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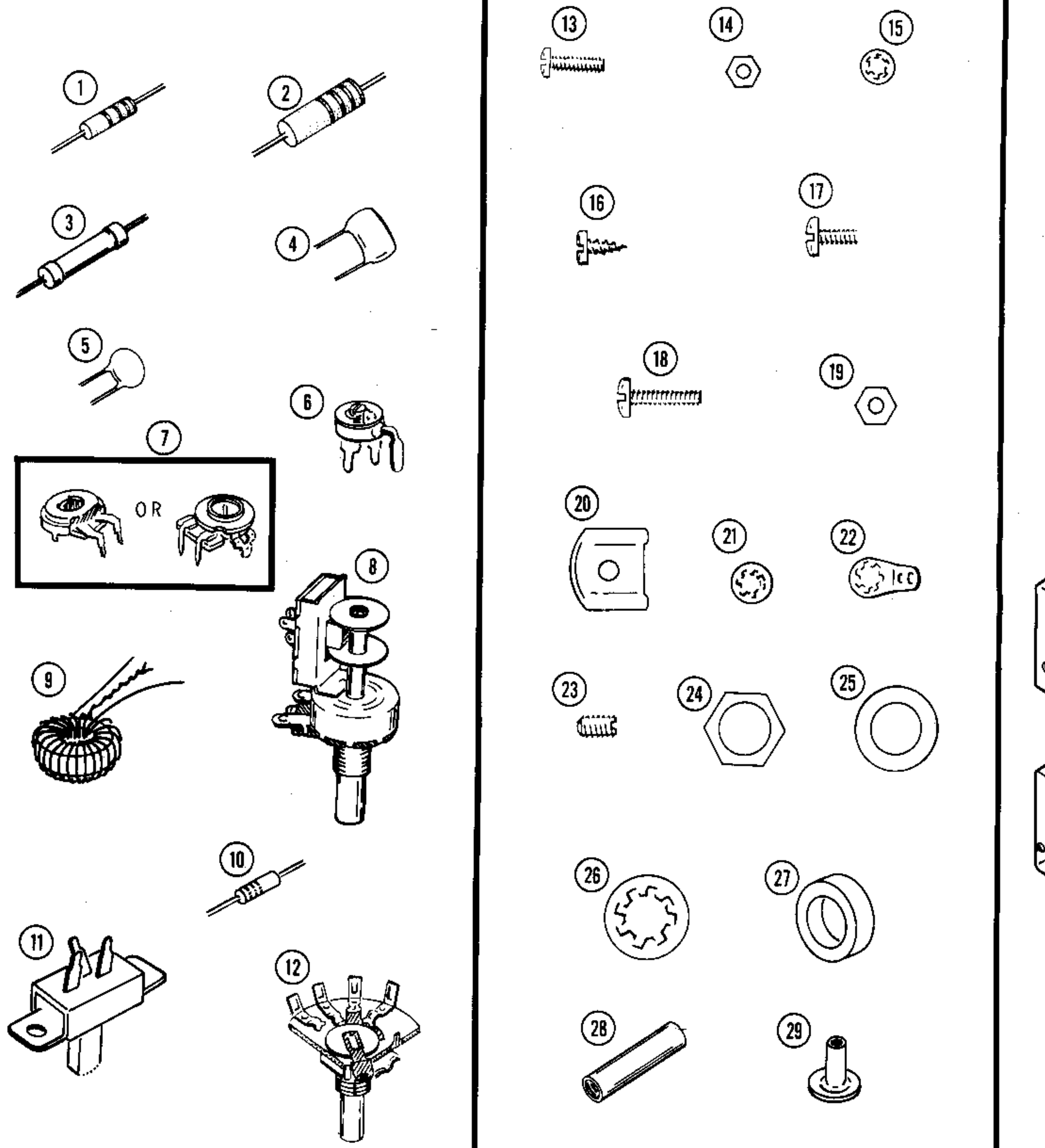
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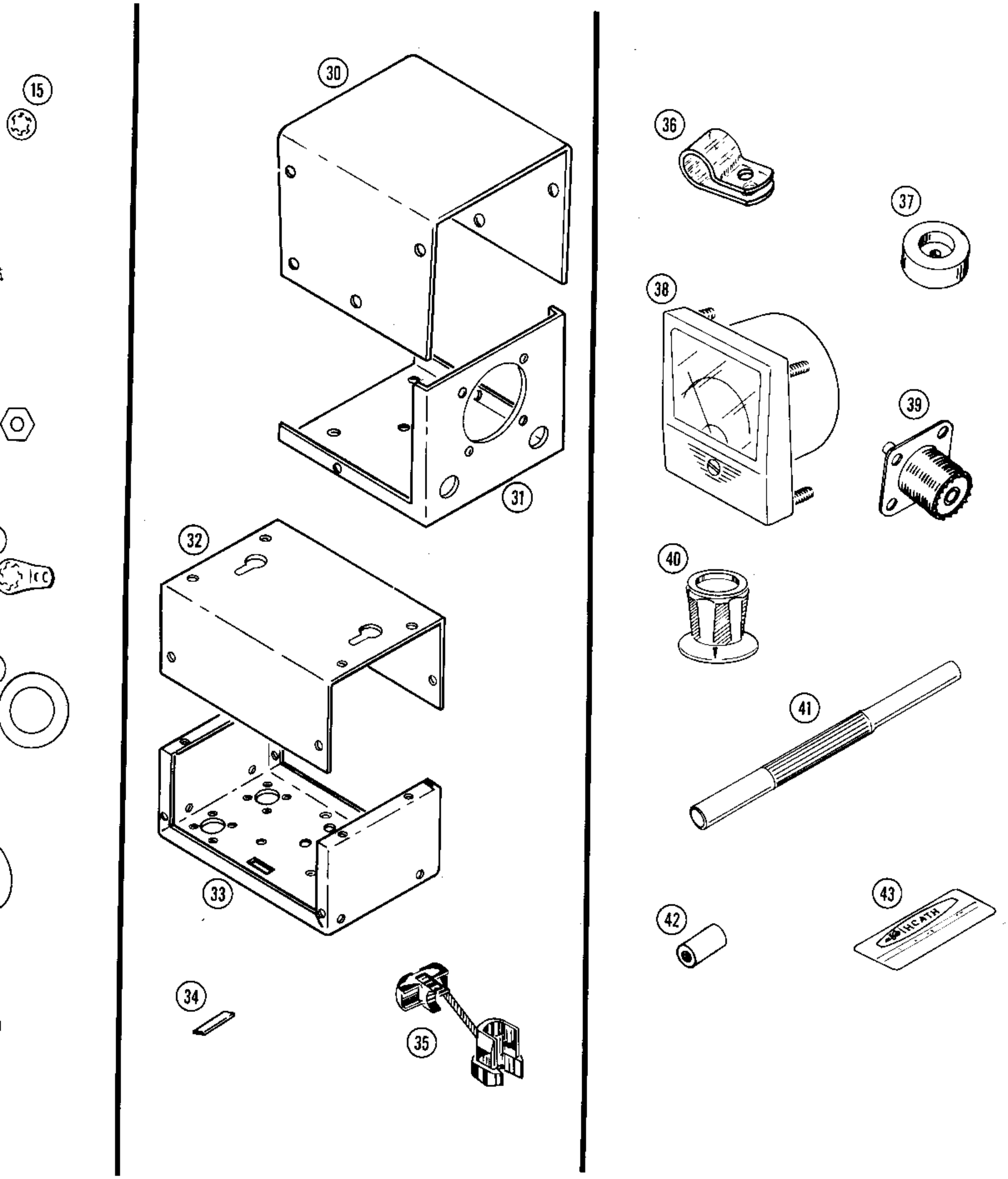
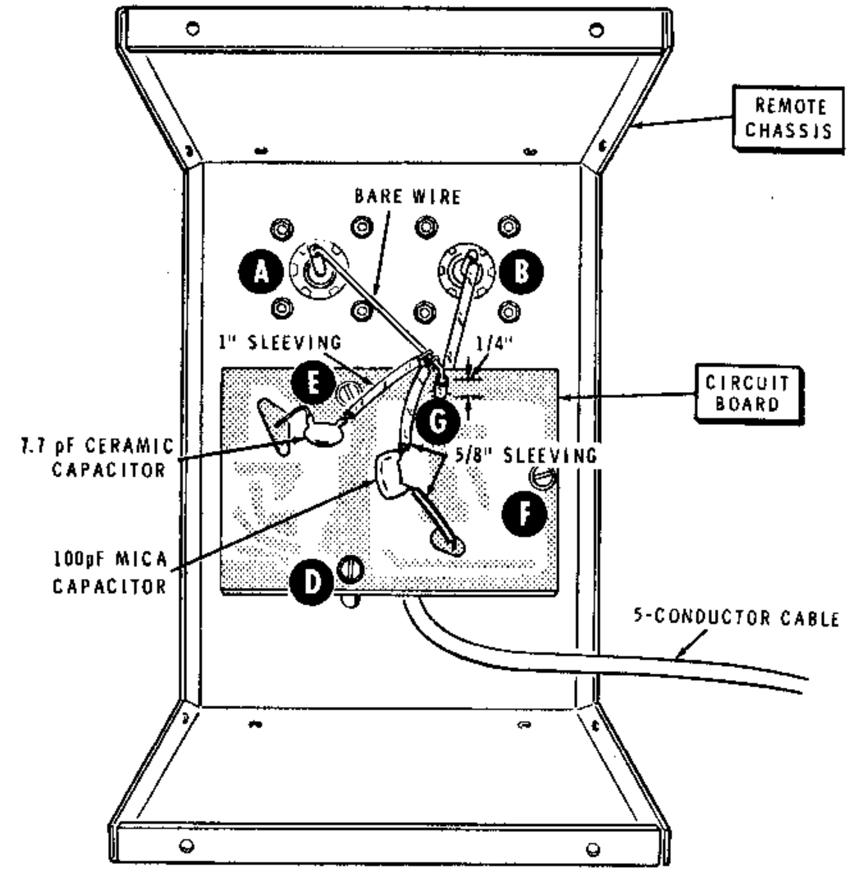
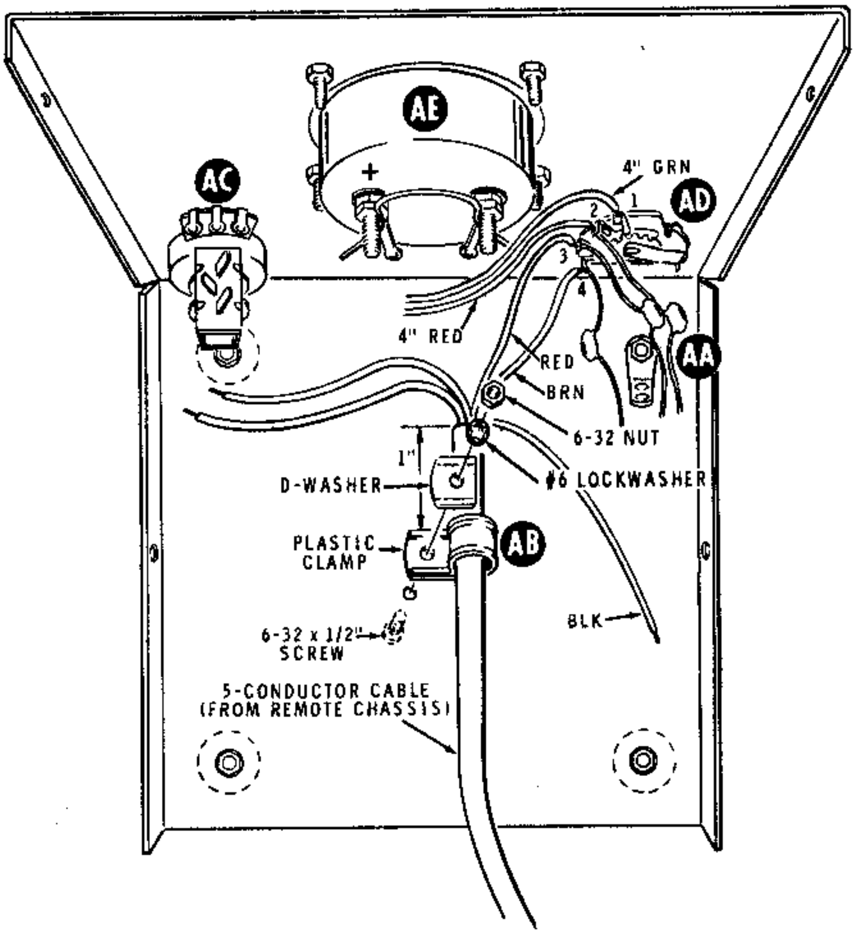
PARTS PICTORIAL





PICTORIAL 4



PICTORIAL 6

STEP-BY-STEP ASSEMBLY

Before you start the "Circuit Board Assembly," be sure to read the "Circuit Board Parts Mounting" and "Soldering" sections of the "Kit Builders Guide."

CIRCUIT BOARD ASSEMBLY

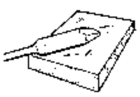
Components will be installed on the circuit board by following the steps on Pages 4 through 6. Position all parts as shown in the Pictorials. Follow the instructions carefully and read the entire step before performing the operation.

All resistors will be called out by resistance values (in Ω or kΩ); the color code will also be given for all except precision resistors. Capacitors will be called out by capacitance value (in pF or μF) and type (mica or ceramic).

Locate the circuit board and position it lettered side up as shown in Pictorial 1. Then complete each step on Pictorials 1 and 2.

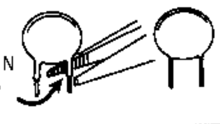
START

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...
WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.



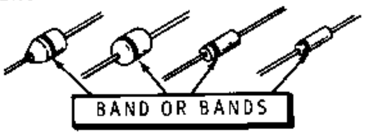
(✓) 90 kΩ precision resistor.

(✓) .005 μF ceramic.



(✓) 100 pF mica.

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. THE CATHODE END OF THE DIODE IS MARKED WITH A BAND OR BANDS. ALWAYS POSITION THIS END AS SHOWN IN THE PICTORIAL.



(✓) 1N295 diode (red-white-green) at D1 (#56-20).

(✓) .001 μF ceramic.

(✓) 150 pF ceramic.

(✓) 1N295 diode (red-white-green) at D2 (#56-20).

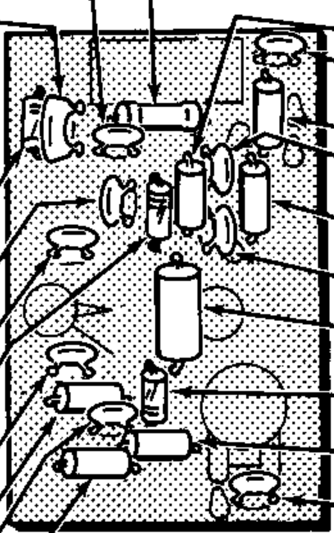
(✓) 150 pF ceramic.

(✓) 3300 Ω (orange-orange-red).

(✓) .001 μF ceramic.

(✓) 100 kΩ (brown-black-yellow).

(✓) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

(✓) 470 Ω (yellow-violet-brown).

(✓) .001 μF ceramic.

(✓) 82 kΩ (gray-red-orange).

(✓) .001 μF ceramic.

(✓) 22 kΩ (red-red-orange).

(✓) .001 μF ceramic.

(✓) 68 Ω, 1-watt (blue-gray-black).

(✓) 1N295 diode (red-white-green) at D3 (#56-20).

(✓) 470 Ω (yellow-violet-brown).

(✓) .001 μF ceramic.

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: Save one of the excess lead lengths for use in later steps.

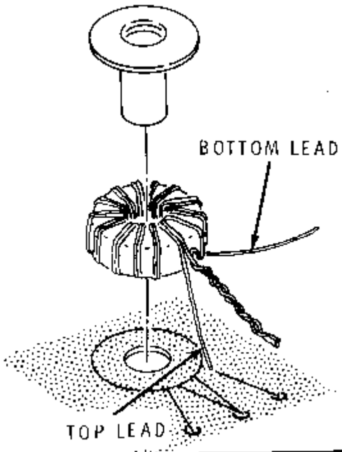
PROCEED TO PICTORIAL 2.

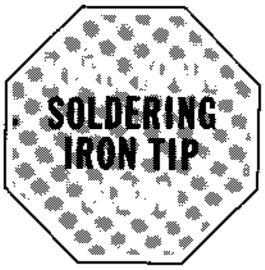
PICTORIAL 1

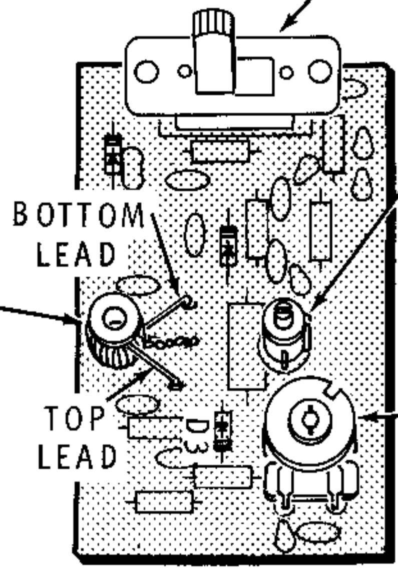
START

(✓) Install the toroid coil as follows:

1. Push an eyelet through the center of the toroid coil as shown, either side up. Then push the eyelet through the circuit board. Solder the eyelet to the foil.
2. Position the three toroid coil leads as shown, and push the leads through the circuit board. NOTE: Be sure the twisted pair of leads goes into the center hole. The lead coming from the top of the coil must go to the hole nearest D3, and the lead from the bottom must go to the hole nearest the slide switch outline.
3. Solder the three leads to the foil and remove any excess lead lengths.



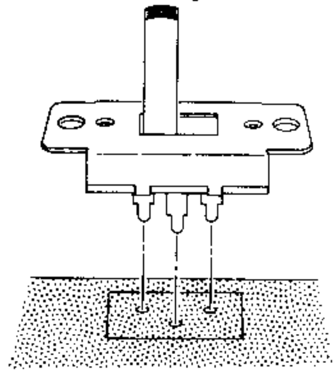




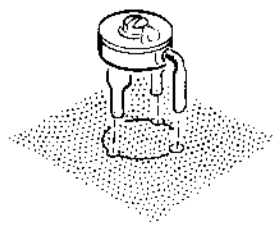
PICTORIAL 2

CONTINUE

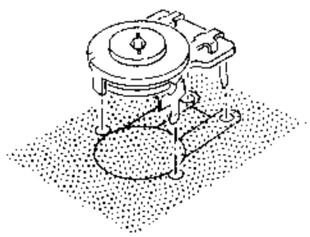
(✓) Install the 3-lug slide switch as shown. Press the switch firmly onto the surface of the circuit board, then solder the three lugs to the foil.



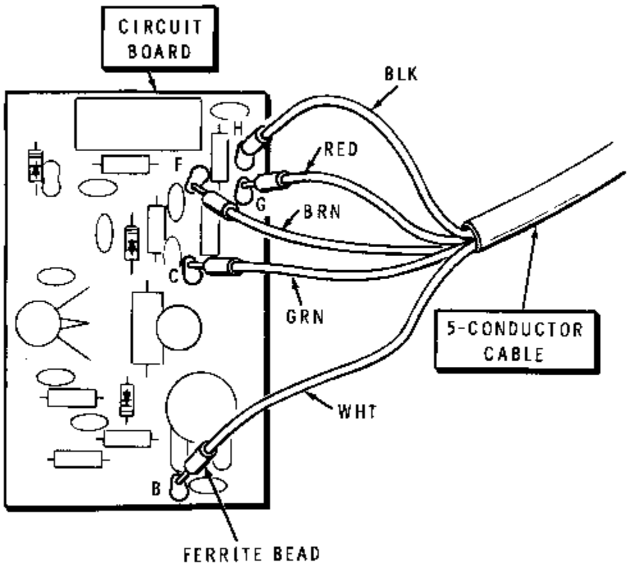
(✓) Install the 2.7-20 pF trimmer as shown. Solder the three lugs to the foil.



(✓) Install the 50 kΩ control as shown. Solder the four lugs to the foil.



PROCEED TO PICTORIAL 3.



PICTORIAL 3

Refer to Pictorial 3 for the following steps.

(✓) Locate the 5-conductor cable and cut 4" from one end of it. Save this short piece for use later.

( ) Refer to Detail 3A and prepare both ends of the long 5-conductor cable as shown. Twist the bare wire ends tightly and apply a small amount of solder to each to hold the small strands together.

NOTE: The 2" prepared end of the 5-conductor cable will be connected in the following steps.

(✓) Refer to Detail 3B and place a ferrite bead over the end of the black wire. Then, push the end of the black wire through hole H until the ferrite bead is down against the component side of the circuit board. Solder the wire to the foil. Cut off any excess wire length on the foil side of the circuit board.

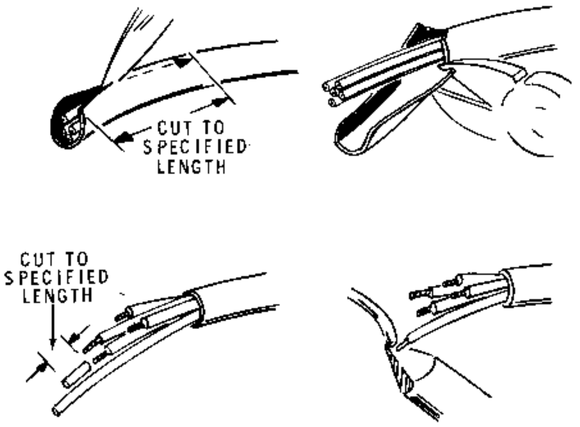
(✓) In the same manner, install the white wire and bead combination at B (S-1).

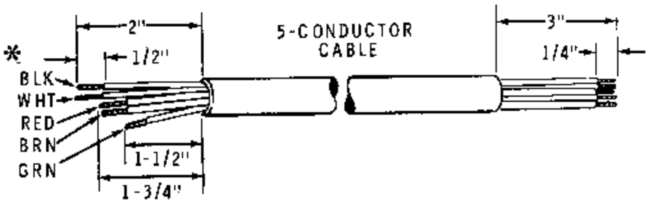
(✓) Install the red wire and bead combination at G (S-1).

(✓) Install the green wire and bead combination at C (S-1).

(✓) Install the brown wire and bead combination at F (S-1).

(✓) Cut off the excess lead lengths on the foil side of the board.





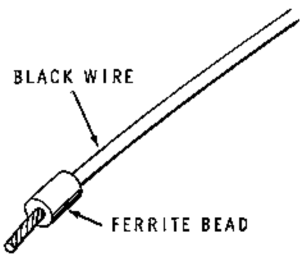
* NOTE: REMOVE 1/2" OF INSULATION FROM EACH WIRE ON THIS END.

Detail 3A

(✓) Carefully inspect the foil side of the circuit board and be sure that all the connections are soldered and that there are no solder bridges between foils.

NOTE: Some of the circuit board holes will not be used.

Set the circuit board aside temporarily.

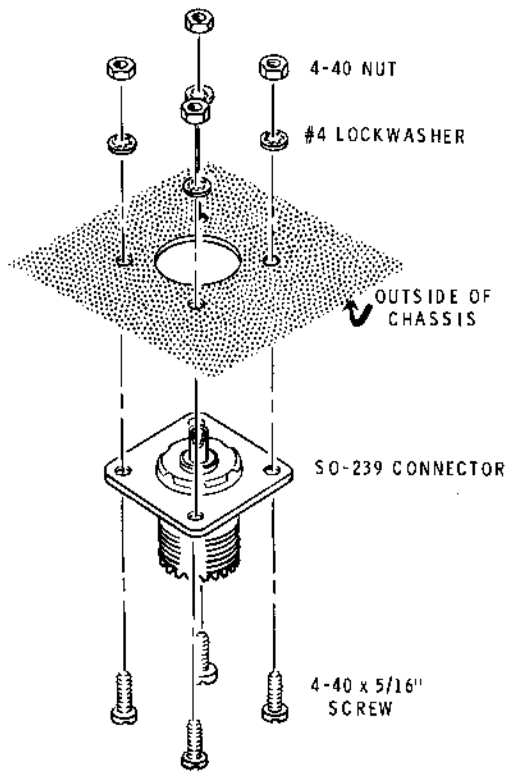


Detail 3B

REMOTE CHASSIS ASSEMBLY

Refer to Pictorial 4 (fold-out from Page 4) for the following steps.

(✓) Mount an SO-239 connector on the outside of the remote chassis at A with four 4-40 x 5/16" screws, four #4 lockwashers, and four 4-40 nuts as shown in Detail 4A.

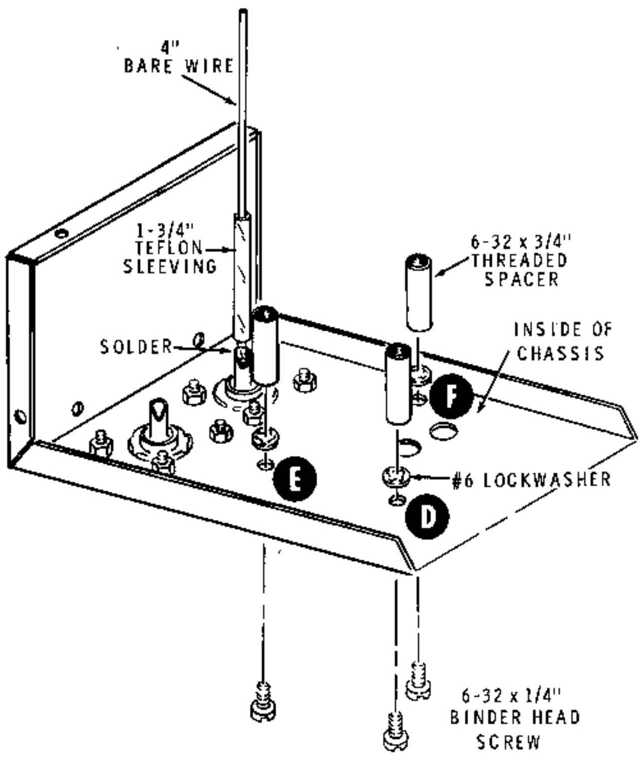


Detail 4A

(✓) Mount the other SO-239 connector at B with four 4-40 x 5/16" screws, four #4 lockwashers, and four 4-40 nuts.

Refer to Detail 4B for the following steps.

(✓) Solder a 4" length of bare wire to the center pin of connector B as shown in Detail 4B.



Detail 4B

(✓) Place a 1-3/4" length of Teflon sleeving over the 4" bare wire and slide it all the way down to the center pin of connector B.

(✓) Install a 6-32 x 3/4" threaded spacer on the chassis at D with a 6-32 x 1/4" binder head screw and a #6 lockwasher. Place the lockwasher between the spacer and the chassis as shown. Tighten the spacer finger tight.

(✓) In the same manner, install 6-32 x 3/4" threaded spacers at E and F on the chassis with 6-32 x 1/4" binder head screws and #6 lockwashers. Tighten the spacers finger tight.

Refer to Detail 4C for the following steps.

(✓) Turn the circuit board foil-side-up; then slide the bare wire and sleeving from connector B up through the center of toroid coil eyelet G as shown. Push the wire and sleeving through the eyelet until approximately 1/4" of the sleeving is beyond the tip of the eyelet. The bare wire must NOT short to the eyelet.

(✓) Press downward on the circuit board and, at the same time, pull the board to the left and away from connectors A and B. The slide switch lever must enter slot C at the left side of the chassis.

(✓) Secure the circuit board loosely to threaded spacer D with a 6-32 x 1/4" binder head screw and a #6 lockwasher.

(✓) Similarly, start 6-32 x 1/4" binder head screws and #6 lockwashers into spacers E and F.

NOTE: Be sure none of the wires are pinched between the spacers and the chassis or circuit board.

(✓) Tighten the three circuit board mounting screws. When the screw heads press down on the lockwashers, make sure the lockwashers, particularly at F, do not short out against the adjacent foils.

(✓) Turn the chassis over and tighten the three spacer mounting screws on the outside of the chassis.

Refer to Pictorial 4 for the following steps.

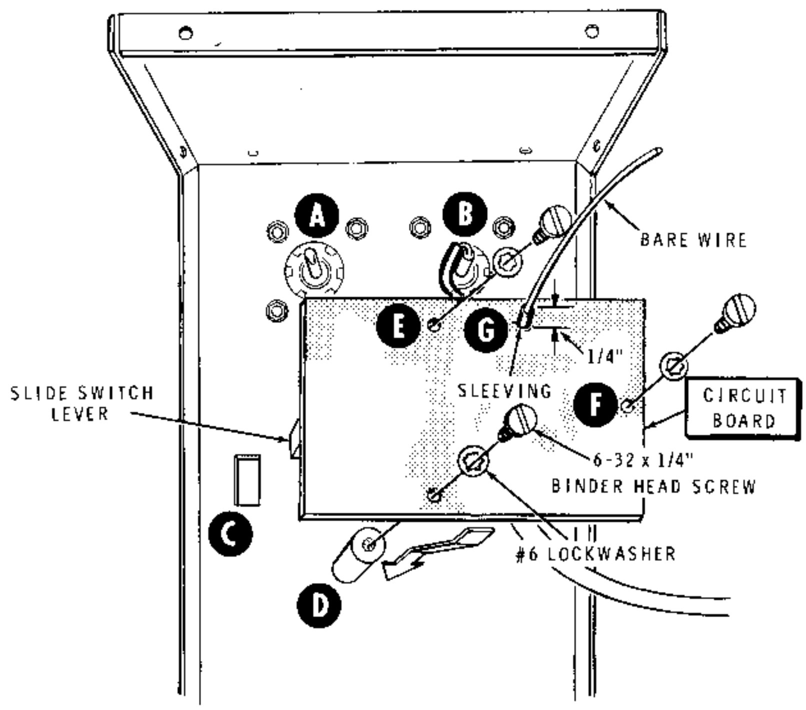
(✓) Bend the bare wire from eyelet G over the edge of the circuit board, making sure it doesn't touch the edge of the foil. Route the wires as directly as possible to the center pin of connector A. Cut off any excess wire length. Solder the wire to the center pin of the connector.

(✓) Cut one 1" length and two 5/8" lengths of sleeving.

(✓) Cut one lead of the 7.7 pF ceramic capacitor to 1/4".

(✓) Insert the 1/4" lead of the 7.7 pF capacitor into the hole in the foil outlined in the Pictorial. Solder the lead to the foil. Place a 1" length of sleeving over the other lead. Wrap the end of the lead around the bare wire 1/4" from eyelet G as shown. Do not solder this lead.

(✓) Cut both leads of a 100 pF mica capacitor to 1". Place a 5/8" length of sleeving on each lead. Connect one lead of the 100 pF capacitor to the other circuit board foil outlined in the Pictorial. Solder the lead to the foil. Connect the other lead of the capacitor to the bare wire 1/4" from eyelet G as shown in the Pictorial. Solder both capacitor leads to the bare wire.



Detail 4C

NOTE: Be sure no component leads, lockwashers, or screws touch solder connections on the circuit board.

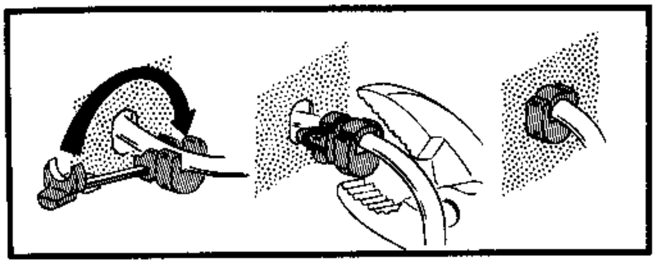
Refer to Pictorial 5 for the following steps.

(✓) Pass the free end of the 5-conductor cable through opening H in the side of the remote chassis cover. Pull the cable through until most of it is through the hole.

(✓) Place the remote chassis face down on the work area with the connectors to your right as shown. Now place the cover onto the chassis, so the cable emerges from the side of the cover facing you.

NOTE: Be sure the cable is positioned as shown in the Pictorial. The cable must not be positioned near connectors A or B.

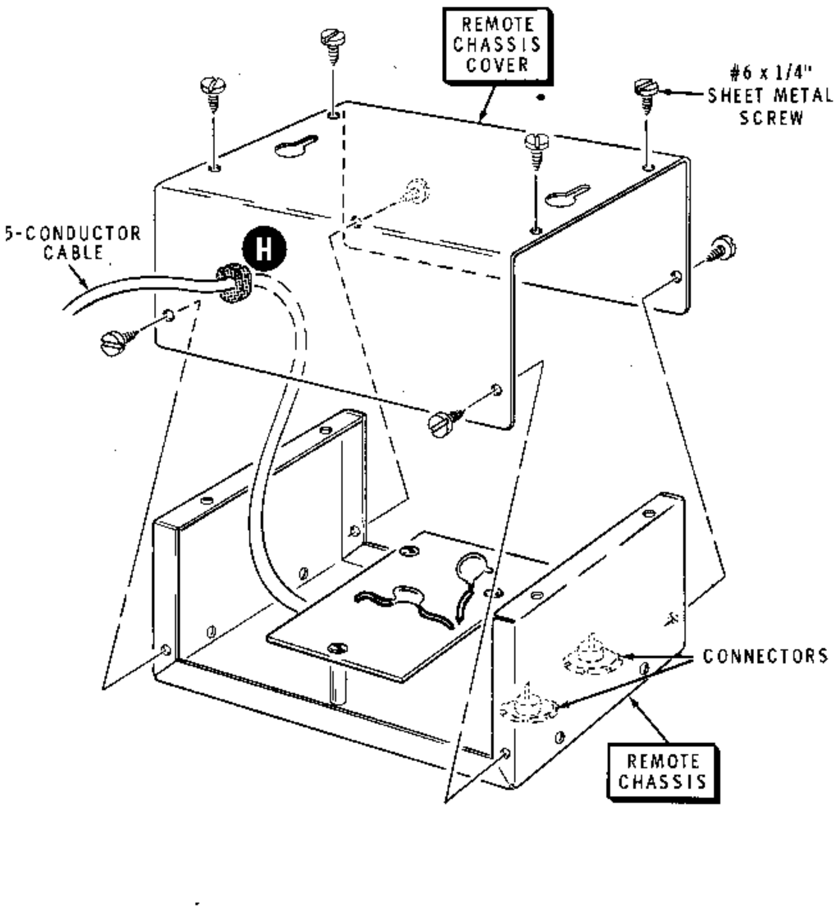
(✓) Secure the cover to the remote chassis with eight #6 x 1/4" sheet metal screws. NOTE: Do not use the black screws at this time.



Detail 5A

(✓) Refer to Detail 5A and install the cable strain relief on the 5-conductor cable in hole H on the remote chassis cover as follows: First pull the cable from the hole in the cover until it is snug; then place the clamp onto the cable 1" away from the hole. Finally, insert the strain relief in the hole with pliers.

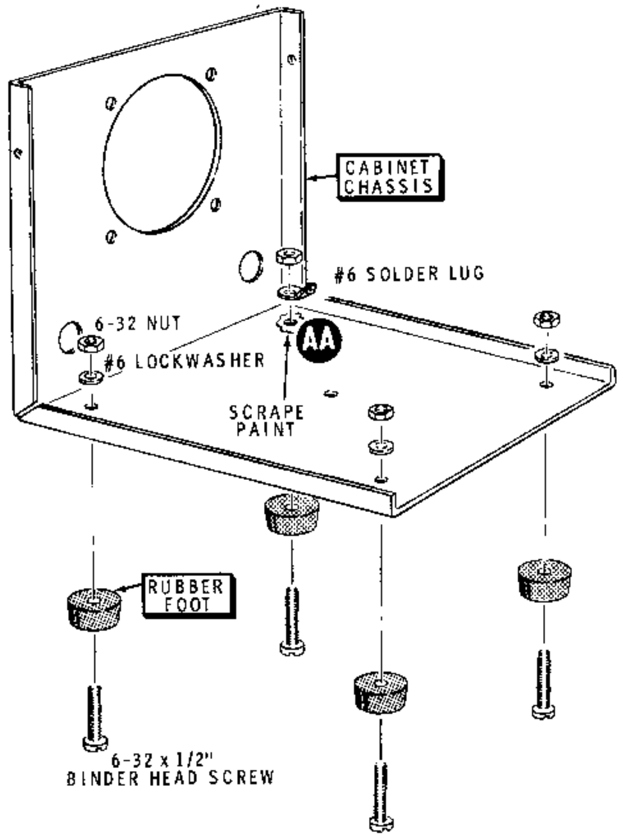
This completes the assembly of the remote chassis. Set it aside temporarily.



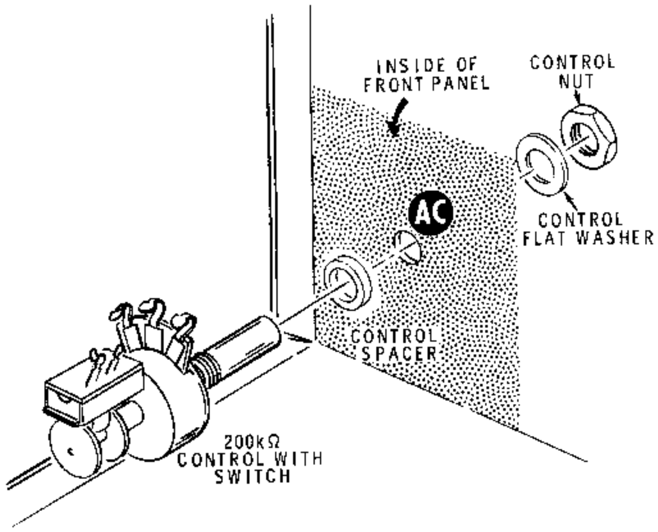
PICTORIAL 5

CABINET ASSEMBLY

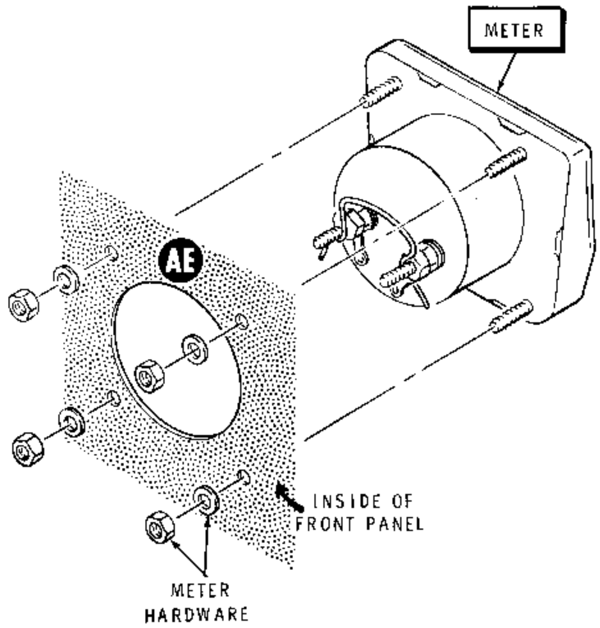
Refer to Pictorial 6 (fold-out from Page 4) for the following steps.



Detail 6A



Detail 6B



Detail 6C

( ) Refer to Detail 6A and scrape the paint from around hole AA to provide a good ground for the solder lug.

( ) Install four rubber feet on the cabinet chassis with four 6-32 x 1/2" binder head screws, three #6 lockwashers, and four 6-32 nuts. Use a #6 solder lug at AA in place of a #6 lockwasher. Position the solder lug as shown.

( ) Install the 200 kΩ control with switch at AC on the front panel with a control spacer, a control flat washer, and a control nut, as shown in Detail 6B.

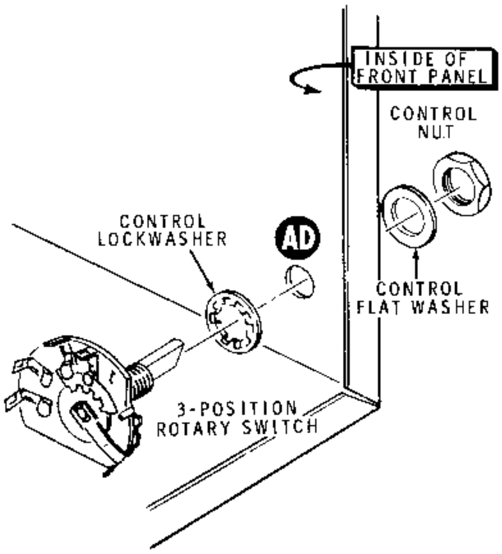
( ) Remove the meter from its carton and locate the meter hardware in the same container. Mount the meter at AE, using the meter hardware as shown in Detail 6C. NOTE: Do not overtighten the meter nuts, as the meter case can be broken. Make sure the meter top is parallel with the top of the panel.

¾ ½ ¼ 0 1" 2" 3" 4" 5" 6"

Refer to Pictorial 6 for the following steps.

( ) Place the cable clamp around the free end of the 5-conductor cable so 1" of the outer insulation extends beyond the clamp as shown. Secure the clamp to the chassis at AB with a 6-32 x 1/2" binder head screw, a D-washer, a #6 lockwasher, and a 6-32 nut.

( ) Refer to Detail 6D and install the 3-position rotary switch at AD with a control lockwasher, a control flat washer, and a control nut. Position the switch as shown in Pictorial 6.



Detail 6D

Refer to Detail 6E for the following steps.

(✓) Connect the black wire coming from the 5-conductor cable to solder lug AA (NS).

(✓) Connect the brown wire coming from this cable to lug 4 of rotary switch AD (NS).

( ) Locate three .001 μF ceramic capacitors. Cut both leads of each capacitor to 3/4".

(✓) Connect a .001 μF ceramic capacitor from lug 4 of switch AD (S-2) to solder lug AA (NS).

(✓) Connect the red wire coming from the 5-conductor cable to lug 3 of rotary switch AD (NS).

(✓) Connect a .001 μF ceramic capacitor from lug 3 of switch AD (S-2) to solder lug AA (NS).

(✓) Connect a .001 μF ceramic capacitor from lug 2 of switch AD (NS) to solder lug AA (NS).

( ) Locate the 4" length of 5-conductor cable previously removed from the original cable length. Carefully cut about 1/2" of the outer insulation from the five wires. Then, with a pair of long-nose pliers, pull the red, the black, and the green wires out of the outer insulation. Discard the remaining two wires and the outer insulation.

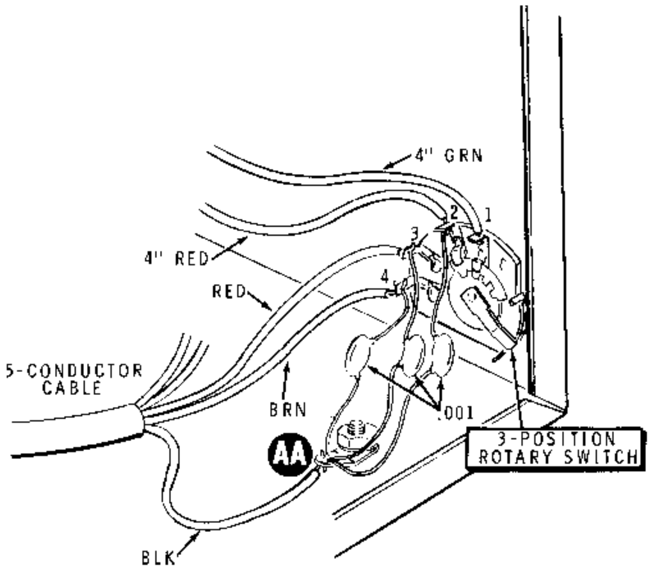
(✓) Prepare the 4" red, black, and green wires by removing 1/4" of insulation from both ends of each wire. Then twist the ends tightly and apply a small amount of solder to each to hold the small strands together.

(✓) Connect one end of the 4" red wire to lug 2 of the rotary switch (S-2).

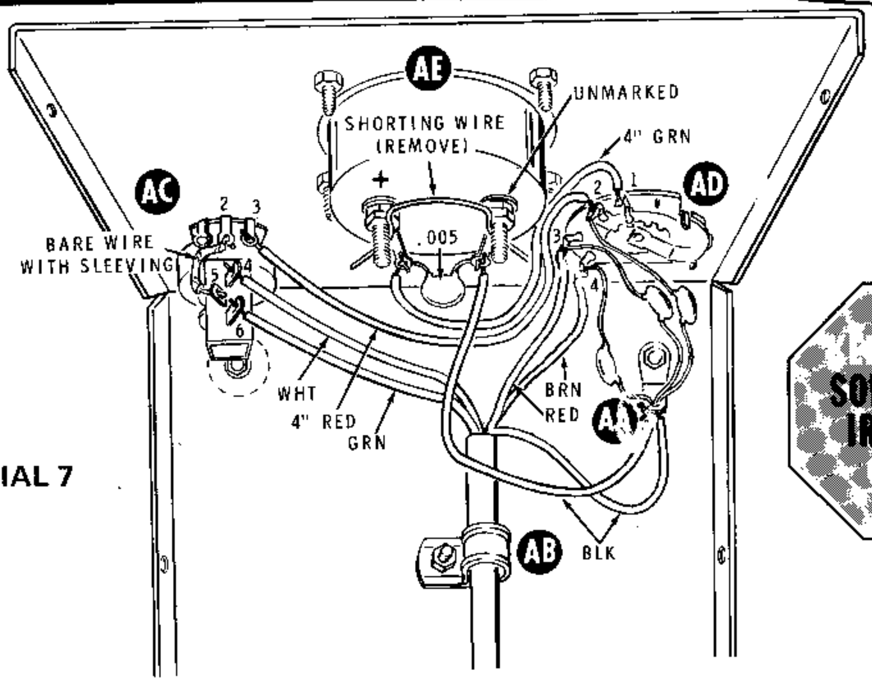
(✓) Connect one end of the 4" black wire to solder lug AA (S-5). Use enough solder to make sure all five wires and leads are well soldered.

(✓) Connect one end of the green wire to lug 1 of the rotary switch (S-1).

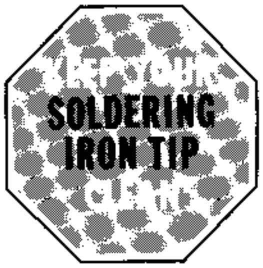
( ) Carefully cut all the excess wire and lead ends that extend beyond the lugs of the rotary switch.



Detail 6E



PICTORIAL 7



CABINET WIRING

Refer to Pictorial 7 for the following steps.

(✓) Connect the green wire coming from lug 1 of switch AD to the positive (+) terminal lug of meter AE (NS).

(✓) Connect the red wire coming from lug 2 of switch AD to lug 3 of control switch AC (S-1).

(✓) Connect the free end of the 4" black wire from solder lug AA to the negative (unmarked) terminal lug of meter AE (NS).

(✓) Cut both leads of a .005 μF ceramic capacitor to 1/2". Connect this capacitor between the positive (+) terminal lug (S-2) and the negative (unmarked) terminal lug (S-2) of meter AE.

( ) Locate the bare lead length saved when the circuit board was assembled.

(✓) Connect one end of this bare wire to lug 2 of control-switch AC (S-1).

( ) Cut a 1/2" of Teflon sleeving and push this onto the wire installed in the previous step.

(✓) Connect the free end of this wire to lug 5 of control-switch AC (S-1).

(✓) Connect the green wire coming from cable clamp AB to lug 6 of control-switch AC (S-1).

(✓) Connect the white wire coming from cable clamp AB to lug 4 of control-switch AC (S-1).

(✓) Remove and discard the shorting wire from the terminals of meter AE.

This completes the wiring of the cabinet.

Refer to Pictorial 8 (fold-out from Page 15) for the following steps.

( ) Loosely secure the cabinet top to the chassis with four #6 x 1/4" black sheet metal screws as shown.

( ) Start an 8-32 x 1/4" setscrew into each of the knobs.

( ) Turn the Function switch shaft to its center position.

( ) Install a knob on the Function (SWR-2000-200) switch shaft. Position the knob so the pointer is directly toward the "2000" on the front panel. Tighten the setscrew securely.

( ) Turn the SWR Sens control shaft fully counterclockwise. Place the other knob on the control shaft and position it so the pointer is at the 7 o'clock position (at the lower end of the rotation arrow); then, tighten the setscrew securely.

CALIBRATION

Before calibrating the Meter, prepare an alignment tool in the following manner: Locate the small 1/8" x 3/4" alignment tool blade. Refer to Figure 1 and install the blade into the small end of the nut starter as shown. Leave 1/8" of the blade protruding from the end of the alignment tool.

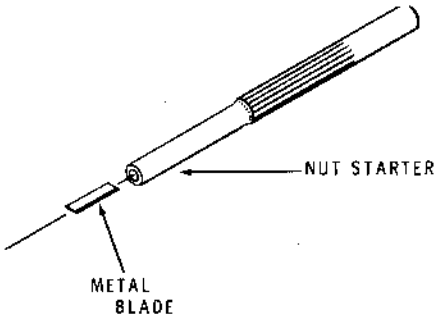


Figure 1

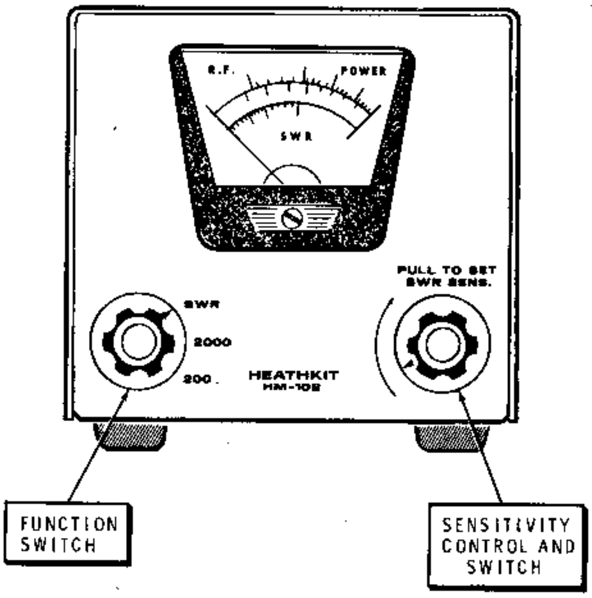


Figure 2

NOTE: During the following steps, the remote cabinet may be placed so you can easily make the adjustments while watching the meter.

SWR BALANCE ADJUSTMENT

NOTE: Perform steps 1 through 8 to make sure you have a normal output from your transmitter, through the meter, to your dummy load. You must obtain a reading on the RF Power Meter scale before continuing with steps 9 through 15.

1.( ) Check to see that the meter needle is directly over the zero on the scale. If it is not, adjust the screw head on the meter case slightly to position the needle over the zero.

2.( ) Connect a 50-ohm noninductive load, such as the Heathkit Cantenna, to the remote chassis OUTPUT jack. (See Figure 3 on Page 14).

3.( ) Connect the transmitter output to the INPUT jack on the remote chassis. (See Figure 3.)

4.( ) Set the FUNCTION switch to 200. (See Figure 2.)

5.( ) Push the SWR SENS control knob in and turn the control fully counterclockwise.

6.( ) Set the CALIBRATION switch, on the rear of the remote chassis, to NORM (see Figure 3).

7.( ) Turn on the transmitter, and set it to the CW mode in the 40-meter band. Then tune the transmitter and watch the RF Power Meter needle move up-scale. If the meter needle does not move up-scale, refer to the "In Case of Difficulty" section of this Manual.

8.( ) Turn the Transmitter output level down.

9.( ) Set the FUNCTION switch to SWR.

10.( ) Increase the transmitter output level until a reading of approximately 25 is seen on the 200 RF Power Meter scale. Even if the meter reading is not this high, proceed with the following steps.

11.( ) With the SWR SENS control knob still pushed in, set it for a full-scale reading.

12.( ) Refer to Figure 3, and adjust SWR NULL trimmer C4, through the rear of the remote chassis, with the alignment tool (nut starter) for the best null or greatest dip of the meter needle. This reading should be at or near zero. NOTE: Do not use any metal tool other than the nut starter blade to make these adjustments.

13.( ) Increase the transmitter output to full power and readjust SWR NULL trimmer C4. Make this final adjustment carefully and precisely. The accuracy of the instrument depends on a well-balanced bridge circuit.

14.( ) Repeat steps 12 and 13.

15.( ) After removing the paper backing place the 1" square insulator paper over the hole to trimmer C4. This adjustment must not be disturbed during the following steps.

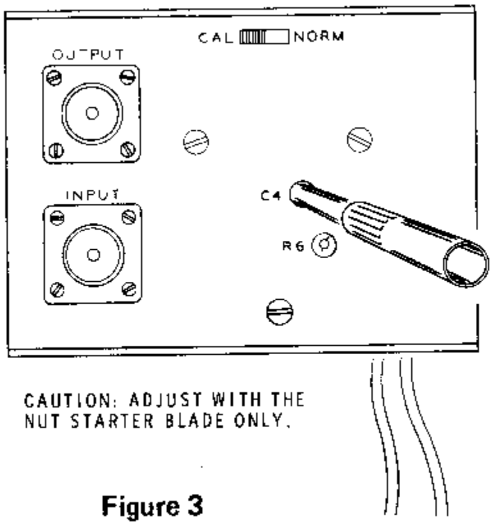


Figure 3

Do not disconnect the RF Power Meter, the transmitter, or the load; they will be used in the following section.

POWER METER

This section of the Manual contains two calibration procedures: one for calibrating the RF Power Meter on the 40-meter band, and one for calibrating the Meter on any one of the other bands.

For maximum accuracy, the Meter should be calibrated on the 40-meter band, even if it is going to be used on the other bands. Therefore, if your transmitter will tune to the 40-meter band, use the "Normal Calibration" procedure to calibrate your Meter. However, if your transmitter will not tune to the 40-meter band, use the "Calibration on Other Bands" procedure. Since the meter readings are more accurate in the upper-half of the meter scale, it is desirable to use a transmitter that is capable of delivering at least 100 watts of output power for either calibration procedure.

Normal Calibration

( ) Turn the FUNCTION switch to 200.

( ) Adjust the transmitter output to 100 watts.

( ) Complete the calibration as follows:

1. Set the CALIBRATE switch on the remote chassis to CAL and note the meter reading.
2. Now set the CALIBRATE switch to NORM.
3. Adjust POWER CALIBRATE control R6 with the alignment tool so the meter reads the same as noted in step 1.
4. Repeat steps 1 through 3 until the meter readings for the CAL and NORM switch positions are the same.

Leave the CALIBRATE switch in the NORM position.

This completes the calibration of your RF Power Meter.

Calibration on Other Bands

NOTE: During the following steps you will need a VTVM with a high impedance input and an RF probe, or an RF voltmeter to measure the RF output of your transmitting system.

If you cannot tune your transmitter to the 40-meter band, acceptable calibration accuracy can be obtained on another band by using the following power formula:

$$P = \frac{E^2}{R}$$

Where P = watts output
E = RF voltage across the load
R = load resistance

To determine E, measure the RF voltage across the 50-ohm resistive load (Cantenna) with an RF voltmeter or a VTVM equipped with an RF probe.

With this method, the watts output determined by the formula is compared with the watts reading on the scale of the Power Meter. The Power Meter is then adjusted to read the same as the power determined by the formula.

EXAMPLE: If you wish to use the 25-watt figure on the meter scale for calibration and you are using a 50-ohm resistive load, set your transmitter output so the RF voltmeter across the load reads 35-volts RF.

$$25 \text{ watts (P)} \times 50 \text{ ohms (R)} = 1250\ (E^2)$$
$$E = \sqrt{1250} = 35 \text{ volts (approximately)}$$

When the RF voltmeter indicates 35 volts, you know the transmitter is putting out 25 watts; therefore, you can adjust the RF Power Meter to indicate 25 watts.

Any other figure for watts between 10 and 2000 may be substituted in the formula and in the example.

If you have an accurate RF wattmeter, adjust R6 to the same reading as shown on the wattmeter.

1. ( ) Select the power you wish to obtain from your transmitter.

2. ( ) Use the power formula to calculate the RF voltage that should appear across the resistive load when the transmitter is putting out the selected power (refer to the example).

3. ( ) Turn the **FUNCTION** switch to 200 or 2000, depending upon the output power of your transmitting system.

4. ( ) Connect the RF voltmeter across the resistive load. NOTE: Do not exceed the current rating of your RF probe.

5. ( ) Adjust the transmitter output so the RF voltage across the resistive load is the same as the calculated RF voltage.

6. ( ) Adjust control R6 through the rear of the remote chassis so the RF Power Meter indicates the power you selected to obtain from the transmitter.

This completes the calibration of your RF Power Meter.

FINAL ASSEMBLY

Refer to Pictorial 9 for the following steps.

NOTE: In the following steps, the remote chassis will be installed in the cabinet. If you wish to place the remote chassis in some location away from the cabinet, so the remote unit will be near the transmission lines, do not complete the following steps. In this case, place the four black screws in a small envelope and tape them to the floor of the cabinet.

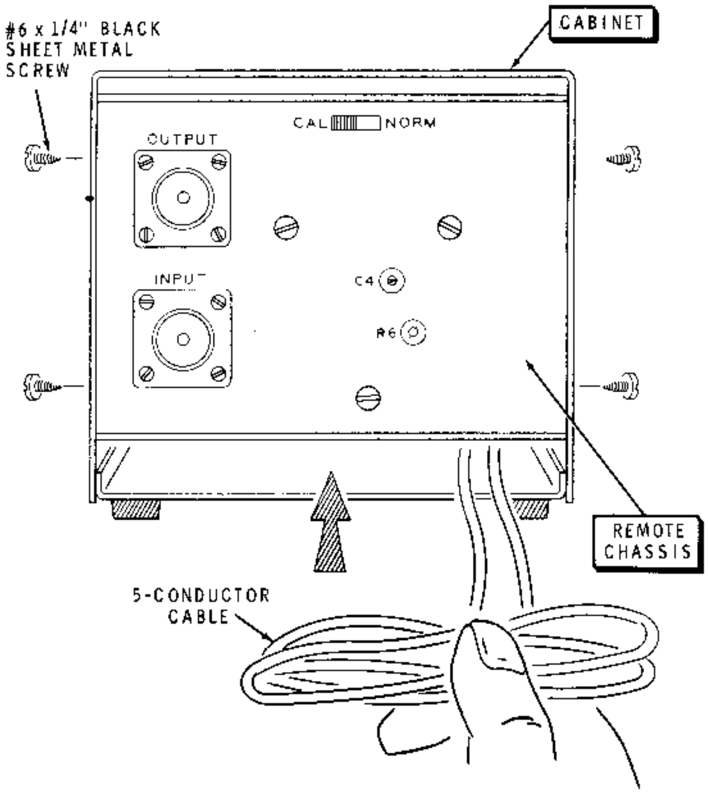
( ) Position the remote chassis inside the top rear opening of the cabinet. Secure the remote chassis to the cabinet with four #6 x 1/4" black sheet metal screws.

( ) Tighten the remaining four black cabinet screws.

( ) Coil the 5-conductor remote cable neatly and slide it into the opening beneath the remote unit.

( ) Turn the cabinet upside down. Remove the paper backing from the blue and white label; then, press the label firmly onto the bottom of the cabinet as shown on Pictorial 8 (fold-out from this Page).

This completes the step-by-step assembly of your RF Power Meter.



PICTORIAL 9

OPERATION

SWR METER

NOTE: The RF power meter SWR bridge can only be used with 50 ohm nominal transmission lines. Also it will not work on transmission lines that are used as tuned feeders, since tuned feeders normally have a high SWR.

1. Turn the FUNCTION switch to SWR.
2. Pull the SWR SENS switch out and turn it fully counterclockwise.
3. Apply power to the transmitter and tune it for maximum RF output reading. Disregard the Power Meter readings at this time.
4. Turn the SWR SENS control clockwise for a midscale meter reading. A minor "touch-up" tuning of the transmitter may show an increase on the Meter. This indicates a closer match between the transmitter and the transmission line.
5. Turn the SWR SENS control clockwise to give a full-scale meter reading.
6. Push the SWR SENS control knob in and read the SWR ratio directly on the lower meter scale.

Normal Operating Characteristics

The Power Meter (SWR Bridge) may be left in the transmission line at all times for continuous monitoring purposes.

The peaks on controlled carrier modulation will "kick" the meter needle upward. SSB and DSB signals will give a bouncing indication when transmitting; so no SWR measurement can be made with these signals. Therefore, use a single-tone or CW carrier with sideband transmitters when taking readings. When operating SSB, any indication with no modulation indicates spurious or parasitic emission, or poor carrier suppression.

Physical Placement and Losses

The detector unit may be removed from the cabinet and placed at a location more convenient for connection to your transmission line. The 6' interconnecting cord that is furnished may be replaced by a longer one, if this is desired. You may even position the detector unit at the antenna, although there is always the possibility of RF pickup on the extended interconnecting cable from the transmission line. If this should occur, the use of properly grounded, shielded interconnecting cable may be required. NOTE: The remote cabinet is not weatherproofed. Any outdoor application should be temporary.

The SWR meter readings may vary if the Meter is placed at different locations in the transmission line, or if the length of the transmission line is changed. For this reason, assume that the highest SWR reading is most correct. Keep in mind that the closer the SWR approaches 1:1, the more accurate the Power Meter becomes.

Misleading readings may be obtained with long transmission lines since the losses in the cable tend to "smooth out" the standing waves, giving a much better indication at the transmitter than actually exists at the antenna. Therefore, if you are using a transmission line long enough to have appreciable losses, locate the Power Meter near the antenna, especially when adjusting beams or tuning traps. You can better understand the extent of this effect when you realize that a line with a 3 dB loss will show an SWR of 3 when it is terminated in a dead short. A line with a loss of over 10 dB will show an SWR of practically 1:1, on this or any other SWR meter, regardless of what load or termination is connected at the far end.

The power losses in these cases are occurring in the cable, but the SWR meter reading will not indicate that anything is wrong. When in doubt, make measurements at the antenna and at the transmitter, so future changes in the readings will be meaningful. The values of cable losses at various frequencies can be obtained from Figure 4. These losses become worse as time and moisture affect the cable.

With a high SWR, the transmission line losses may become so great that the radiated power is appreciably reduced; with high-power transmitters, the cable ratings may be exceeded. Figure 5 shows the effect of increasing cable losses caused by various values of SWR. When these losses occur, the RF power is turned into heat in the cable instead of being radiated from the antenna.

To obtain total losses in a given length of coaxial cable, determine the dB loss per foot of the cable from Figure 4. This is done by finding your operating frequency on the bottom line of the chart, and moving up to find the type of cable used. By looking at this same level on the left-hand side of the chart, you can read the dB loss per 100 feet of the cable at that frequency.

Now determine the additional loss caused by the SWR from Figure 5 as follows: Use the amount of loss determined from Figure 4 and find this value on the bottom line of Figure 5. Now move up the graph until you come to the SWR of your antenna system. Move over to the left-hand side of the graph and determine the amount of loss caused by the SWR. To obtain the total loss of your system, add the value from Figure 4 to the value from Figure 5. Multiply the total loss by the cable length in feet. Then divide by 100.

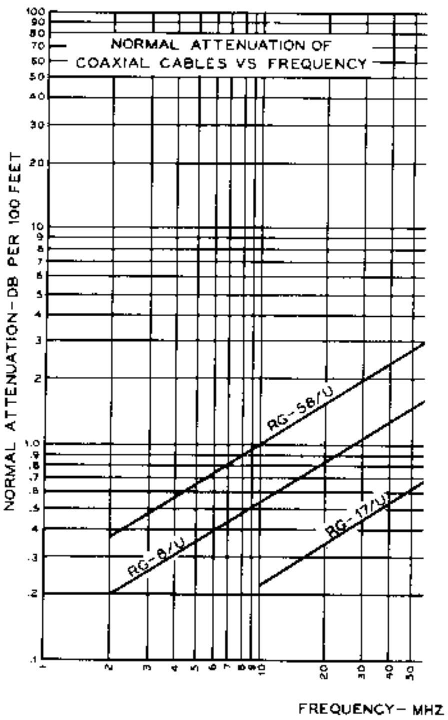


Figure 4

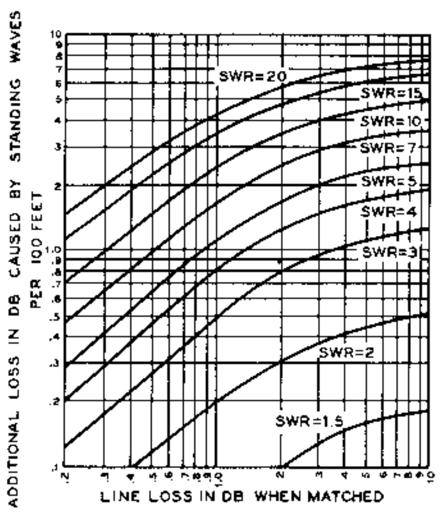


Figure 5

Loading

The load presented to the transmitter output circuit may create conditions that make it touchy or impossible to load the transmitter. With a low SWR, the load that the transmitter sees is practically pure resistive. However, at a high SWR, the apparent load may change from a very low to a very high resistance, accompanied by either capacitive or inductive reactance. These resistance and reactance values change when the transmission line length or frequency is changed.

Remember when you are using 50 Ω nominal unbalanced feed lines that the SWR cannot be changed by changing the transmission line length. However, the loading to the transmitter may be changed considerably; thus making it appear that "pruning" the cable length offers improvement, when it actually does not affect the SWR.

The SWR can only be changed by changing the load or termination at the end of the cable. If the transmission line length is changed, for example, with 50 Ω cable and an SWR of 3, the apparent load to the transmitter may vary from 16-2/3 Ω to 150 Ω resistive in series with reactance varying from 66-2/3 Ω capacitive, to zero, to 66-2/3 Ω inductive. If the transmitter output tuning adjustments will not accommodate this impedance range, the transmitter will be difficult to load until the load is properly matched to the line. When the load is matched, the SWR will be low, approaching 1:1.

POWER METER

The operation of the Power Meter is relatively uncomplicated. Merely place the FUNCTION switch in either the 200- or 2000-watt position; then read the corresponding scale on the meter scale to obtain the power output of the transmitter. A load must be connected to the output jack of the Meter.

Low Power Measurments (1 to 20 Watts)

1. Place the Function switch at 200.
2. Increase the transmitter output to 10 on the 200 scale.
3. Turn the Function switch to SWR.
4. Pull out the SWR SENS switch and adjust the meter reading to 100 on the 200 scale.
5. Read from 0 to 20-watts directly from the 200 scale providing the SWR SENS control is not touched.

IN CASE OF DIFFICULTY

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 constructor.
2. It is interesting to note that 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 "Soldering" section of the "Kit Builders Guide."
3. Check the values of 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.
4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.
5. A review of the Circuit Description and the Schematic Diagram may prove helpful in locating a trouble.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover of the Manual.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE
Meter reads down-scale on SWR or wattmeter.	1. Meter leads reversed. 2. Diode D1 or D2 reversed.
Higher meter reading for SWR Set than for SWR.	1. Input and output plugs reversed. 2. Pickup coil L1 leads reversed. 3. Switch S3 incorrectly wired.
Calibrator portion of meter not functioning correctly.	1. Input and output plugs reversed. 2. Diode D3 reversed. 3. Capacitor C7, C8, C11, or C9. 4. Resistor R5.
SWR reading while transmitter is off.	1. Nearby transmitter in operation.

SPECIFICATIONS

Frequency Range	1.8 to 30 MHz.
Wattmeter Accuracy	±10% of full-scale reading.*
Power Capability	To 2000 watts.
SWR Sensitivity	Less than 10 watts.
Impedance	50 ohms nominal.
SWR Bridge	Continuous to 2000 watts P-P.
Connectors	UHF type SO-239.
Dimensions	5-1/4" wide, 5-1/16" high, and 6-1/2" deep, assembled as one unit.
Net Weight	2-1/2 lbs.

*Using a 50 Ω noninductive load.

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

CIRCUIT DESCRIPTION

Refer to the Schematic (fold-out from Page 23) while reading this "Circuit Description."

SWR BRIDGE CIRCUIT

Toroid coil L1 is a current pickup element for forward and reflected power. A bus wire is routed from the Input jack through toroid coil L1, and then to the Output jack. A transmitted signal routed along this wire induces a current in coil L1. The voltage formed in coil L1 is rectified by diode D3 and decoupled by capacitor C5 and resistor R4. Resistor R3 creates a load for forward power readings. Reverse power readings are determined, in the same manner, by the circuit consisting of diode D2, capacitor C2, and resistor R1.

Forward and reverse voltages are connected to the meter through switch S2, Sensitivity control R11, and Function switch S3.

Resistor R7 is a ground-return path for diodes D2 and D3. Capacitors C4, C12, C13, and C1 form a voltage divider circuit to balance the capacitive effects of the bifilar (doubled) windings in coil L1, which provides correct SWR readings.

POWER METER CIRCUIT

Current is induced in toroid coil L1 in the same manner as for the SWR bridge circuit. Resistor R2 forms a load across coil L1 to reduce the Q of the coil circuit. This prevents the transmitted frequency from affecting the wattmeter.

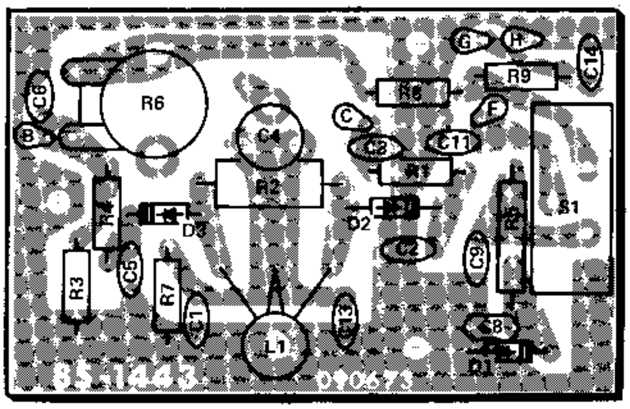
The wattmeter is calibrated by measuring the voltage at control R6, which varies the power going to the meter. Resistors R8 and R9 are voltage dividers for the two power ranges: 200 watts and 2000 watts.

Capacitors C7 and C8, diode D1, and voltage divider resistor R5 through switch S1 complete a voltmeter circuit for the wattmeter.

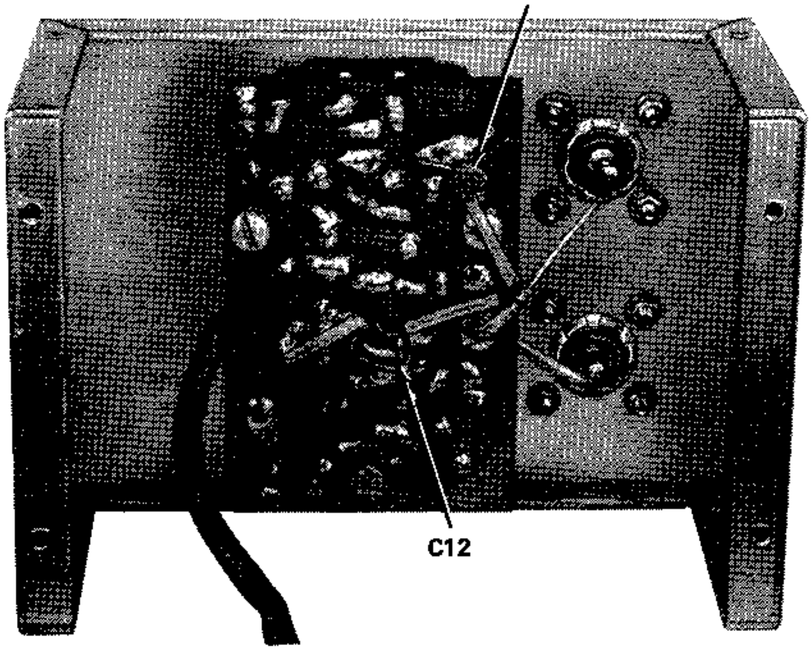
By using an accurate device, such as an RF probe with a VTVM or a wattmeter calibrator, this Power Meter can be calibrated to a desired degree of accuracy.

Ferrite beads L2 through L6 prevent RF from traveling through the 5-conductor cable into the readout circuits.

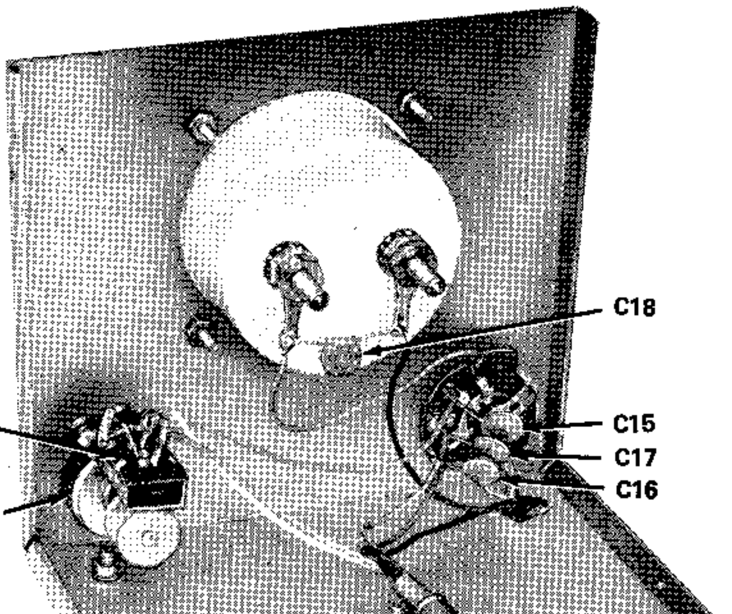
CIRCUIT BOARD X-RAY VIEW



REMOTE CHASSIS PHOTO

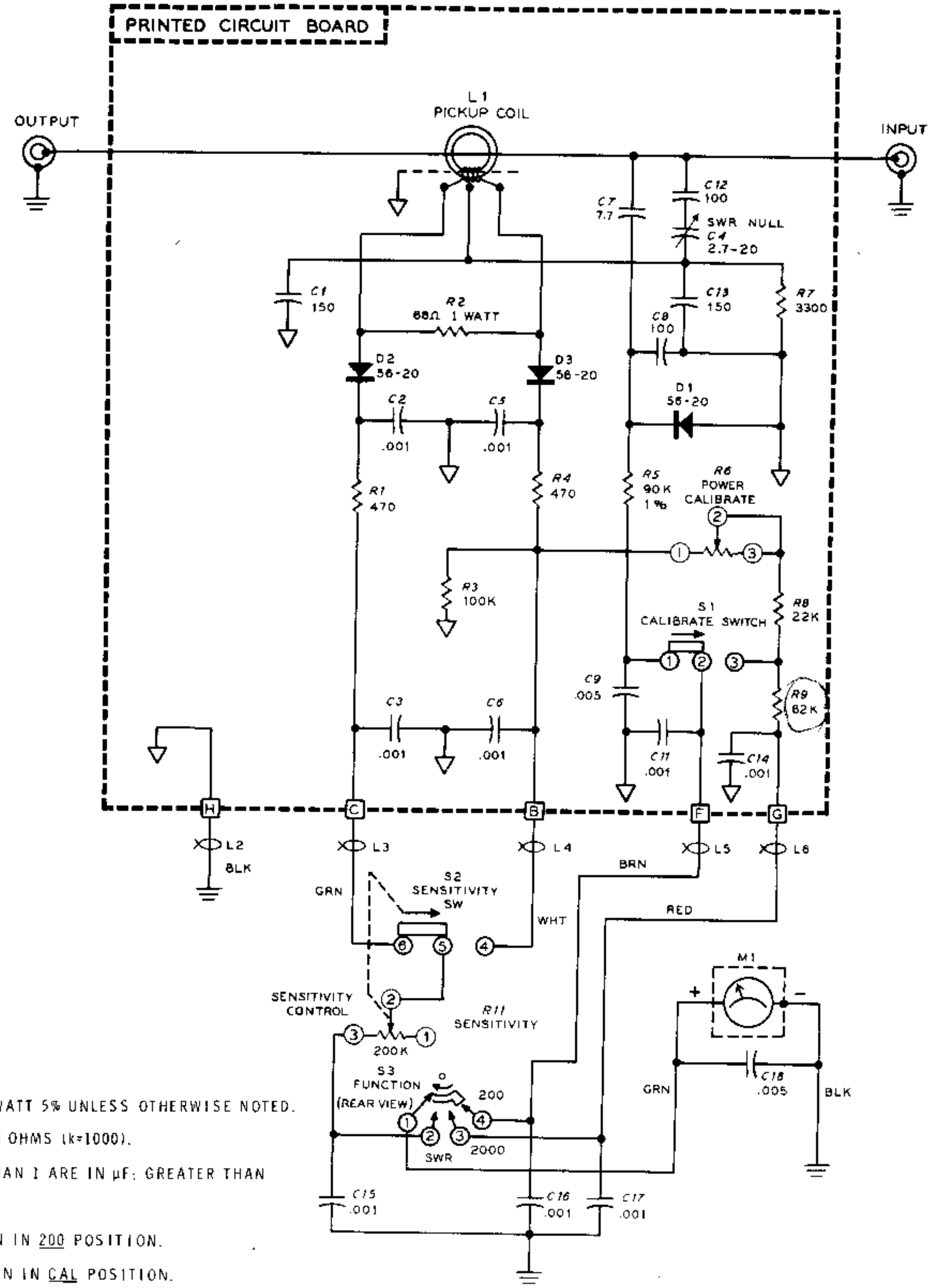


CABINET PHOTO



NOTES:

1. ALL RESISTOR
RESISTOR VAL
2. ALL CAPACITO
1 ARE IN pF.
3. FUNCTION SW
4. CALIBRATE SW
5. SENSITIVITY
6. THIS S
7. THIS S
8. THIS S
TO THE
9. THIS S



NOTES:

1. ALL RESISTORS ARE 1/2 WATT 5% UNLESS OTHERWISE NOTED. RESISTOR VALUES ARE IN OHMS (k=1000).
2. ALL CAPACITORS LESS THAN 1 ARE IN μF; GREATER THAN 1 ARE IN pF.
3. FUNCTION SWITCH SHOWN IN <u>200</u> POSITION.
4. CALIBRATE SWITCH SHOWN IN <u>CAL</u> POSITION.
5. SENSITIVITY SWITCH SHOWN PUSHED IN.
6. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD COMMON.
7. ⏚ THIS SYMBOL INDICATES CHASSIS GROUND.
8. □ THIS SYMBOL INDICATES AN EXTERNAL CONNECTION TO THE CIRCUIT BOARD.
9. THIS SYMBOL INDICATES A FERRITE BEAD.

SCHEMATIC OF THE HEATHKIT®

RF POWER METER MODEL HM-102