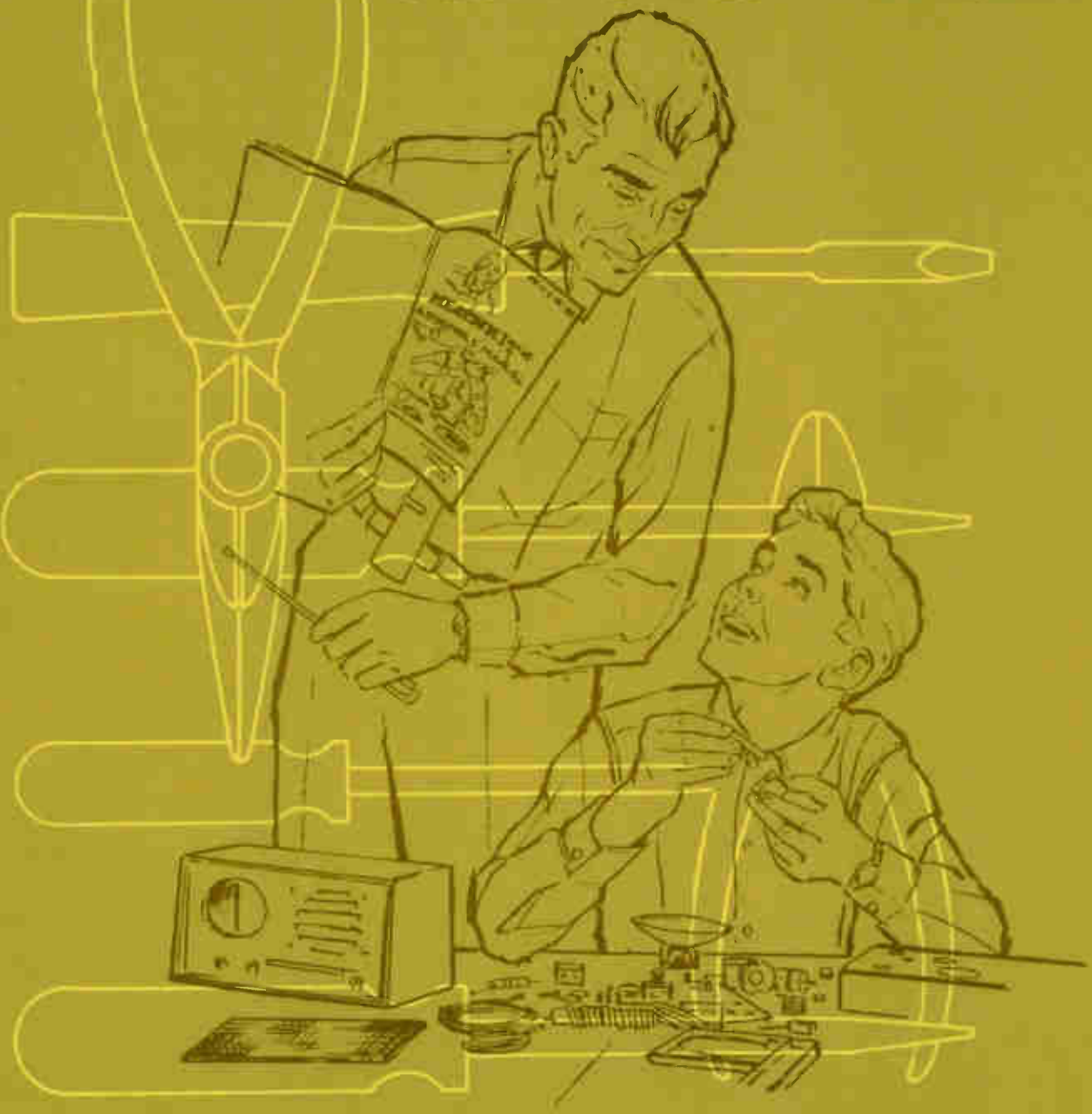
MODEL HM-2103 RF Load Wattmeter

HEATHKIT®

ASSEMBLY MANUAL



HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATHKIT

PRICE $2.00

595-1518-01

Dear Customer:

The Heathkit electronic product you have purchased is one of the best performing electronic products in the world.

Here's how we aim to keep it that way:

Your Heathkit Warranty

During your first 90 days of ownership, any parts which we find are defective, either in materials or workmanship, will be replaced or repaired free of charge. And we'll pay shipping charges to get those parts to you — anywhere in the world.

If we determine a defective part has caused your Heathkit electronic product to need other repair, through no fault of yours, we will service it free — at the factory, at any retail Heathkit Electronic Center, or through any of our authorized overseas distributors.

This protection is exclusively yours as the original purchaser. Naturally, it doesn't cover damage by use of acid-core solder, incorrect assembly, misuse, fire, flood or acts of God. But, it does insure the performance of your Heathkit electronic product anywhere in the world — for most any other reason.

After-Warranty Service

What happens after warranty? We won't let you down. If your Heathkit electronic product needs repairs or you need a part, just write or call the factory, your nearest retail Heathkit Electronic Center, or any Heath authorized overseas distributor. We maintain an inventory of replacement parts for each Heathkit model at most locations — even for many models that no longer appear in our current product line-up. Repair service and technical consultation are available through all locations.

We hope you'll never need our repair or replacement services, but it's nice to know you're protected anyway — and that cheerful help is nearby.

Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022

Assembly and Operation of the

HEATHKIT

RF LOAD WATTMETER

MODEL HM-2103

TABLE OF CONTENTS

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model HM-2103 RF Load Wattmeter is a reliable instrument for measuring the RF power output of a radio transmitting system such as an amateur radio transmitter. This compact instrument combines a wattmeter and a load that can be easily switched into the output of your transmitting system.

You can tune your transmitter before transmitting, or test and troubleshoot your transmitter with this dummy load.

The unit is designed as a 50 ohm nominal characteristic impedance with a negligible SWR at frequencies up to 30 MHz. A high-temperature lamp warns you of temperatures that might damage the load impedance, and there is a lamp test circuit so you can be sure the lamp and battery are working.

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

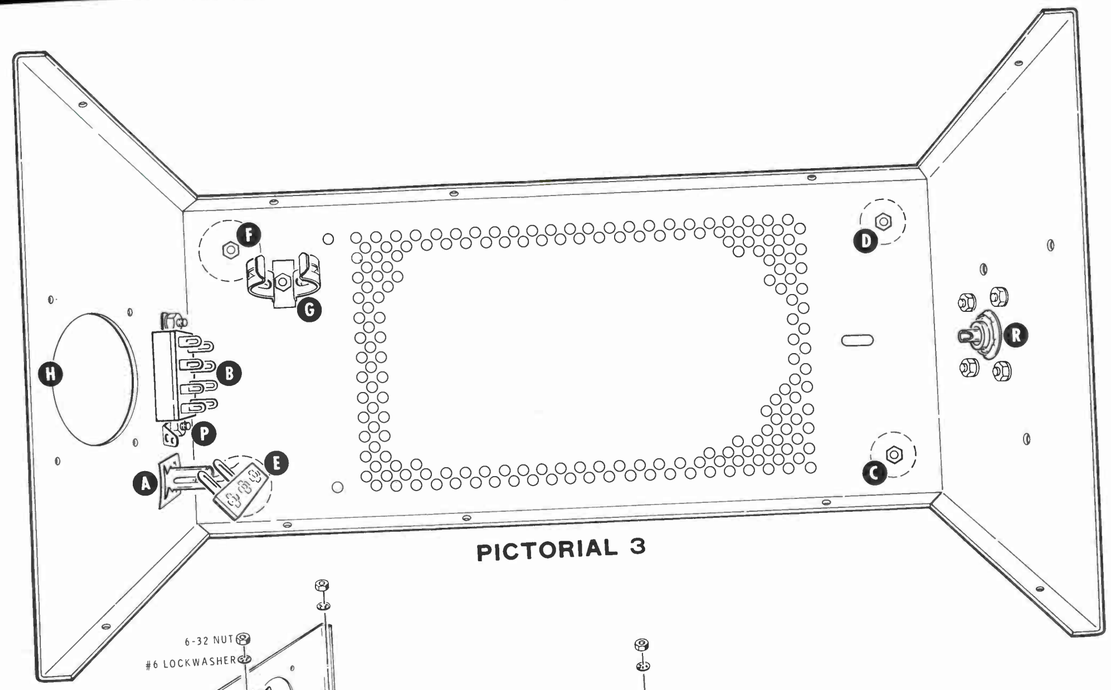
PARTS LIST

Check each part against the following list. The key numbers correspond to the numbers in the Parts Pictorial.

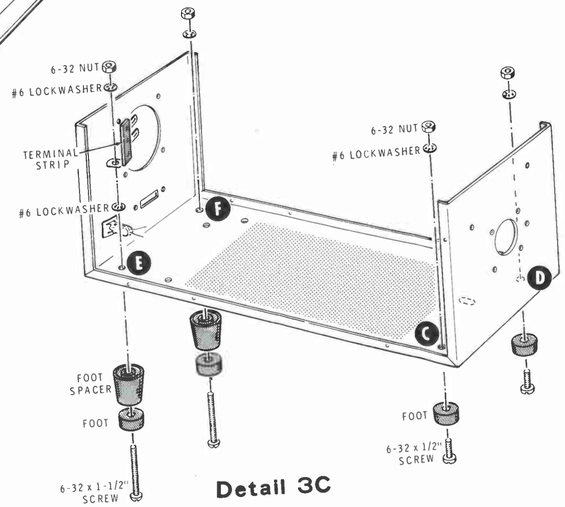
To order a replacement part, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
A1	1-3-10	1	50 Ω, 175-watt load resistor	20.00
A2	1-16-1	1	68 Ω, 1-watt (blue-gray-black)	.10
A3	1-157	2	470 Ω (yellow-violet-brown)	.10
A3	1-122	1	3300 Ω (orange-orange-red)	.10
A3	1-58	1	22 kΩ (red-red-orange)	.10
A3	1-104	1	100 kΩ (brown-black-yellow)	.10
A4	2-41	2	90 kΩ, precision	.20
CAPACITORS				
A5	20-148	2	100 pF mica	.20
A6	21-11	2	150 pF disc	.10
A6	21-140	6	.001 μF disc	.10
A6	21-27	1	.005 μF disc	.10
A6	21-181	1	7.7 pF disc	.25
A7	31-53	1	2-18.5 pF trimmer	.65

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
INDUCTOR-DIODE-SWITCH				
B1	40-1011	1	Toroid coil	1.20
B2	475-10	3	Ferrite bead	.10
B3	56-20	3	1N295 diode (red-white-green)	.25
B4	60-22	1	Switch	.45
HARDWARE				
#4 Hardware				
C1	250-213	6	4-40 x 5/16" screw	.05
C2	252-2	6	4-40 nut	.05
C3	254-9	6	#4 lockwasher	.05
#6 Hardware				
C4	250-237	14	#6 x 3/8" sheet metal screw	.05
C5	250-233	3	6-32 x 3/8" screw	.05
C5	250-381	2	6-32 x 3/8" black screw	.05
C6	250-162	2	6-32 x 1/2" screw	.05
C7	250-364	3	6-32 x 7/8" screw	.05
C8	250-40	2	6-32 x 1-1/2" screw	.05
C9	252-3	12	6-32 nut	.05
C10	254-1	12	#6 lockwasher	.05
C11	259-1	1	#6 solder lug	.05



PICTORIAL 3

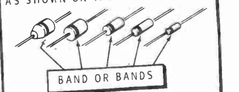


Detail 3C

HEATHKIT

START

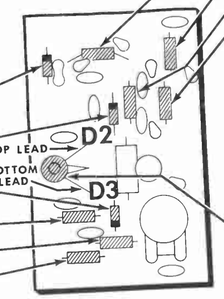
NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



- ( ) 1N295 diode (#56-20, red-white-green) at D1.
- ( ) 1N295 diode (#56-20, red-white-green) at D2.
- ( ) 1N295 diode (#56-20, red-white-green) at D3.
- ( ) 3300 Ω (orange-orange-red).
- ( ) 470 Ω (yellow-violet-brown).
- ( ) 100 kΩ (brown-black-yellow).

SAFETY WARNING: Avoid eye injury when you clip off excess leads. We suggest that you wear glasses, or at least clip the leads so the ends will not fly toward your eyes.

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



PICTORIAL 1

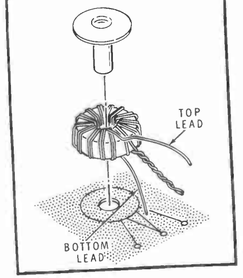
CONTINUE

- ( ) 90 kΩ precision. Position this resistor over the screened outline.
- ( ) 90 kΩ precision.
- ( ) 470 Ω (yellow-violet-brown).
- ( ) 22 kΩ (red-red-orange).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) Install the toroid coil as follows:

1. 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 D2, and the lead from the bottom must go to the hole nearest D3.
2. Carefully push an eyelet through the center of the toroid coil, through the circuit board, and solder it to the foil. Do not force the eyelet.

NOTE: If an ohmmeter is available, check between the eyelet and one of the coil leads to be sure they are insulated.

3. Solder the tinned ends of the three leads to the foil and remove any excess lead lengths.



KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Other Hardware				
D1	250-403	1	10-32 x 9" threaded shaft	.40
D2	252-5	2	10-32 nut	.05
D3	253-30	2	Flat washer	.05
D4	252-32	1	Speed Nut*	.05
D5	257-12	1	Eyelet	.05
METAL PARTS				
E1	90-591	1	Shield	
E2	90-592-1	1	Front cover	4.05
E3	90-593-1	1	Chassis	3.10
E4	204-1879	1	Small bracket	5.00
E5	204-1880-1	1	Large bracket	.40
E6	208-6	1	Battery clip	1.30
				.10
INSULATORS-SPACERS				
F1	71-4	1	Ceramic insulator (with screws, washers and insulator)	.40
F2	75-189	2	Fiber insulation	.10
F3	255-50	3	9/16" spacer	.05
F4	255-59	2	Foot spacer	.10
F5	255-176	1	Phenolic spacer	.55
F6	255-177	1	10-32 x 1/2" threaded aluminum spacer	.15
MISCELLANEOUS				
G1	10-325	1	50 kΩ control	.35
G2	65-47	1	Thermal switch	1.60
G3	73-1	1	Grommet	.10
	85-394-7	1	Circuit board	1.25
G4	205-778	1	Alignment tool blade	.10

*Registered Trademark, Tinnerman Co.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Miscellaneous (cont'd.)				
G5	261-9	4	Foot	.05
	340-3	1	Bare wire	.05/ft
	346-21	1	Sleeve	.30/ft
	347-9	1	Cable	.10/ft
	352-13	1	Silicone grease	.15
G6	407-180	1	Meter	14.45
G7	412-90	1	Lamp	1.30
G8	413-10	1	Red lens	.10
G9	431-51	1	Terminal strip	.10
G10	432-33	1	Battery connector	.25
G11	432-120	1	Female connector	.10
G12	432-121	2	Male connector	.10
G13	436-5	1	Coaxial jack	.85
	490-5	1	Nut starter	.10
	597-260	1	Parts Order Form	
	391-34	1	Blue and white label	
	597-308	1	Kit Builders Guide	
		1	Assembly Manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder can be ordered under part number 331-6 for $.15 each.)	

The following battery should be purchased at this time for use in the completed kit.

1	9-volt type, NEDA #1604 (such as Eveready #216, Burgess #246, RCA #VS 323, Ray-o-vac #1604, etc.).

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.

STEP-BY-STEP ASSEMBLY

Before starting to assemble this kit, be sure you have read the wiring, soldering, and step-by-step assembly information in the "Kit Builders Guide."

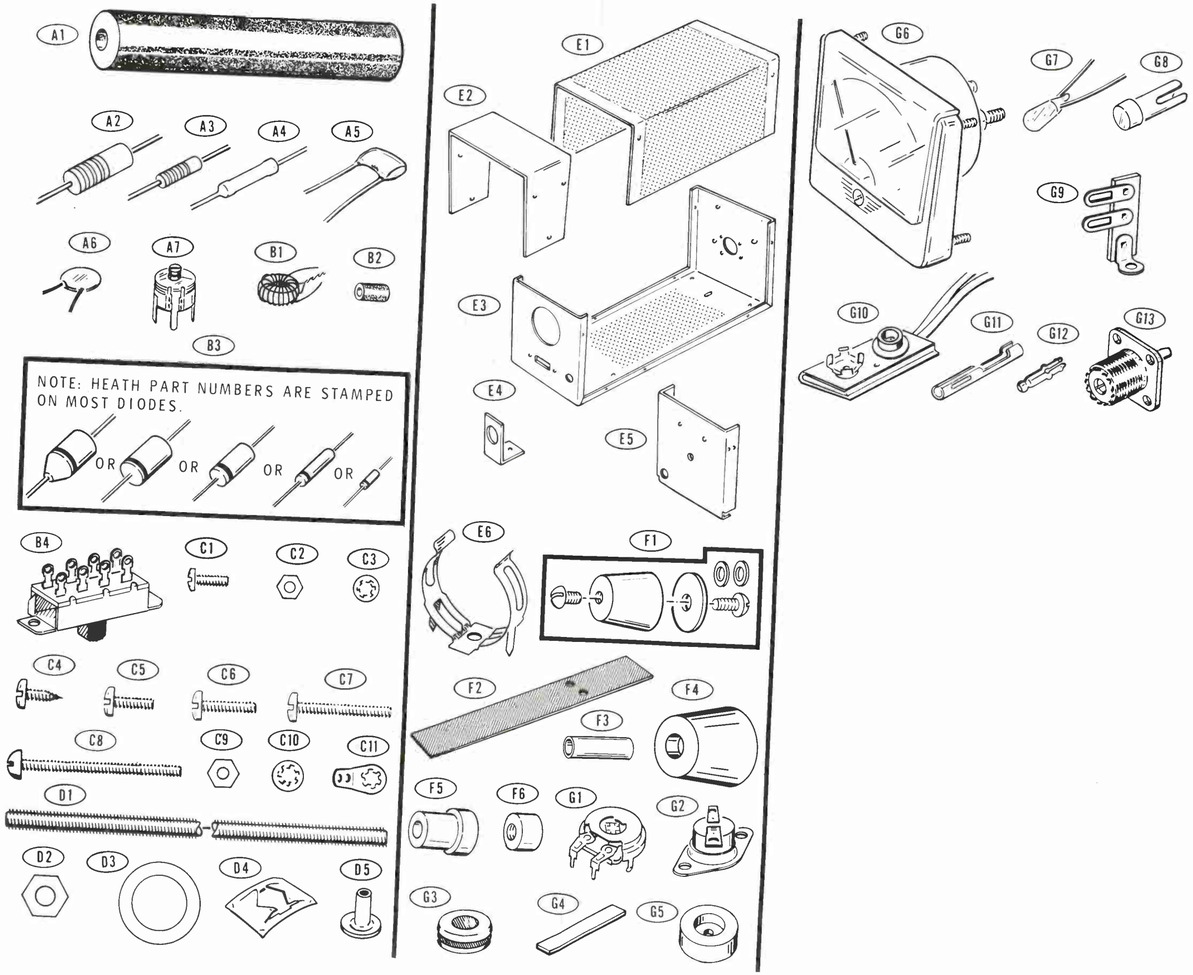
CIRCUIT BOARD ASSEMBLY

Components will be installed on the circuit board by following the steps on Pages 4 and 5. 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 designated by capacitance value (in pF or μF) and type (mica or disc).

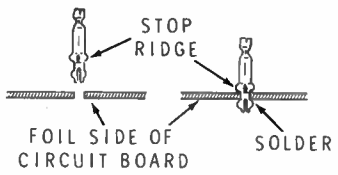
Locate the circuit board and position it lettered side up as shown in Pictorial 1. Then complete each step on Pictorials 1 and 2.

PARTS PICTORIAL



START

( ) Install a connector pin in the circuit board as shown.



( ) Connector pin.

( ) 100 pF mica.

NOTE: Before you install ceramic capacitors, remove any insulation from the leads as shown.

( ) .005 µF disc.

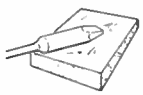
( ) 150 pF disc.

( ) 150 pF disc.

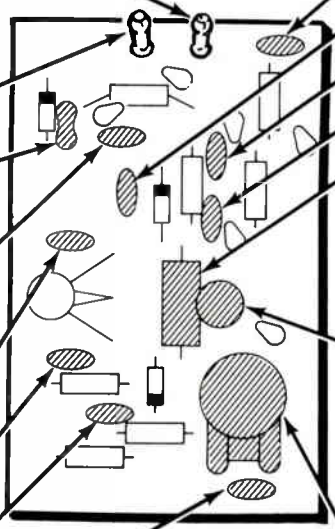
( ) .001 µf disc.

( ) .001 µF disc.

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



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



CONTINUE

( ) .001 µF disc.

( ) .001 µF disc.

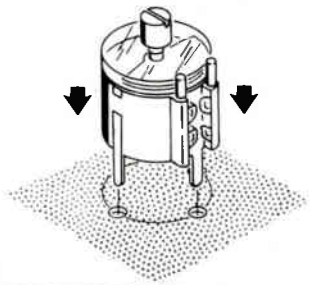
( ) .001 µF disc.

( ) .001 µF disc.

( ) 68 Ω, 1-watt (blue-gray-black).

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

( ) Install the 2-18.5 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.

Lay the circuit board aside. It will be installed later.

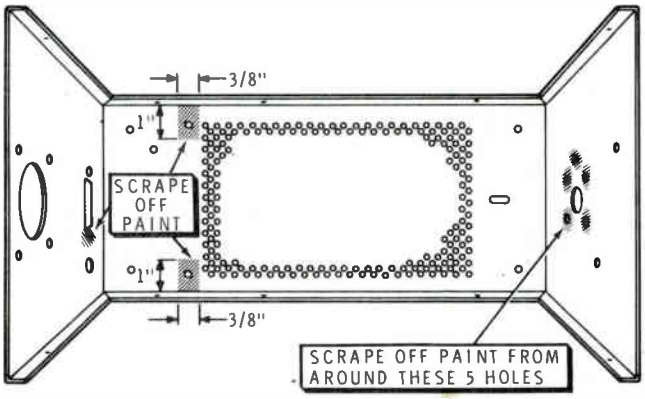
FINISH

PICTORIAL 2

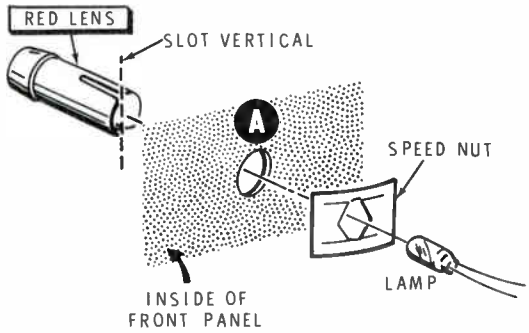
CABINET ASSEMBLY

Refer to Pictorial 3 (fold-out from Page 4) for the following steps.

( ) Refer to Detail 3A and scrape the paint from the eight indicated areas inside the rear and the bottom of the chassis. This will insure good ground connections.



Detail 3A



Detail 3B

( ) Mount a red lens at A with a Speed Nut. Position the slot in the lens vertically as shown in Detail 3B and press the Speed Nut firmly against the front panel.

( ) Insert the lamp into the lens. Position the leads carefully to fit the vertical slot in the lens.

NOTES:

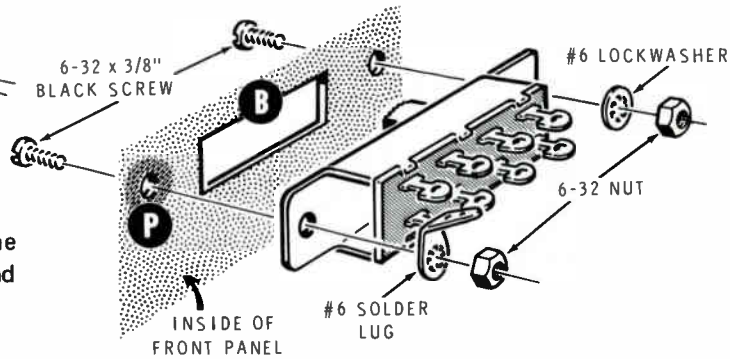
1. When hardware is called for in a step, only the screw size will be given. For instance, if "6-32 x 1-1/2" hardware" is called for, it means that a 6-32 x 1-1/2" screw, one or more #6 lockwashers, and a 6-32 nut should be used at each mounting hole. The Detail referred to in the step will show the proper number of lockwashers to use.
2. Use the plastic nut starter supplied with this kit to hold and start 6-32 and 4-40 nuts on screws.

( ) Mount a foot at C and one at D with 6-32 x 1/2" hardware as shown in Detail 3C.

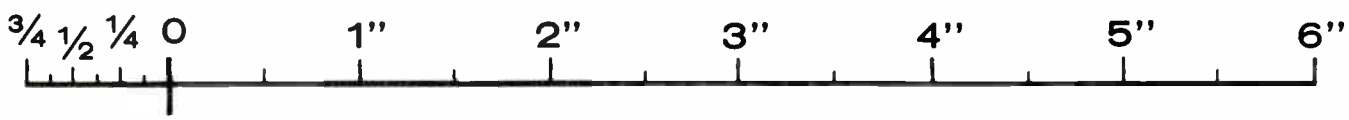
( ) In a similar manner, mount a foot and foot spacer at F with 6-32 x 1-1/2" hardware.

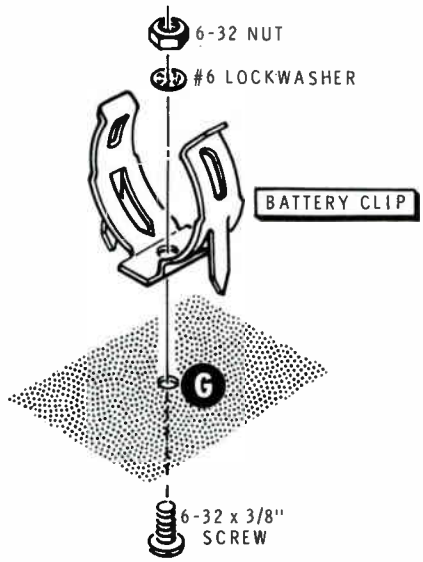
( ) Mount a foot, a foot spacer, and a terminal strip at E with 6-32 x 1-1/2" hardware as shown in Detail 3C. Do not tighten the hardware until the terminal strip is positioned in a later step.

( ) Mount a switch at P with a 6-32 x 3/8" black screw, a #6 solder lug, and a 6-32 nut. Position the lug upward as shown in Detail 3D. Use 6-32 x 3/8" black hardware in the other switch hole.



Detail 3D

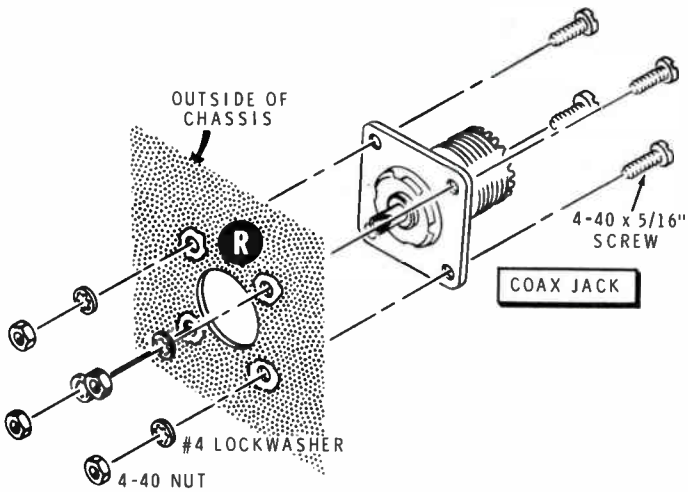




Detail 3E

( ) Refer to Detail 3E and mount a clip at G with 6-32 x 3/8" hardware.

( ) Mount a coaxial jack on the outside of the rear panel at R with 4-40 x 5/16" hardware. See Detail 3F.



Detail 3F

CABINET WIRING

Refer to Pictorial 4 (fold-out from Page 9) for the following steps.

( ) Locate the cable and cut a 7-1/2" length and a 21" length. From the 7-1/2" length, carefully cut about 1/2" of the outer insulation from the wire. Then, with a pair of long-nose pliers, pull the three wires out of the outer insulation and shield. Discard the insulation and shield.

NOTE: When a wire is called for in a step, use the color specified and cut the wire to the proper length. Then remove 1/4" of insulation from each end and melt a small amount of solder on the bare wire ends to hold the small wire strands together.

( ) Prepare the following wires from the three 7-1/2" wires. The wires are prepared in the order in which they will be used.

2" white	2" white
3" red	4-1/2" red
4" black	3-1/2" black
1-1/2" white	2" white

Connect the prepared wires in the following manner.

( ) 2" white wire from lug 6 (S-1) to lug 4 (NS) of switch B.

( ) 3" red wire to lug 4 of switch B (S-2). The other end will be connected later.

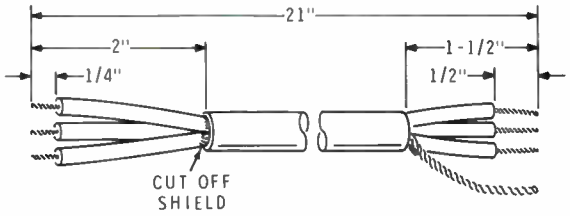
( ) 4" black wire to solder lug P (NS). The other end will be connected later.

( ) 1-1/2" white wire from solder lug P (NS) to lug 1 of terminal strip E (NS).

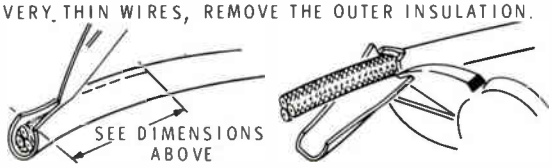
( ) 2" white wire from solder lug P (S-3) to lug 2 of switch B (S-1).

( ) 4-1/2" red wire to lug 1 of switch B (NS). The other end will be connected later.

CUT THE CABLE ACCORDING TO THE DIMENSIONS BELOW. PREPARE EACH END AS SHOWN.

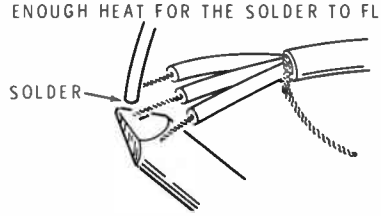


TAKING CARE NOT TO CUT THE OUTER SHIELD OF VERY THIN WIRES, REMOVE THE OUTER INSULATION.



PUSH BACK THE SHIELD. THEN MAKE AN OPENING IN THE SHIELD AND BEND OVER AS SHOWN. PICK OUT THE INNER LEADS.

REMOVE THE INNER INSULATION AND STRETCH OUT THE SHIELD. APPLY A SMALL AMOUNT OF SOLDER TO THE END OF THE SHIELD AND THE INNER LEADS. USE ONLY ENOUGH HEAT FOR THE SOLDER TO FLOW.



Detail 4A

NOTE: In the next two steps, leave the lamp leads as long as possible.

( ) Connect the lowest lamp lead to lug 2 of terminal strip E (NS).

( ) Connect the other lamp lead to lug 1 of terminal strip E (S-2).

( ) Locate the battery connector and connect the black lead to lug 2 of terminal strip E (S-2).

( ) Turn terminal strip E to press the lamp as far into the lens as possible. Then tighten the hardware. Be sure the lamp leads are not touching.

( ) Connect the red battery connector lead to lug 1 of switch B (S-2).

( ) Prepare both ends of the 21" lengths of cable as shown in Detail 4A.

Connect the wires from the 2" end of the prepared cable to switch B in the following steps.

( ) Red to lug 7 (S-1).

( ) White to lug 5 (S-1).

( ) Black to lug 3 (S-1).

NOTE: In the next step, do not overtighten the meter nuts as the meter case can be broken. Also, make sure the meter top is parallel with the top of the panel.

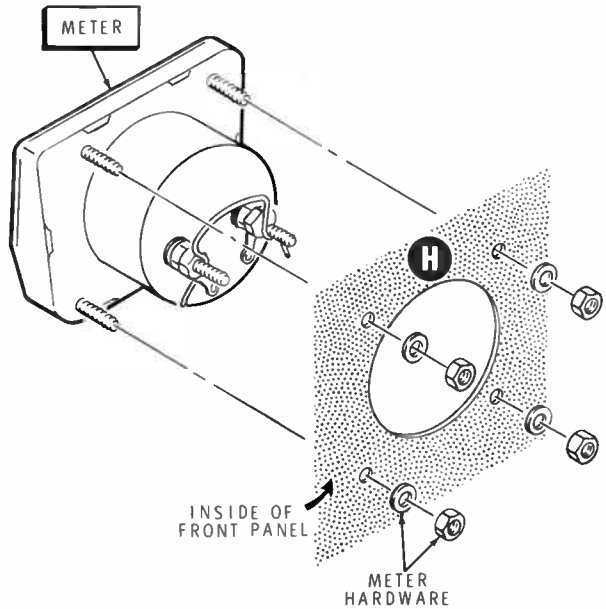
( ) Remove the meter and meter hardware from its carton. Mount the meter at H with the meter hardware. See Detail 4B. The shorting wire will be removed later.

( ) Connect the red wire coming from lug 4 of switch B to the positive (+) lug of meter H (S-1).

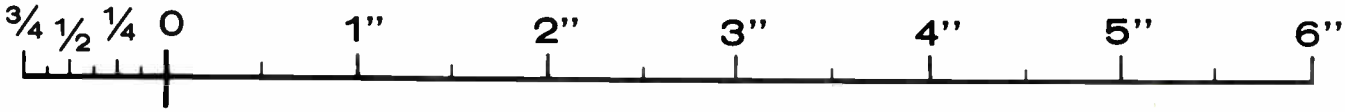
( ) Connect the black wire coming from solder lug P to the negative (unmarked) lug of meter H (NS).

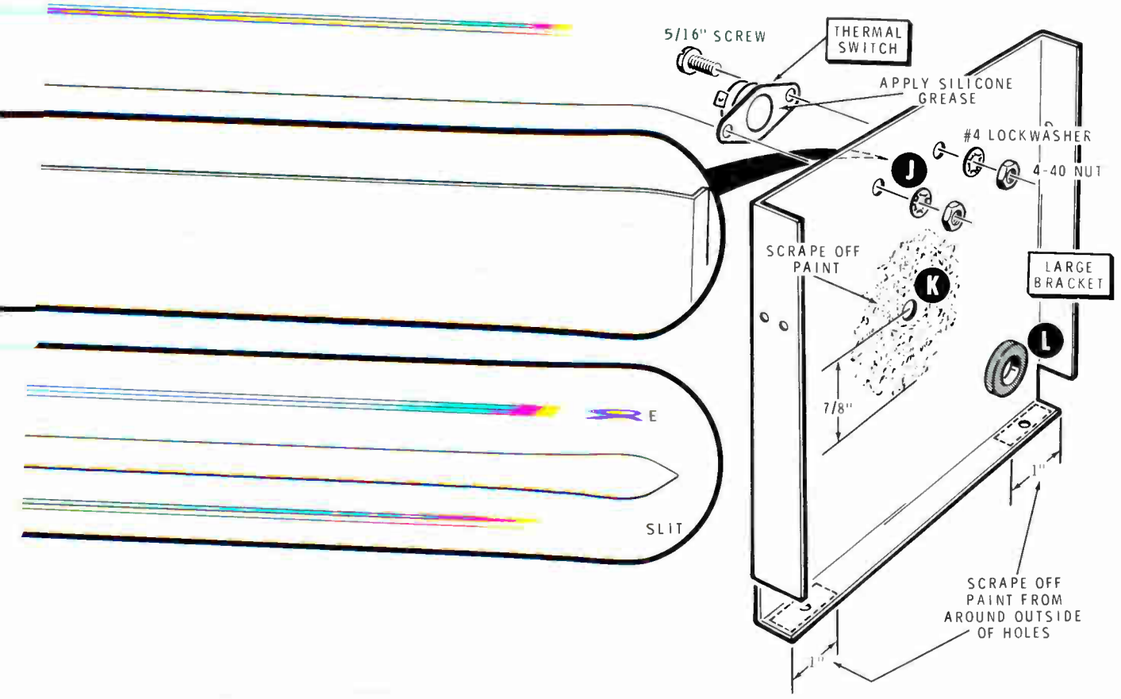
( ) Connect a 3-1/2" black wire to the negative lug of meter H (S-2). The other end will be connected later.

NOTE: The 2" white wire will be used later.



Detail 4B





PICTORIAL 5

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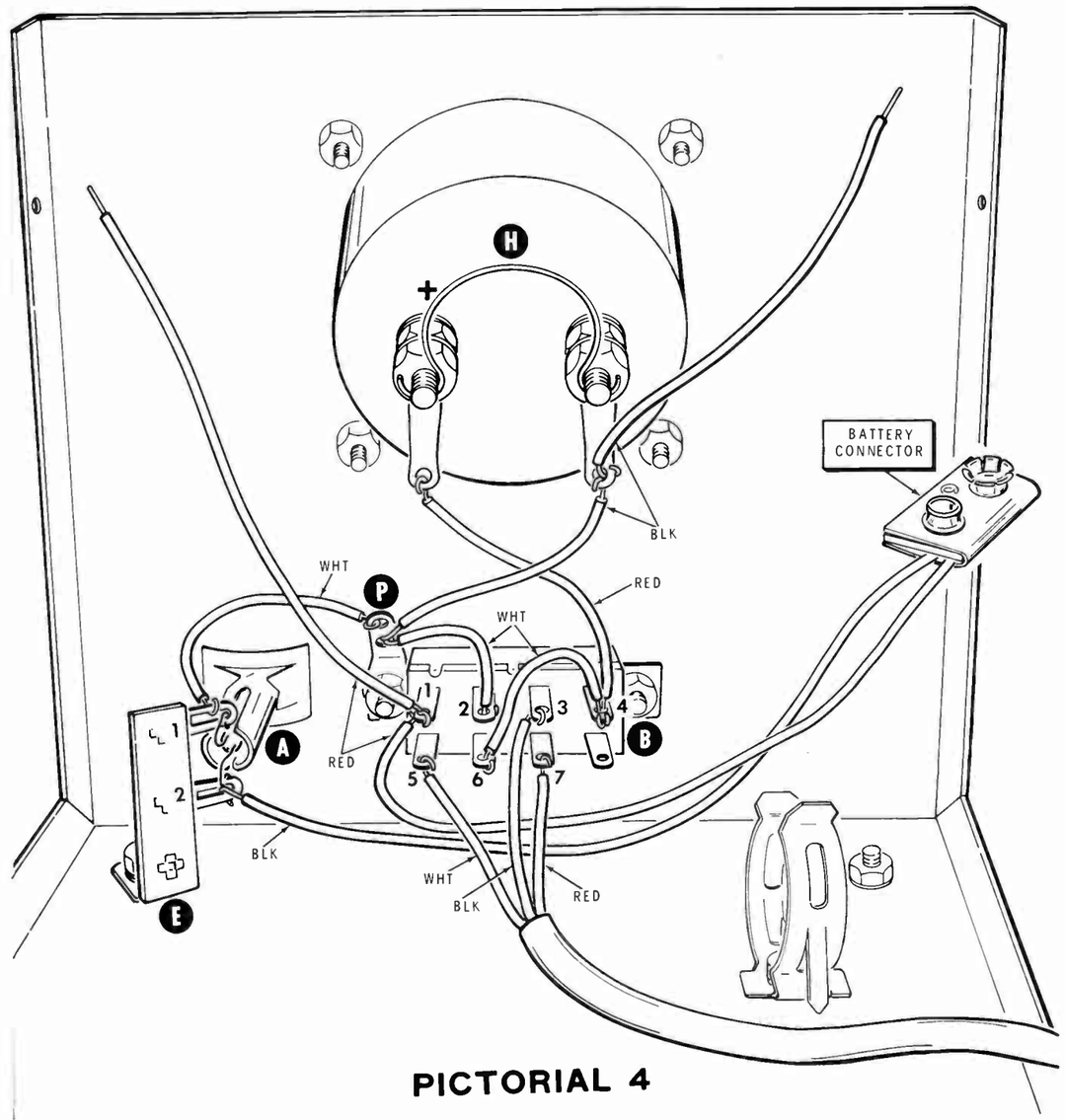
he paint from an
ide of the flange,

rge bracket.

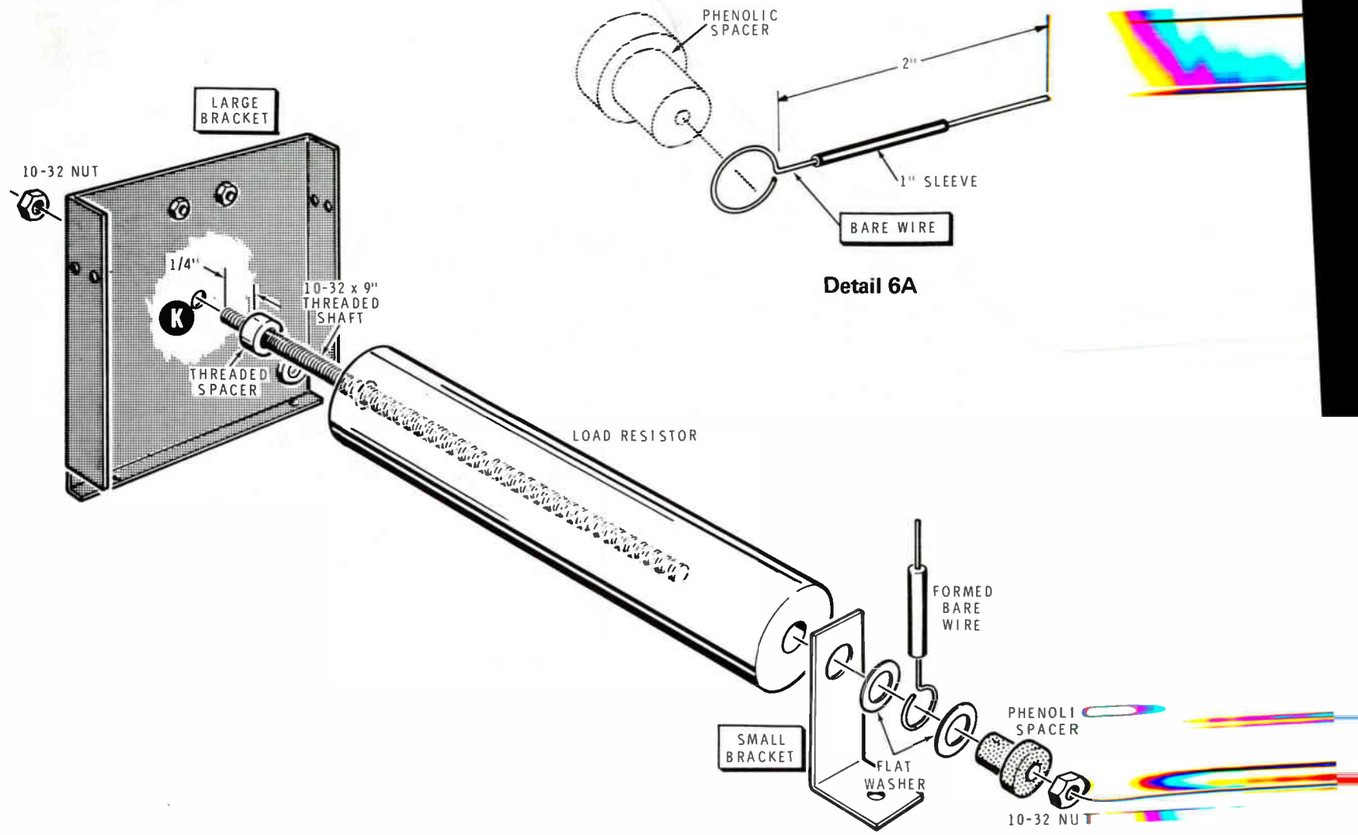
( ) Open the container of silicone grease as shown in inset drawing #2 on Pictorial 5.

( ) Apply a liberal amount of silicone grease to the thermal switch.

( ) Mount the thermal switch at J on the front of the large bracket with 4-40 x 5/16" hardware.



PICTORIAL 4



Detail 6A

PICTORIAL 6

Refer to Pictorial 6 for the following steps.

( ) Turn the threaded spacer onto the 10-32 x 9" threaded shaft until 1/4" of the shaft is exposed as shown in Pictorial 6.

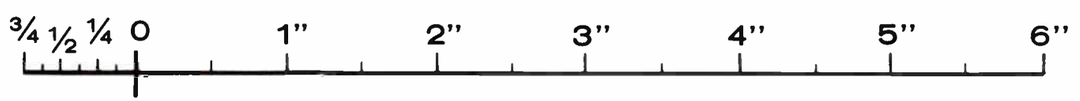
( ) Mount the shaft tightly to the bracket at hole K with a 10-32 nut.

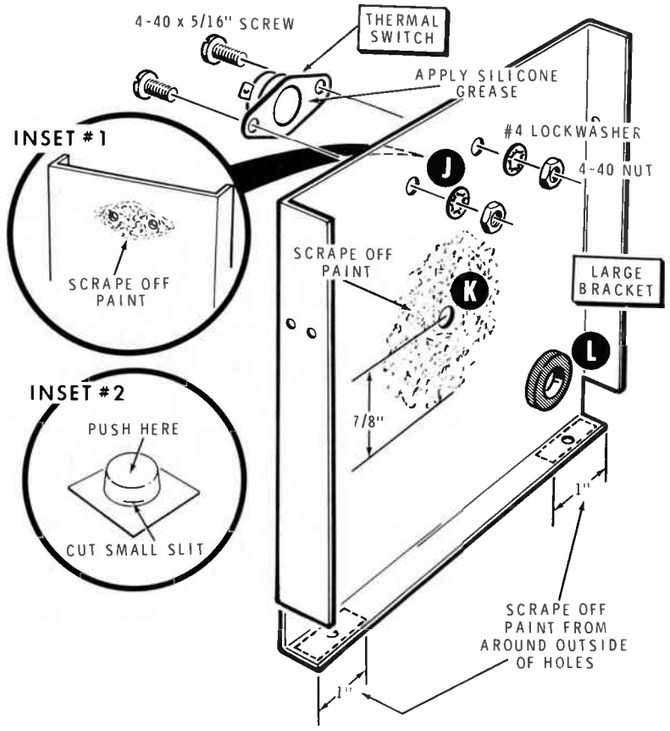
( ) Form a bare wire around the phenolic spacer as shown in Detail 6A.

( ) Mount the 50 ohm, 175-watt load resistor in the following manner. Place the load resistor on the threaded shaft. Place a flat washer, the formed wire, a flat washer, and the small bracket on the phenolic spacer. Then place the spacer on the threaded shaft and secure the assembly with a 10-32 nut. Refer to Pictorial 6 and position the small bracket as shown.

( ) Cut the extended end of the bare wire to 2".

( ) Cut a 1" length of sleeve and place it on the wire.





PICTORIAL 5

Refer to Pictorial 5 for the following steps.

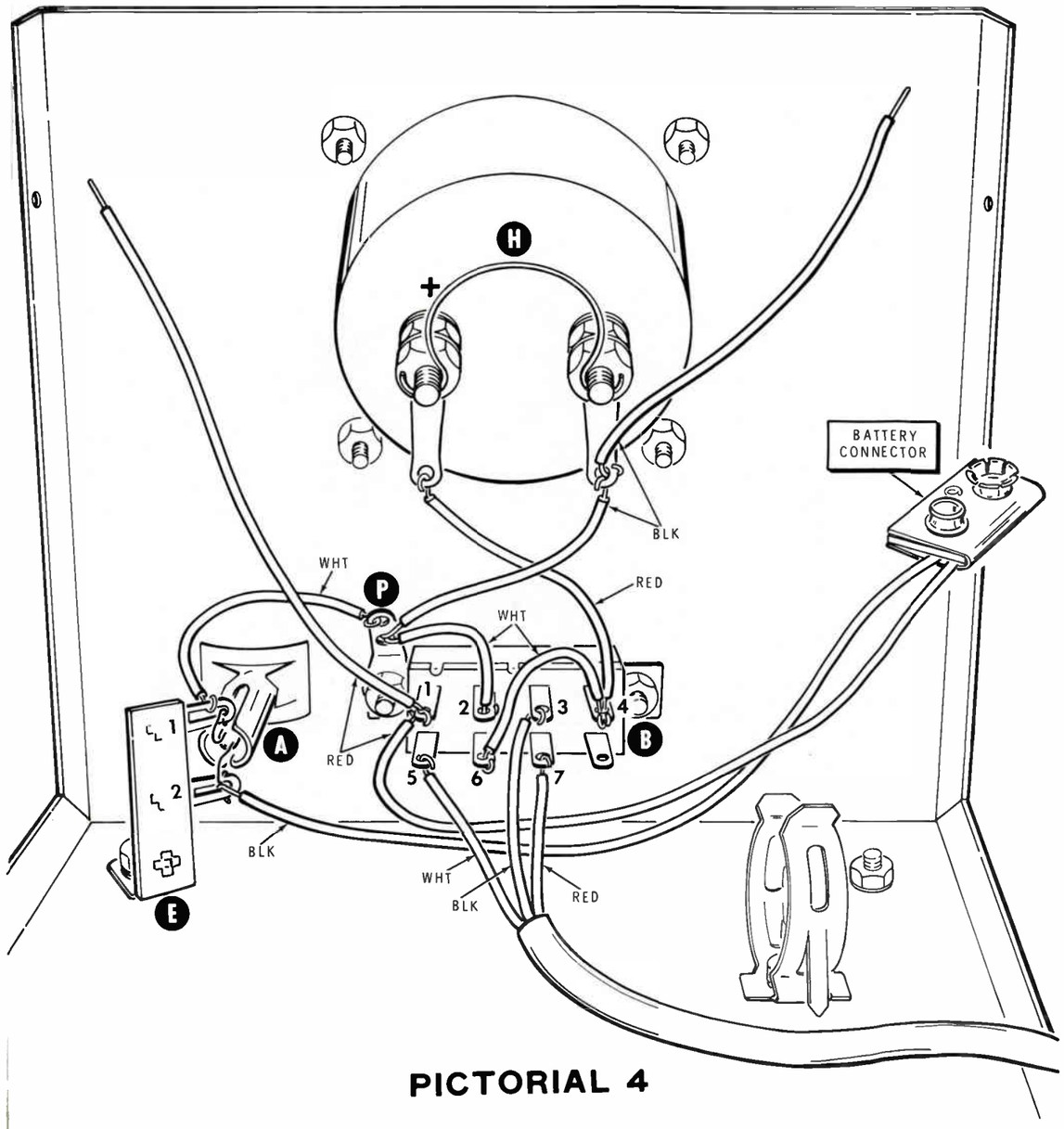
( ) Locate the large bracket and scrape the paint from a 7/8" radius at hole K. Also scrape the paint from an area 1" from each end on the outside of the flange, and from around J, see inset #1.

( ) Mount a grommet in hole L on the large bracket.

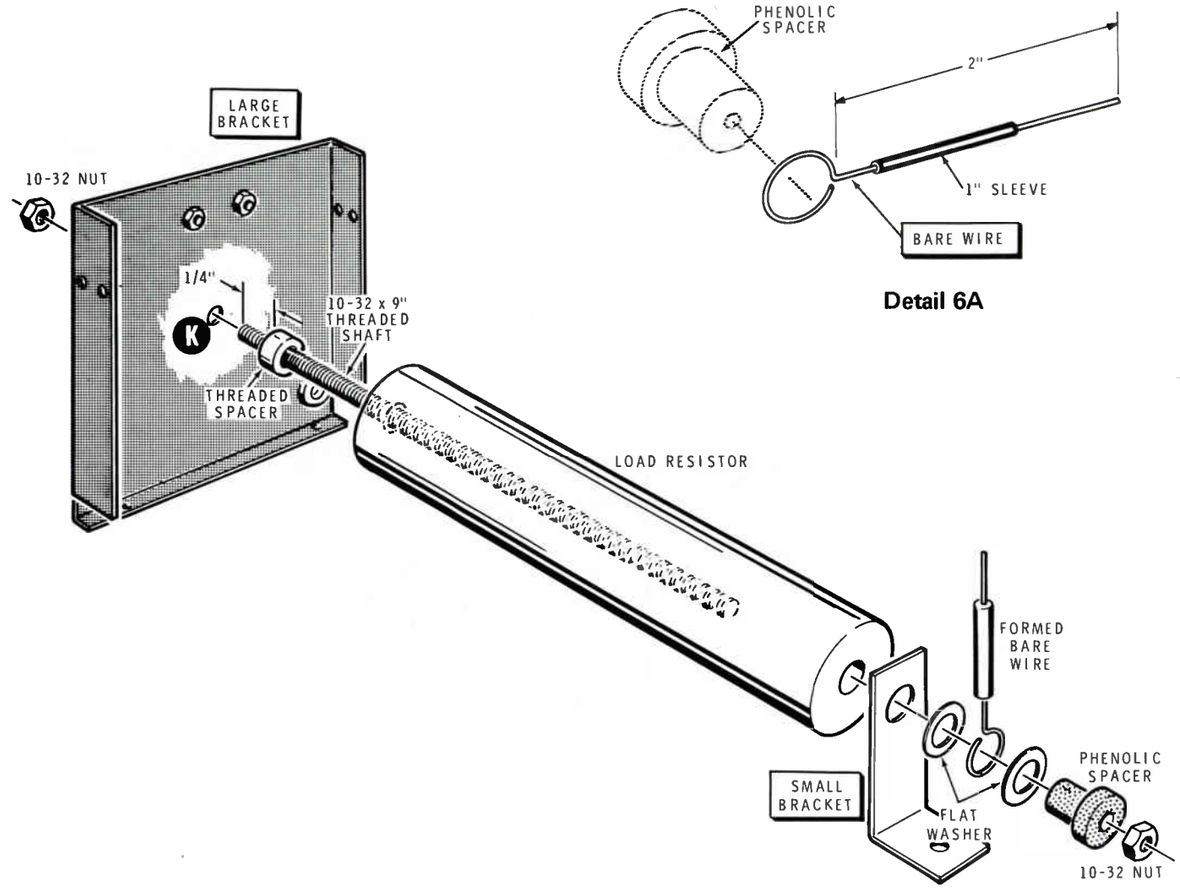
( ) Open the container of silicone grease as shown in inset drawing #2 on Pictorial 5.

( ) Apply a liberal amount of silicone grease to the thermal switch.

( ) Mount the thermal switch at J on the front of the large bracket with 4-40 x 5/16" hardware.



PICTORIAL 4



Detail 6A

PICTORIAL 6

Refer to Pictorial 6 for the following steps.

( ) Turn the threaded spacer onto the 10-32 x 9" threaded shaft until 1/4" of the shaft is exposed as shown in Pictorial 6.

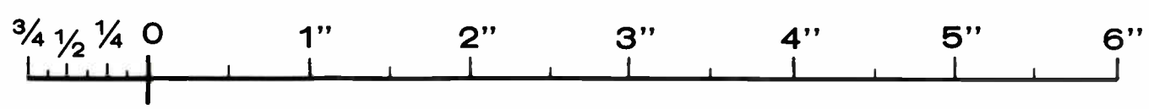
( ) Mount the shaft tightly to the bracket at hole K with a 10-32 nut.

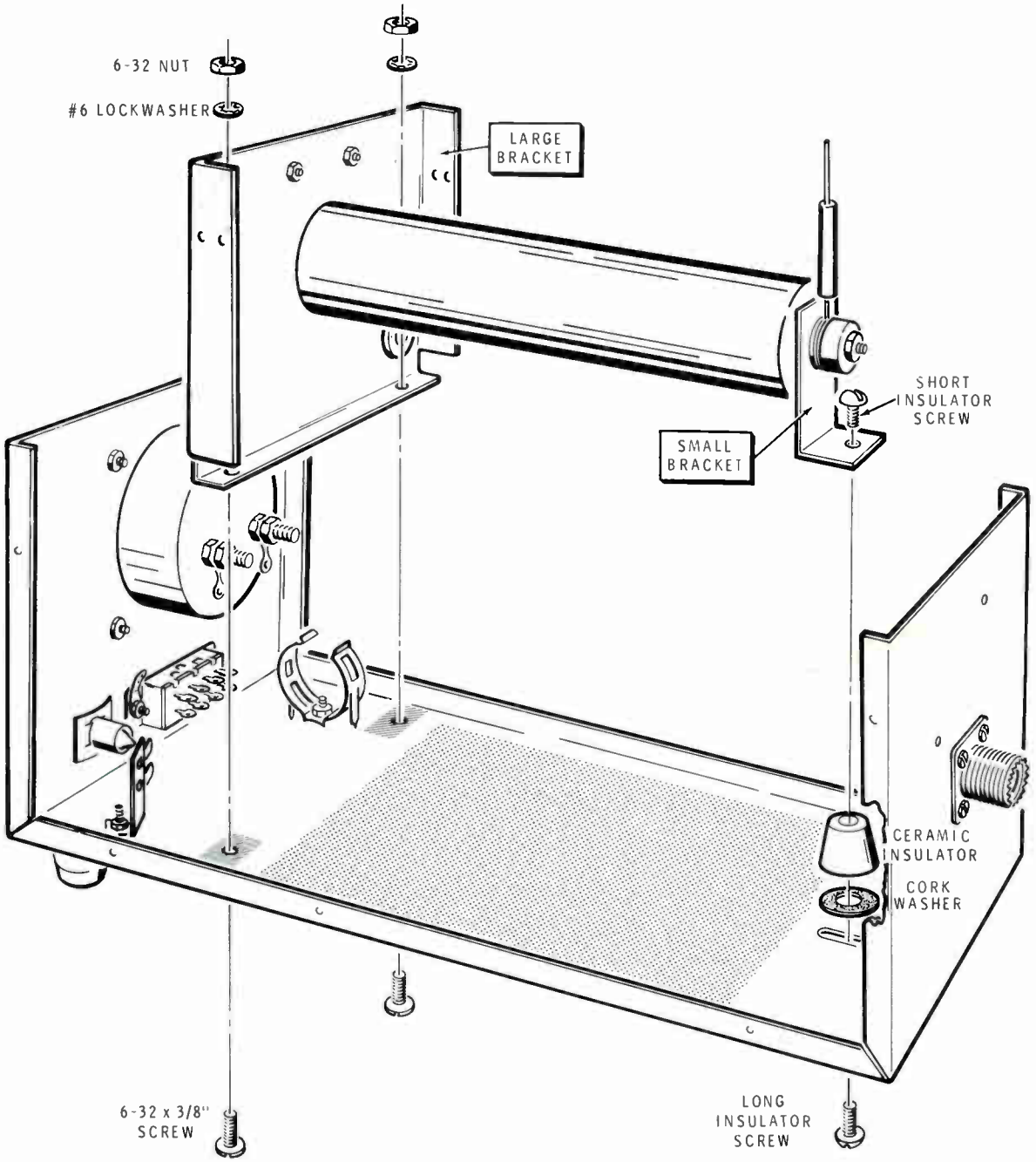
( ) Form a bare wire around the phenolic spacer as shown in Detail 6A.

( ) Mount the 50 ohm, 175-watt load resistor in the following manner. Place the load resistor on the threaded shaft. Place a flat washer, the formed wire, a flat washer, and the small bracket on the phenolic spacer. Then place the spacer on the threaded shaft and secure the assembly with a 10-32 nut. Refer to Pictorial 6 and position the small bracket as shown.

( ) Cut the extended end of the bare wire to 2".

( ) Cut a 1" length of sleeve and place it on the wire.





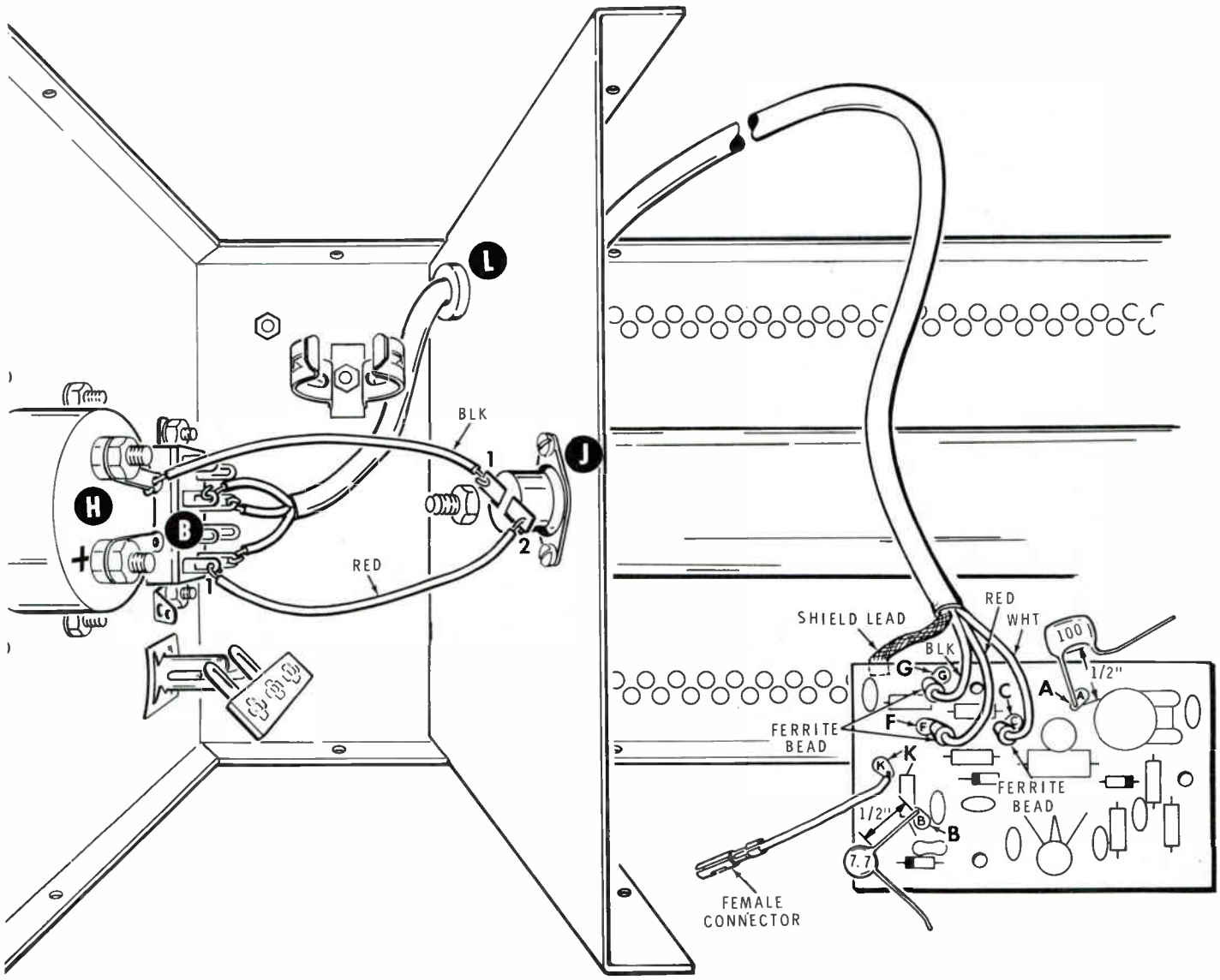
PICTORIAL 7

Refer to Pictorial 7 for the following steps.

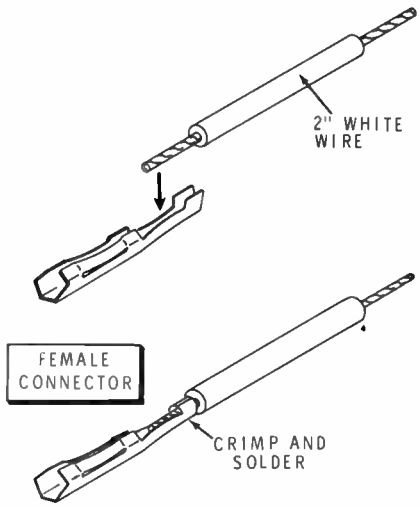
( ) Mount the ceramic insulator and the cork washer to the chassis with the long insulator screw as shown, but do not tighten the screw. Discard the two metal flat washers.

( ) Mount the large bracket to the chassis with 6-32 x 3/8" hardware.

( ) Position the ceramic insulator and mount the small bracket with the short insulator screw as shown. Tighten both screws; do not overtighten them or they may crack the ceramic insulator.


L
BLK
J
H
B
1
2
RED
SHIELD LEAD
RED
WHT
BLK
100
1/2"
G
C
A
F
FERRITE
BEAD
K
FERRITE
BEAD
1/2"
B
7.7
FEMALE
CONNECTOR

PICTORIAL 8



Detail 8A

Refer to Pictorial 8 for the following steps.

( ) Solder a female connector to one end of the 2" white wire prepared earlier as shown in Detail 8A. Do not let the solder flow past the wire end and down inside the connector.

( ) Insert the other end of the white wire into hole K on the circuit board and solder the wire to the foil.

( ) Route the cable through the grommet at hole L and connect the cable to the circuit board in the following steps.

Refer to Detail 8B and place a ferrite bead on the end of each wire as it is installed and then solder each wire to the foil.

( ) Red to hole F (S-1).

( ) Black to hole G (S-1).

( ) White to hole C (S-1).

( ) Solder the shield lead to the ground foil as shown in Pictorial 8.

( ) Insert one end of a 100 pF capacitor into hole A, position the capacitor 1/2" from the circuit board, and solder the lead to the foil.

( ) In a similar manner, connect a 7.7 pF capacitor at hole B.

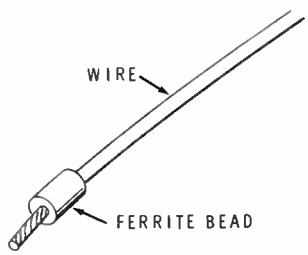
( ) Cut off the excess lead lengths on the foil side of the circuit board.

( ) Carefully inspect the foil side of the circuit board and be sure that all connections are soldered and that there are no solder bridges between foils. NOTE: Some of the circuit board holes will not be used.

( ) Connect the free end of the black wire from the negative meter lug to lug 1 of the thermal switch (S-1).

( ) Connect the free end of the red wire from switch B to lug 2 of the thermal switch (S-1).

( ) Remove the shorting wire from the meter terminals.



Detail 8B

Refer to Pictorial 9 for the following step.

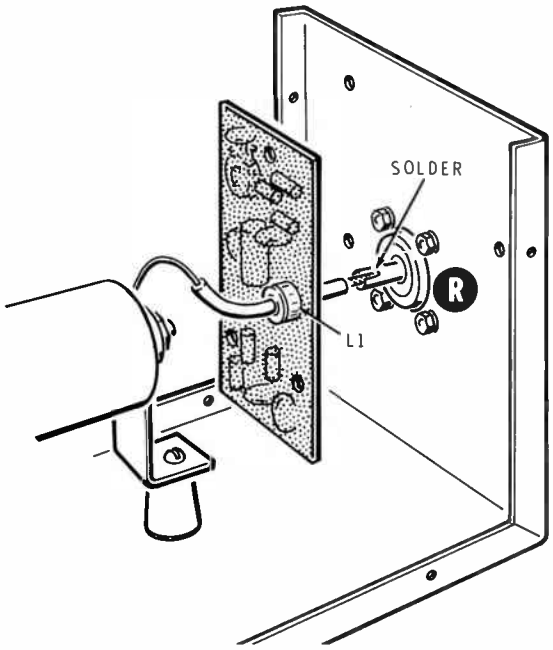
( ) Form the bare wire from the load resistor as shown in Pictorial 9. Then, from the component side of the circuit board, insert the bare wire through the circuit board eyelet, L1, and into the center coaxial jack lug. Solder the bare wire to the lug.

Refer to Pictorial 10 for the following steps.

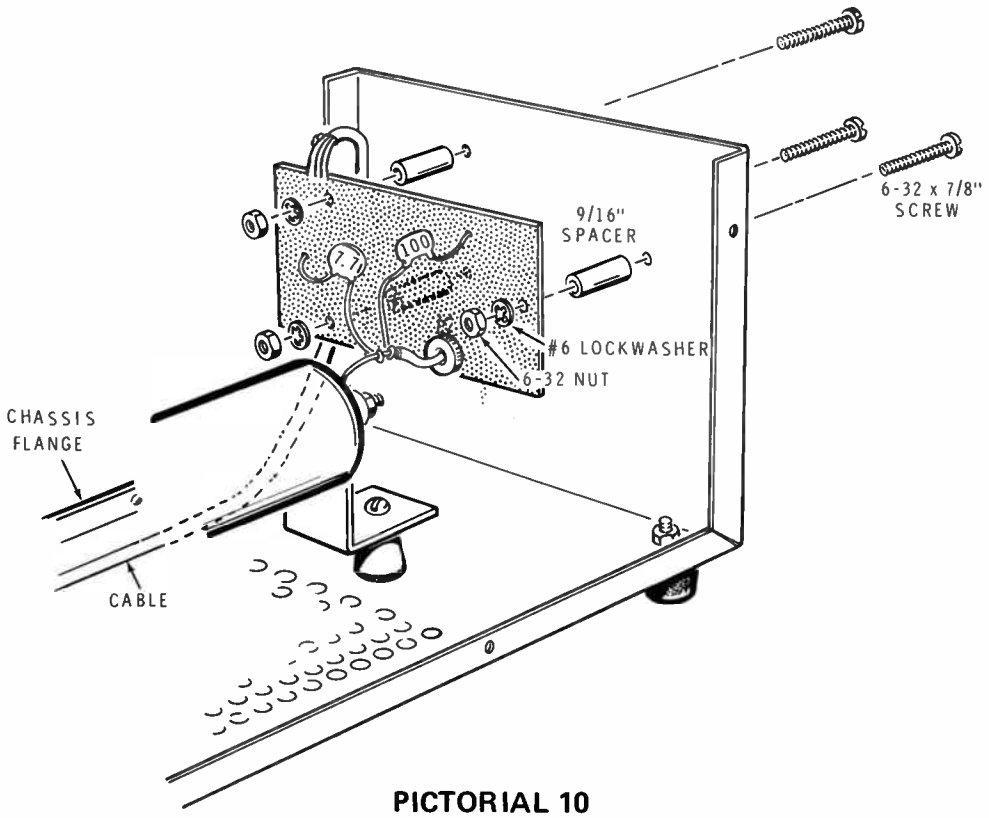
( ) Mount the circuit board to the rear panel with 6-32 x 7/8" hardware and 9/16" spacers.

( ) Slide the sleeve through L1, against the connector lug, and connect the free leads of the 7.7 pF and the 100 pF capacitors to the bare wire. Solder both leads and position the 100 pF capacitor clear of NULL trimmer C4.

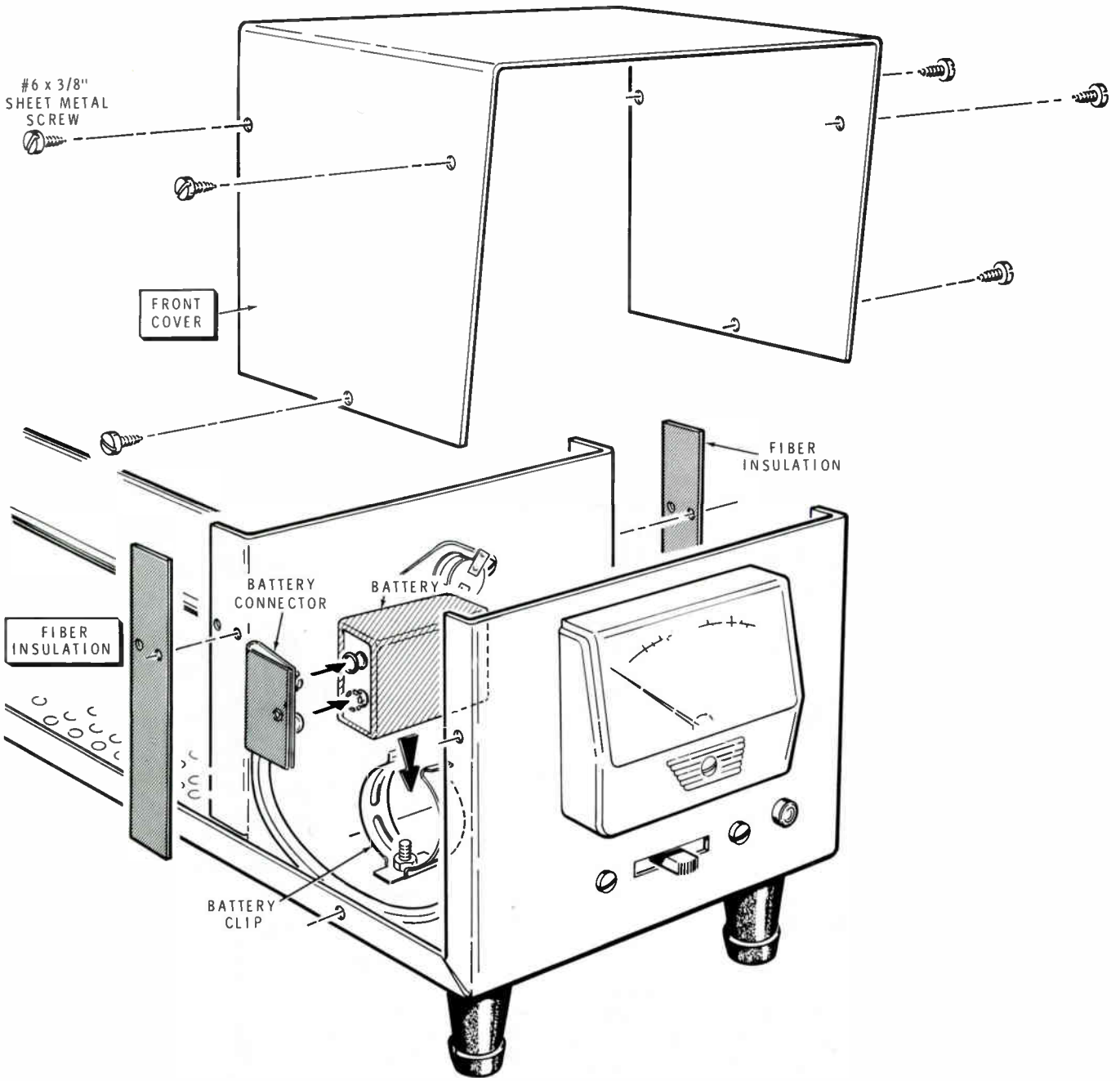
( ) Route the cable along the chassis, and away from the load resistor and the chassis flange.



PICTORIAL 9



PICTORIAL 10



PICTORIAL 11

Refer to Pictorial 11 for the following steps.

( ) Set the FUNCTION switch to the center position.

( ) Connect the battery connector to the 9-volt battery (not included) and insert the battery into the battery clip.

( ) Install the front cover and fiber insulation to the bracket with six #6 x 3/8" sheet metal screws. Align the holes in the fiber insulation with the front holes in the large bracket, as shown in Pictorial 11, and position the angled edge of the cover toward the front of the instrument.

This completes the "Step-by-Step Assembly" of your RF Load Wattmeter. Proceed to the "Calibration" section.

CALIBRATION

CAUTION

RF power will be applied to the unit as you make adjustments. Therefore use caution and do not touch the load resistor or its rear connections.

PREPARATION

( ) Connect your transmitter output to the RF Load Wattmeter. If you intend to use an inline wattmeter for calibration purposes (see "Power Meter Calibration," Page 17), connect it between the transmitter and the RF Load Wattmeter.

( ) Prepare an alignment tool in the following manner: Insert the 1/8" x 3/4" alignment tool blade into the small end of the nut starter as shown in Figure 1. Leave 1/4" exposed.

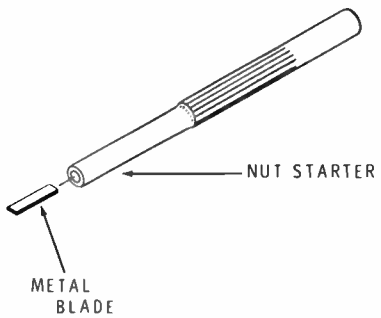


Figure 1

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

( ) Connect the CALIBRATION jumper on the circuit board to the CAL pin (see Figure 2.

NULL ADJUSTMENT

( ) Set the FUNCTION switch to LAMP TEST (see Figure 3). The lamp should light, which indicates that circuit is working correctly. Leave the switch in this position for the following steps.

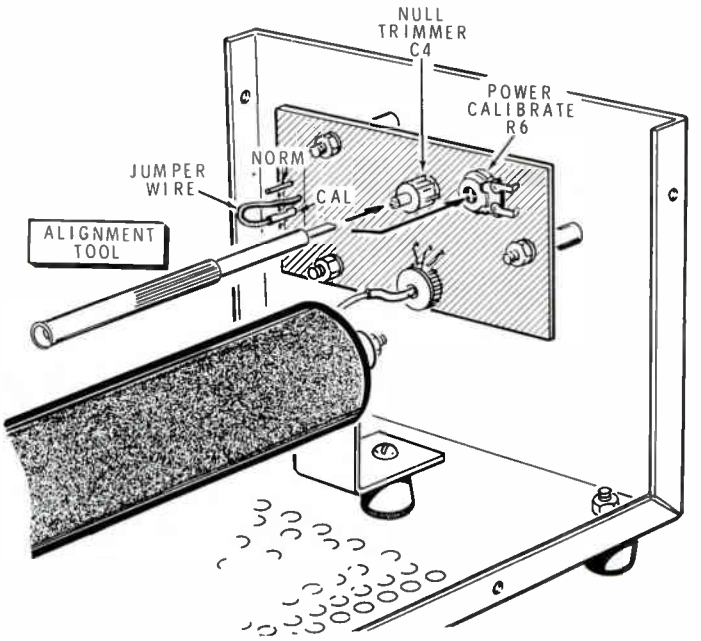


Figure 2

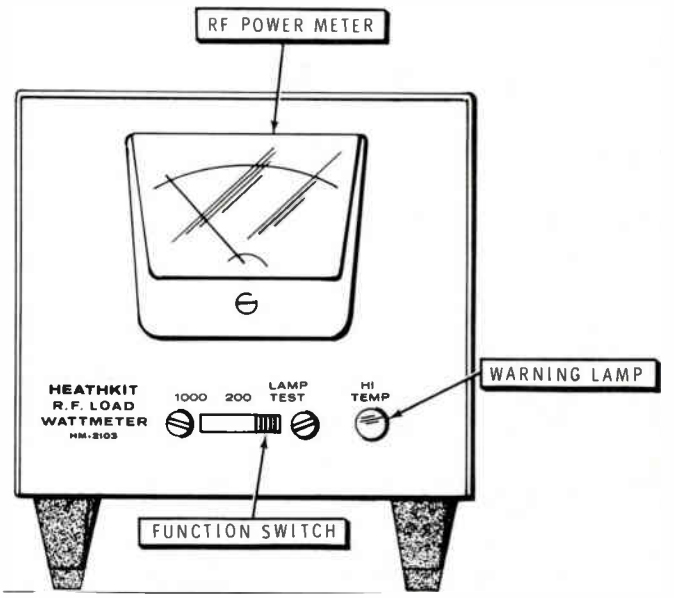


Figure 3

(✓) Set the transmitter to the TUNE or CW mode, tune the transmitter, and watch the RF POWER METER needle. If the meter needle does not move up-scale, carefully increase the transmitter output. If the meter needle does not move up-scale at 1/4 output, adjust NULL trimmer C4 for a reading. If there still is not a reading, refer to the "In Case of Difficulty" section of this Manual.

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

( ) Refer to Figure 2 and adjust NULL trimmer C4 on the circuit board for the best null or greatest dip of the meter needle. This reading should be at or near zero. NOTE: Use only the alignment tool (nut starter) for this adjustment.

( ) Increase the transmitter output to full power and readjust NULL trimmer C4.

( ) Repeat the above step. Make this final adjustment carefully and precisely. The accuracy of the instrument depends on a well balanced bridge circuit. Once this is set, be careful not to touch NULL trimmer C4 in the following steps.

( ) Place the FUNCTION switch to the 200 position. Do not disconnect the RF Wattmeter from the transmitter.

POWER METER CALIBRATION

Three calibration procedures are provided in this section. Use only one of these procedures:

1. "Internal Calibration (40-Meter Only)."
2. "Calibration With External Wattmeter."
3. "Calibration With VTVM."

For maximum accuracy calibrate your RF Load Wattmeter on the 40-meter band, even if it will be used on other bands. If you cannot tune your transmitter (or transceiver) to the 40-meter band, you can use one of the other two procedures.

If possible, use 100 watts of power (not less than 50) for the calibration steps. This will give the greatest meter accuracy.

Internal Calibration (40-Meter Only)

At this time, the Power Meter accurately indicates actual power for only the conditions of the following steps. After calibration, the unit will be accurate for the full specification range.

1. ( ) Connect the CALIBRATE jumper on the circuit board to the CAL pin.

2. ( ) Set the FUNCTION switch to 200.

3. ( ) Adjust the transmitter to read approximately 100 watts on the 200 watt scale.

4. ( ) Note the Power Meter reading.

5. ( ) Connect the CALIBRATE jumper to the NORM pin and adjust POWER CALIBRATE control R6 with the alignment tool so the meter reads the same as it read in the CAL position.

6. ( ) Repeat steps 1, 4, and 5 above until the meter readings for both CAL and NORM connections are the same.

7. ( ) Be sure the CALIBRATE jumper is on the NORM pin.

This completes the calibration of your RF Load Wattmeter. Proceed to the "Final Assembly" section of the Manual.

Calibration With External Wattmeter

( ) Connect the CALIBRATE jumper on the circuit board to the NORM position.

( ) Set the FUNCTION switch to 200.

( ) Adjust the transmitter output to approximately 100 watts on any band.

( ) Note the reading on the external Wattmeter and adjust POWER CALIBRATE control R6 until both meter readings are the same. Check the readings for accuracy and proceed to the "Final Assembly" section of the Manual.

Calibration With VTVM

If another Wattmeter is not available, you can obtain acceptable accuracy by using the following power formula. You will need a VTVM with a high impedance input and an RF probe, or an RF voltmeter.

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

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

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

With this method, you will compare the watts output determined by the formula with the watts reading on the scale of the Power Meter.

Then you will adjust the Power Meter 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 1000 may be substituted in the formula and in the example.

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

( ) 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).

( ) Turn the FUNCTION switch to 200 or 1000 depending upon the output power of your transmitting system.

( ) Connect the CALIBRATE jumper on the circuit board to the NORM pin.

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

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

( ) Adjust control R6 on the circuit board so the RF Power Meter indicates the power you selected to obtain from the transmitter.

This completes the calibration of your RF Load Wattmeter.

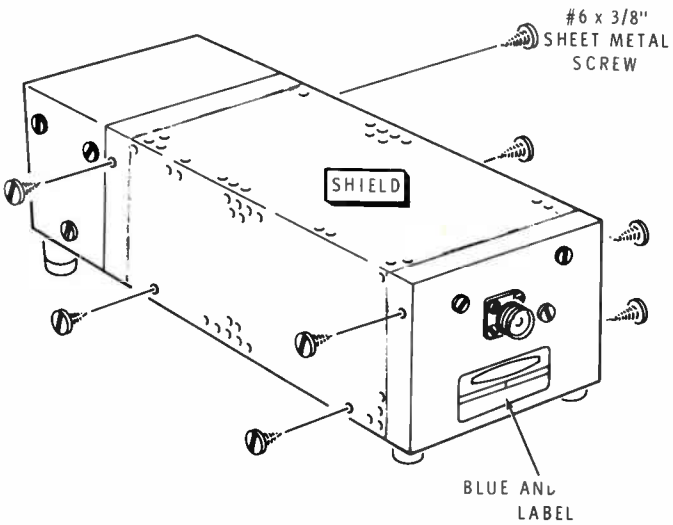
FINAL ASSEMBLY

Refer to Pictorial 12 for the following steps.

( ) Mount the shield to the chassis with eight #6 x 3/8" sheet metal screws. NOTE: Handle the shield carefully in case there are sharp areas on the edges.

( ) Carefully peel away the backing paper from the blue and white label. Then press the label on the rear of the chassis. Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

This completes the assembly of your RF Load Wattmeter.



PICTORIAL 12

OPERATION

The operation of the RF Load Wattmeter is simple. Merely place the FUNCTION switch in the LAMP TEST position to test for proper lamp and battery operation. Place the switch in either the 200- or 1000-watt position; then read the corresponding scale on the meter to obtain the power output of the transmitter.

The shield is designed to reduce RF radiation. Do not remove the shield or the load will radiate RF energy.

A fan may be used to cool the load when maximum power or time elements are critical. The Power Dissipation Derating Curve was plotted for average conditions without external cooling.

Figure 4 is a switching system guide that might be used with your Wattmeter to decrease interference on amateur bands by making regular use of the load for tune-up and testing.

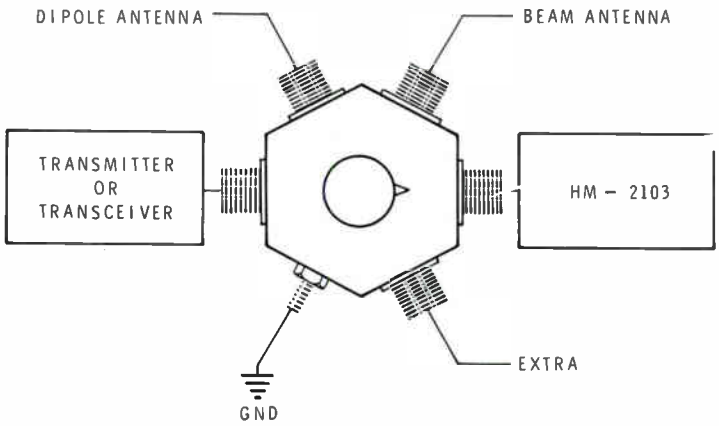
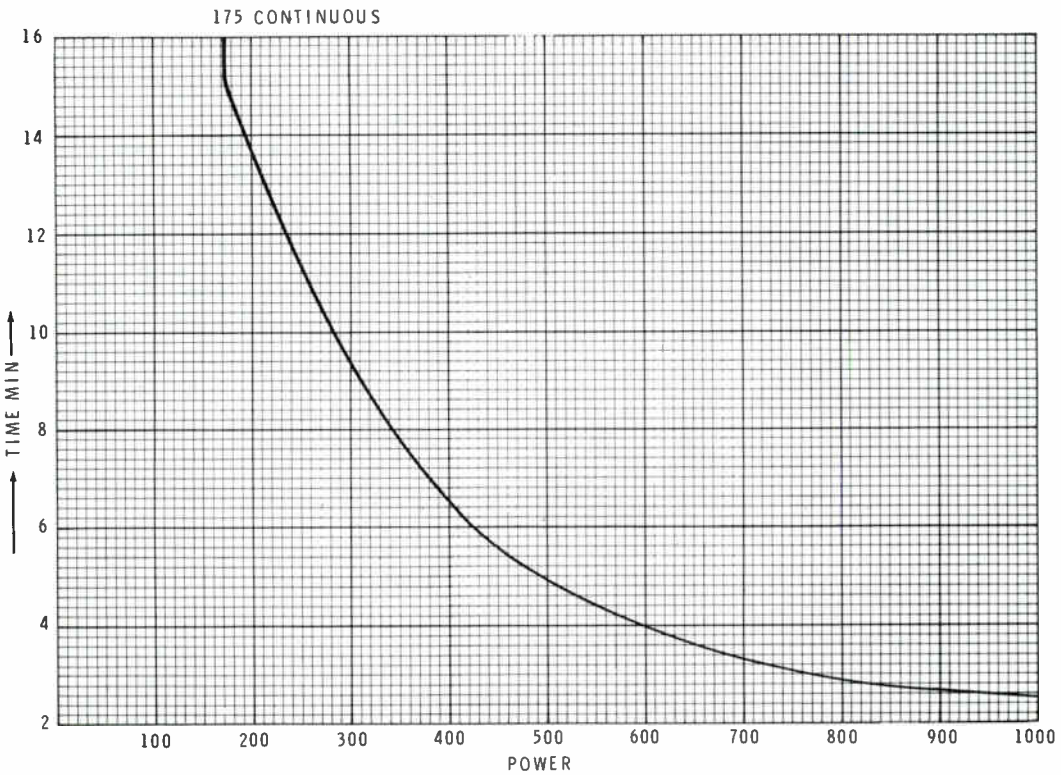


Figure 4



POWER DISSIPATION DERATING CURVE

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.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE
Lamp test not working.	1. Function switch incorrectly wired. 2. Faulty bulb. 3. Faulty thermal switch. 4. Lamp leads may be shorted.
No null.	1. Outside toroid leads reversed. 2. Function switch incorrectly wired, or not in Lamp Test position.
Power reading low.	1. Outside toroid leads reversed. 2. Meter shorted or shorting wire not removed. 3. Function switch incorrectly wired. 4. Short between eyelet and toroid coil.
Power reading very high.	1. Load resistor poorly grounded. 2. Circuit board components.
Calibration doesn't work.	1. Circuit board jumper wire connected to wrong pin.
Meter reads down.	1. Diode or diodes reversed.

SPECIFICATIONS

Frequency Range	1.8 to 30 MHz.
Wattmeter Range	0-200 and 0-1000 watts.
Wattmeter Accuracy	±10% of full-scale reading.
Power Rating	175 watts continuous, 1000 watts maximum, see the derating curve on Page 19.
Overload Indication	Thermal switch activated (requires 9 volt battery, NEDA #1604).
SWR	Less than 1.2:1.
Load Type	Noninductive, solid carbon.
Load Impedance	50 ohms nominal.
Connectors	UHF type SO-239.
Dimensions	5-3/8" wide x 6" high x 13-3/4" deep.
Net Weight	4-1/2 lbs.

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.

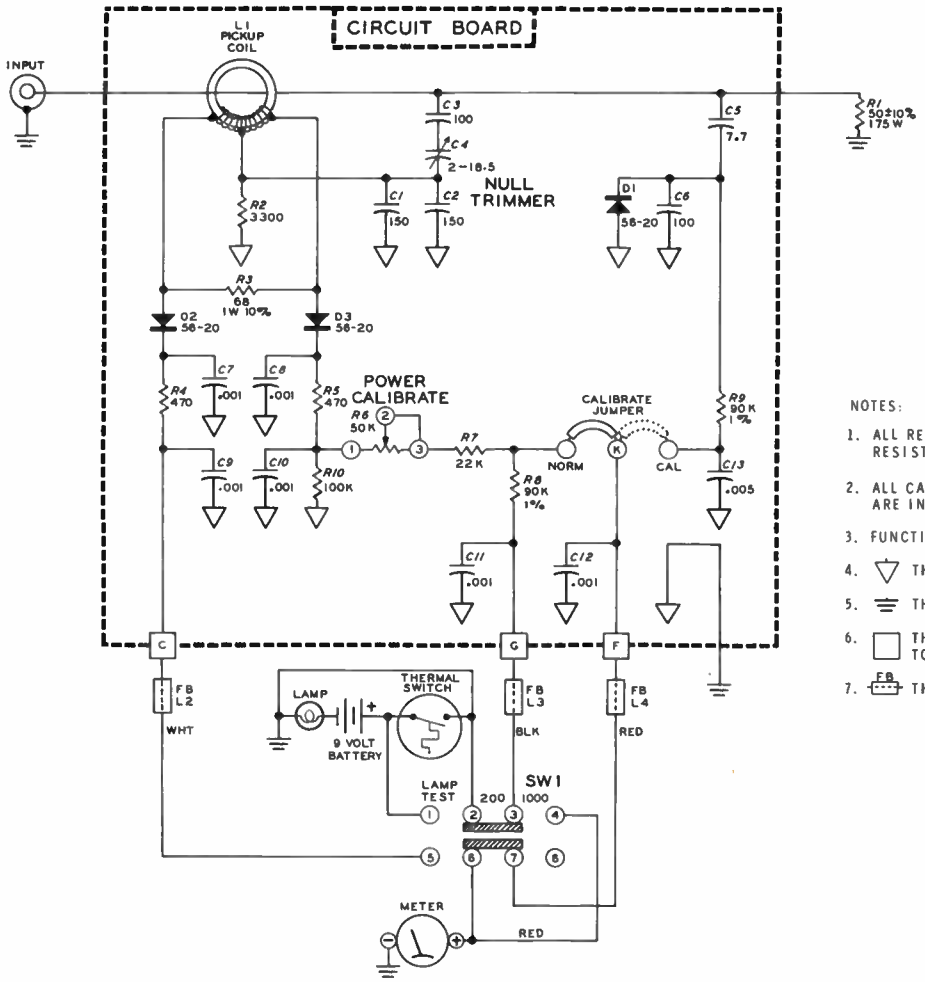
CIRCUIT DESCRIPTION

Refer to the Schematic while you read this Circuit Description.

Toroid coil L1 is a current pickup element. When power is transmitted into the load resistor, R1, an AC field is present around the wire that passes through the eyelet in coil L1. The AC field induces current into L1 and produces a voltage that is rectified by diode D3. Then it is adjusted by resistor R6 to a calibrated level, and applied to the meter to indicate the amount of power present in the load. Capacitor C8 and resistor R5 filter and decouple the voltage. Resistors R7 and R8 form a voltage divider for the two power ranges. Resistor R3 forms a load across L1 to reduce the Q of the coil circuit for a broader frequency range.

Another winding on coil L1 picks up reverse current. This is effectively an SWR bridge and is used only to null out the capacitive effects in coil L1 through capacitors C1, C2, C3, and C4.

Capacitors C5 and C6, diode D1, and resistor R9 form a frequency sensitive RF voltmeter. At 40 meters, it accurately indicates actual power on the meter. Ferrite beads L2, L3, and L4 prevent RF from traveling through the cable into the meter.



SCHEMATIC OF THE HEATHKIT® RF LOAD WATTMETER MODEL HM-2103

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 200 POSITION.
4. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD COMMON.
5. ⏚ THIS SYMBOL INDICATES CHASSIS GROUND.
6. □ THIS SYMBOL INDICATES AN EXTERNAL CONNECTION TO THE CIRCUIT BOARD.
7. FB ⊣···⊢ THIS SYMBOL INDICATES A FERRITE BEAD.

CIRCUIT BOARD X-RAY VIEW

NOTE: To identify a part shown in this View, so you can order a replacement, proceed in either of the following ways:

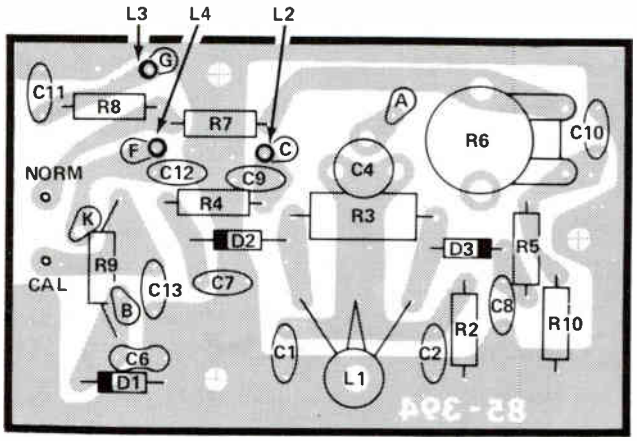
1. A. Refer to the place where the part is installed in the Step-by-Step instructions and note the "Description" of the part (for example: 22 kΩ, .005 μF, or 1N295).

   B. Look up this Description in the "Parts List."

2. A. Note the identification number of the part (R-number, C-number, etc.).

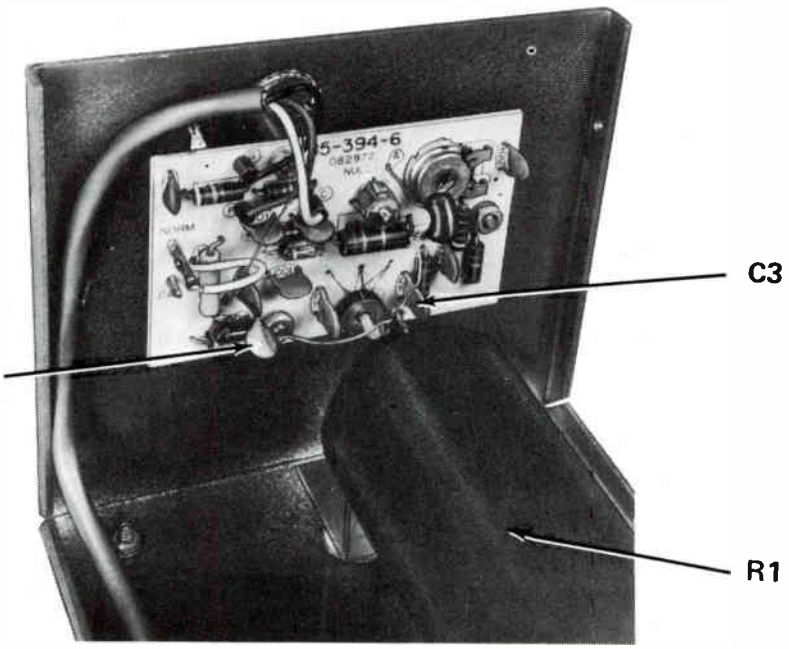
   B. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part will also appear near the part.

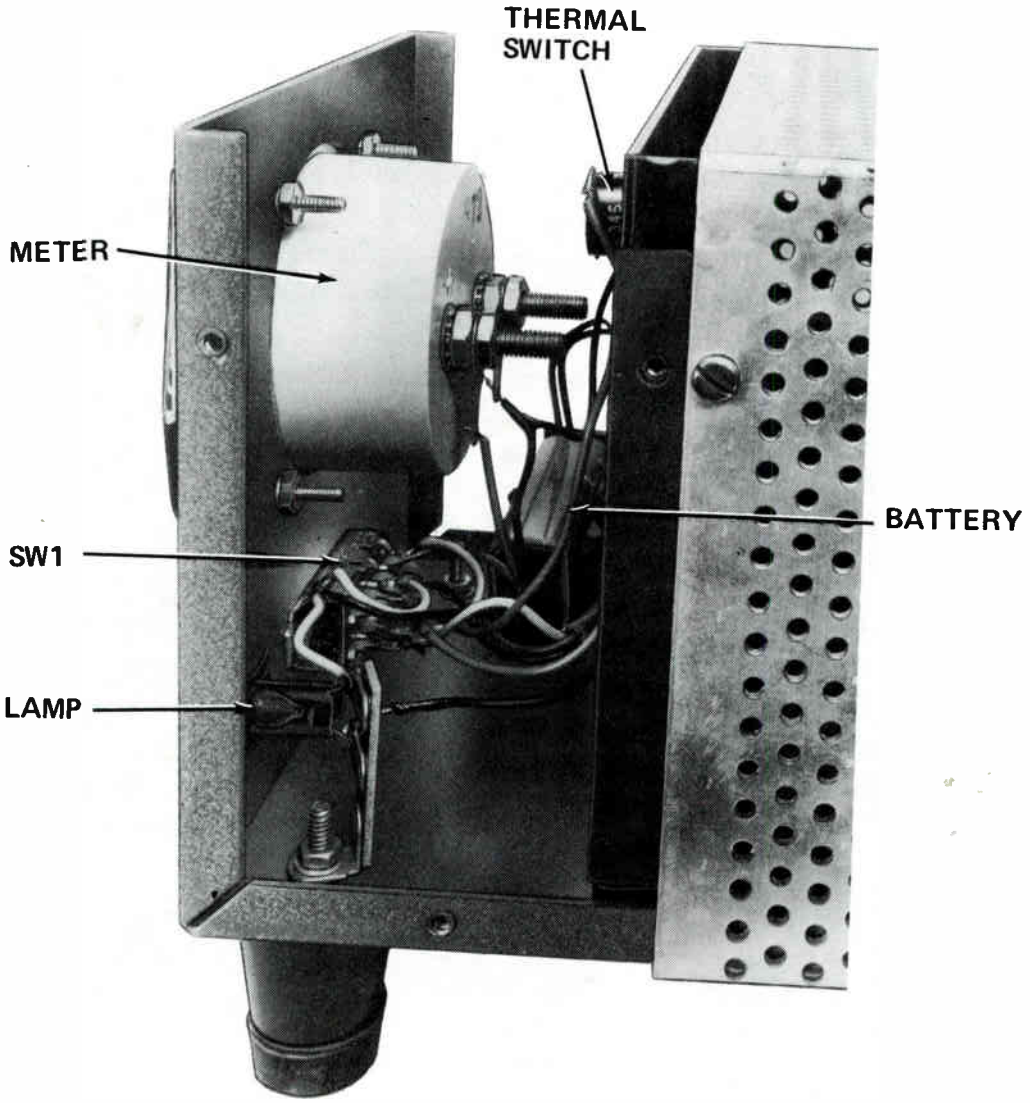
   C. Look up this Description in the "Parts List."



VIEW FROM COMPONENT SIDE

CABINET PHOTOGRAPH




THERMAL
SWITCH
METER
BATTERY
SW1
LAMP

CUSTOMER SERVICE

REPLACEMENT PARTS

If you need a replacement part, please fill in the Parts Order Form that is furnished and mail it to the Heath Company. Or, if you write a letter, include the:

- **Part number and description as shown in the Parts List.**
- Model number and Series number from the blue and white label.
- Date of purchase.
- Nature of the defect.

Please do not return parts to the factory unless they are requested. Parts that are damaged through carelessness or misuse by the kit builder will not be replaced without cost, and will not be considered in warranty.

Parts are also available at the Heathkit Electronic Centers listed in your catalog. Be sure to provide the Heath part number. Bring in the original part when you request a warranty replacement from a Heathkit Electronic Center.

NOTE: Replacement parts are maintained specifically to repair Heathkit products. Parts sales for other reasons will be declined.

TECHNICAL CONSULTATION

Need help with your Heathkit? . . . . Self-Service? . . . . Construction? . . . .Operation? . . . .Call or write for assistance. You'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek. . .please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit C.O.D. for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

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