|-------------|---------------|-------------|
|-------------|---------------|-------------|

### RESISTORS

#### 1/2 Watt

|       |     |                |
|-------|-----|----------------|
| 1-41  | .10 | 10 $\Omega$    |
| 1-54  | .10 | 15 $\Omega$    |
| 1-66  | .10 | 150 $\Omega$   |
| 1-42  | .10 | 270 $\Omega$   |
| 1-6   | .10 | 470 $\Omega$   |
| 1-9   | .10 | 1000 $\Omega$  |
| 1-13  | .10 | 2700 $\Omega$  |
| 1-14  | .10 | 3300 $\Omega$  |
| 1-18  | .10 | 5600 $\Omega$  |
| 1-20  | .10 | 10 K $\Omega$  |
| 1-21  | .10 | 15 K $\Omega$  |
| 1-22  | .10 | 22 K $\Omega$  |
| 1-25  | .10 | 47 K $\Omega$  |
| 1-60  | .10 | 68 K $\Omega$  |
| 1-26  | .10 | 100 K $\Omega$ |
| 1-121 | .10 | 120 K $\Omega$ |
| 1-29  | .10 | 220 K $\Omega$ |
| 1-99  | .15 | 240 K $\Omega$ |
| 1-31  | .10 | 330 K $\Omega$ |
| 1-33  | .10 | 470 K $\Omega$ |
| 1-35  | .10 | 1 megohm       |
| 1-36  | .10 | 1.5 megohm     |

#### 1 Watt

|       |     |               |
|-------|-----|---------------|
| 1-2-1 | .10 | 1000 $\Omega$ |
| 1-5-1 | .10 | 22 K $\Omega$ |
| 1-7-1 | .10 | 47 K $\Omega$ |
| 1-8-1 | .10 | 68 K $\Omega$ |

#### 2 Watt

|        |     |                |
|--------|-----|----------------|
| 1-13-2 | .20 | 220 $\Omega$   |
| 1-17-2 | .20 | 6800 $\Omega$  |
| 1-11-2 | .20 | 22 K $\Omega$  |
| 1-18-2 | .20 | 33 K $\Omega$  |
| 1-10-2 | .20 | 47 K $\Omega$  |
| 1-24-2 | .20 | 100 K $\Omega$ |

#### Other Resistors

|        |     |                     |
|--------|-----|---------------------|
| 3-19-5 | .15 | 330 $\Omega$ 5 watt |
| 3-9-7  | .15 | 100 $\Omega$ 7 watt |

| PART<br>No. | PRICE<br>Each | DESCRIPTION |
|-------------|---------------|-------------|
|-------------|---------------|-------------|

### CAPACITORS

#### Resin

|        |     |             |
|--------|-----|-------------|
| 20-130 | .15 | 12 pf       |
| 20-99  | .15 | 22 pf       |
| 20-96  | .15 | 36 pf       |
| 20-101 | .15 | 47 pf       |
| 20-110 | .15 | 75 pf       |
| 20-102 | .15 | 100 pf      |
| 20-104 | .15 | 130 pf      |
| 20-108 | .20 | 200 pf      |
| 20-106 | .30 | 390 pf      |
| 20-107 | .40 | 680 pf      |
| 20-122 | .30 | 1000 pf     |
| 27-47  | .20 | .1 $\mu$ fd |

#### Disc

|        |     |                      |
|--------|-----|----------------------|
| 21-3   | .10 | 10 pf                |
| 21-7   | .10 | 33 pf                |
| 21-49  | .20 | 68 pf 4 KV           |
| 21-139 | .20 | 150 pf 2 KV or 4 KV  |
| 21-56  | .10 | 470 pf               |
| 21-14  | .10 | .001 $\mu$ fd        |
| 21-71  | .15 | .001 $\mu$ fd 1.4 KV |
| 21-36  | .10 | .002 $\mu$ fd        |
| 21-57  | .10 | .005 $\mu$ fd        |
| 21-35  | .15 | .005 $\mu$ fd 1.6 KV |
| 21-31  | .10 | .02 $\mu$ fd         |

#### Electrolytic

|        |      |                      |
|--------|------|----------------------|
| 25-54  | .40  | 10 $\mu$ fd          |
| 25-206 | .85  | 20-20 $\mu$ fd       |
| 25-179 | 2.65 | 50-40-80-80 $\mu$ fd |
| 25-17  | 1.05 | 50 $\mu$ fd          |

#### Other Capacitors

|        |      |                 |
|--------|------|-----------------|
| 21-29  | .15  | 4.7 pf tubular  |
| 31-31  | 1.05 | 3-12 pf trimmer |
| 26-113 | 1.55 | 54 pf variable  |

### COILS

|        |      |  |
|--------|------|--|
| 40-79  | .45  | 40-meter oscillator coil               |
| 40-360 | .40  | 15-meter heterodyne oscillator coil    |
| 40-363 | .40  | 15-meter RF coil                       |
| 40-795 | .40  | 80-meter RF coil                       |
| 40-796 | .40  | 40-meter RF coil                       |
| 40-797 | .40  | 40/80-meter heterodyne oscillator coil |
| 40-798 | 1.10 | 80/40/15-meter final coil              |
| 40-799 | .55  | VFO shielded coil                      |
| 40-801 | .60  | 80-meter driver coil (shielded)        |

| PART No.               | PRICE Each | DESCRIPTION                     |
|------------------------|------------|---------------------------------|
| <b>Coils (cont'd.)</b> |            |                                 |
| 40-802                 | .55        | 40-meter driver coil (shielded) |
| 40-803                 | .55        | 15-meter driver coil (shielded) |
| 40-800                 | .80        | Crystal filter coil (shielded)  |

**CHOKES**

|       |     |  |
|-------|-----|--|
| 45-30 | .40 | .5 mH RF choke   |
| 45-3  | .30 | 1 mH RF choke  |
| 45-19 | .40 | Parasitic RF choke, wound on 47 $\Omega$ (yellow-violet-black) |

**TRANSFORMERS**

|        |       |                  |
|--------|-------|------------------|
| 51-55  | 1.75  | AF output        |
| 52-71  | .65   | IF               |
| 52-102 | 2.25  | Bandpass coupler |
| 54-179 | 10.25 | Power            |

**DIODES-TRANSISTOR**

|         |      |                     |
|---------|------|---------------------|
| 56-26   | .30  | 1N191 crystal diode |
| 57-27   | .60  | Silicon diode       |
| 417-150 | 1.05 | 2N1274 transistor   |

**TUBES**

|         |      |       |
|---------|------|-------|
| 411-26  | 1.20 | 12AX7 |
| 411-63  | 1.90 | 6CL6  |
| 411-124 | 1.50 | 6EA8  |
| 411-170 | 1.20 | 6EW6  |
| 411-171 | 2.00 | 6HF8  |
| 411-185 | 1.95 | 6GE5  |

**CRYSTALS**

|         |      |                             |
|---------|------|-----------------------------|
| 404-206 | 5.00 | 3396.4 kHz product detector |
| 404-301 | 5.00 | 9.045 MHz                   |
| 404-302 | 5.00 | 12.545 MHz                  |
| 404-303 | 5.00 | 26.545 MHz                  |

|         |      |  |
|---------|------|--|
| 404-305 | 9.45 | Matched set of crystals consisting of the following: |
| 404-241 |      | 3395.150 kHz   |
| 404-242 |      | 3395.450 kHz   |

**LAMPS**

|        |     |                     |
|--------|-----|---------------------|
| 412-1  | .15 | 6 volt incandescent |
| 412-34 | .55 | Neon                |

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

**CONTROLS-SWITCHES**

|        |      |   |
|--------|------|---|
| 10-33  | .35  | 200 $\Omega$ control (RF Gain)                          |
| 11-78  | 1.70 | 15 K $\Omega$ control (Power-Level)                     |
| 19-72  | .95  | 500 K $\Omega$ control with switch (AF Gain and Off-On) |
| 60-4   | .20  | SPDT slide switch (Rel-Pwr-Plate)                       |
| 63-436 | 4.70 | 4-section band switch                                   |
| 65-10  | .45  | 3 ampere circuit breaker                                |

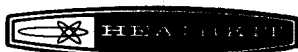
**SOCKETS-JACKS-PLUGS**

|         |     |  |
|---------|-----|--|
| 434-2   | .10 | Octal tube socket                        |
| 434-38  | .20 | Large crystal socket                     |
| 434-42  | .10 | Phono socket                             |
| 434-43  | .20 | 9-pin, shielded tube socket              |
| 434-74  | .15 | Small crystal socket                     |
| 434-79  | .15 | 9-pin, circuit board type tube socket    |
| 434-90  | .20 | Miniature pilot lamp socket with bracket |
| 434-112 | .10 | 7-pin circuit board type tube socket     |
| 434-121 | .20 | 12-pin, compactron tube socket           |
| 436-4   | .35 | Phone jack                               |
| 438-3   | .45 | Phone plug                               |
| 438-4   | .10 | Phono plug                               |
| 431-10  | .10 | 3-lug terminal strip                     |
| 431-11  | .10 | 5-lug terminal strip                     |
| 431-12  | .10 | 4-lug terminal strip                     |
| 431-16  | .10 | 2-lug terminal strip                     |
| 431-55  | .10 | 6-lug terminal strip                     |
| 481-1   | .10 | Capacitor mounting wafer, 4-prong metal  |
| 481-4   | .10 | Capacitor mounting wafer, 3-prong fiber  |
| 206-54  | .30 | Tube shield                              |

**COAXIAL CABLE-WIRE-SLEEVING**

|        |        |                    |
|--------|--------|--------------------|
| 343-7  | .05/ft | Coaxial cable      |
| 344-50 | .05/ft | Black hookup wire  |
| 344-51 | .05/ft | Brown hookup wire  |
| 344-52 | .05/ft | Red hookup wire    |
| 344-54 | .05/ft | Yellow hookup wire |
| 344-55 | .05/ft | Green hookup wire  |
| 344-56 | .05/ft | Blue hookup wire   |
| 344-59 | .05/ft | White hookup wire  |
| 340-3  | .05/ft | Large bare wire    |
| 340-8  | .05/ft | Small bare wire    |
| 346-4  | .05/ft | Sleeving           |

| PART No.              | PRICE Each | DESCRIPTION             | PART No.   | PRICE Each | DESCRIPTION   |
|-----------------------|------------|-------------------------|--|------------|---|
| <b>HARDWARE</b>       |            |                         | <b>METAL PARTS</b>   |            |   |
| <b>#3 Hardware</b>    |            |                         | 90-358   | 2.80       | Top cover   |
| 250-49                | .05        | 3-48 x 1/4" screw       | 100-43   | .25        | Dial hub assembly                                     |
| 254-7                 | .05        | #3 lockwasher           | 200-485-1  | 4.15       | Chassis   |
| 252-1                 | .05        | 3-48 x 3/16" nut        | 203-479-1  | 1.00       | Front panel   |
| <b>#4 Hardware</b>    |            |                         | 204-102  | .10        | Shield bracket  |
| 250-34                | .05        | 4-40 x 1/2" screw       | 205-260  | .90        | Plate, chassis bottom                                 |
| 252-15                | .05        | 4-40 x 3/16" nut        | 206-334  | .30        | Small shield plate                                    |
| <b>#6 Hardware</b>    |            |                         | 206-335  | .45        | Large shield plate                                    |
| 250-138               | .05        | 6-32 x 3/16" screw      | 206-336  | .90        | RF shield   |
| 250-56                | .05        | 6-32 x 1/4" screw       | <b>MISCELLANEOUS</b>   |            |   |
| 250-116               | .05        | 6-32 x 1/4" black screw | 73-1   | .10        | 3/8" rubber grommet                                   |
| 250-8                 | .05        | #6 sheet metal screw    | 73-4   | .10        | 5/16" rubber grommet                                  |
| 250-162               | .05        | 6-32 x 1/2" screw       | 75-24  | .10        | Line cord strain relief                               |
| 254-1                 | .05        | #6 lockwasher           | 89-1   | .35        | Line cord   |
| 252-3                 | .05        | 6-32 x 1/4" nut         | 85-173-1   | 3.70       | Circuit board   |
| 252-22                | .05        | 6-32 speednut           | 100-624  | 1.20       | Dial drive assembly                                   |
| 259-1                 | .05        | #6 solder lug           | 407-121  | 3.10       | Meter   |
| 259-6                 | .05        | #6 small solder lug     | 464-29-5   | 1.15       | Dial  |
| <b>#8 Hardware</b>    |            |                         | 453-39   | .10        | Shaft, 5-13/16"                                       |
| 250-16                | .05        | 8-32 x 3/16" setscrew   | 462-122  | .20        | Gray knob with skirt and pointer                      |
| 250-92                | .05        | 8-32 x 3/8" screw       | 462-258  | .30        | Dark green knob                                       |
| 253-9                 | .05        | #8 small flat washer    | 462-189  | .60        | 2" gray knob  |
| 253-45                | .05        | #8 large flat washer    | 446-59   | 1.45       | Escutcheon  |
| 254-2                 | .05        | #8 lockwasher           | 346-25   | 1.05/ft    | Black tubing  |
| 252-4                 | .05        | 8-32 x 3/8" nut         | 260-7  | .05        | IF transformer clip                                   |
| 252-28                | .10        | 8-32 nut                | 261-9  | .05        | Rubber foot   |
| 259-24                | .05        | #8 wire lug             | 489-1  | .15        | Sandpaper, #24 or #28                                 |
| <b>Other Hardware</b> |            |                         | 331-6  | .15        | Solder  |
| 251-1                 | .05        | 6-32 spade bolt         | 490-5  | .10        | Nut starter   |
| 252-7                 | .05        | Control nut             | 490-1  | .10        | Alignment tool  |
| 253-10                | .05        | Control flat washer     |  | 2.00       | Instruction Manual (See front cover for part number.) |
| 254-4                 | .05        | Control lockwasher      | The above 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 a 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. |            |   |
| 254-5                 | .05        | Thin control lockwasher |  |            |   |
| 259-10                | .05        | Control solder lug      |  |            |   |
| 455-9                 | .15        | Bushing                 |  |            |   |
| 259-20                | .05        | Terminal pin            |  |            |   |



## FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) If you wish you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you sent the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and follow the following shipping instructions:

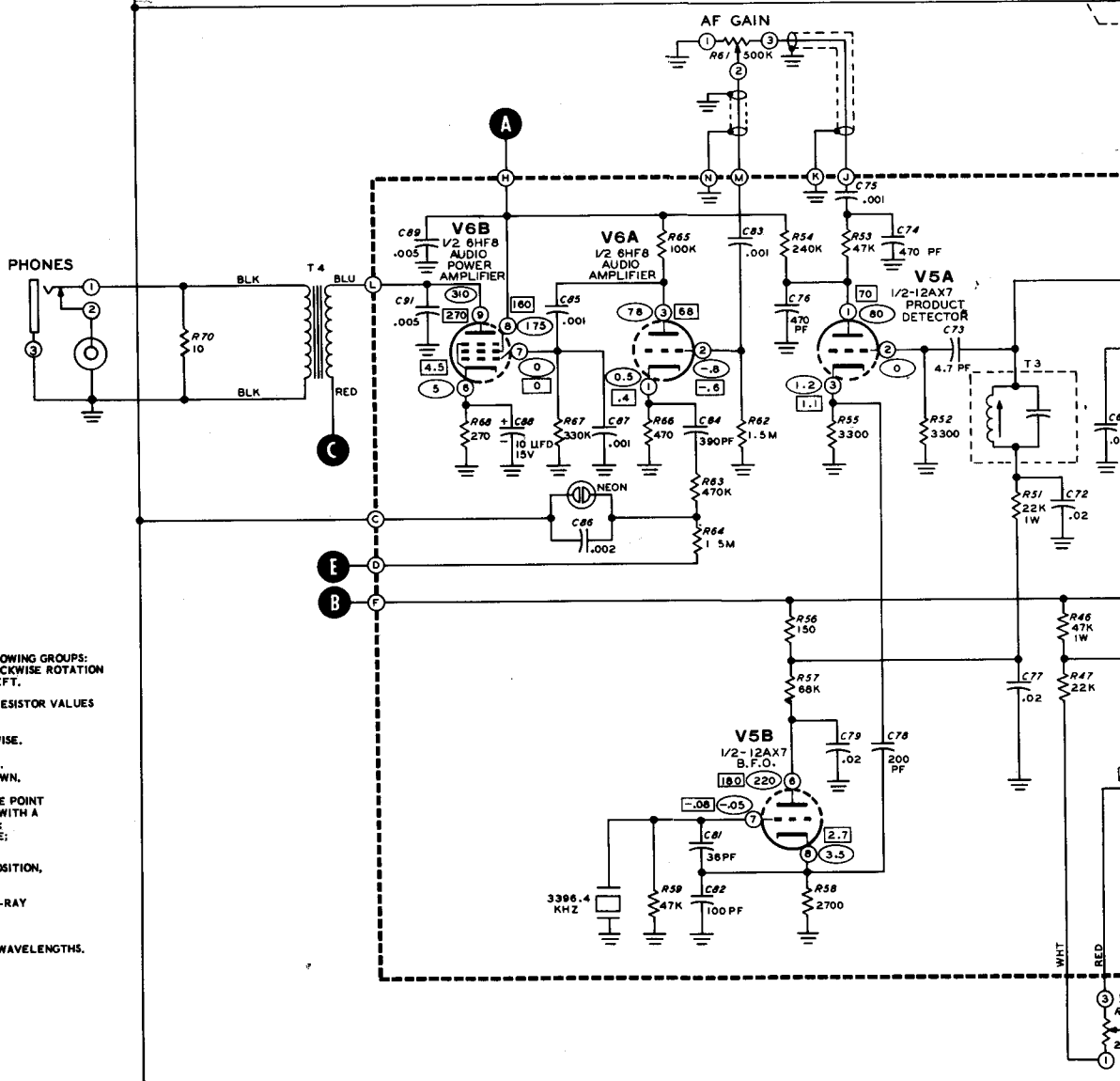
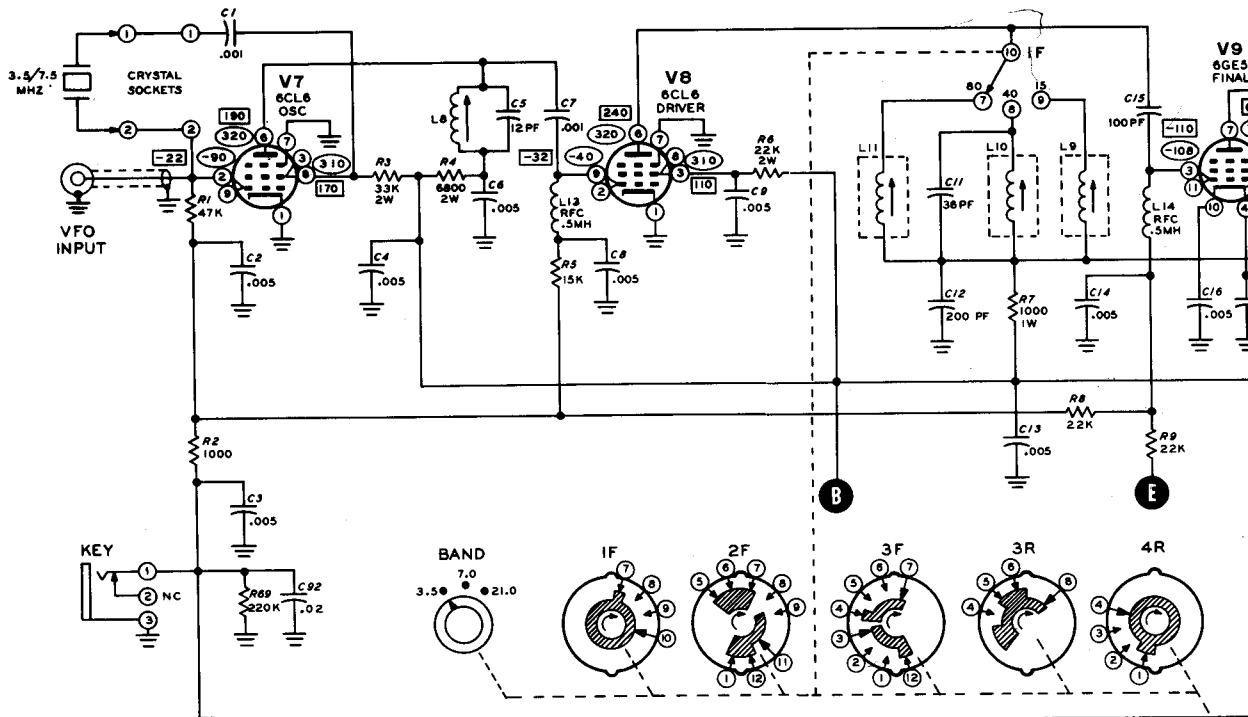
Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan.

Check the equipment to see that all parts and screws are in place. (Do not include wooden cabinets when shipping receivers, tuners, amplifiers, or TV sets, as these are easily damaged in shipment.) Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least **THREE INCHES** of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company  
Service Department  
Benton Harbor, Michigan 49022

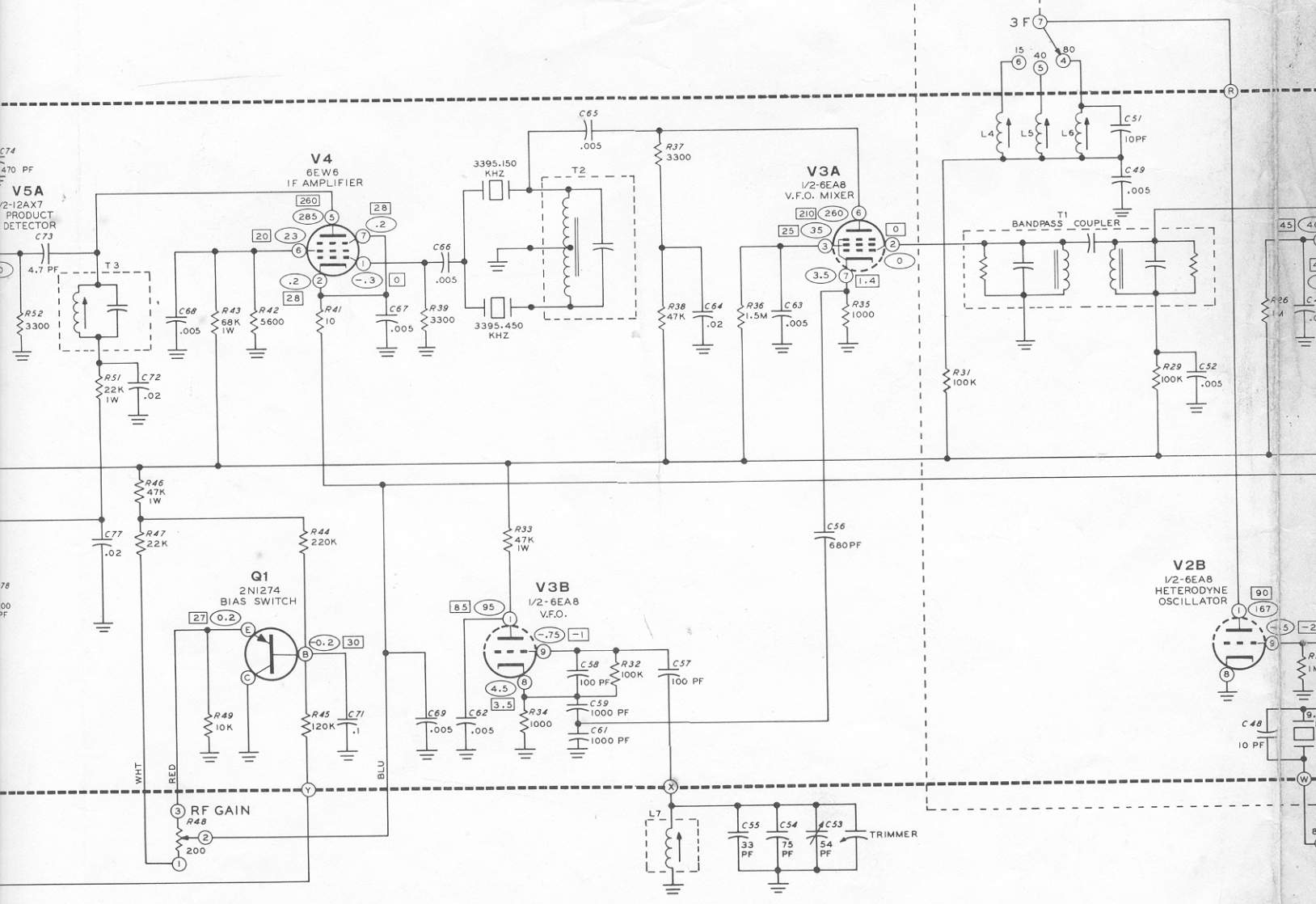
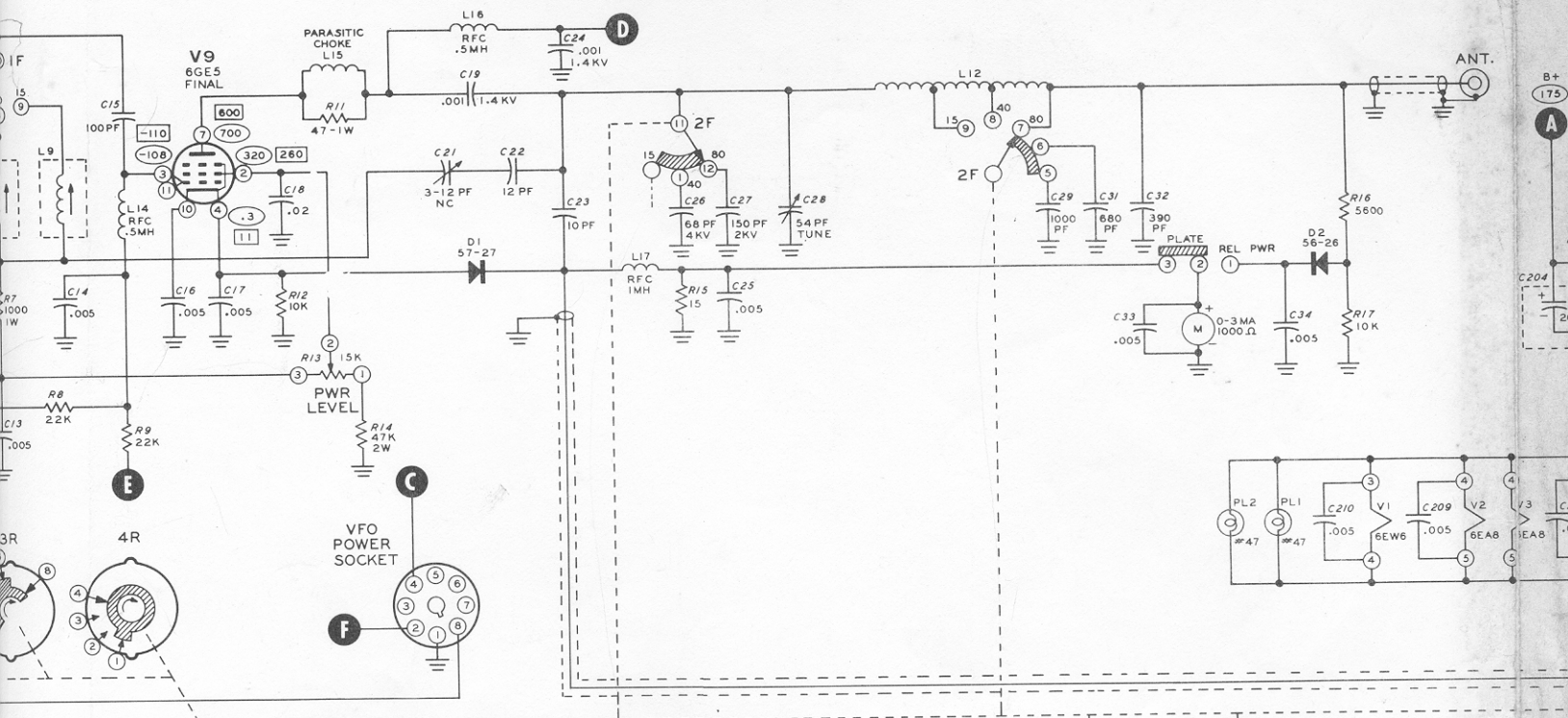


**SCHEMATIC OF THE  
HEATHKIT®  
CW TRANSCEIVER  
MODEL HW-16**

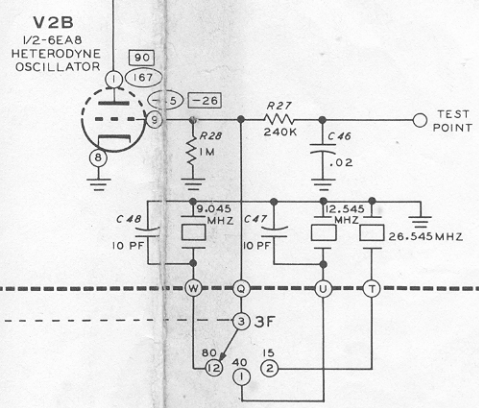
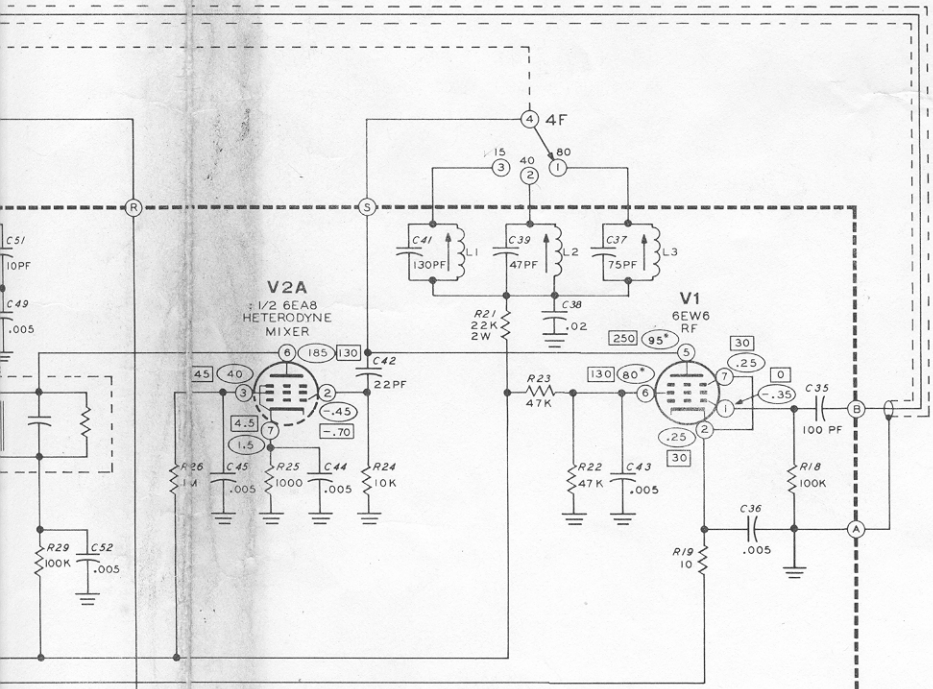
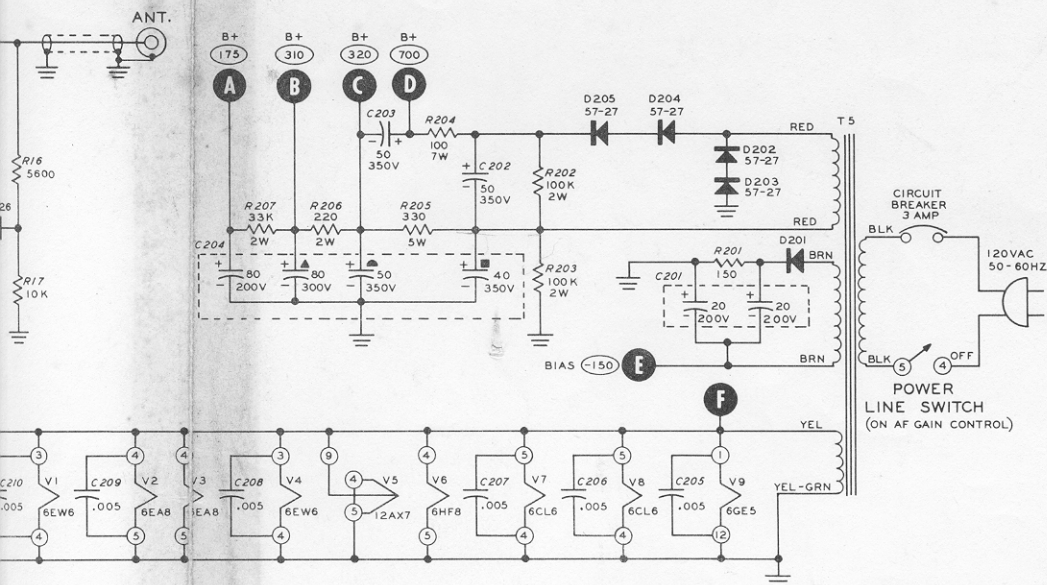
**NOTES:**

1. RESISTOR, CAPACITOR AND DIODE NUMBERS ARE IN THE FOLLOWING GROUPS:  
0-99 PARTS OF TRANSMITTER AND RECEIVER CIRCUITS IN CLOCKWISE ROTATION  
207-299 PARTS OF POWER SUPPLY CIRCUIT FROM RIGHT TO LEFT.
2. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K = 1,000, MEG = 1,000,000).
3. ALL CAPACITOR VALUES ARE IN  $\mu$ FD UNLESS MARKED OTHERWISE.
4. THIS SYMBOL INDICATES A DC VOLTAGE WITH KEY UP.  
 THIS SYMBOL INDICATES A DC VOLTAGE WITH KEY DOWN.
5. ALL VOLTAGES TAKEN WITH AN 11 MEGOHM VTVM FROM THE POINT INDICATED TO CHASSIS GROUND. VOL TAGES MAY VARY  $\pm$ 10% WITH A LINE VOLTAGE OF 120 VAC AND CONTROLS SET AS FOLLOWS:  
RF GAIN - FULL CLOCKWISE; PWR LEVEL - FULL CLOCKWISE;  
BAND SWITCH - 3.5 MHz; AF GAIN - FULL CLOCKWISE.
6. ALL SWITCH WAFERS SHOWN IN FULL COUNTERCLOCKWISE POSITION, AS VIEWED FROM THE KNOB END OF THE SHAFT.
7. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.
8. THE BANDSWITCH PANEL MARKINGS ARE IN MEGAHERTZ. THE BANDSWITCH SCHEMATIC CONTACTS ARE IDENTIFIED IN WAVELENGTHS.  
3.5 MHz CORRESPONDS TO 80 METERS  
7 MHz CORRESPONDS TO 40 METERS  
21 MHz CORRESPONDS TO 15 METERS

\* VOLTAGE VARIES WITH POSITION OF RF GAIN CONTROL




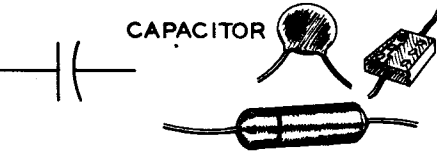
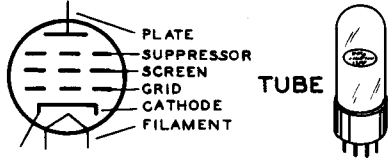
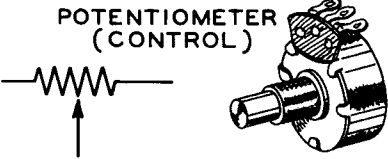
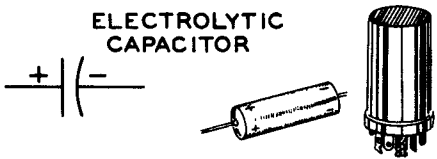
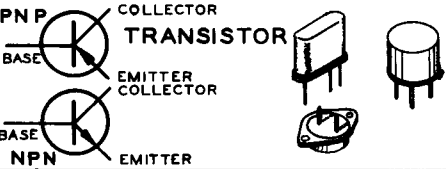
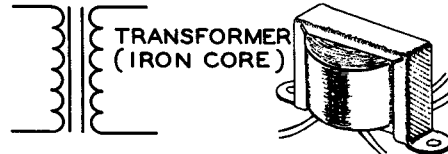
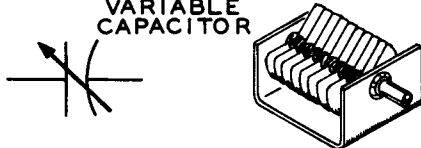
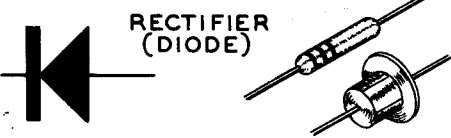
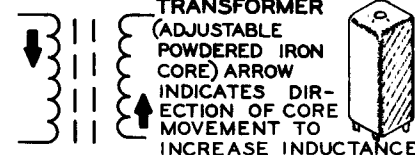
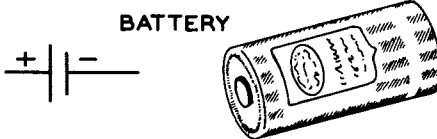
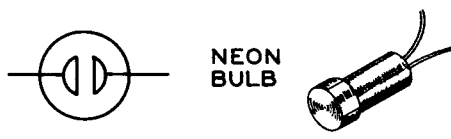
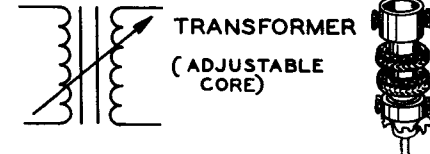
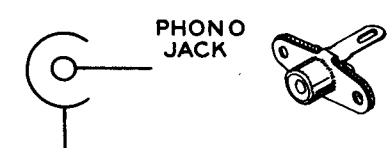

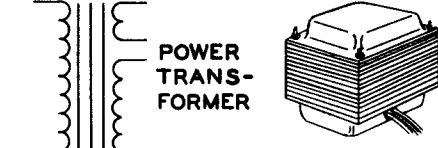

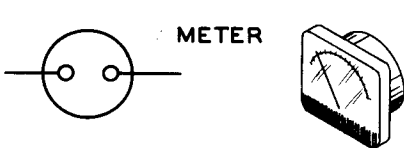


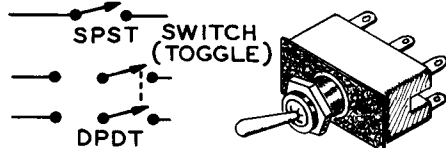

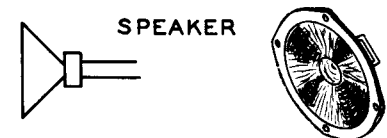
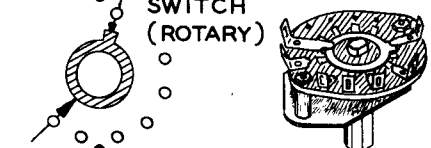
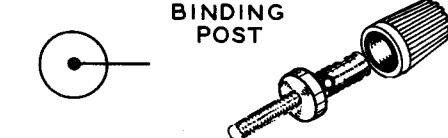

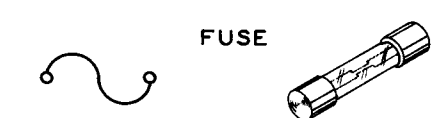
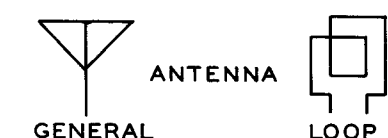
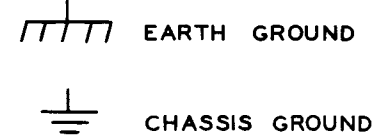
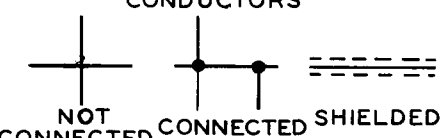




## TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations

should prove helpful in identifying most parts and reading the schematic diagrams.

|   |   |  |
|---|---|--|
| <p style="text-align: center;"><b>RESISTOR</b></p>   | <p style="text-align: center;"><b>CAPACITOR</b></p>   | <p style="text-align: center;"><b>TUBE</b></p>                |
| <p style="text-align: center;"><b>POTENTIOMETER (CONTROL)</b></p>    | <p style="text-align: center;"><b>ELECTROLYTIC CAPACITOR</b></p>    | <p style="text-align: center;"><b>TRANSISTOR</b></p>          |
| <p style="text-align: center;"><b>TRANSFORMER (IRON CORE)</b></p>    | <p style="text-align: center;"><b>VARIABLE CAPACITOR</b></p>   | <p style="text-align: center;"><b>RECTIFIER (DIODE)</b></p>   |
| <p style="text-align: center;"><b>TRANSFORMER (ADJUSTABLE POWDERED IRON CORE) ARROW INDICATES DIRECTION OF CORE MOVEMENT TO INCREASE INDUCTANCE</b></p>  | <p style="text-align: center;"><b>BATTERY</b></p>   | <p style="text-align: center;"><b>NEON BULB</b></p>           |
| <p style="text-align: center;"><b>TRANSFORMER (ADJUSTABLE CORE)</b></p>   | <p style="text-align: center;"><b>PHONO JACK</b></p>    | <p style="text-align: center;"><b>ILLUMINATING BULB</b></p>  |
| <p style="text-align: center;"><b>POWER TRANSFORMER</b></p>    | <p style="text-align: center;"><b>PHONE JACK</b></p>    | <p style="text-align: center;"><b>METER</b></p>             |
| <p style="text-align: center;"><b>INDUCTOR (COIL)</b></p>    | <p style="text-align: center;"><b>RECEPTACLE</b></p>    | <p style="text-align: center;"><b>SWITCH (TOGGLE)</b></p>   |
| <p style="text-align: center;"><b>PIEZOELECTRIC CRYSTAL</b></p>    | <p style="text-align: center;"><b>SPEAKER</b></p>    | <p style="text-align: center;"><b>SWITCH (ROTARY)</b></p>   |
| <p style="text-align: center;"><b>BINDING POST</b></p>   | <p style="text-align: center;"><b>MICROPHONE</b></p>    | <p style="text-align: center;"><b>FUSE</b></p>              |
| <p style="text-align: center;"><b>ANTENNA</b></p>    | <p style="text-align: center;"><b>EARTH GROUND</b></p> <p style="text-align: center;"><b>CHASSIS GROUND</b></p>  | <p style="text-align: center;"><b>CONDUCTORS</b></p>        |