

Assembly
and
Operation
of the



**1-30 VDC
REGULATED
POWER SUPPLY**

MODEL IP-28

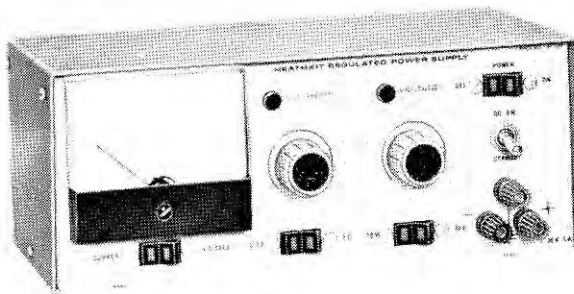


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INTRODUCTION

The Heathkit Model IP-28 1-30 VDC Regulated Power Supply can be used as a regulated voltage source and as a current limited source up to 1 ampere.

The front panel meter can be switched to read current in ranges of 0.1 ampere and 1 ampere. The voltage ranges are 10 volts DC and 30 volts DC.

The Power Supply has an internal voltage reference source or it can be easily connected for either AC or DC programming. Connections are also provided for external voltage sensing at the actual load terminals. This voltage sensing compensates for the voltage drop caused by the heavy current through the connecting leads to the load.

Either output terminal of the Power Supply may be connected to chassis ground as polarity requires, or the Power Supply may be used ungrounded (floating ground).

The Power Supply primary circuit can be wired for either 120 or 240 volts AC, 50/60 Hz. The line cord is supplied with a polarized plug and a grounded third wire which can protect the user against shocks caused by short circuits to the chassis. Line cord retainers are provided on the rear of the case.

Voltage and Current panel lamps show at a glance which function is being displayed on the meter. A Standby switch is also included so that the voltage may be removed from the load without disturbing the connections.

This Model IP-28 1-30 VDC Regulated Power Supply is versatile and dependable and is housed in a compact package. It is easy to build and convenient to use.

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 parts list. Any part packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until that part is called for in a step. The numbers in parentheses in the Parts List are keyed to the

numbers on the Parts Pictorial (fold-out from Page 5) to aid 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	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			CONTROLS-SWITCHES		
1/2 Watt			(9) 10-285	1	100 Ω control
(1) 1-6	1	470 Ω (yellow-violet-brown)	(10) 10-203	1	5000 Ω (5 k) control
1-63	2	510 Ω (green-brown-brown)	(11) 11-124	1	1 Ω control
1-81	1	1500 Ω (brown-green-red)	(12) 60-24	1	SPST rocker switch
1-14	1	3300 Ω (orange-orange-red)	(13) 60-25	2	DPDT rocker switch
1-16	1	4700 Ω (yellow-violet-red)	(14) 60-34	1	TPDT rocker switch
1-20	1	10 k Ω (brown-black-orange)	(15) 61-3	1	DPST toggle switch
1-23	2	27 k Ω (red-violet-orange)	DIODES-TRANSISTORS		
1/2 Watt 1% Precision (Resistance value marked on each. Appearance varies.)			Appearance of diodes and transistors may vary. Check each part number carefully.		
(2) 2-262	1	.505 Ω	(16) 56-26	1	1N191 crystal diode (brown-white-brown)
2-167	1	4 Ω	(17) 57-27	7	Silicon diode
2-261	1	454 Ω	(18) 56-55	1	36 V zener diode
2-35	1	9000 Ω (9 k)	56-13	1	56 V zener diode
2-189	1	18 k Ω	(19) 417-135	2	2N3859A transistor
Other Resistors			417-201	2	PNP transistor*
(3) 1-23-1	1	2200 Ω (red-red-red) 1 watt	(20) 417-237	1	SE6020 transistor
1-3-1	1	3300 Ω (orange-orange-red) 1 watt	(21) 417-215	1	2N3055 transistor
1-12-2	1	470 Ω (yellow-violet-brown) 2 watt	*See transistor replacement chart on the Schematic.		
(4) 3-21-5	1	2.6 Ω , 5 watt	BINDING POSTS-TERMINALS		
CAPACITORS			(22) 75-17	5	Binding post bushing
(5) 21-21	1	200 pF, disc	(23) 427-3	3	Binding post base
(6) 25-126	2	50 μ F, 50 VDC	(24) 100-16-2	1	Black binding post cap
(7) 25-57	1	100 μ F, 200 VDC	100-16-18	1	Red binding post cap
(8) 25-214	2	500 μ F, 75 VDC	100-699	1	Green binding post cap
			(25) 431-50	1	1-lug terminal strip
			(26) 431-42	1	5-lug terminal strip
			(27) 431-7	1	6-screw terminal strip
			(28) 431-82	2	Terminal collar



<u>PART No.</u>	<u>PARTS Per Kit</u>	<u>DESCRIPTION</u>	<u>PART No.</u>	<u>PARTS Per Kit</u>	<u>DESCRIPTION</u>
HARDWARE			Miscellaneous (cont'd.)		
(29) 250-56	1	6-32 x 1/4" screw	(51) 75-60	1	Mica insulator (packaged between 2 pieces of cardboard)
(30) 250-365	4	#6 x 1/4" hex head sheet metal screw	(52) 75-88	1	Transistor case insulator
(31) 250-8	6	#6 x 3/8" sheet metal screw	75-108	1	Fish paper (adhesive backed)
(32) 250-89	16	6-32 x 3/8" screw	85-309-3	1	Circuit board
(33) 250-206	11	6-32 x 11/16" screw	(53) 90-446-1	1	Cover
(34) 252-3	15	6-32 nut	(54) 203-613	1	Panel
(35) 254-1	21	#6 lockwasher	(55) 203-614	1	Chassis
(36) 254-27	1	#6 internal-external lockwasher	134-198	1	Wiring harness
(37) 259-1	2	#6 solder lug	(56) 207-5	3	Plastic cable clamp
(38) 250-137	4	8-32 x 3/8" screw	(57) 261-29	4	Plastic foot
(39) 259-25	3	Double solder lug	(58) 261-30	2	Line cord retainer
(40) 252-7	2	Control nut	344-59	1	White hookup wire
(41) 253-10	2	Control flat washer	346-1	1	Sleeving
(42) 254-5	2	Control lockwasher	(59) 352-13	1	Silicone grease
(43) 252-32	2	Speednut	407-127	1	Meter
(44) 255-1	2	1/8" spacer	(60) 412-15	2	NE-2H neon lamp
(45) 255-23	1	15/32" spacer, tapped 6-32	(61) 413-10	1	Red lens
(46) 255-74	2	1/16" spacer	413-14	1	Amber lens
(47) 255-15	8	1/2" spacer	421-29	1	3/4 ampere slow-blow fuse
(48) 255-37	4	3/4" long spacer tapped 8-32	(62) 422-1	1	Fuseholder
(49) 255-21	4	7/8" long spacer tapped 6-32	(63) 432-27	1	Line cord adapter
MISCELLANEOUS			(64) 434-117	1	Transistor socket
54-228	1	Power transformer	(65) 455-50	2	Knob bushing
(50) 75-71	1	Strain relief, flat line cord	(66) 462-246	2	Knob
75-30	1*	Strain relief, round line cord	(67) 490-5	1	Nut starter
89-23	1	Line cord	391-34	1	Blue and white label
			597-260	1	Parts order form
			597-308	1	Kit Builders Guide
				1	Manual (See front cover for part number.)
					Solder

*This strain relief is supplied for use in areas where round line cords are required.



STEP-BY-STEP ASSEMBLY

Before starting to assemble this kit, read the Kit Builders Guide for complete information on wiring, soldering, and step-by-step assembly procedures.

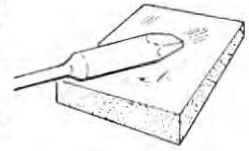
CIRCUIT BOARD ASSEMBLY

This section of the Manual contains separate Step-By-Step Assembly instructions for the circuit board.

Components will be installed on the circuit board by following the steps on Pictorials 1-1 and 1-2.

All resistors will be called out by the resistance value (in Ω or $k\Omega$) and the color code for color-coded resistors. Use 1/2 watt resistors unless the step directs otherwise. Capacitors will be called out by the capacitance value and type.

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

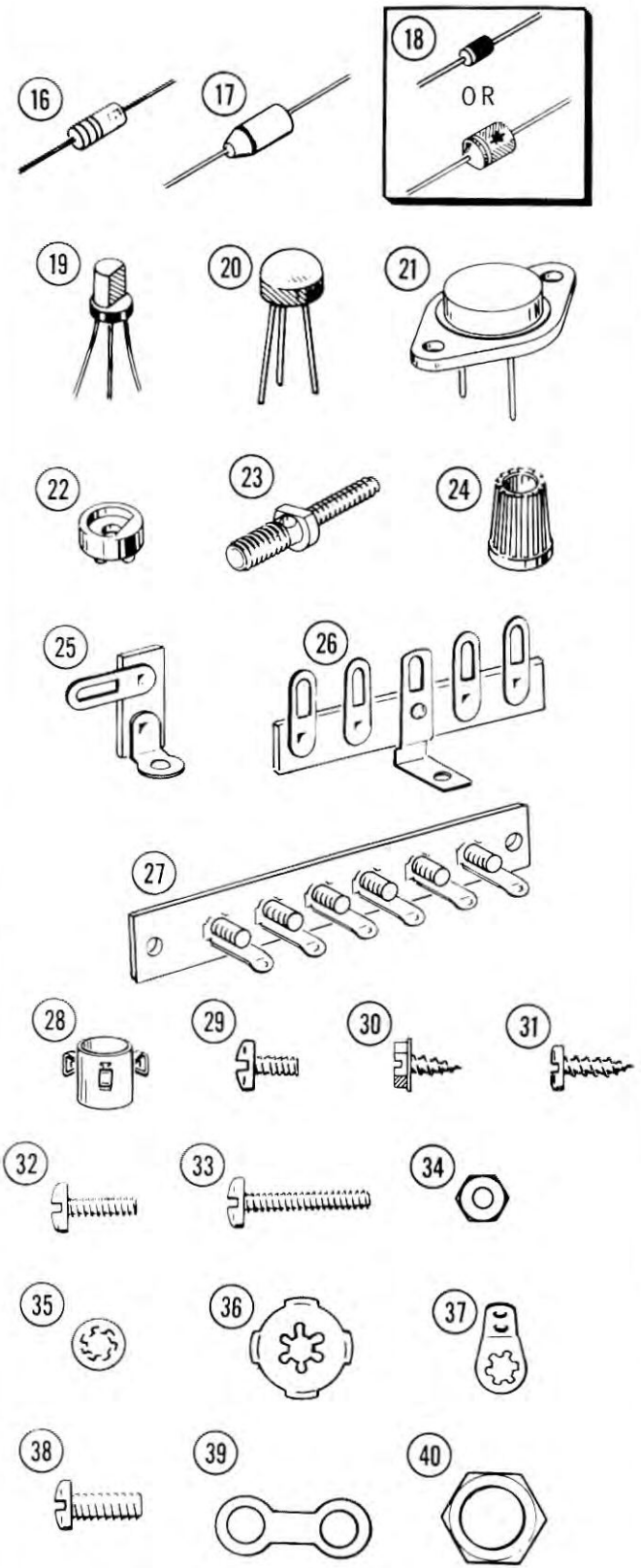
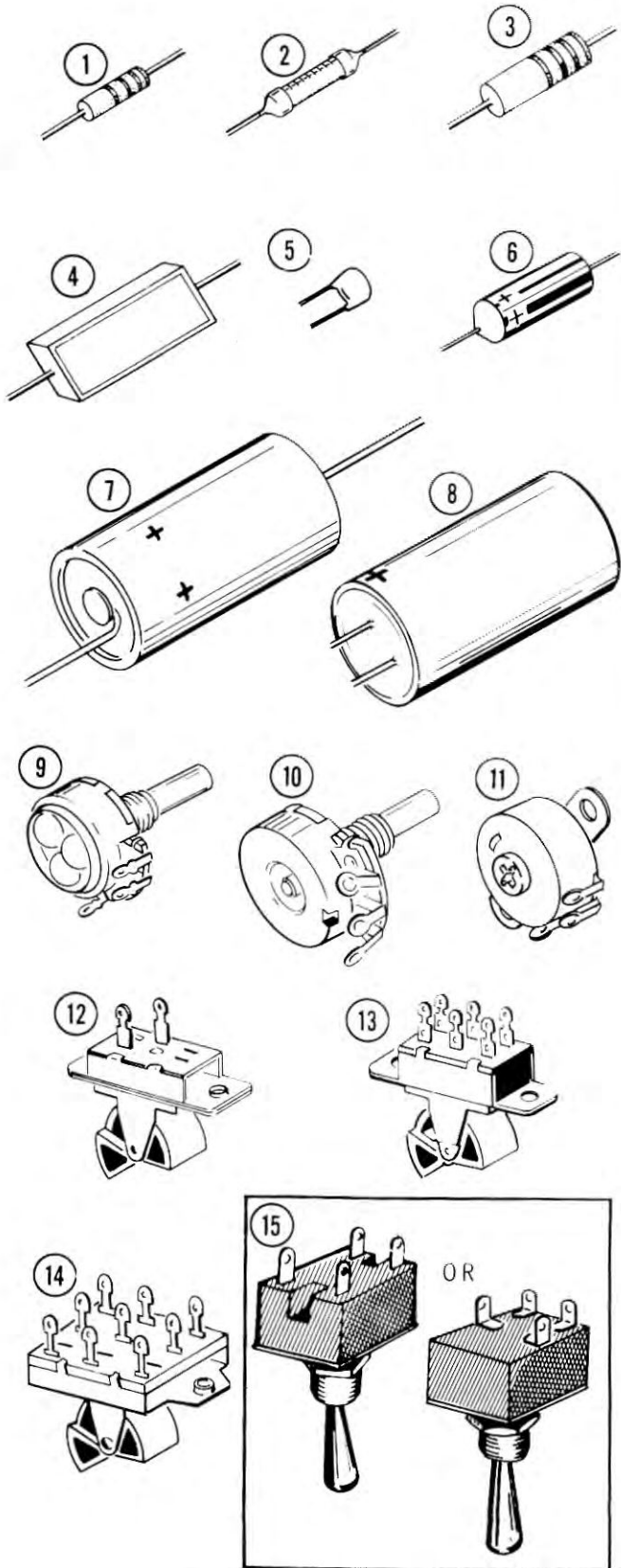


Mount parts on the circuit board so their values can be easily seen after installation. This will make it easier to check your work later.

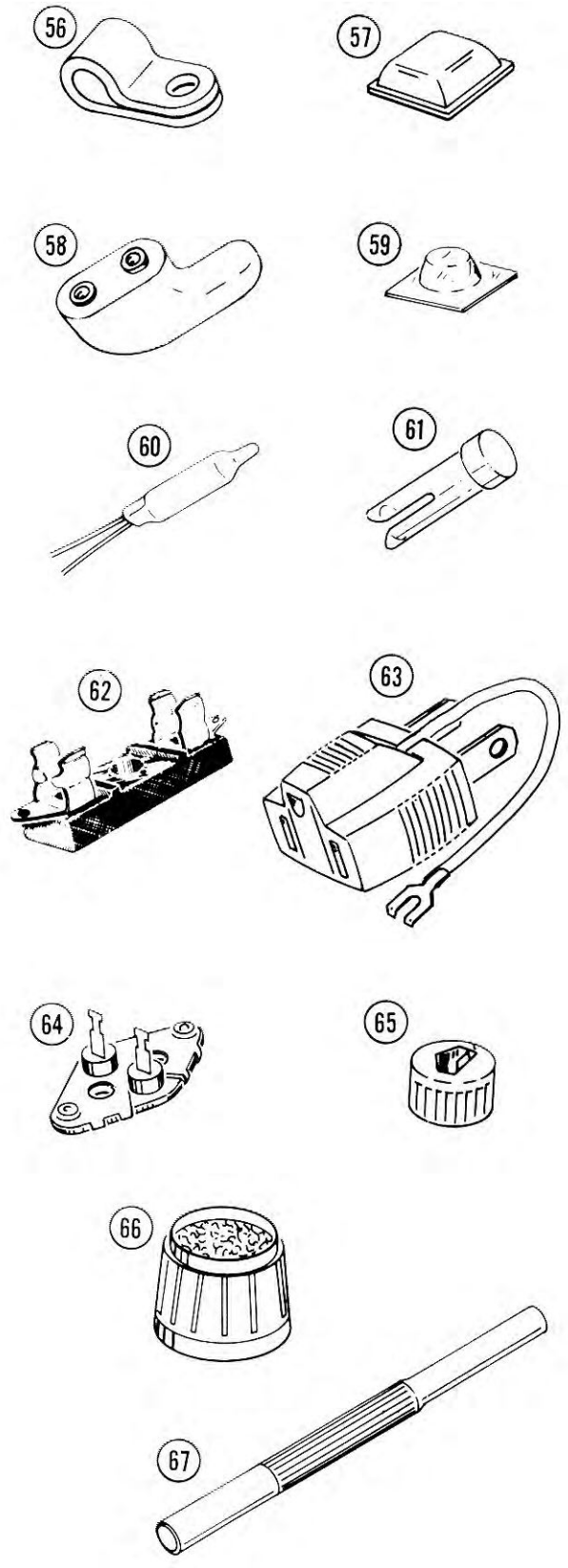
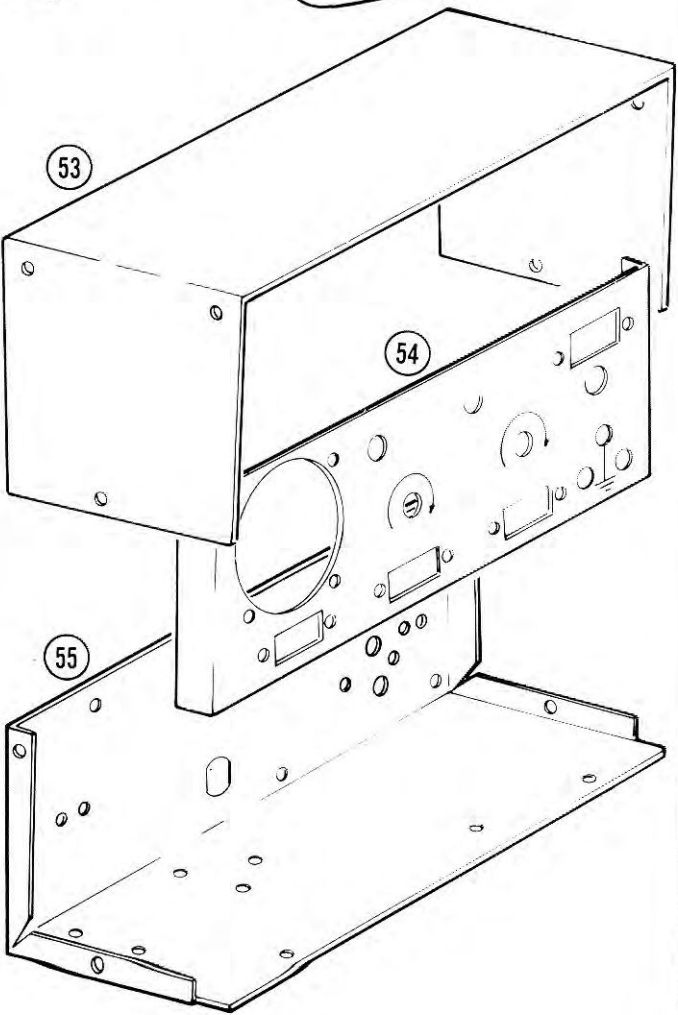
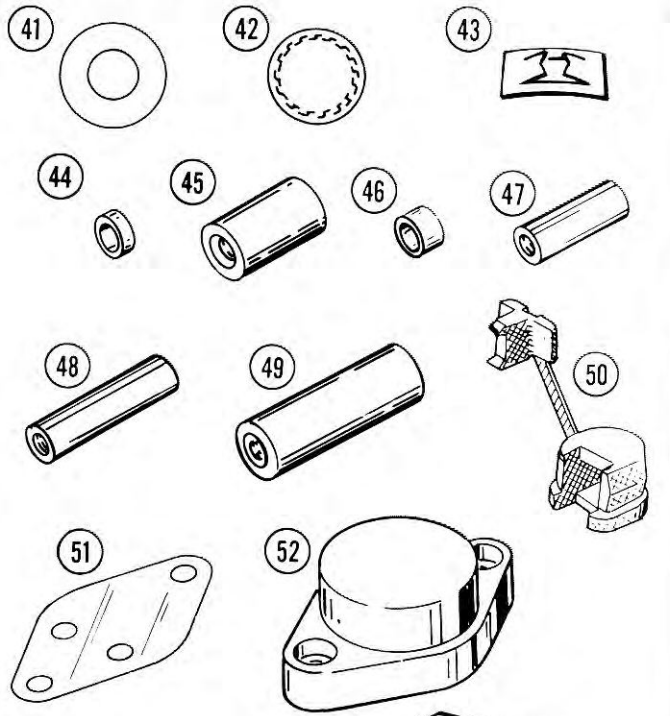
Be especially careful not to cover unused holes with solder, or to bridge solder between foils during the assembly of the circuit boards.

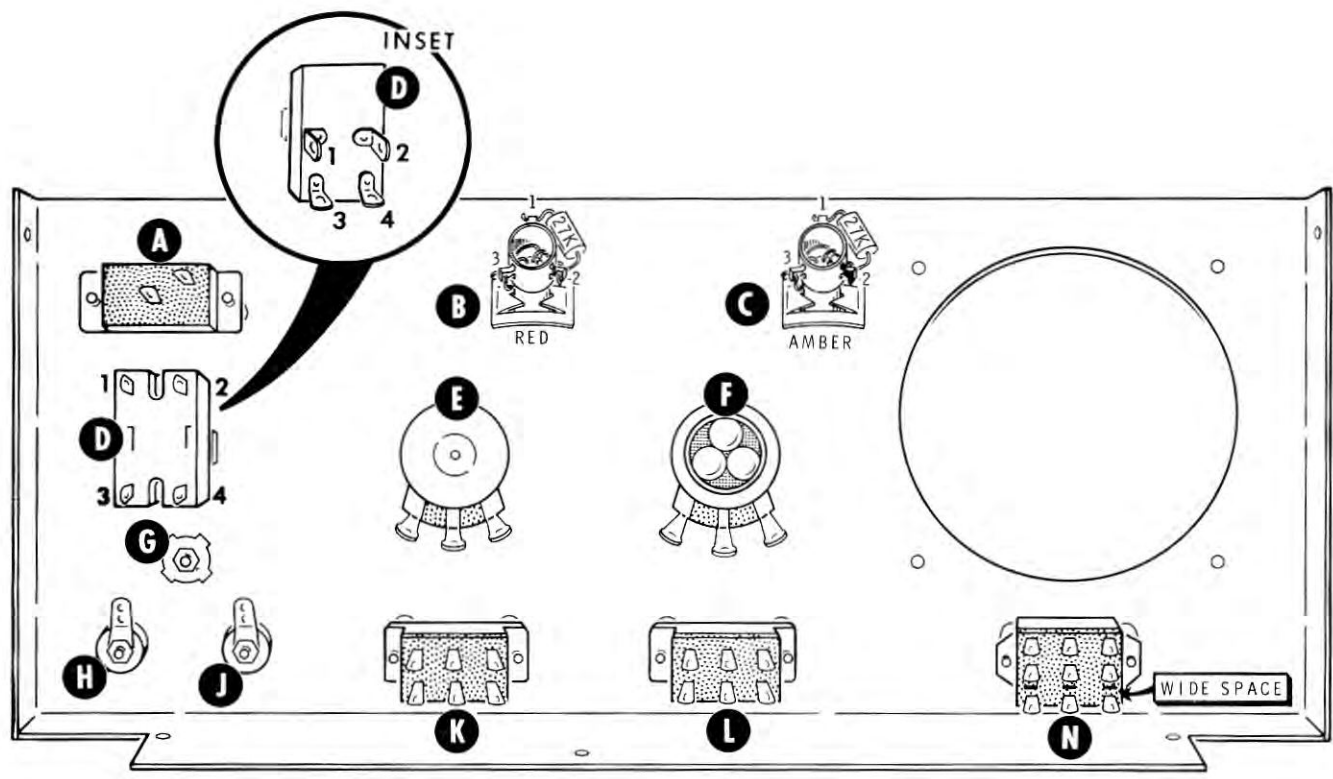
In one instance, a resistor will be mounted vertically. Position the circuit board and all parts as shown in the Pictorials. Follow the instructions carefully, and read the entire step before performing the operation.

PARTS PIC



TUTORIAL





PICTORIAL 2-1

START

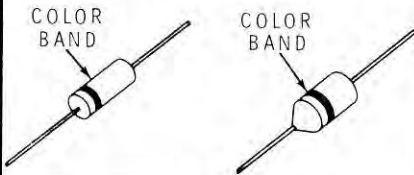
FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH



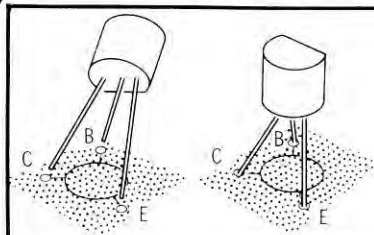
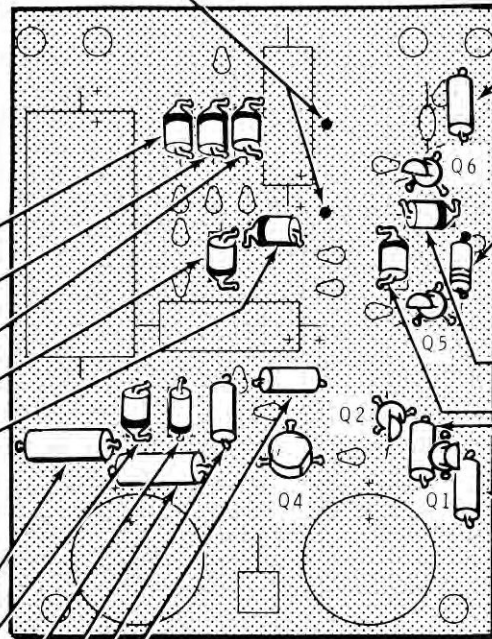
() Position the circuit board (#85-309-3) lettered side up as shown. Then perform the following steps. Do not solder or cut off any leads until you are directed to do so.

NOTE: These two holes are not used.

NOTE: When installing diodes, be sure to place the cathode end as directed. The cathode end is marked with a color band.



- () Silicon diode (#57-27) at D3.
- () Silicon diode (#57-27) at D2.
- () Silicon diode (#57-27) at D1.
- () Silicon diode (#57-27) at D10.
- () Silicon diode (#57-27) at D9.
- () Solder all leads to the foil and cut off excess lead lengths.
- () 3300 Ω , 1 watt (orange-orange-red).
- () 56 V zener diode (#56-13) at D4.
- () 36 V zener diode (#56-55) at D5.
- () 2200 Ω , 1 watt (red-red-red).
- () 510 Ω (green-brown-brown).
- () 10 k Ω (brown-black-orange).
- () Solder all leads to the foil and cut off excess lead lengths.

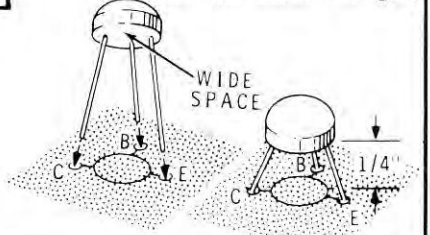


CONTINUE

NOTE: To install the following four transistors, match the flat side of each one with the outline of the flat on the circuit board. Then insert the emitter (E), base (B), and collector (C) leads into the similarly marked holes with the body 1/4" above the board as shown following. As you install each transistor, solder each lead to the circuit board and cut off the excess lead length.



- () 2N3859A (#417-135) transistors at Q5 and Q6.
- () (#417-201) transistors at Q1 and Q2.
- () 4700 Ω (yellow-violet-red).
- () Germanium diode (#56-26) (brown-white-brown) at D6. Position the cathode end as shown.
- () Silicon diode (#57-27) at D8.
- () Silicon diode (#57-27) at D7.
- () 1500 Ω (brown-green-red).
- () 3300 Ω (orange-orange-red).
- () Solder all leads to the foil and cut off excess lead lengths.
- () Install the SE6020 (#417-237) transistor at Q4. Position the wide space as shown. Then insert the emitter (E), base (B), and collector (C) leads into their proper holes. Solder each lead and cut off the excess length.



PICTORIAL 1-1

PROCEED TO PICTORIAL 1-2.



START



Circuit Board-Continued.

NOTE: When mounting electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.

() 100 μ F (MFD) 200 V electrolytic.

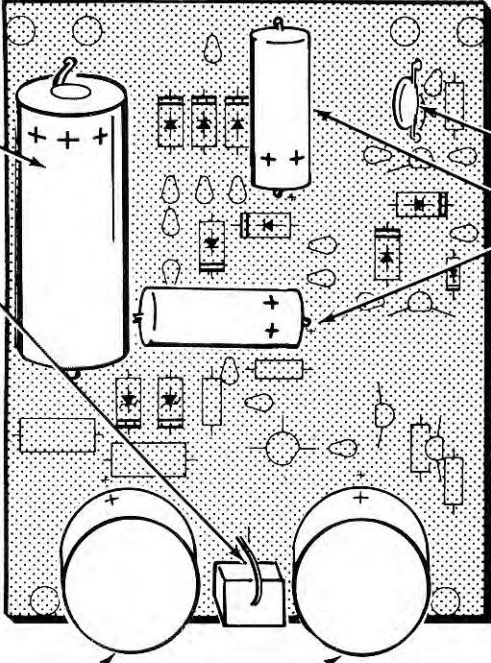
() 2.6 Ω 5 watt. Install vertically.

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

In the following two steps, solder the leads of each capacitor as it is installed. Do not cut off leads.

() 500 μ F (MFD) 75 V electrolytic.

() 500 μ F (MFD) 75 V electrolytic.



CONTINUE



() 200 pF disc.

() 50 μ F (MFD) 50 V electrolytic.

() 50 μ F (MFD) 50 V electrolytic.

() Solder all leads to the foil and cut off excess lead lengths. Save three of these cut leads for use later.

() Inspect the foil side of the circuit board for unsoldered leads, and unintentional solder bridges between foils.

Proceed to Panel Preparation; the circuit board will be installed later.

PICTORIAL 1-2

PANEL PREPARATION

Some of the drawings in the Manual are slightly distorted to show all the parts clearly. Look at the Chassis Photograph (Page 45) from time-to-time to see the actual position of wires and components.

When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

Lockwashers and nuts will be used with most screws when mounting parts, unless the assembly step states otherwise. The applicable steps will call out only the size and type of hardware used. For example, the phrase "Use 6-32 x 1/4" hardware" means to use 6-32 x 1/4" screws, one or more #6 lockwashers, and 6-32 nuts. The Detail referred to in the step will show the proper number of lockwashers to use. Be sure to position each part as shown in the Pictorials.

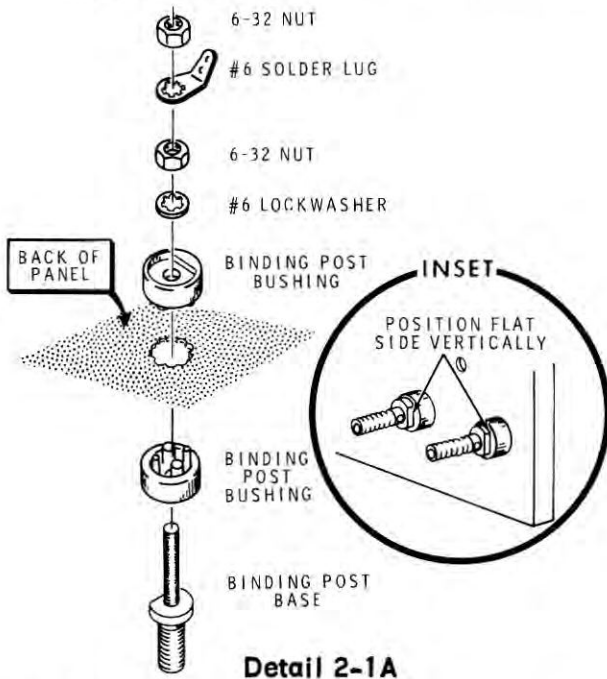
Parts Mounting

Refer to Pictorial 2-1 (fold-out from Page 6) for the following steps. Pictorial 2-1 illustrates the mounting of parts on the panel.

NOTE: Use the plastic nut starter provided to hold and start 6-32 nuts on screws. Refer to the Kit Builders Guide for further information.

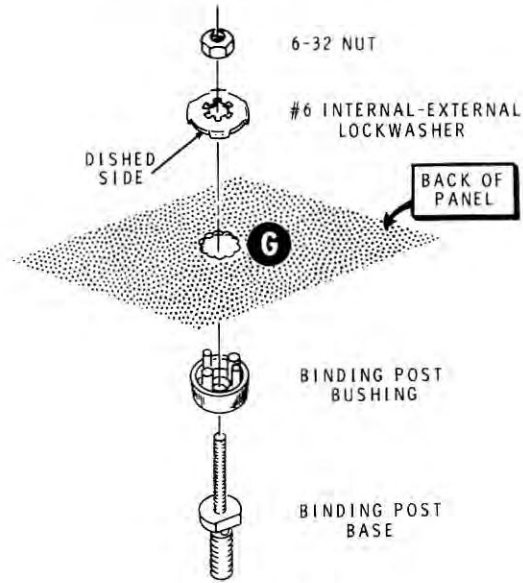
To prevent scratching the front panel, spread a soft cloth on your work bench.

- () Refer to Detail 2-1A and install binding post bases at H and J on the panel. Use two binding post bushings, a #6 lockwasher, two 6-32 nuts, and a #6 solder lug for each. Be sure to seat the binding post base down into the binding post bushing. Position the flat side of each binding post base as shown in the inset drawing. Tighten the first nut before you install the solder lug and second nut on each binding post.



Detail 2-1A

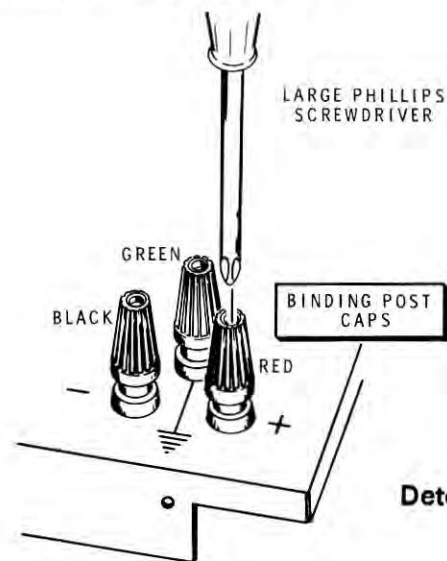
- () Refer to Detail 2-1B and install a binding post base at G. Use a binding post bushing, a #6 internal-external lockwasher and a 6-32 nut. Be sure the dished side of the lockwasher faces the inside surface of the front panel, and that the flat side of the binding post base is positioned vertically as before. Tighten the nut firmly.
- () Screw the black binding post cap on binding post J (-), the green cap on G (ground), and the red cap on H (+).



Detail 2-1B

NOTE: In the following two steps (optional), use a phillips screwdriver to expand the end of the metal binding post base so the cap will not come off the binding post. The screwdriver tip must be large enough so it will pass through the cap but not go inside of the binding post base.

- () Refer to Detail 2-1C and place the tip of a large phillips screwdriver through the opening in the end of each binding post cap and against the hollow end of the binding post base. Support the binding post base with a block of wood or a thick magazine to avoid bending the panel.



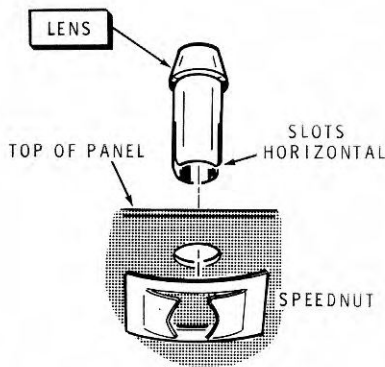
Detail 2-1C

() Now tap the handle end of the phillips screwdriver sharply with a small hammer to expand the hollow end of the binding post base. The binding post base should be expanded only enough to prevent the caps from coming off.

NOTE: In the next two steps, be sure to position the slots in each lens horizontally as shown.

() Refer to Detail 2-1D and install the red neon lamp lens with a speednut at B. The speednut is on the back of the panel. Use a screwdriver to push the nut tightly against the panel.

() Similarly, install the amber lens with a speednut at C.

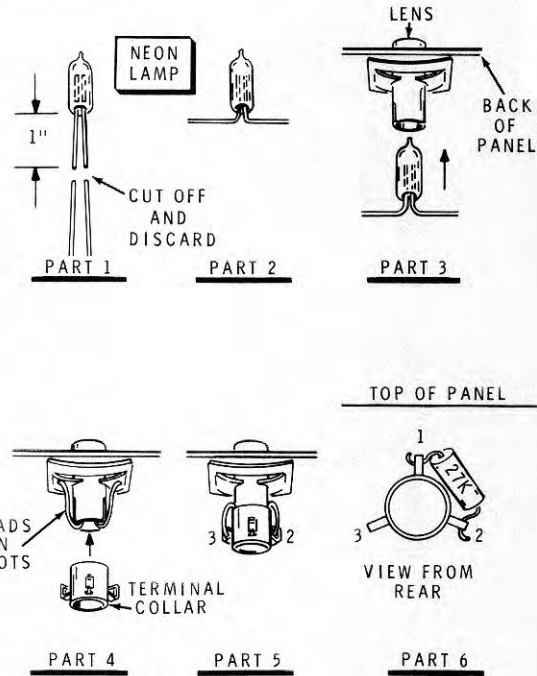


Detail 2-1D

NOTE: Two neon lamp assemblies will be prepared in the following steps, and two sets of brackets are included with each step. Go through the steps once for one lens assembly and check one set of brackets as you perform each step. Then go through the steps again for the second lens assembly and check off your work in the remaining set of brackets.

Refer to Detail 2-1E for the following 5 steps. The Detail is divided into parts and each step will refer to the pertinent part.

() () Refer to Part 1 and cut the leads of a neon lamp (#412-15) to a length of 1". Bend the cut leads straight out on each side of the lamp as shown in Part 2.



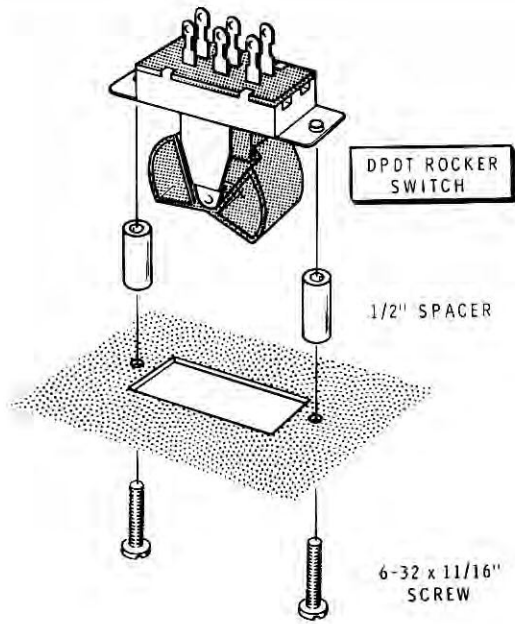
Detail 2-1E

() () Refer to Part 3 and insert the lamp as far as it will go into a lens. Align the lamp leads with the lens slots.

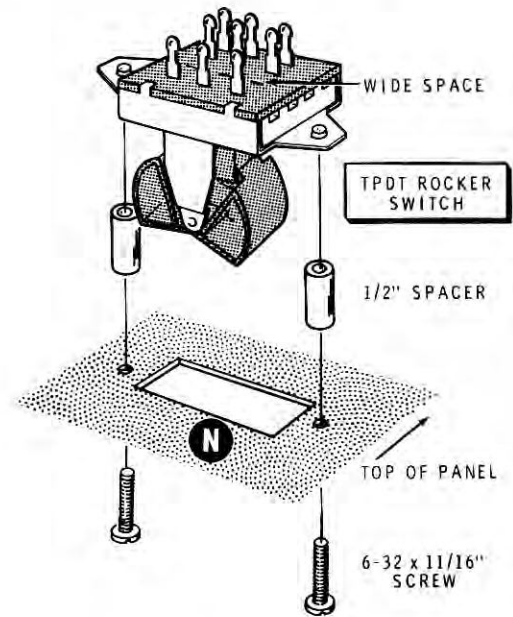
() () Refer to Part 4 and press the lamp leads into the lens slots. Then position one lug of a terminal collar (#431-82) straight up toward the top of the panel and push the collar onto the lens until the ends of the collar and the lens are flush with each other.

() () Refer to Part 5 and connect one lamp lead to lug 2 (NS) and the other lamp lead to lug 3 (NS) of the terminal collar.

() () Refer to Part 6 and connect a 27 kΩ (red-violet-orange) resistor from lug 1 (NS) to lug 2 (S-2) of the terminal collar. Cut off any excess lead lengths.



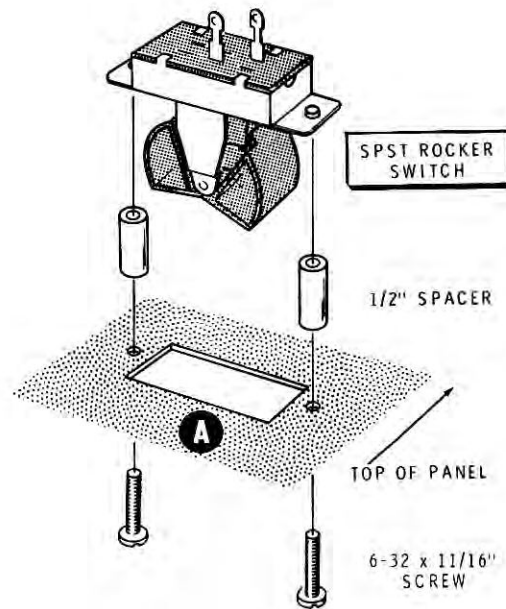
Detail 2-1F



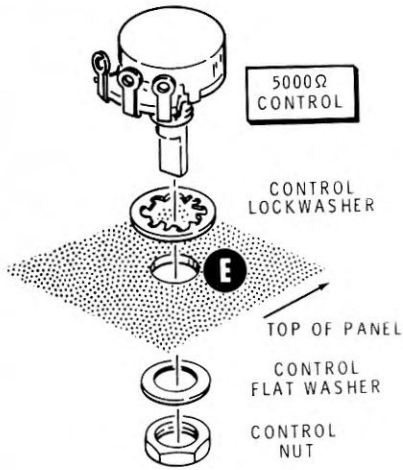
Detail 2-1G

NOTE: Before you finally tighten the rocker switch hardware in the following steps, make sure that the rockers move freely and do not rub against the edges of the panel holes.

- () Refer to Detail 2-1F and install a DPDT rocker switch at K on the back of the panel. Use 1/2" spacers and 6-32 x 11/16" screws.
- () Similarly, install another DPDT rocker switch at L.
- () Refer to Detail 2-1G and install a TPDT rocker switch at N. Position the wide space between the lug rows as shown. Use 1/2" spacers and 6-32 x 11/16" screws.
- () Refer to Detail 2-1H and install a SPST rocker switch at A. Be sure to position the switch with the lugs as shown. Use 1/2" spacers and 6-32 x 11/16" screws.

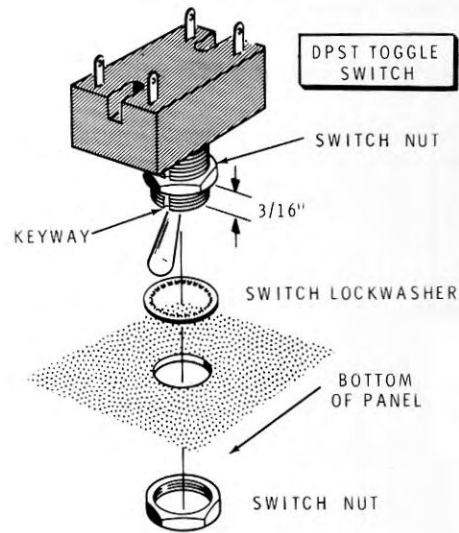


Detail 2-1H



Detail 2-1J

- () Refer to Detail 2-1J and mount a 5000 Ω control (#10-203) at E. Position the control with the lugs as shown in the Pictorial. Use a control lockwasher, a control flat washer, and a control nut.
- () Similarly, mount a 100 Ω (#10-285) control at F.
- () Remove one nut and the lockwasher from the DPST toggle switch. Position the remaining nut $3/16''$ from the end of the bushing as shown in Detail 2-1K.



Detail 2-1K

- () Refer to Detail 2-1K and mount the DPST toggle switch at D on the panel. Use the lockwasher and the nut removed in the preceding step. Position the switch with the keyway in the bushing toward the bottom of the panel. If the lug configuration is not as shown in the Pictorial, refer to the inset drawing. Note the similarity of lug number locations.

The panel will be installed later.

Wiring Harness Preparation

Refer to Pictorial 2-2 for the following steps.

Pictorial 2-2 illustrates preparation of the wiring harness and part of the panel wiring. For clarity, some of the wiring harness panel connections are shown in Pictorial 2-2 and the remainder are shown in a following Pictorial.

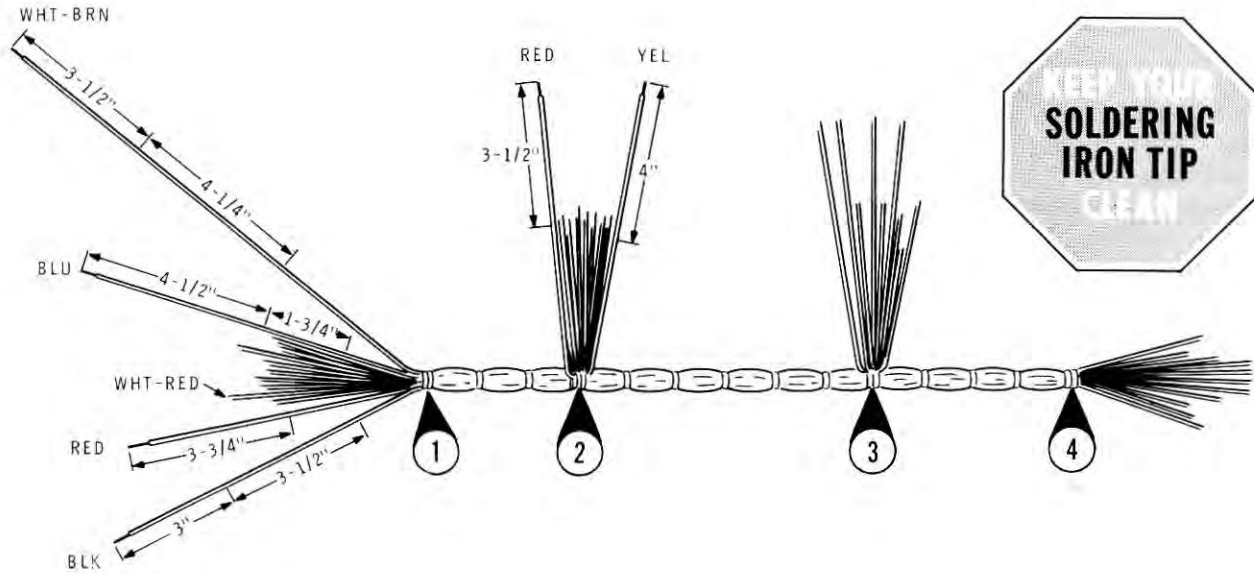
A place where one or more wires leaves the wiring harness is called a "breakout". It is abbreviated "BO" in the assembly steps and the illustrations. Each BO is numbered.

- () Refer to Detail 2-2A and form the wiring harness as shown. Note that the end of the harness which has a long white-brown wire is BO#1, and that the next breakout, which has two red wires and two violet wires, is BO#2.
- () Cut the exact lengths of wire from each of the following wires in the wiring harness. Check the dimensions carefully before you

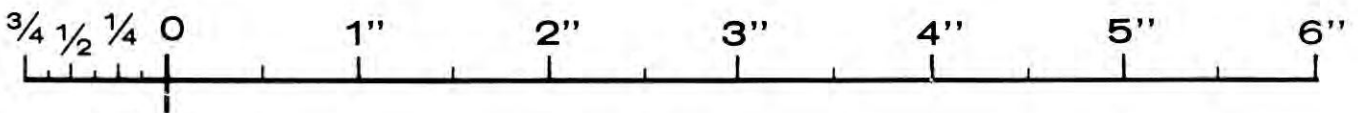
cut and be sure you cut from the proper wire at the designated breakout. Cut one wire of each length shown. These wires will be used later.

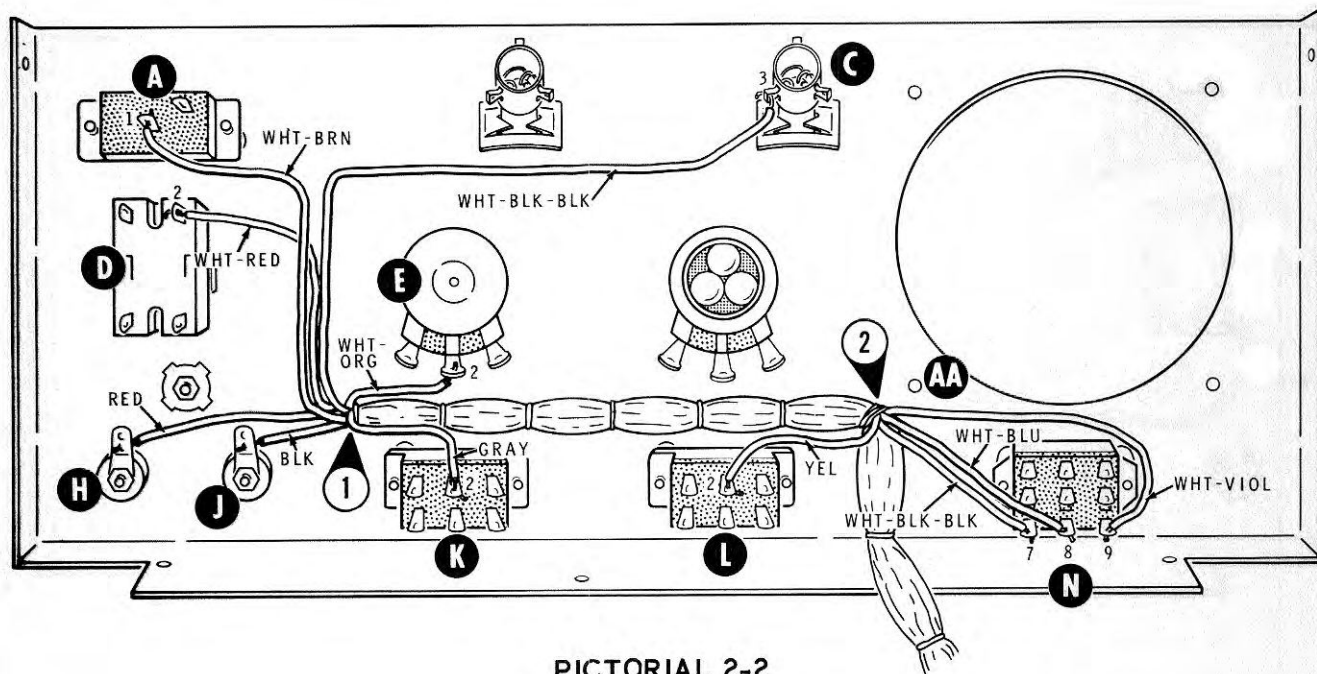
	CUT FROM	LENGTHS TO BE CUT
BO#1	black wire	1 - 3" and 1 - 3-1/2"
	red wire	1 - 3-3/4"
	blue wire	1 - 4-1/2" and 1 - 1-3/4"
	white-brown wire	1 - 3-1/2" and 1 - 4-1/4"
BO#2	red wire	1 - 3-1/2"
	yellow wire	1 - 4"

- () Remove 1/4" of insulation from the end of each cut wire, including the wiring harness.



Detail 2-2A





PICTORIAL 2-2

Panel Wiring

- () Position the wiring harness against the front panel as shown in the Pictorial. Note the locations of BO#1 and BO#2 in relation to other components. Form the harness to clear hole AA.

NOTE: For clarity in the wiring instructions, two Pictorials are used for panel harness wiring. Approximately half the wiring from each of the two breakouts is shown in each Pictorial. The wiring steps are grouped in the same manner.

As you connect each wire, position it as shown in the Pictorial.

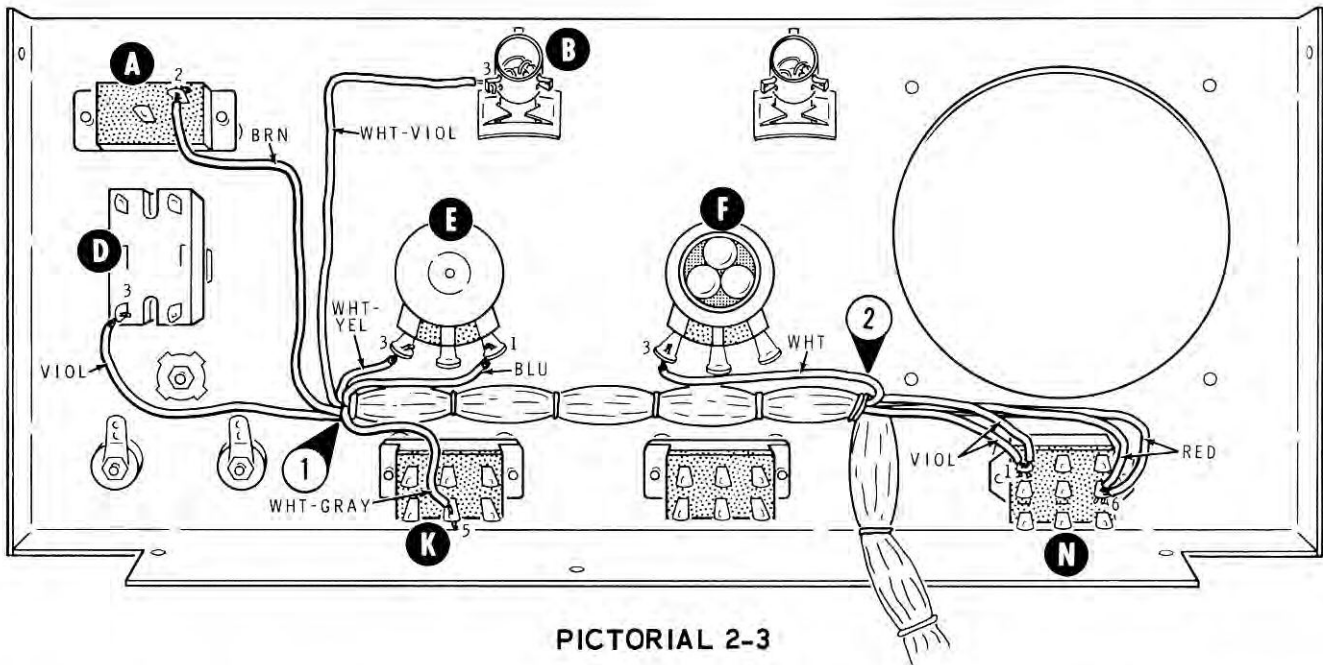
Connect wires from BO#1 as follows:

- () White-orange to lug 2 of control E (S-1).
 () Gray to lug 2 of switch K (S-1).

- () Black to binding post J (NS).
 () Red to binding post H (NS).
 () White-red to lug 2 of switch D (S-1).
 () White-brown to lug 1 of switch A (NS).
 () White-black-black to lug 3 of terminal collar C (S-2).

Connect wires from BO#2 as follows:

- () Yellow to lug 2 of switch L (NS).
 () White-black-black to lug 7 of switch N (S-1).
 () White-blue to lug 8 of switch N (S-1).
 () White-violet to lug 9 of switch N (S-1).



PICTORIAL 2-3

Refer to Pictorial 2-3 for the following steps.

Pictorial 2-3 completes the wiring harness connections on the panel.

Connect wires from BO#1 as follows:

- () White-gray to lug 5 of switch K (NS).
- () Blue to lug 1 of control E (NS).
- () White-yellow to lug 3 of control E (S-1).
- () White-violet to lug 3 of terminal collar B (S-2).
- () Brown to lug 2 of switch A (S-1).
- () Violet to lug 3 of switch D (S-1).

Connect wires from BO#2 as follows:

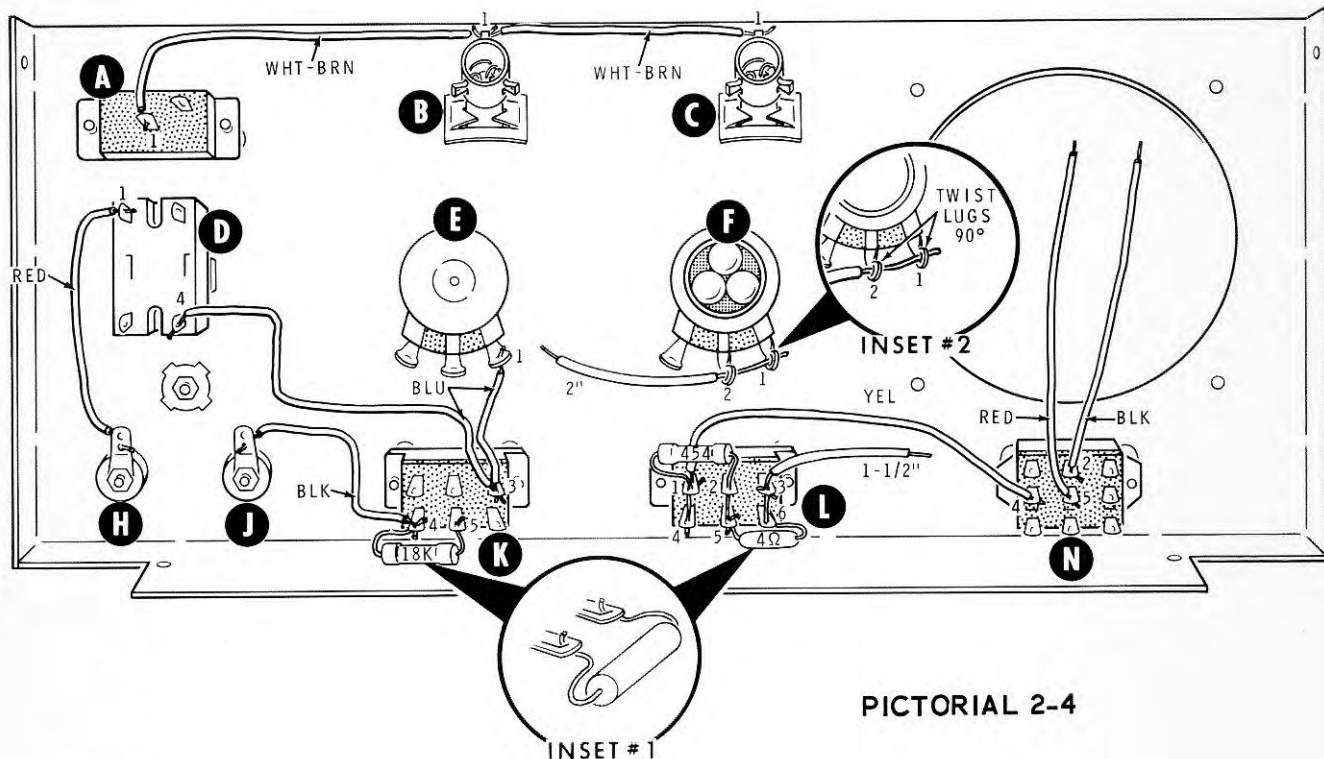
- () Two violet to lug 1 of switch N (NS).
- () Two red to lug 6 of switch N (NS).
- () White to lug 3 of control F (S-1).

The brown wire and the white-gray wire will be connected later.

Refer to Pictorial 2-4 for the following steps.

Pictorial 2-4 shows the mounting of components on the panel and associated wiring. Use the wire lengths cut from the wiring harness for the following group of steps.

- () Connect the shorter black wire (3") from lug 4 of switch K (NS) to binding post J (S-2).
- () Connect the shorter red wire (3-1/2") from binding post H (S-2) to lug 1 of switch D (S-1).
- () Connect the shorter blue wire (1-3/4") from lug 1 of control E (S-2) to lug 3 of switch K (NS).
- () Connect the 4-1/2" blue wire from lug 3 of switch K (S-2) to lug 4 of switch D (S-1).
- () Connect the longer white-brown wire (4-1/4") from lug 1 of switch A (S-2) to lug 1 of terminal collar B (NS).
- () Connect the 3-1/2" white-brown wire from lug 1 of terminal collar B (S-3) to lug 1 of terminal collar C (S-2).
- () Connect the 4" yellow wire from lug 1 of switch L (NS) to lug 4 of switch N (S-1).



PICTORIAL 2-4

- () Connect one end of the 3-3/4" red wire to lug 5 of switch N (S-1). The other end of this wire will be connected later.
- () Connect one end of the 3-1/2" black wire to lug 2 of switch N (S-1). The other end of this wire will be connected later.

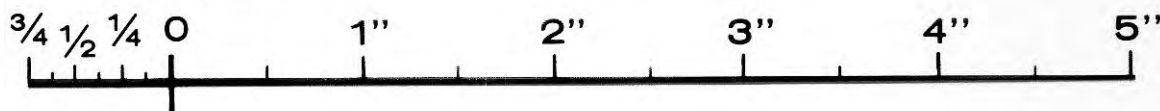
NOTE: When you connect a resistor, fit it as shown in the Pictorial and then cut off excess lead lengths. Position resistors as close as possible to the switch lugs. Note in inset #1 of Pictorial 2-4 that the resistors come straight out from the switch lugs so they will not touch the chassis when the panel is mounted.

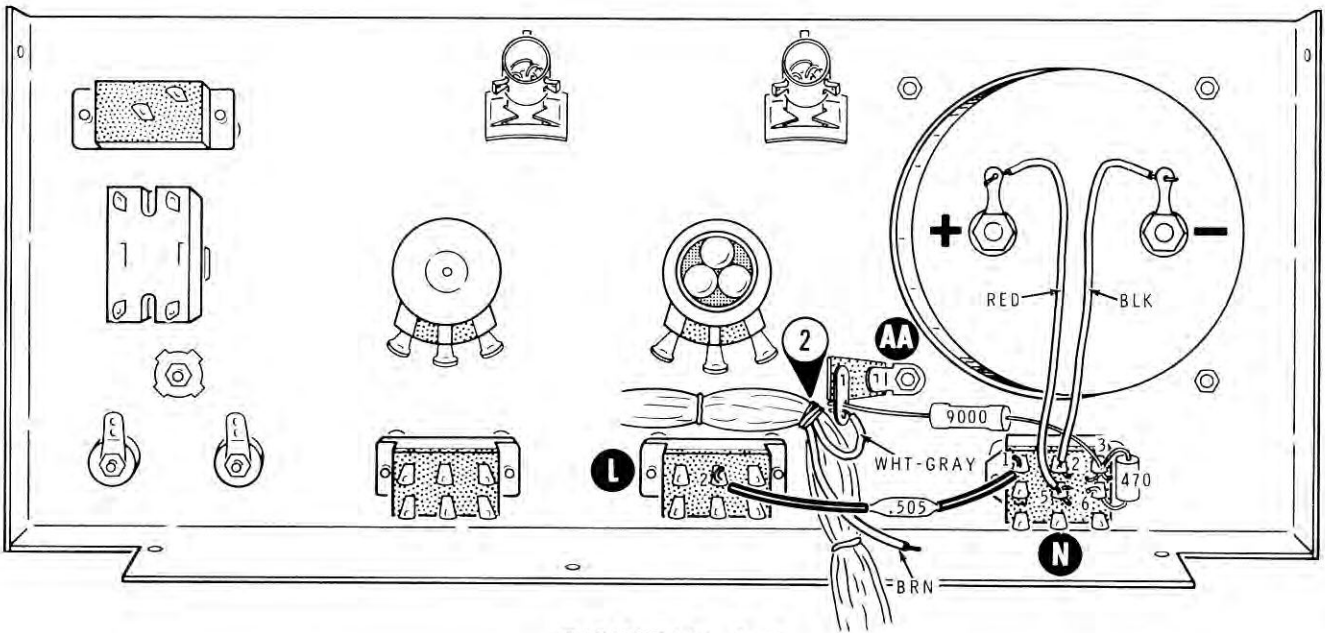
- () Connect an 18 k Ω precision resistor from lug 4 (S-2) to lug 5 (S-2) of switch K.

NOTE: When a wire (or lead) passes through a connection and then goes to another point (as in the next step), it will count as two wires in the soldering instructions (S-2), one entering and one leaving the connection.

- () Insert one lead of the 454 Ω precision resistor through lug 1 (S-3) to lug 4 (S-1), and the other lead through lug 2 (NS) to lug 5 (NS) of switch L.

- () Pass one end of a 4 Ω precision resistor through lug 6 (S-2) to lug 3 (NS) of switch L.
- () Connect the other end of this resistor to lug 5 of switch L (S-2).
- () Prepare a 1-1/2" length of white hookup wire by removing 1/4" of insulation from each end.
- () Connect this 1-1/2" wire to lug 3 of switch L (S-2). The other end of this wire will be connected later.
- () Twist lugs 1 and 2 of control F 90 degrees as shown in inset #2 of Pictorial 2-4.
- () Prepare a 2" length of white hookup wire by removing 1/4" of insulation from one end and 1/2" of insulation from the other end.
- () Pass the 1/2" bare end of this wire through lug 2 (S-2) to lug 1 (S-1) of control F. The other end will be connected later.





PICTORIAL 2-5

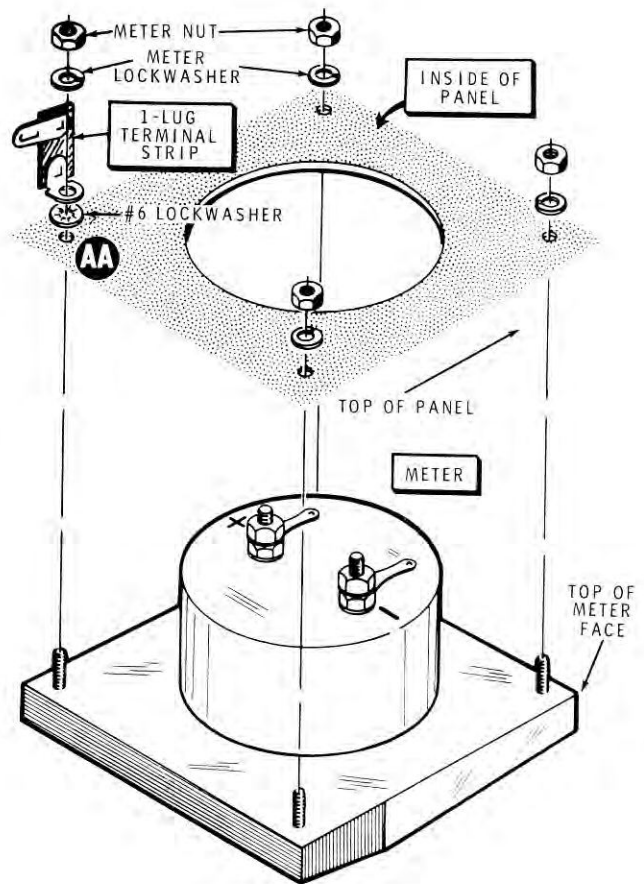
Meter Mounting And Wiring

Refer to Pictorial 2-5 for the following steps.

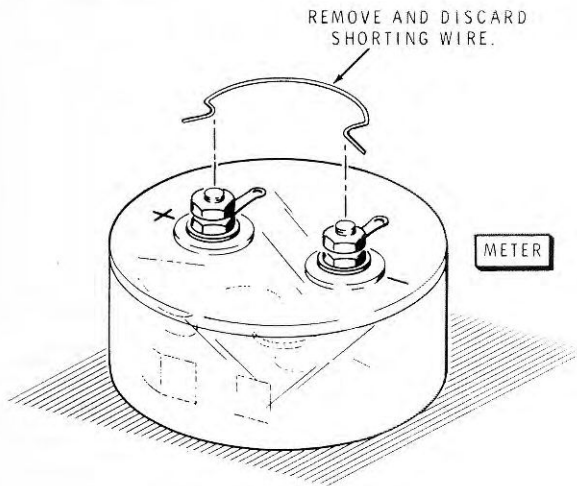
Pictorial 2-5 illustrates the mounted meter, and associated wiring.

A soft cloth on your work bench will protect the meter face from being scratched until you apply a protective cover in a later step.

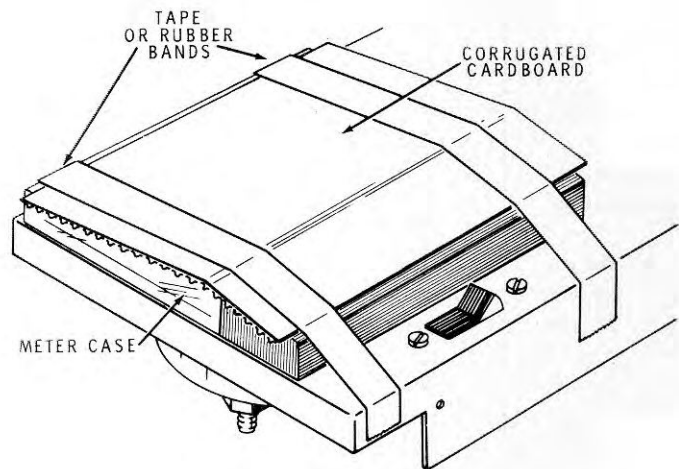
- () Refer to Detail 2-5A and mount the meter in the 4 holes provided. The mounting hardware will be found in the meter box. Be sure to place the polarity markings as shown. Mount a 1-lug terminal strip with a #6 lockwasher at AA. Do not overtighten the meter mounting nuts as the plastic case can be broken.



Detail 2-5A



Detail 2-5B



Detail 2-5C

- () Refer to Detail 2-5B and remove and discard the shorting wire between the two meter terminals. Loosen the nuts on the meter terminals if necessary. Then position the two terminal solder lugs as shown and retighten the nuts.
- () Cover the meter case with a piece of cardboard from the meter box so it will not be scratched. Hold the cardboard in place with adhesive tape or rubber bands as shown in Detail 2-5C.
- () Connect the white-gray wire from BO#2 to the 1-lug terminal strip (NS).
- () Connect a 9000 Ω (may be marked 9 k Ω) precision resistor from the 1-lug terminal strip (S-2) to lug 3 of switch N (NS). Be sure the lead of this resistor has adequate clearance from the switch body.
- () Place a 1" length of sleeving on each lead of the .505 Ω precision resistor.
- () Connect the .505 Ω precision resistor from lug 2 of switch L (S-4) to lug 1 of switch N (S-3).
- () Connect a 470 Ω (yellow-violet-brown) 1/2 watt resistor from lug 3 (S-2) to lug 6 (S-3) of switch N.
- () Connect the red wire coming from lug 5 of switch N to the solder lug at the meter terminal marked + (S-1).
- () Connect the black wire coming from lug 2 of switch N to the solder lug on the other meter terminal (S-1).
- () Check carefully to make sure that all connections are soldered and that any wire clippings or solder splashes are removed. The brown wire from BO#2 will be connected later.

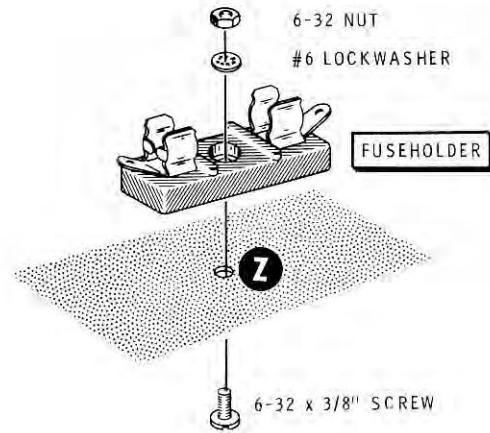
This completes the Panel Preparation. It will be mounted later.

CHASSIS PARTS MOUNTING

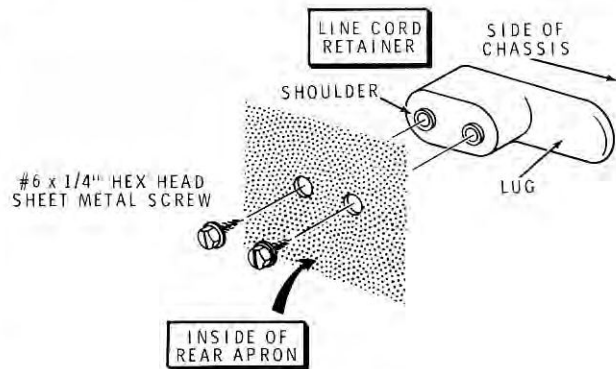
Refer to Pictorial 2-6 (fold-out from Page 19) for the following steps.

Pictorial 2-6 shows parts mounted on the chassis.

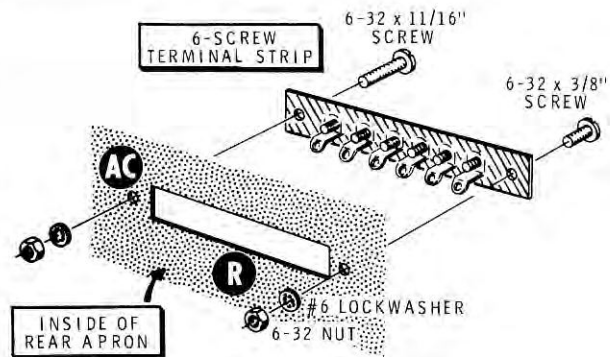
- () Remove and discard the light colored adhesive backing from the 2" x 1-3/4" piece of fish paper. Position the 2" edge of the fish paper along the front edge of the chassis as shown in the Pictorial. Be sure you do not cover any screw holes. Press the paper firmly into place.
- () Refer to Detail 2-6A and mount a fuseholder at Z on the chassis bottom. Use 6-32 x 3/8" hardware.
- () Refer to Detail 2-6B and mount line cord retainers at S and T on the outside of the rear apron. Use #6 x 1/4" hex head sheet metal screws. Each of the two retainers must be positioned as shown by the dotted lines in the Pictorial. Before you tighten the screws, make sure that the two shoulders on each retainer fit into the two mounting screw holes.
- () Refer to Detail 2-6C and mount a 6-screw terminal strip on the outside of the rear apron at R. Use 6-32 x 11/16" hardware at AC and 6-32 x 3/8" hardware at the other mounting hole. Be sure the solder lugs are positioned as shown in the inset drawing of the Pictorial.
- () Refer to Detail 2-6D and prepare three double solder lugs as shown. Use diagonal cutters to clip out enough of the upper edge of a lug to allow it to pass freely over the threaded portion of one of the terminal strip screws.



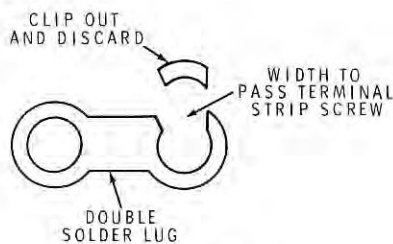
Detail 2-6A



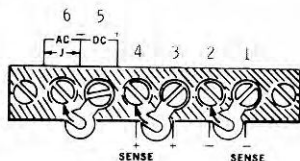
Detail 2-6B



Detail 2-6C



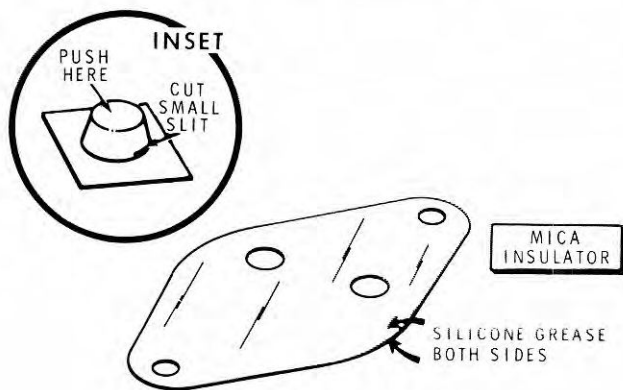
Detail 2-6D



Detail 2-6E

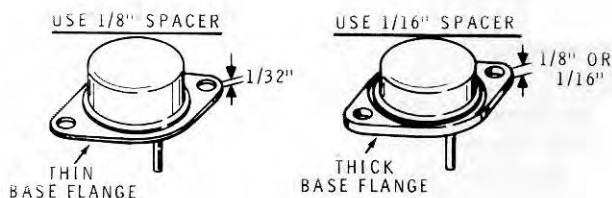
Refer to Detail 2-6E to identify the terminal numbers of terminal strip R, viewed from the rear of the chassis apron.

- () Temporarily remove the screws from terminals 1, 3, and 5 of the terminal strip.
- () Refer to Detail 2-6E and pass one of the three removed screws through the uncut end of a double solder lug. Replace the screw in terminal 1 with the cut end of the lug up. Tighten the screw.
- () Similarly, install double solder lugs at terminals 3 and 5 and tighten both screws.
- () Remove the mica insulator from between the two pieces of cardboard.
- () Open the container of silicone grease as shown in the inset to Detail 2-6F.



Detail 2-6F

- () As shown in the Detail, spread a layer of silicone grease on both sides of the mica insulator. Use at least half of the grease. Spread it with your finger.

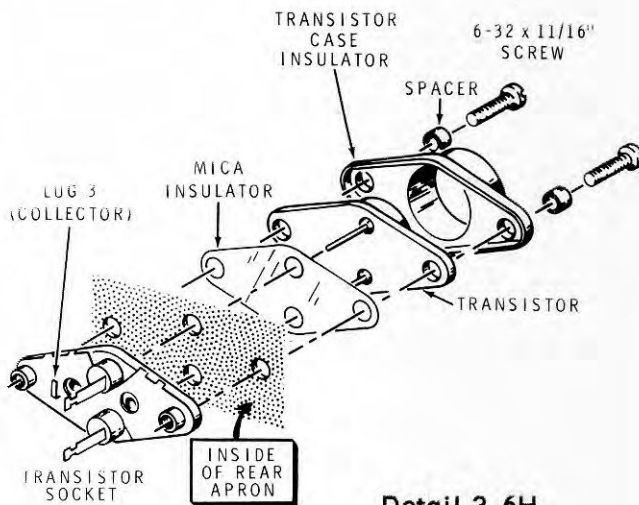


Detail 2-6G

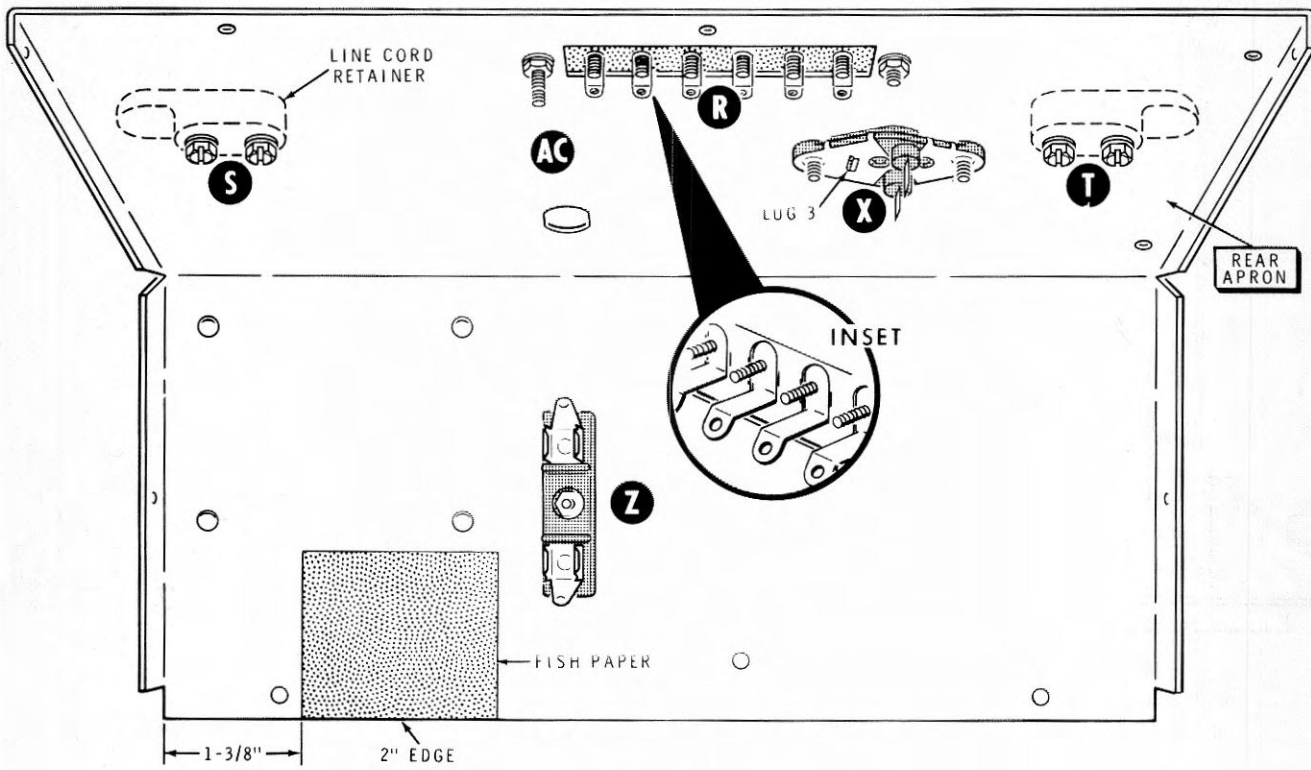
- () Press the greased insulator against the power transistor body. Center the insulator holes around the transistor terminals.

NOTE: Refer to Detail 2-6G and determine whether the power transistor (#417-215) included in your kit has a thick or a thin base flange. In the following step, use 1/8" spacers if the transistor has a thin base flange, or use 1/16" spacers if the transistor has a thick base flange.

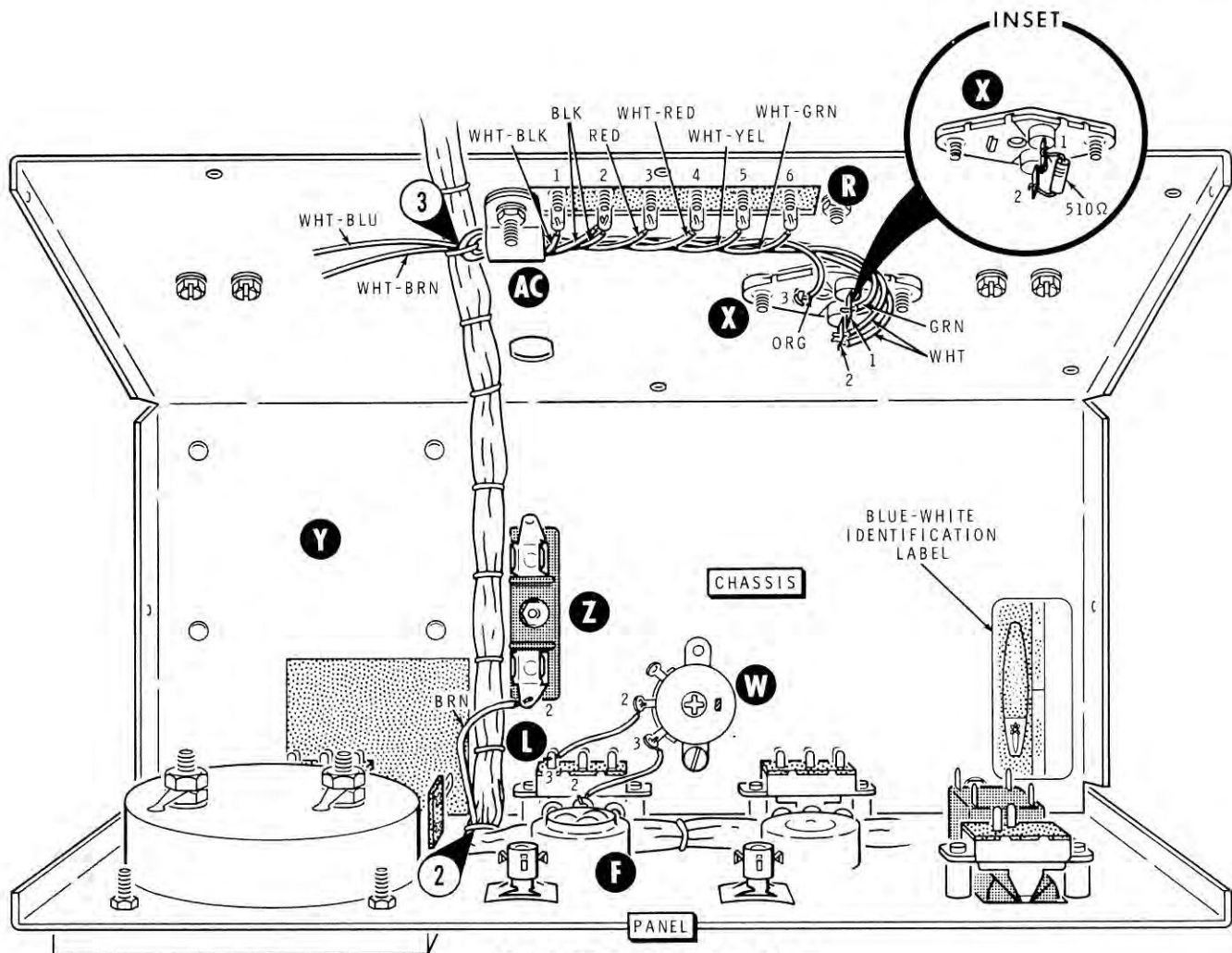
- () Refer to Detail 2-6H and install the power transistor at X with 6-32 x 11/16" screws, two spacers, a transistor case insulator, a mica insulator and a transistor socket. Note that lug 3 is toward hole AC. Be sure the socket is fully seated in the mounting holes and that the holes in the mica insulator are aligned with the transistor socket holes. Then tighten the screws securely. Tighten until the screw heads are fully seated in the recessed holes in the transistor case insulator.



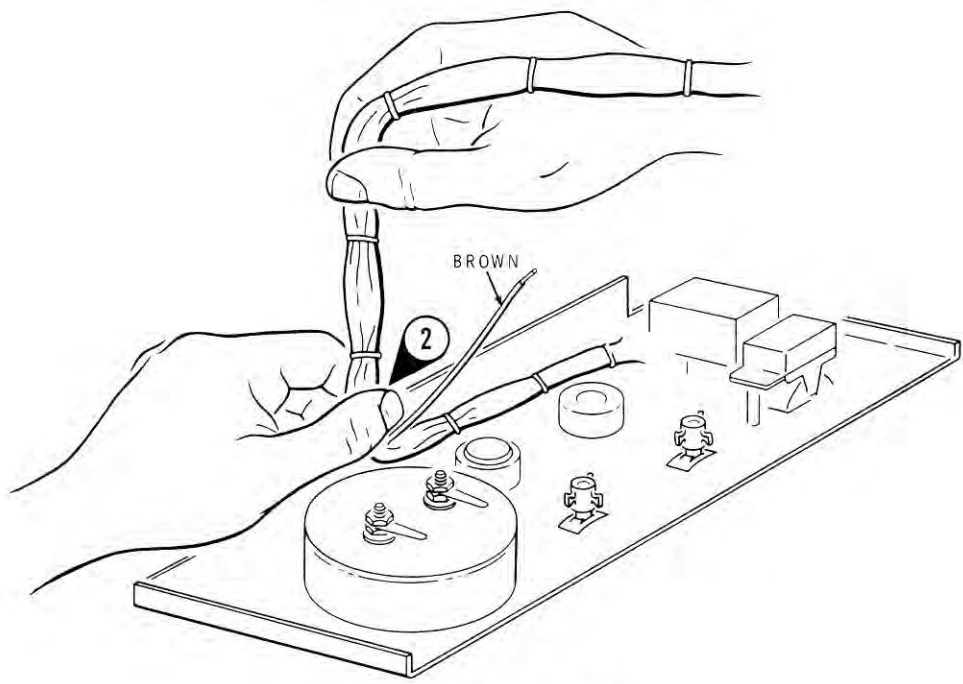
Detail 2-6H



PICTORIAL 2-6



PICTORIAL 2-7



Detail 2-7A

CHASSIS ASSEMBLY

Panel Mounting

Refer to Pictorial 2-7 for the following steps. Pictorial 2-7 shows the mounted panel, part of the harness wiring, and includes the application of the plastic feet.

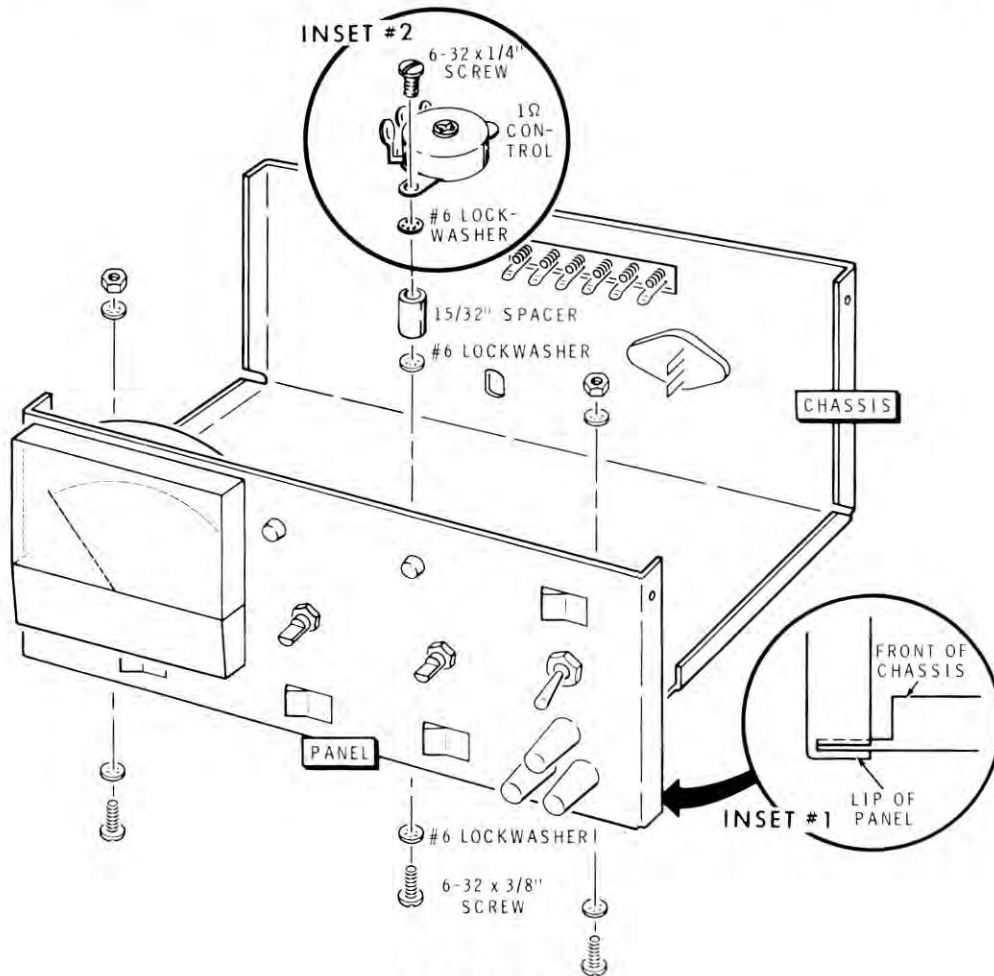
- () Refer to Detail 2-7A and hold BO#2 of the wiring harness against the back of the panel so there will be no pull on connections already made. With the other hand, bend the wiring harness and the brown wire back and up from the panel.
- () Refer to Detail 2-7B and mount the panel on the chassis. Be sure the lip of the panel is under the chassis as shown in inset drawing #1. Fasten these pieces in the center with a 6-32 x 3/8" screw, two #6 lockwashers, and a 15/32" spacer. Use 6-32 x 3/8"

hardware on both sides. Be sure to use two lockwashers, as shown, with each screw. Tighten the screws firmly to insure a good ground connection between the panel and the chassis.

- () Refer to inset drawing #2 of Detail 2-7B and install a 1 Ω control (#11-124) on the spacer with a 6-32 x 1/4" screw and two #6 lockwashers.

NOTE: In the following step, you will avoid smearing the numbers on the label if you will put the piece of waxed backing paper on top of the label and then rub on it instead of directly on the label.

- () Install the blue and white identification label on the chassis bottom back of the binding posts as shown in the Pictorial. Carefully peel away the backing paper and press the label into position. Refer to the numbers on this label in any communications that you may have with the Heath Company concerning this kit.



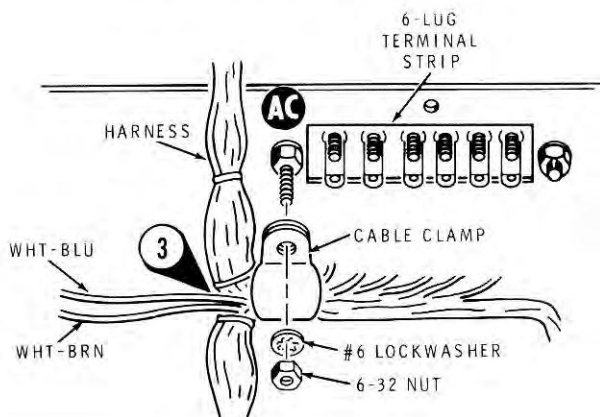
Detail 2-7B



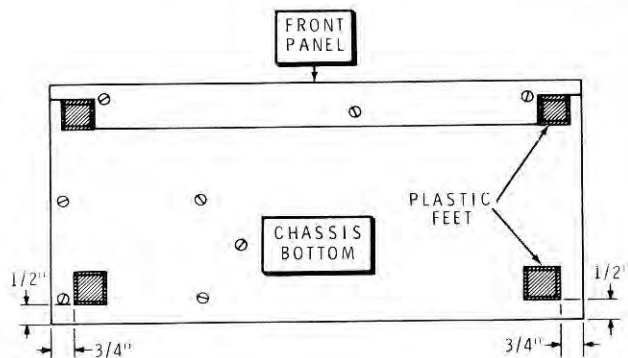
- () Refer to Detail 2-7C, turn the chassis and panel assembly over, and install the four plastic feet on the bottom of the chassis. Be sure to position each foot correctly before it contacts the chassis, as it will be very difficult to move. Peel away the protective paper from the adhesive backing and press each foot firmly into place.

Panel to Chassis Wiring

- () Form the wiring harness snugly against the chassis along the side of the fuseholder, into the corner, and up against the rear apron as shown in Pictorial 2-7. Keep in mind that the power transformer will be mounted later at Y.
- () Connect the brown wire from BO#2 to lug 2 of the fuseholder (S-1).
- () Connect the wire from lug 3 of switch L to lug 2 of control W (S-1).
- () Connect the wire from lug 2 of control F to lug 3 of control W (S-1).
- () Refer to Detail 2-7D and bend the white-blue and white-brown wires from BO#3 out of the way. Then place a cable clamp around the rest of the wires of BO#3 and mount the cable clamp at AC with a #6 lockwasher and a 6-32 nut.



Detail 2-7D



Detail 2-7C

Connect wires from BO#3 to terminal strip R as follows:

- () White-black to lug 1 (S-1).
- () Two black to lug 2 (S-2).
- () Red to lug 3 (S-1).
- () White-red to lug 4 (S-1).
- () White-yellow to lug 5 (S-1).
- () White-green to lug 6 (S-1).

Connect wires from BO#3 to the power transistor at X as follows:

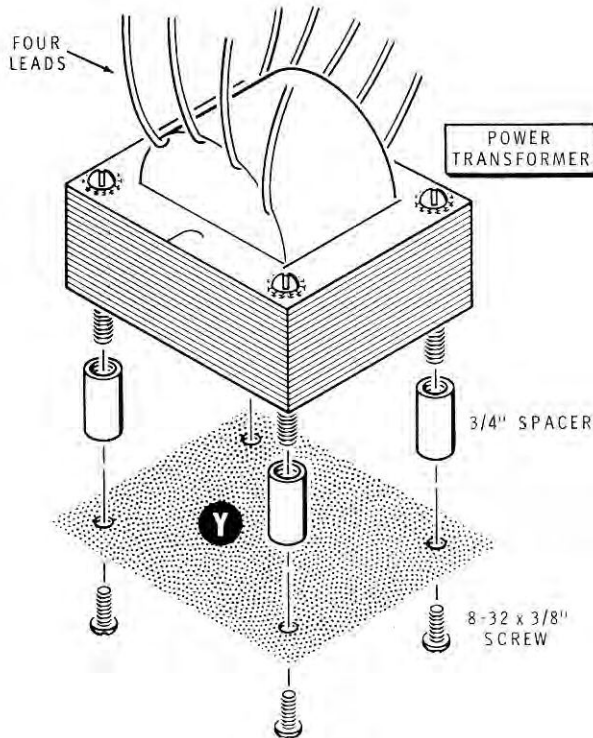
- () Orange to lug 3 (S-1).
- () Two white to lug 2 (NS).
- () Green to lug 1 (NS).
- () Refer to the inset drawing of Pictorial 2-7 and connect a 510 Ω (green-brown-brown) resistor from lug 1 (S-2) to lug 2 (S-3) of the power transistor at X.

Power Transformer Mounting

Refer to Pictorial 2-8 for the following steps.

Pictorial 2-8 shows the mounting of the power transformer and the line cord installation.

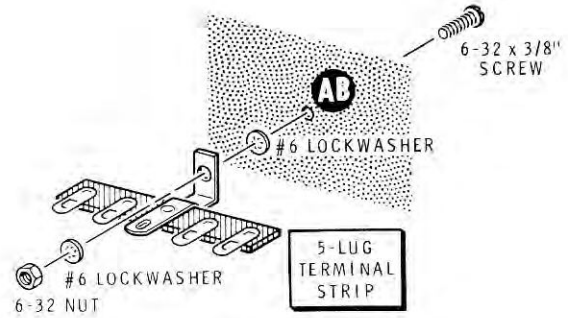
- () Refer to Detail 2-8A and install four 3/4" spacers on the screws at the four corners of the transformer core.



Detail 2-8A

NOTE: When positioning the heavy transformer, take care not to damage the fragile meter. Do not lift the transformer by its leads.

- () Bend the leads up out of the way, and mount the power transformer at Y. Be sure to position the side of the winding with four leads toward the meter. Use 8-32 x 3/8" screws.



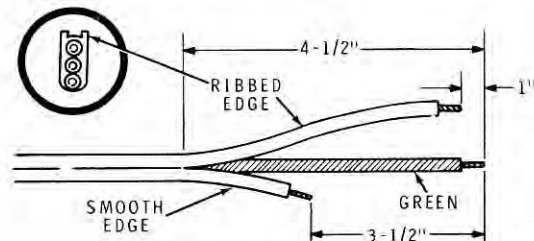
Detail 2-8B

- () Refer to Pictorial 2-8 and bend the five leads from the rear of the transformer to the side toward the wiring harness.
- () Refer to Detail 2-8B and mount a 5-lug terminal strip at AB with the mounting foot pointing up. Use 6-32 x 3/8" hardware.

Line Cord Installation

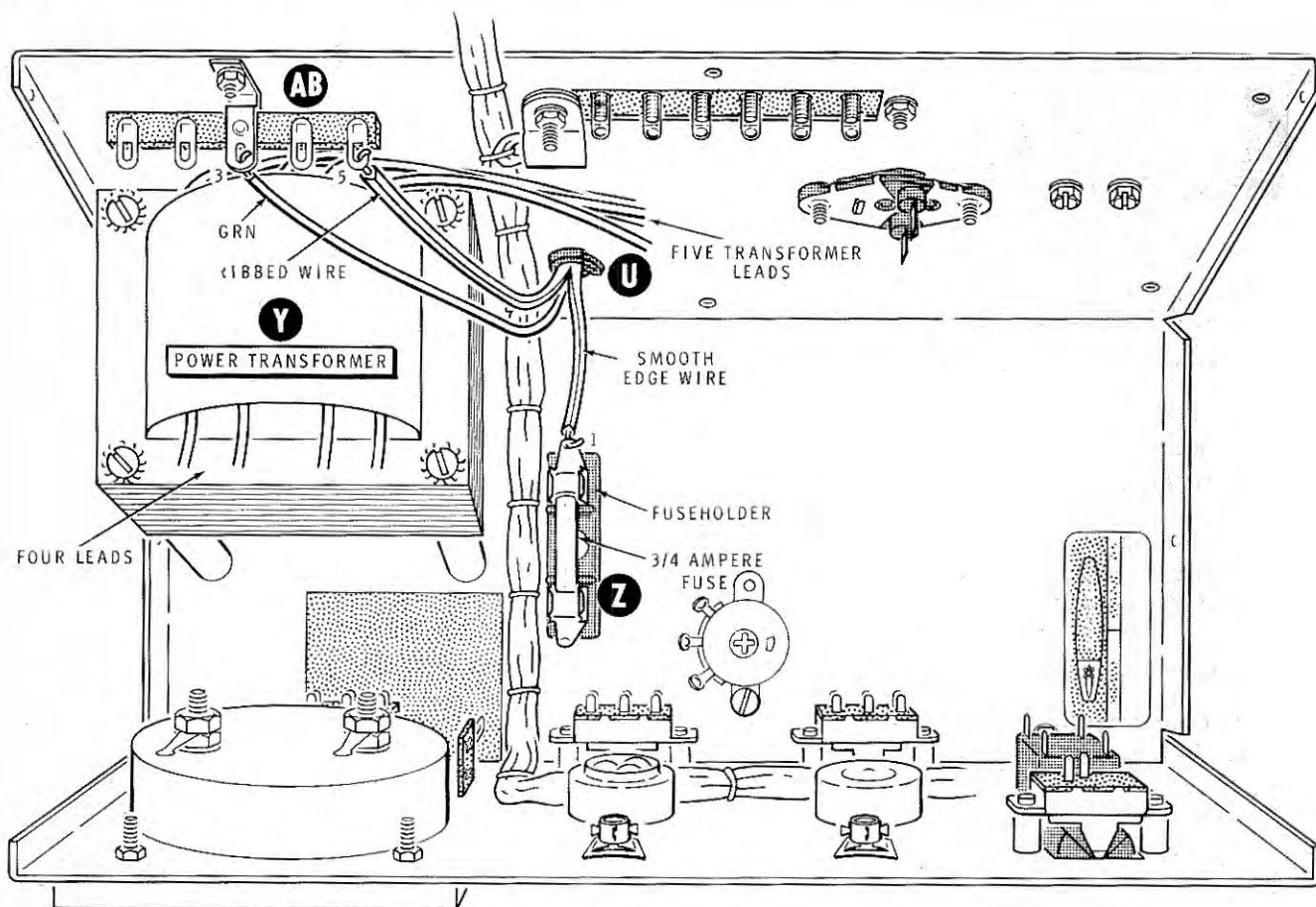
NOTE: In some areas a round line cord is required, and a strain relief for this type of cord is included in the kit. The round line cord and its plug are not supplied with this kit.

- () Refer to Detail 2-8C and prepare the end of the line cord as shown. Remove 1/4" of insulation from the end of each wire. Note the ribbed edge of the line cord.



Detail 2-8C

If you are going to wire the power transformer for 240 VAC, save the piece of wire cut from the wire with the smooth edge; otherwise, it may be discarded.

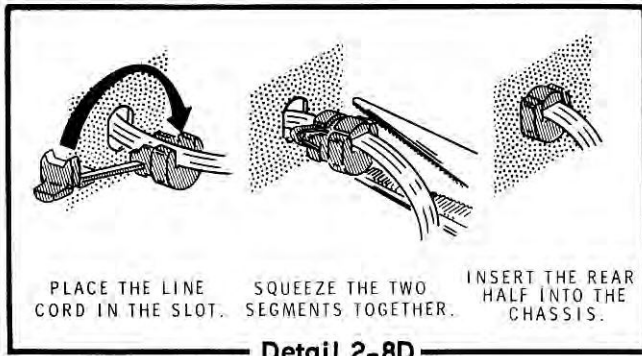


PICTORIAL 2-8

() Twist the strands of wire at the end of each conductor, and melt a small amount of solder on the end of each (just enough to keep the fine wires together.)

If you use a round line cord, read the steps for the installation of the 3-wire flat line cord supplied, and apply those principles to the installation of the round cord. If you use a polarized plug, note that the "hot" side of your electric service line should be connected through the line cord to the fuseholder.

- () Pass the end of the line cord through hole U to the interior of the chassis.
- () Connect the shortest wire (with the smooth edge) to lug 1 of the fuseholder (S-1).
- () Connect the green line cord wire to lug 3 of terminal strip AB (S-1).
- () Connect the ribbed wire of the line cord to lug 5 of terminal strip AB (NS).
- () Press the 3/4 ampere fuse into the fuseholder.



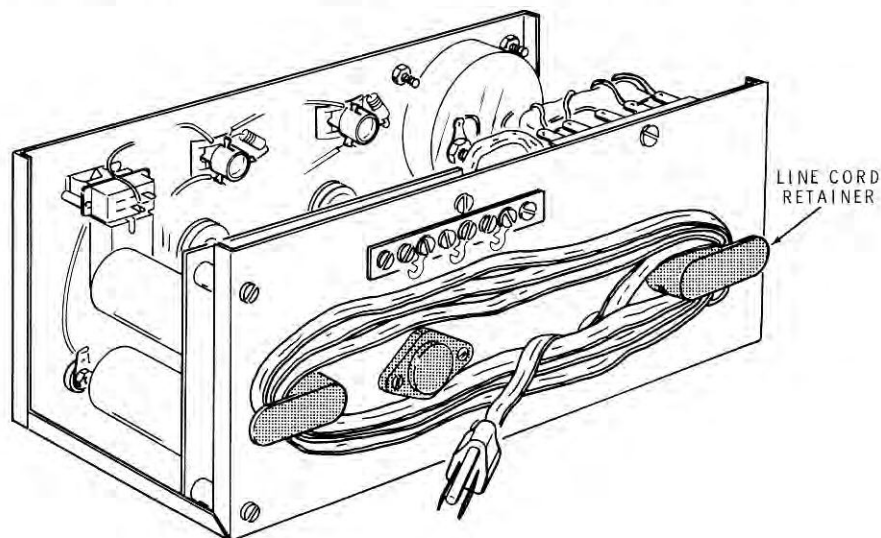
- () Refer to Detail 2-8D and install a strain relief for a flat line cord from the rear of the chassis apron.
- () Refer to Detail 2-8E and wind the line cord around the two line cord retainers on the outside of the rear apron.

Transformer Primary Wiring

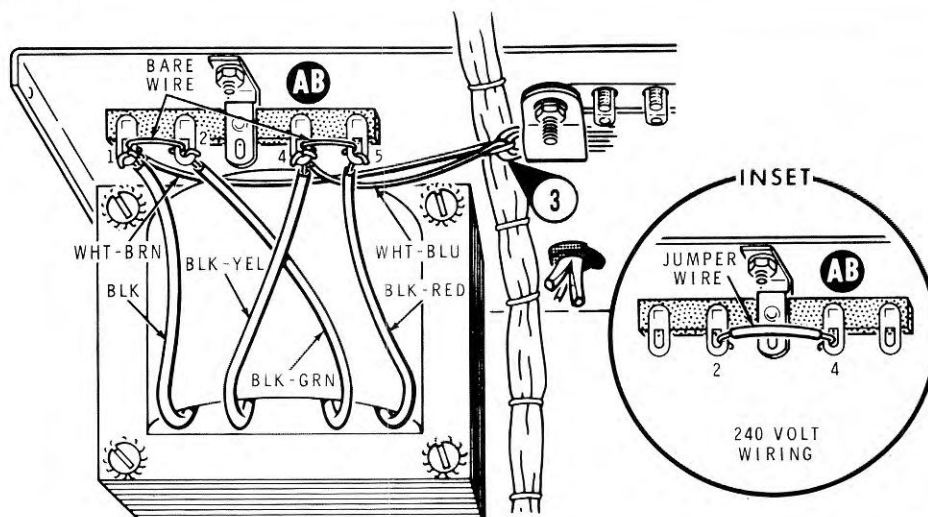
Refer to Pictorial 2-9 for the following steps. Pictorial 2-9 shows the wiring of the power

transformer primary circuit for 120 VAC, with and inset to show 240 VAC wiring. Be sure to place the leads and wires as shown.

- () Connect the white-brown wire from BO#3 of the wiring harness to lug 1 of terminal strip AB (NS).
- () Connect the white-blue wire from BO#3 to lug 4 of terminal strip AB (NS).
- () Connect the black transformer lead to lug 1 of terminal strip AB (NS).
- () Connect the black-green transformer lead to lug 2 of terminal strip AB (NS).
- () Connect the black-yellow transformer lead to lug 4 of terminal strip AB (NS).
- () Connect the black-red transformer lead to lug 5 of terminal strip AB (NS).



Detail 2-8E



PICTORIAL 2-9

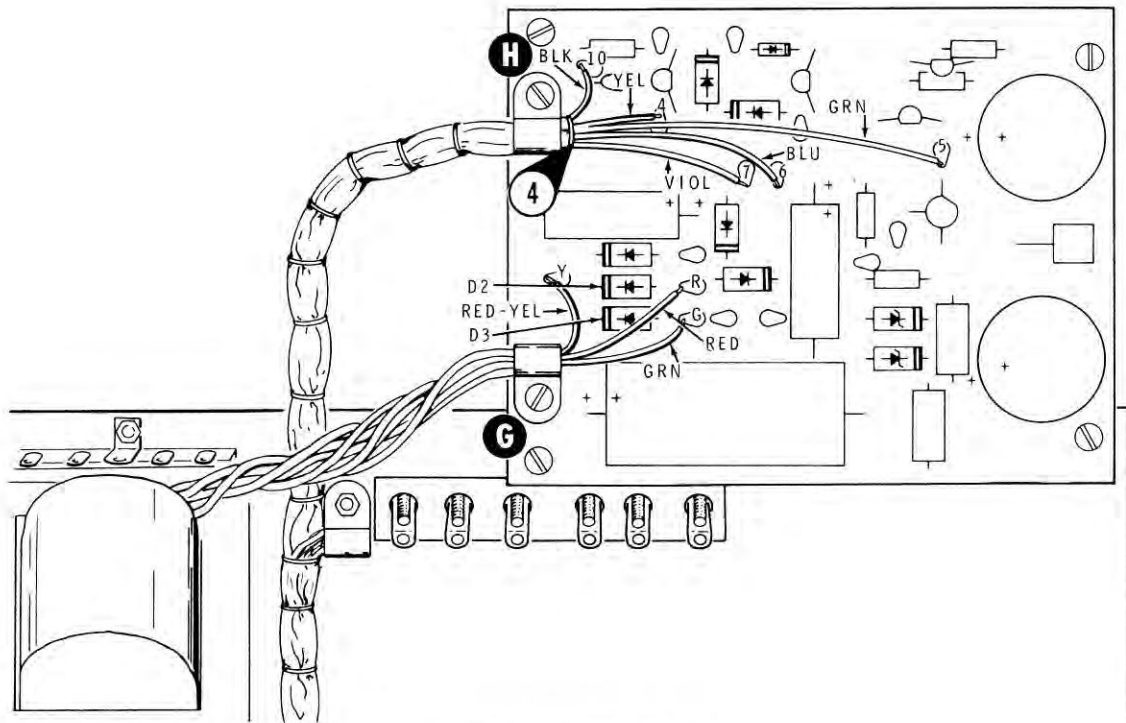
NOTE: Perform the "120 VAC" or the "240 VAC" group of steps which follow according to your power line voltage.

120 VAC WIRING

- () Connect a 1" bare wire jumper from lug 1 (S-3) to lug 2 (S-2) of terminal strip AB. Use the bare wire cut earlier from circuit board components.
- () Connect a 1" bare wire jumper from lug 4 (S-3) to lug 5 (S-3) of terminal strip AB.

240 VAC WIRING

- () Prepare an insulated wire jumper by removing 1/4" of insulation from the cut end of the 2" length of wire cut earlier from the line cord.
- () Refer to the inset drawing of Pictorial 2-9 and connect the jumper from lug 2 (S-2) to lug 4 (S-3) of terminal strip AB.
- () Solder the two wires at lug 1 of terminal strip AB.
- () Solder the two wires at lug 5 of terminal strip AB.



PICTORIAL 2-10

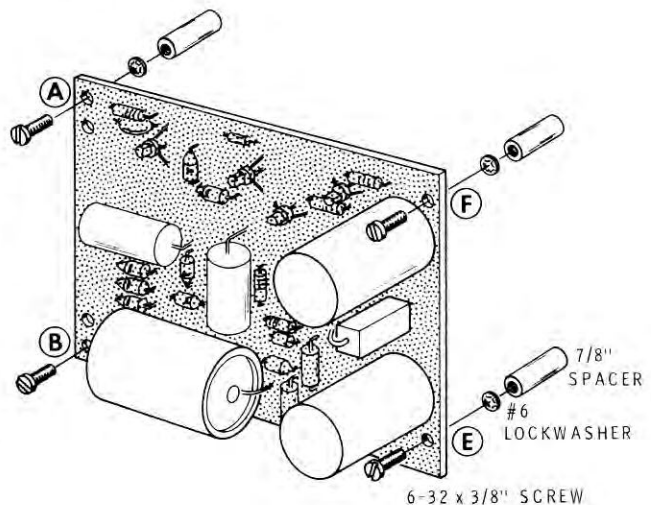
CIRCUIT BOARD CONNECTIONS

NOTE: For clarity in the circuit board wiring instructions, two Pictorials are used. Approximately half of the wiring from each of the two breakouts is shown on each Pictorial. The wiring steps are grouped in the same manner.

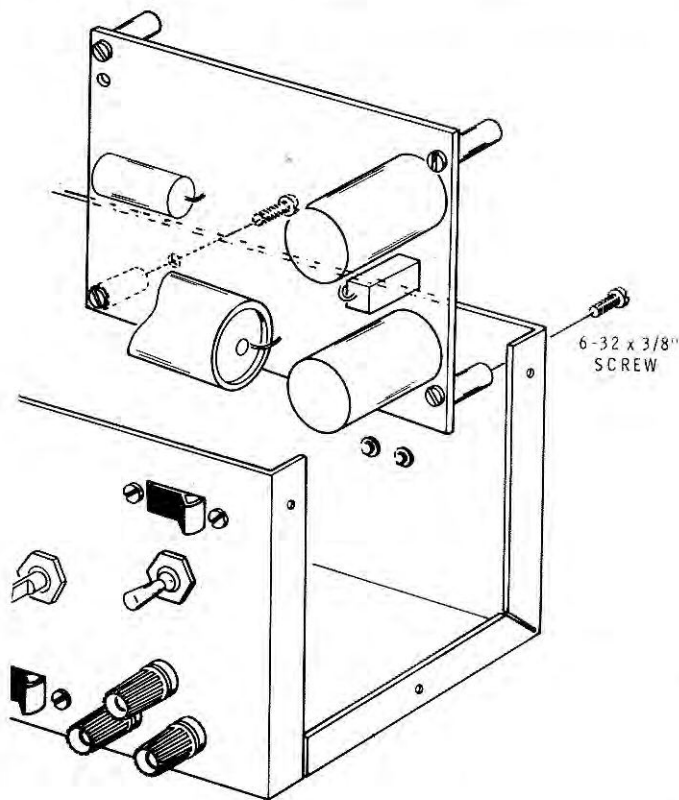
Refer to Pictorial 2-10 for the following steps.

Pictorial 2-10 shows part of the connections to the circuit board.

- () Refer to Detail 2-10A and mount a 7/8" spacer at each corner of the circuit board at holes A, B, F and E. Use a 6-32 x 3/8" screw and a #6 lockwasher at each corner. Do not overtighten the screws as the circuit board can be broken.



Detail 2-10A

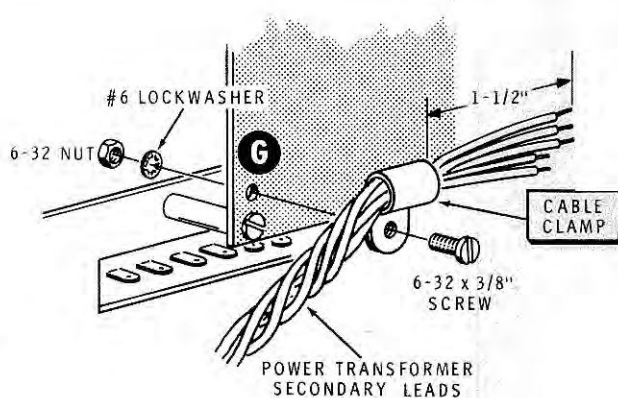


Detail 2-10B

- () Temporarily mount the circuit board as shown in Detail 2-10B. This permits access to the foil side of the board for soldering. Use two 6-32 x 3/8" screws (the board will be tilted a little to one side).
- () Group the five transformer secondary leads together, twist the group to hold the leads together, and put a plastic cable clamp on the leads about 1-1/2" from the end of the shortest lead as shown in Detail 2-10C.
- () Refer to Detail 2-10C and mount the cable clamp at G on the circuit board with 6-32 x 3/8" hardware.

Refer to Pictorial 2-10 for the following steps. Be sure to use the holes shown in the Pictorial.

- () Connect the shortest green transformer lead to small hole G on the circuit board near diode D3 (S-1).

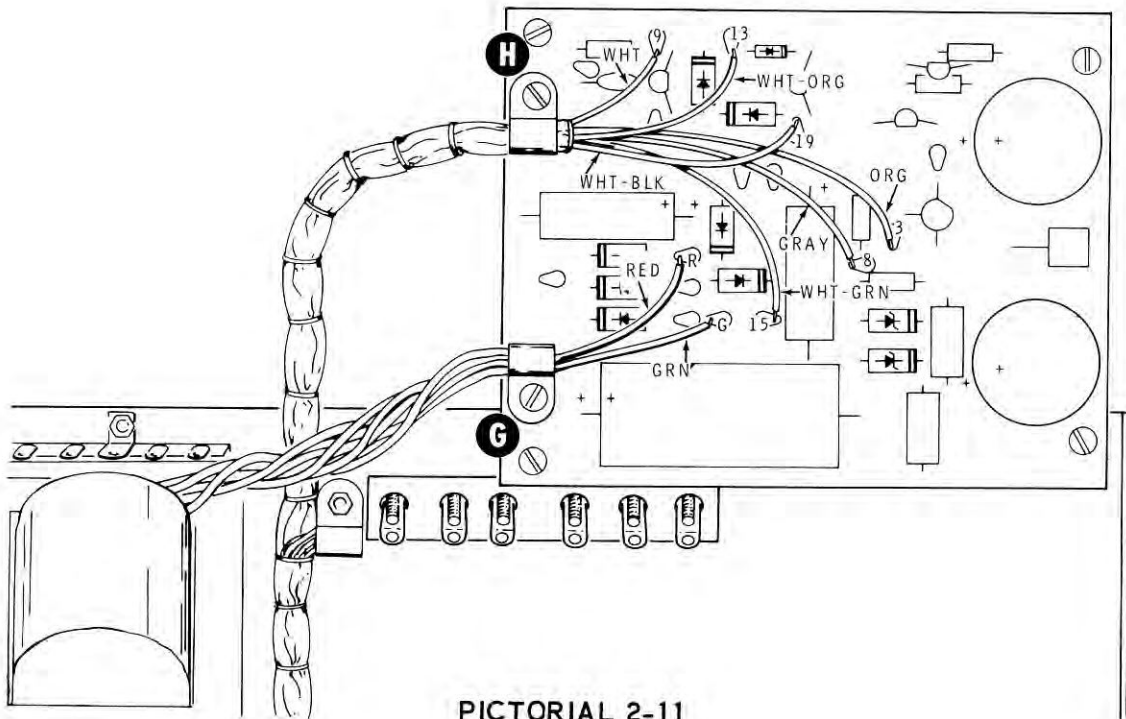


Detail 2-10C

- () Connect the shorter red transformer lead to hole R on the circuit board, just above the green wire (S-1) in the preceding step.
- () Connect the red-yellow transformer lead to hole Y on the circuit board near diode D2 (S-1).
- () Place a plastic cable clamp around the last interval of the cable harness lacing leading to BO#4. Mount the cable clamp in hole H on the circuit board with 6-32 x 3/8" hardware.

Connect part of the wires from BO#4 to the circuit board as follows:

- () Blue wire to hole 6 (S-1).
- () Violet wire to hole 7 (S-1).
- () Yellow wire to hole 4 (S-1).
- () Black wire to hole 10 (S-1).
- () Green wire to hole 5 (S-1).



PICTORIAL 2-11

Refer to Pictorial 2-11 for the following steps.

Pictorial 2-11 shows the completion of the circuit board wiring.

- () Connect the remaining green lead from the transformer to hole G on the circuit board (S-1).
- () Connect the remaining red lead from the transformer to hole R on the circuit board (S-1).

Connect the other wires from BO#4 to the circuit board as follows:

- () Gray wire to hole 8 (S-1).
- () Orange wire to hole 3 (S-1).

- () White-green wire to hole 15 (S-1).
- () White-black wire to hole 19 (S-1).
- () White-orange wire to hole 13 (S-1).
- () White wire to hole 9 (S-1).
- () Adjust the wires in both cable clamps so there is no strain on any connection. Then tighten both clamp mounting screws.
- () Cut off excess leads from the foil side of the circuit board and inspect it carefully to make sure there are no solder splashes between foils.
- () Turn the chassis upside down and shake out any wire clippings or bits of solder.

Proceed to Testing and Final Assembly section.



TESTING AND FINAL ASSEMBLY

RESISTANCE CHECKS

NOTE: In these tests, control and switch settings are not important.

If you have an ohmmeter available, make the following resistance measurements. These measurements will help you determine if you made any construction errors. If you do not obtain readings at least as high as the values given in the following steps, (except the desired zero ohms reading) refer to the In Case Of Difficulty section on Page 38. Before doing any actual troubleshooting, however, complete all the checks. The resistance readings thus obtained may establish a pattern which will make the difficulty easier to locate.

Refer to Figure 1 and make the following resistance tests at the power transistor socket (socket X). A reading of zero ohms at any of the points indicates a short circuit to the chassis; in this case you should remove the transistor assembly and carefully reinstall it as directed on Page 19. Then repeat the resistance checks.

FROM TRANSISTOR	TO	RESISTANCE
() Lug 1	green (\perp) binding post	infinity (∞)
() Lug 2	green (\perp) binding post	infinity (∞)
() Lug 3	green (\perp) binding post	infinity (∞)

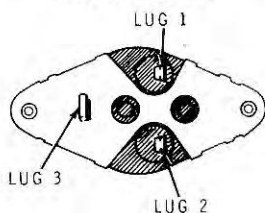


Figure 1

NOTE: Use a VTVM or VOM to make the diode polarity checks in the following steps (the modern, solid-state ohmmeter does not furnish a voltage high enough to meet the threshold voltage requirement of diodes).

Make sure you have the ohmmeter set correctly as the range setting influences the meter reading when there is a diode in the circuit.

If you do not obtain the resistance readings in the following table, reverse the meter leads and make the measurement again. If you still do not get the proper reading, remove the diode from the Power Supply circuit board, check the Manual installation step carefully, and reinstall the diode.

If the proper reading is not obtained after the diode is reinstalled, refer to the "In Case of Difficulty" section of this Manual.

- () Set your ohmmeter range switch to RX1000 for the measurements in the following table. If your meter does not have an RX1000 range, use the next higher range setting.
- () Place the STANDBY switch in the DC ON position:

Refer to Figures 2 and 3 (fold-out from Page 37). A reference to a lug number in the table refers to a numbered lug in Figure 2 (viewed from the rear of the power supply). Additional test points for the ohmmeter's positive lead are shown in Figure 3.

COMMON LEAD	POSITIVE LEAD	RESISTANCE
() lug 1	lug 2	Over 15 k Ω
() lug 2	Top of R8	Over 6000 Ω
() lug 3	lug 4	Over 40 k Ω
() lug 5	Base of Q5	Over 100 k Ω
() lug 6	lug 5	Over 80 k Ω
() lug 6	+ end of C1	Over 100 k Ω

- () Disconnect the ohmmeter leads.
- () Set your ohmmeter range switch on R x 1.
- () Push the POWER switch ON.

- () Connect the ohmmeter leads to the two flat prongs on the line cord plug. If the transformer was wired for 120 VAC, the resistance should be from 4 to 8 Ω . If the transformer was wired for 240 VAC, the resistance should be from 16 Ω to 30 Ω .
- () Connect one ohmmeter lead to the round (grounded) pin on the line cord plug and connect the other lead to the metal part of the green binding post. The resistance should measure near zero ohms, indicating a good ground connection through the panel, chassis, and line cord.
- () Push the POWER switch to OFF.
- () Move the ohmmeter lead from the line cord plug to the white-brown wire which connects to the neon lamps. The resistance should measure infinity.
- () Refer to the inset drawing of Figure 4 (fold-out from Page 37). Loosen the six terminal screws, position the three jumpers as shown, and tighten the six screws.

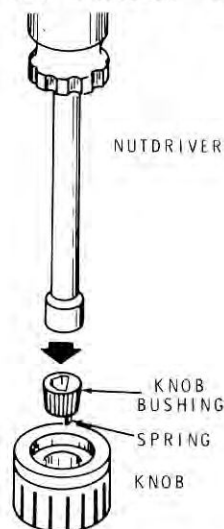
This completes the resistance tests.

KNOB INSTALLATION

Refer to Pictorial 2-12 (Page 33) for the following steps.

- () Refer to Detail 2-12A and place a knob bushing on each of the two knobs; the spring tab on the bushing should face down toward the interior of the knob.

Detail 2-12A



- () The knob and bushings are a force fit. Press the bushings completely into the knobs. Use a nutdriver, or other appropriate tool, as shown.
- () Install each knob on a control shaft.
- () Remove and discard the protective cardboard from the meter face.

ADJUSTMENTS

Perform these checks to determine if the Power Supply operates correctly. The actual use of the Power Supply is described in the Operation section.

- () Refer to Figure 4 (fold-out from Page 37) and set and panel controls and switches as follows:

CURRENT control - Fully clockwise (10 turns)

VOLTAGE control - Fully counterclockwise

METER switch - VOLTAGE

CURRENT RANGE switch - 0.1A

VOLTAGE RANGE switch - 30V

STANDBY switch - STANDBY

POWER switch - OFF

HIGH CURRENT ADJ control - fully counterclockwise

- () If necessary, turn the meter adjust screw on the meter case with a small screwdriver until the meter needle is directly over the "0" line on the meter scale. Tap the face of the meter repeatedly with your finger while making this adjustment.
- () Plug the line cord connector into the electrical outlet.
- () Push the POWER switch to ON. The meter should show no reading (indication). The red VOLTAGE panel lamp should light.
- () Place the STANDBY switch at DC ON. The meter will show a reading of approximately 1/2 volt.
- () Adjust the VOLTAGE control until the meter reads 30 volts.
- () Set the METER switch to CURRENT.
- () Set the CURRENT RANGE switch to 1A.
- () Fasten a piece of wire between the + and - output binding posts.
- () Turn the HIGH CURRENT ADJ control until the meter reads full scale (1 ampere).

- () Disconnect the wire from between the output binding posts.

This concludes the adjustments.

OPERATIONAL CHECKS

NOTE: Figures 5, 7, 8 and 9 depict voltage-current relationships. Voltage is shown on the vertical scale and current is shown on the horizontal scale.

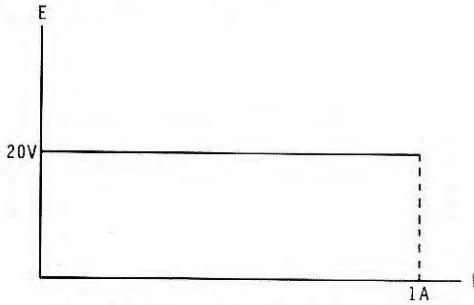


Figure 5

- () Turn the VOLTAGE control clockwise until the meter reads 20 on the lower scale (Figure 5).
- () Push the STANDBY switch to STANDBY.
- () Refer to Figure 6 and insert the leads of the 470 ohm, 2 watt, resistor in the black and the red binding post bases. Tighten the binding post caps down on the two leads.

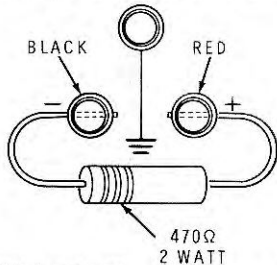


Figure 6

- () Push the STANDBY switch to DC ON.
- () Turn the CURRENT control counterclockwise until the voltage just starts to decrease. (The current is now limited to approximately $20/470 = 42$ mA. See Figure 7.)

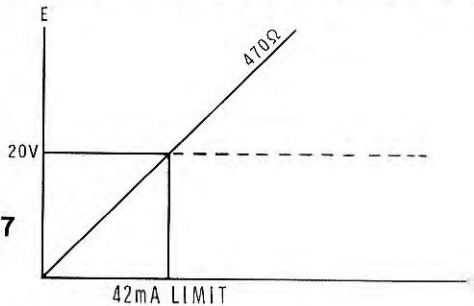


Figure 7

NOTE: For heavier loads (lower resistance), the current drain will be higher than the example and the limit could be set higher, or the output voltage will drop rapidly to a value appropriate for the current limit selected.

- () Turn the VOLTAGE control clockwise. The voltage should not increase (the Power Supply is now current limited. See Figure 8).

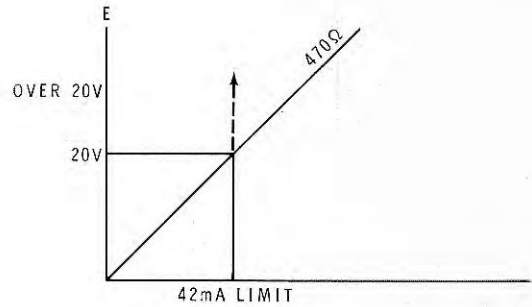


Figure 8

- () Turn the VOLTAGE control counterclockwise until the meter reads less than 20 volts. Then turn the control clockwise until the meter needle just reaches 20 volts.
- () Change the METER switch to CURRENT. The VOLTAGE panel lamp should go out and the amber CURRENT lamp should light up.
- () Turn the VOLTAGE control clockwise. The current reading should not increase significantly.
- () Turn the VOLTAGE control counterclockwise. The voltage and the current should decrease (Figure 9). Check in both CURRENT and VOLTAGE positions of the METER switch.

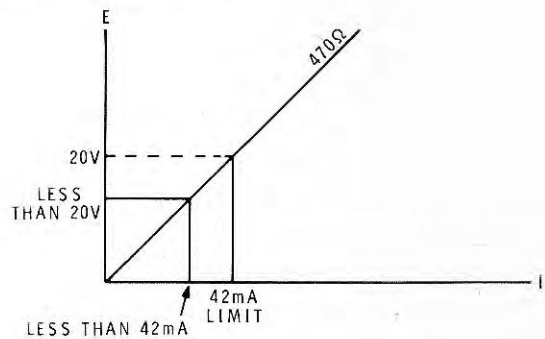


Figure 9

- () Set the STANDBY switch at STANDBY and push the POWER switch to OFF. Remove the power plug from the electric outlet.
- () Remove the 470 ohm resistor from the binding posts. This resistor will not be used again.

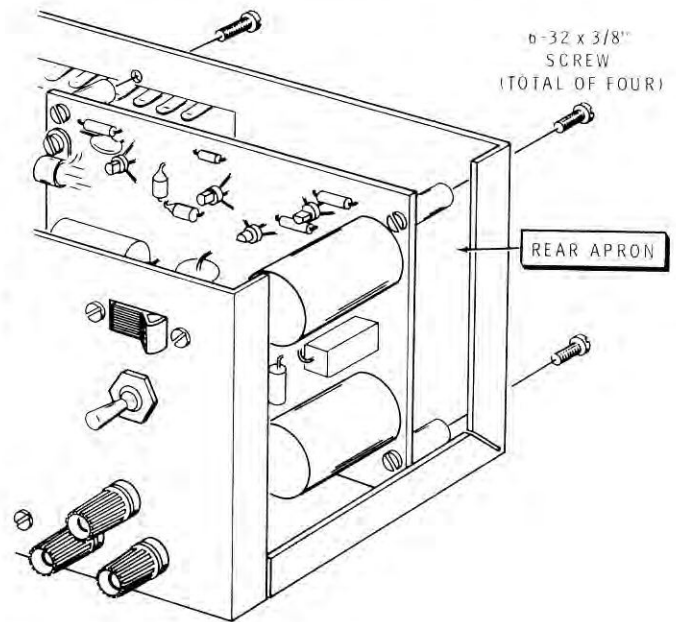
If the foregoing checks indicate proper operation, proceed to the Final Assembly section. If the checks do not result in operation as expected, refer to the In Case of Difficulty section.

FINAL ASSEMBLY

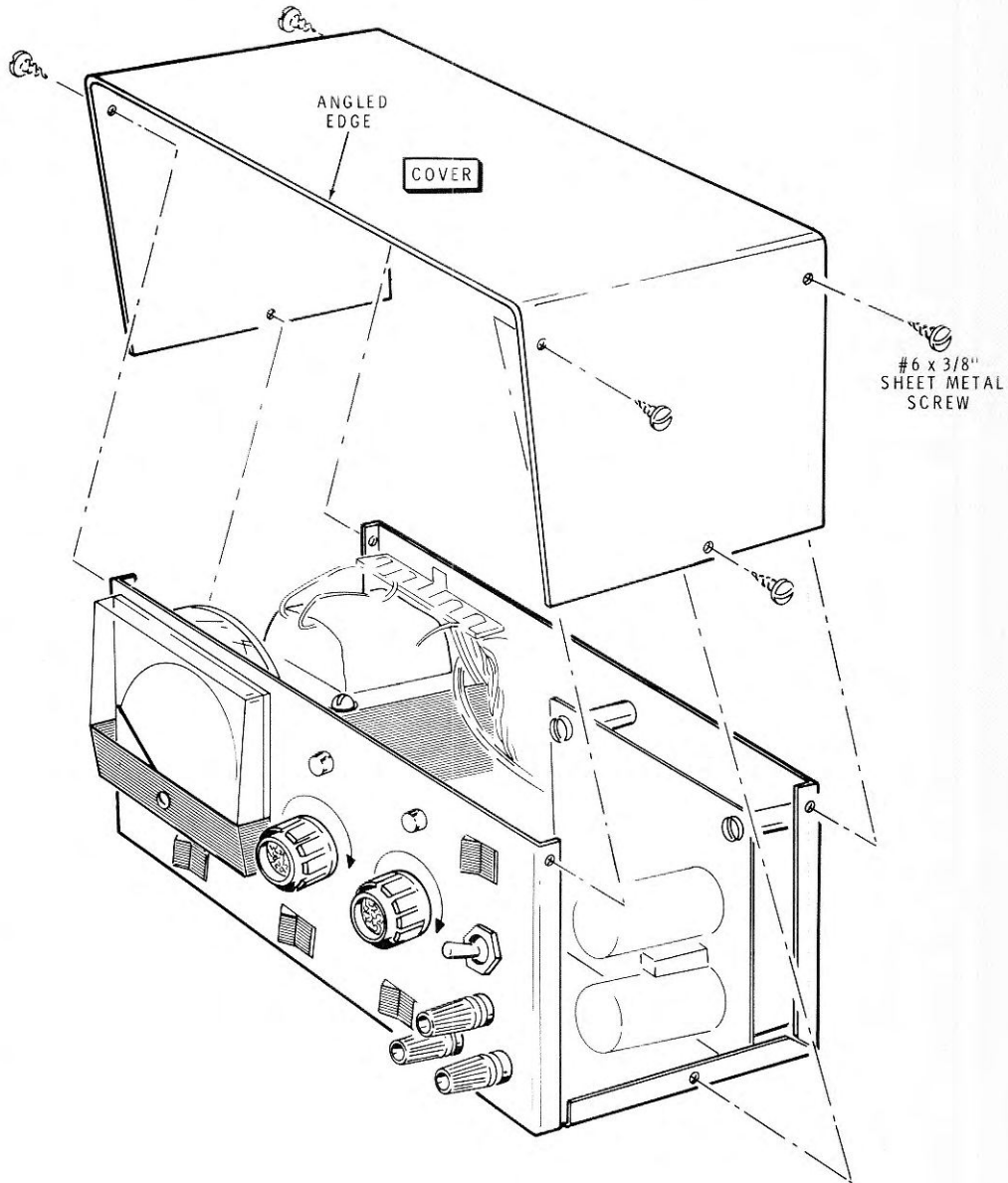
Refer to Pictorial 2-12 for the following steps.

- () Refer to Detail 2-12B, remove the two screws holding the circuit board. Remount the circuit board permanently in the four holes provided in the rear apron. Use 6-32 x 3/8" screws.
- () Install the cover. Use #6 x 3/8" sheet metal screws. Be sure to mount the cover with its angled edge above the front panel.

This completes the assembly of the Power Supply.



Detail 2-12B



PICTORIAL 2-12

OPERATION

In a series regulated power supply the heat dissipation of the supply (the pass transistor in particular) increases with increasing load current and decreasing output voltage. Therefore the power supply will run "hottest" at maximum current and minimum voltage.

The circuit of this Power Supply provides a certain amount of built-in protection when it is adjusted to the knee of the voltage-current output curve. For example, as the load increases (less resistance) the voltage decreases rapidly because the current is limited. If the load decreases (more resistance) the voltage remains constant, while the current decreases.

Refer to Figure 4 (fold-out from Page 37) for control functions and connecting information. Note that the CURRENT control requires approximately ten turns from fully clockwise to fully counterclockwise positions.

A connection to chassis ground has been brought out to a separate binding post (green) on the front panel. This binding post can be connected to either terminal of the floating power supply output to accommodate circuits requiring either a positive or a negative ground.

The jumper between the terminals marked AC on the rear of the cabinet must be connected for all types of operation except Remote Programming (described on Page 35).

The jumpers between rear panel terminals +SENSE and +, and between terminals - and -SENSE, must be connected except when using remote sensing (described on Page 35).

READING THE METER

Refer to Figure 4 for the following explanation.

When the METER switch is in the VOLTAGE position, read the meter scale which corresponds to the position of the VOLTAGE RANGE switch.

When the METER switch is in the CURRENT position, read the 0-10 meter scale only. When the CURRENT RANGE switch is in the 1A

position, divide the meter reading by 10 (i.e., when the meter reads 8, the current is .8A). When the CURRENT RANGE switch is in the 0.1 A position, divide the meter reading on the upper scale by 100 (i.e., when the meter reads 5, the current is .05 A), or multiply by 10 for milliamperes (i.e., when the meter reads 5, the current is 50 mA).

REGULATED VOLTAGE

Constant Voltage Operation

For use when maximum current is not important. In this type of service, only the output voltage is controlled.

1. Preset controls and switches as follows:

CURRENT control - Fully clockwise

VOLTAGE control - Fully counterclockwise

METER switch - VOLTAGE

STANDBY switch - STANDBY

POWER switch - ON

CURRENT RANGE switch - as appropriate.

VOLTAGE RANGE switch - as appropriate.

2. Connect the load to the front panel negative (-) and positive (+) terminals.
3. Set the STANDBY switch to DC ON and advance the VOLTAGE control until the panel meter reads the desired voltage.

LIMITED CURRENT OPERATION

For use when excessive current flow would damage the circuit under test.

1. Preset the controls as follows:

CURRENT control - Fully counterclockwise

VOLTAGE control - Fully counterclockwise

METER switch - VOLTAGE

STANDBY switch - STANDBY

POWER switch - ON

CURRENT RANGE switch - as appropriate.

VOLTAGE RANGE switch - as appropriate.

2. Set the STANDBY switch to DC ON and set the VOLTAGE control for the desired voltage. Then set the STANDBY switch to STANDBY.
3. Connect the load to the front panel negative (-) and positive (+) terminals.
4. Set the STANDBY switch to DC ON.
5. Advance the CURRENT control to a point just past where the preset voltage is obtained.

REMOTE SENSING

Use remote sensing when you wish to measure the error voltage at the terminals of the actual load instead of at the output terminals of the power supply. This will eliminate any error caused by the voltage drop through the power leads to the load.

1. Preset controls and switches as follows:

CURRENT control - Fully clockwise

VOLTAGE control - Fully counterclockwise

METER switch - VOLTAGE

STANDBY switch - STANDBY

POWER switch - ON

CURRENT RANGE switch - as appropriate.
VOLTAGE RANGE switch - as appropriate.

2. Refer to Figure 10 and position the jumpers between the -SENSE and - terminals and the +SENSE and + terminals in the position shown.
3. Connect the load to the front or rear panel negative (-) and positive (+) terminals.
4. Refer again to Figure 10 and connect a pair of insulated wires from terminals -SENSE and +SENSE to the - and + terminals of the load. Be careful to maintain the proper polarity. These wires can be light gauge as they carry only a small current.

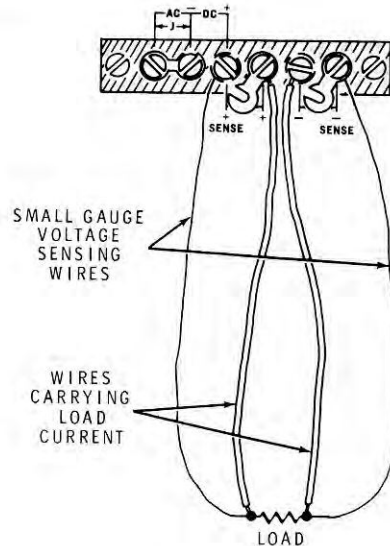


Figure 10

5. Set the STANDBY switch to DC ON and advance the VOLTAGE control until the desired voltage is reached.
6. Set the STANDBY switch to STANDBY and the POWER switch to OFF.
7. Remove the sensing leads and reconnect the sensing jumpers on the terminal strip.

REMOTE PROGRAMMING

The Programming terminals on the rear of the cabinet are connected to the reference voltage circuit in the Power Supply. These terminals make it possible for you to control the reference voltage circuit, and therefore, the output of the Power Supply, from an external DC (DC Programming) or AC (AC Programming) voltage source.

CAUTION: Be sure the power is off before touching any jumpers or terminals on the rear of the Power Supply.

DC Programming

1. Remove the jumper from between the AC lugs (lugs 5 and 6) on the Programming terminal strip to remove the internal reference voltage source. The other two jumpers must remain connected.

2. Connect the leads supplying the desired DC control voltage to the DC terminals on the rear of the cabinet. Be sure to observe proper polarity, and do not use a control voltage which exceeds the capabilities of the Power Supply (30 VDC) or damage may result.
3. Set the VOLTAGE control fully clockwise and the CURRENT control as desired. The output voltage will now follow the voltage applied to the DC PROGRAMMING terminals. Note that the VOLTAGE control can now be used to reduce the output voltage below the applied control voltage.

The output voltage from the Power Supply will now be pulsating DC, with a modulation component which approximates the waveform of the external AC control voltage. The VOLTAGE control will set the average voltage of the pulsating DC output. The CURRENT control operates normally.

NOTE: Be sure to reinstall the jumper between the AC terminals on the Programming terminal strip when you disconnect the external control voltage leads.

AC Programming

1. Make sure the Power Supply is off.
2. Remove the jumper from between the AC lugs on the Programming terminal strip.
3. Connect the leads supplying the desired AC control voltage to these same AC terminals.

NOTE: The AC signal source should have a low DC resistance (such as a low impedance transformer secondary) to maintain a DC output reference.

SERIES OPERATION

Two or more Power Supplies can be connected in series to obtain voltages greater than 30 volts. The correct method of connecting Power Supplies for series operation is shown in Figure 11. CURRENT control settings should be identical in each series unit, but VOLTAGE control settings can be distributed between the Power Supplies as desired.

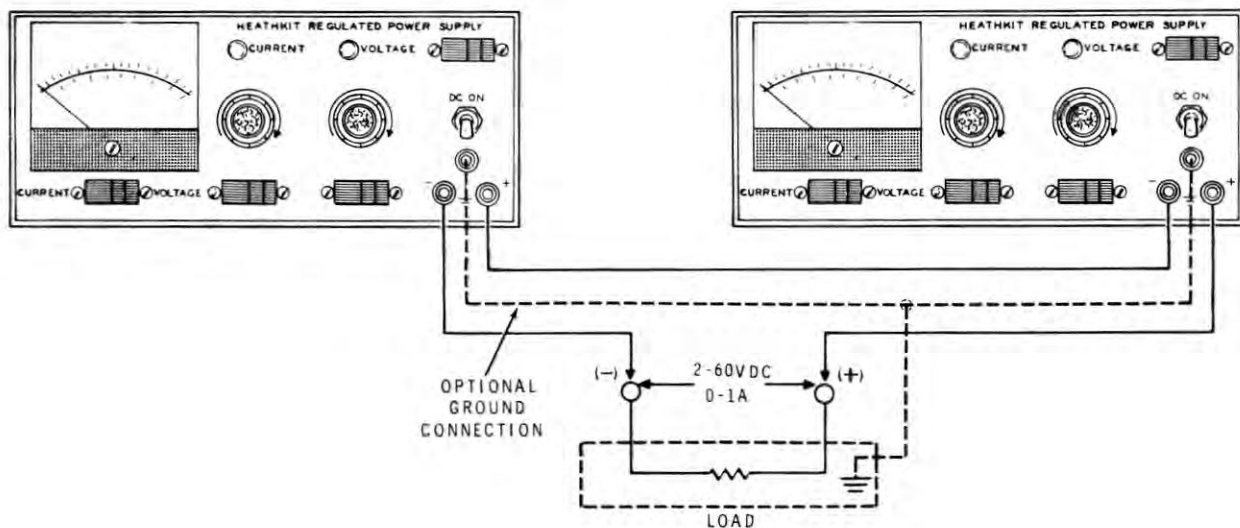


Figure 11

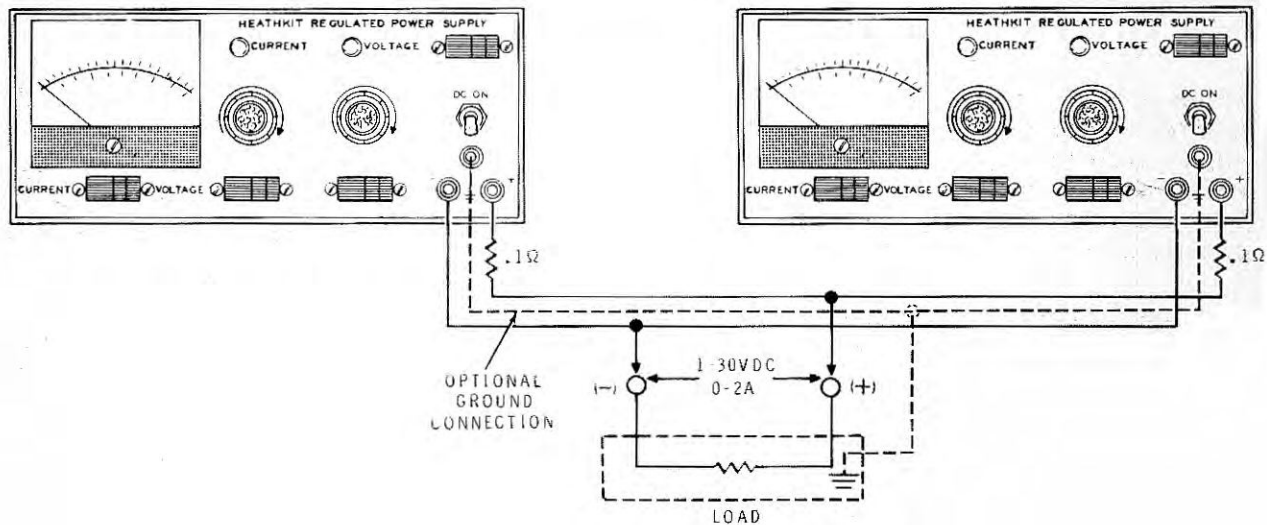


Figure 12

PARALLEL OPERATION

For high current loads, two or more Power Supplies can be connected in parallel, as shown in Figure 12. Use the following steps for parallel connections.

1. Determine the voltage required and pre-adjust the VOLTAGE control of each Power Supply to this value. Do not connect the lead until directed to do so.
2. Set the STANDBY switches of both Power Supplies to STANDBY.
3. Place a $.1\Omega$ resistor (not supplied) in series with the positive (+) lead of each Power Supply as shown.
4. Connect together the negative (-) binding posts of all Power Supplies.
5. Connect the load as shown in Figure 12.

Unless current limiting is required, operate all the Power Supplies with the CURRENT controls at Maximum. If current limiting is required, set the CURRENT controls of all Power Supplies just above the point where the limiting occurs. Also remember that each time you change the voltage setting of one of the Power Supplies, you must also change the others by an equal amount. If this is not done, one Power Supply may load the others.

NOTE: It is important that approximately equal currents be drawn from each of the Power Supplies. Place each METER switch in the CURRENT position and equalize the currents of each Supply with the VOLTAGE controls.

CAUTION: This instrument is not intended for use as a battery charger. If it were used for this purpose, it would be necessary to use an external circuit to protect the power supply from damage caused by reverse current.

REFERENCE

For information on the design of regulated DC power supplies, refer to the Kepeco Power Supply Handbook by Paul Birman, published by Kepeco, Inc., Flushing, New York, 11352.

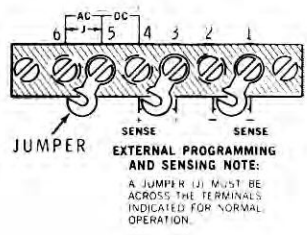


FIGURE 2

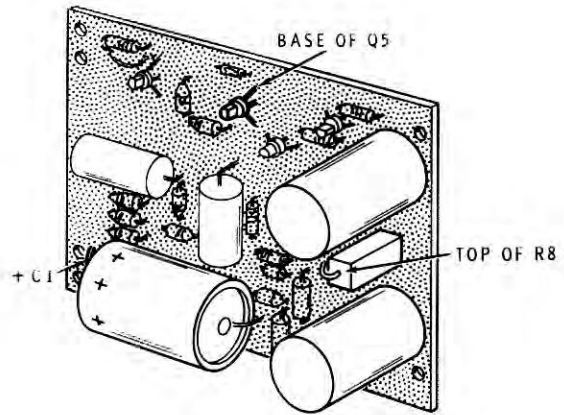


FIGURE 3

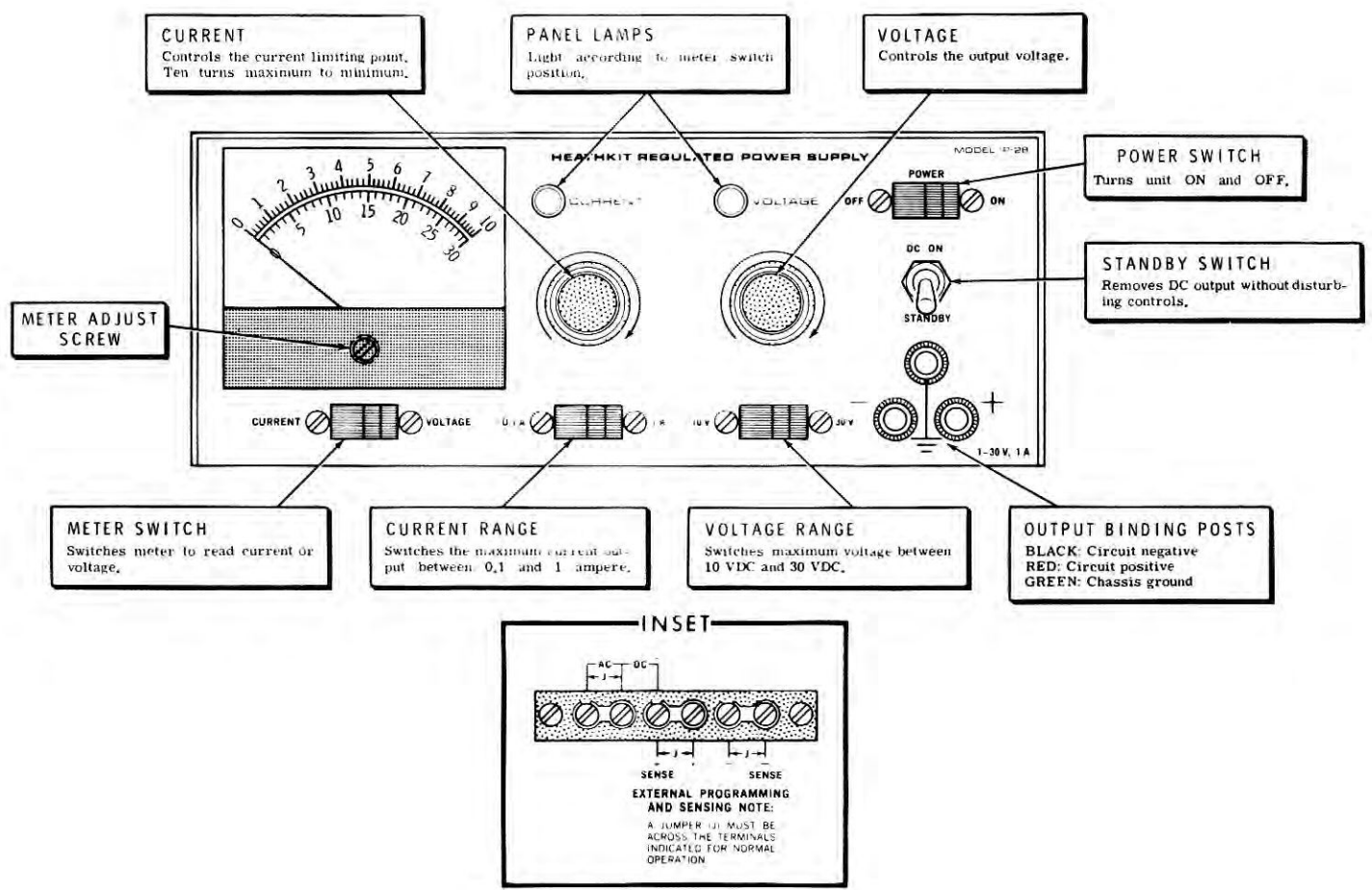


FIGURE 4

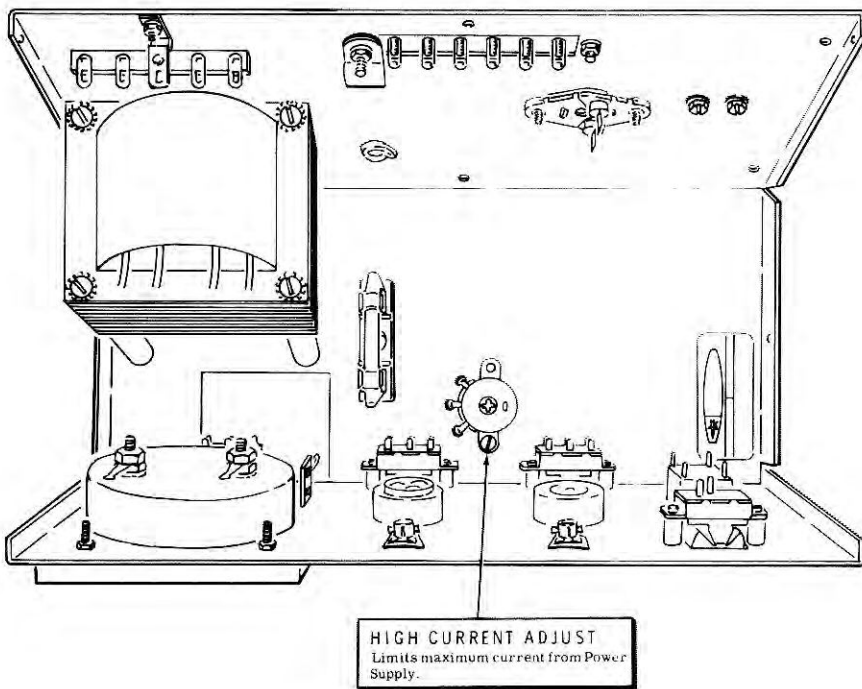


FIGURE 4A

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.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog. NOTE: Do not include wooden cabinets, which are easily damaged in shipment, when returning equipment for service.

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 send 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 observe 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 49022.

Check the equipment to see that all parts and screws are in place. 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

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 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 Soldering section of the Kit Builders Guide.
3. Check the values of the parts. Be sure that the proper parts have been wired into each 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, or solder splashes between foils on the circuit board.
5. Refer to the troubleshooting chart. Before you replace any parts, check all possible causes of the malfunction to avoid damage to the new parts.
6. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary as much as $\pm 10\%$.
7. A review of the Circuit Description may help you locate the trouble.

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 the fold-out from this Page.

Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE
No output voltage (pilot lamp lights).	<ol style="list-style-type: none"> 1. Diodes D1 and D2. 2. Transistor Q3, or Q3 shorted to chassis. Also check Q4 and Q5. 3. Capacitors C3, C4 or C5 shorted. 4. Transformer T1 improperly wired. 5. "AC" Shorting jumper missing from rear terminal strip.
Low output voltage (no voltage control).	<ol style="list-style-type: none"> 1. Diode D3. 2. Diode D4 or D5 shorted. 3. Diode D6 open. 4. Transistor Q5. Also check D6. 5. Transistor Q3, or Q3 shorted to chassis. Also check Q4, Q5, and Q6. 6. Transistor Q4. 7. Capacitor C1 or C2 shorted. 8. Transistor Q6 shorted.

SYMPTOM	POSSIBLE CAUSE
High output voltage (no voltage control).	<ol style="list-style-type: none"> 1. Transistor Q5. Also check D6. 2. Transistor Q4. 3. Transistor Q3, or Q3 shorted to chassis.
No current output (voltage normal).	<ol style="list-style-type: none"> 1. Transistor Q6 shorted. 2. Transistor Q1 or Q2. 3. Control R13 open. 4. Resistor R15 or R16 open.
Current limiting inoperative.	<ol style="list-style-type: none"> 1. Control R13 shorted. 2. Transistor Q6.
Excessive ripple.	<ol style="list-style-type: none"> 1. Capacitors C1, C2, C3 or C4.
Low output voltage with ripple.	<ol style="list-style-type: none"> 1. Diode D1 or D2 open. 2. Capacitor C1, C2, C3, or C4 leaky.
Poor regulation.	<ol style="list-style-type: none"> 1. Diode D4 or D5 open (line regulation only). 2. Transistor Q5 (load regulation only). 3. Transistor Q1 or Q2 (line and load regulation). 4. Transistor Q4 (line and load regulation). 5. Transistor Q3 (line and load regulation). 6. Sensing shorting bars missing on rear terminal strip.
Low output voltage (very little control)	<ol style="list-style-type: none"> 1. Transistor Q6. 2. Transistor Q1 or Q2. 3. Diode D4 or D5. 4. Capacitor C1 or C2 leaky.
Meter inaccurate.	<ol style="list-style-type: none"> 1. Meter. 2. Resistor R16 or R17 (current). R17 on 1A range only. 3. Resistor R18 or R19 (voltage). R19 on 30 V range only. 4. Switch S3 (current) or S4 (voltage). 5. Check the meter zero adjustment.
Output oscillates with low current in current limiting operation.	<ol style="list-style-type: none"> 1. C6 open.



SPECIFICATIONS

Voltage Output.	Two ranges: 1-10 VDC and 1-30 VDC, continuously adjustable.
Load Regulation,	Less than 50 mV variation from no load to full load (at front panel terminals) without remote sensing. Less than 20 mV variation from no load to full load at front or rear panel terminals when using remote sensing.
Line Regulation,	Less than 25 mV variation in output voltage for 10% change in line voltage.
Ripple and Noise,	Less than 5 mV.
Current Output,	1 ampere maximum (.75 ampere maximum continuous load below 5 volts).
Current Limiting,	Two ranges: 10-100 mA and 10 mA - 1 ampere continuously adjustable.
Transient Response,	25 μ s maximum.
Output Impedance,3 Ω or less to 100 kHz.
Meter Accuracy,	3% of full scale.
Meter Ranges,	One switch determines voltage or current reading. Two voltage ranges: 0-10 V, 0-30 V. Two current ranges: 0-100 mA, 0-1 ampere.
External Programming,	AC or DC programming. 5000 Ω load on DC.
Power Requirements,	105-125 or 210-250 VAC, 50/60 Hz, 50 watts, at full load.
Dimensions (over-all),	10-3/4" wide x 4-3/8" deep x 6-1/2" high.
Net Weight,	6-1/2 lbs.

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.

THEORY OF OPERATION

Qualifications for a perfect power supply would include zero internal resistance, a condition that is theoretically ideal but not practically possible. When a load is connected to the output terminals, the voltage tends to decrease due to the increased current flow through the internal resistance of the supply. A common example of this loss can be seen when the lights on a car dim as the engine is being started. The automobile storage battery, which is the power supply in this case, contains internal resistance and causes a voltage drop during the heavy current drain by the starter motor. This reduced voltage causes the lights to dim.

A regulated Power Supply is designed to simulate an ideal zero internal resistance condition. This is done by using automatic correction (regulating) circuits to hold the output voltage at a constant level.

In Figure 13 line A represents the output of a typical power supply. As the current (I) increases, the voltage (E) decreases. Line B represents a regulated Power Supply where the voltage remains constant with increasing current.

Figure 14 shows a basic voltage regulated power supply, where E_s is a DC voltage source, and R_I is the internal resistance of the voltage source. E_{REF} is an independent reference voltage source of the same voltage as desired from the output. When a load, R_L , is applied to the output terminals, current flows. This current flow causes a voltage drop across R_I and R_R , with an attendant voltage drop between the (+) and (-) output terminals.

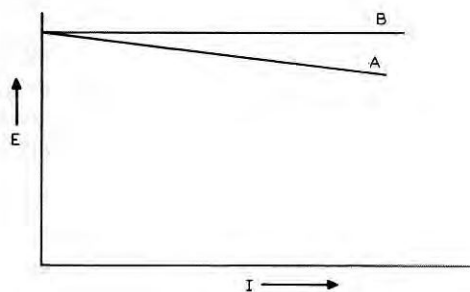


Figure 13

At the same time, the difference voltage (between E_{R_I} and E_{REF}) E_D , occurs at the input of amplifier A. This difference voltage is amplified in A to produce a usable error signal. The error signal is then transferred to some form of variable resistance, such as a transistor (R_R), in series with the load path.

When the output voltage starts to decrease, the error voltage causes resistance R_R to decrease also. This causes less voltage to be dropped across R_R and compensates for the voltage drop across R_I . Thus, when the voltage drop across R_I increases, the voltage across R_R decreases by an equal amount and the output voltage is held at the same level.

When remote sensing is used, the error voltage is sensed at the input terminals of the actual load and therefore includes the voltage drop caused by the resistance of the leads from the power supply.

Although the foregoing is a simplified description of the regulating action, the important point to remember is that a feedback system of the correct value and speed can be made to perform the regulating function. It can also be seen that the original supply voltage must be considerably higher than the desired output voltage, in order to compensate for the voltage drop in series resistance R_R and internal resistance R_I .

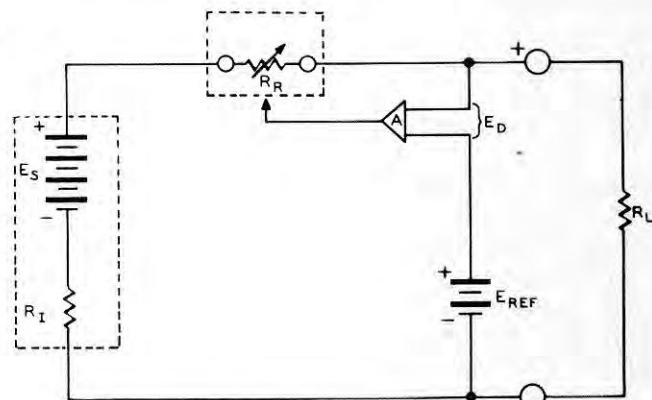


Figure 14

CIRCUIT DESCRIPTION

This Regulated Power Supply consists of four sections: the power source, the reference voltage source, the voltage regulating and sensing circuits, and the current limiter. Each of these sections will be described separately. Refer to the Schematic Diagram (fold-out from Page 47) while you read this description.

POWER SOURCE

AC input voltage from the power line is connected through switch S1 and the 3/4 ampere fuse to power transformer T1. The transformer has two primary windings.

These windings are connected in parallel for 120 volt AC, 50/60 Hz operation, or in series for 240 volt AC operation.

The power transformer has two secondary windings. One winding is used for the Reference Voltage Source, described later. The output of the other winding is rectified by diodes D1 and D2 in a full wave circuit and filtered by C3, R8 and C4 which are connected in a pi configuration.

The green line cord wire connects the chassis to the power line ground when the line cord is plugged into a properly grounded three-wire outlet. A short circuit to the chassis of primary circuit components within the chassis enclosure will therefore complete a circuit to ground and blow the fuse. This protection is not provided when the line cord adapter (furnished) is used with a two-wire outlet, unless the adapter pigtail is connected to the outlet plate mounting screw, and the metal wall outlet box is properly grounded.

The Current and Voltage indicator lamps, PL-1 and PL-2, are alternately connected to one of the two primary transformer windings by S2-C. The proper lamp is illuminated for the corresponding position of S2, the current-voltage switch. Note that the indicator lamps are always wired for 120 VAC operation.

REFERENCE VOLTAGE SOURCE

The reference voltage source consists of the output of the remaining transformer secondary winding, which is rectified by diode D3 and filtered by C1, R3, and R4. The two resistors also act as voltage-dropping resistors for zener diodes D4 and D5 which hold the voltage at the junction of R4 and R5 at 36 VDC. The actual voltage at the junction of R6 and C2 depends upon the position of S4-A, part of the Voltage Range switch. The Voltage panel control (R7) acts as a voltage divider (through the AC jumper) to select the value of reference voltage desired. This voltage is connected to the base of Q5 through diode D6, which protects Q5 against any inverse base-emitter voltage.

CURRENT LIMITER

The current limiter is composed of transistor Q6, Current control R13, High Current control R14, and resistor R15, which act in conjunction with transistors Q3 and Q4.

Transistors Q3 and Q4 are directly connected in a Darlington circuit, which results in a sensitive, high-gain amplifier. They may be considered as a single high-power, high-gain transistor, which is referred to as a "pass" transistor.

Transistor Q6 acts as a current sensing transistor. When sufficient current flows through R13 and R14 (and R15, depending on the position of Current Range switch S3), a voltage drop of .6 V occurs. This voltage appears across the base emitter junction of Q6, causing it to conduct and effectively short the base to the emitter of the Darlington pair (Q3, Q4). This increases the series resistance of Q3 and limits the output of the Power Supply. The point at which this occurs is determined by the setting of Current control R13, which varies the resistance and thus the voltage drop between the base and emitter of Q6. R12 serves as a load (or bleeder) resistor to maintain a current flow through Q3 at all times.

R14 is a current limiting control. It determines the maximum current available from the Power Supply when contacts 2 and 3 of switch S3 are closed (1A range). R15 determines the maximum current available when contacts 2 and 3 of switch S3 are open (0.1A range).

R16 is a meter current shunt for the 0.1A current range. R17 is a series resistor used for meter calibration in the 1A range.

C5 reduces the AC output impedance of the Power Supply.

C6 prevents high frequency oscillations at the output in limited current operation at low current levels.

VOLTAGE REGULATOR

Ordinary Use

The "pass" transistor combination is driven, for voltage regulation purposes, by a voltage divider across the power source. One side of the divider is a constant current source composed of Q1, Q2, R9 and R11. The other side of the divider is formed by Q5 installed between the base of Q4 and the negative (-) side of the power source.

When Q5 is not turned on, the constant current source biases the pass transistor (Q3, Q4) into conduction, producing maximum output voltage. The reference voltage, between the + output terminal and the base of Q5, provides base drive for Q5. The constant current from Q2 is passed to the negative (-) side of the power source through Q5, leaving less drive for the pass transistor. The pass transistor base current decreases and the resistance (R_R of Figure 12) increases. A balanced condition will be reached, depending on the reference voltage. The output voltage will be equal to the reference voltage plus the base-emitter voltage drop in Q5.

Increased current drain increases the voltage drop in R_R , lowering the drive to Q5 and decreasing the constant current flow through Q2. Thus, more drive is available for the pass transistor, lowering its resistance and returning the output voltage practically to the original level.

The meter is connected to read voltage when contacts 2, 3, 5 and 6 of S2 are closed. R18 and R19 are meter multiplier resistors for the 30 volt range. R19 is shorted out by S4B for the 10 volt range.

Voltage regulation is slightly better at the rear apron terminals than at the output binding posts because of internal wiring resistance. However, this slight difference will be of significance only in critical applications.

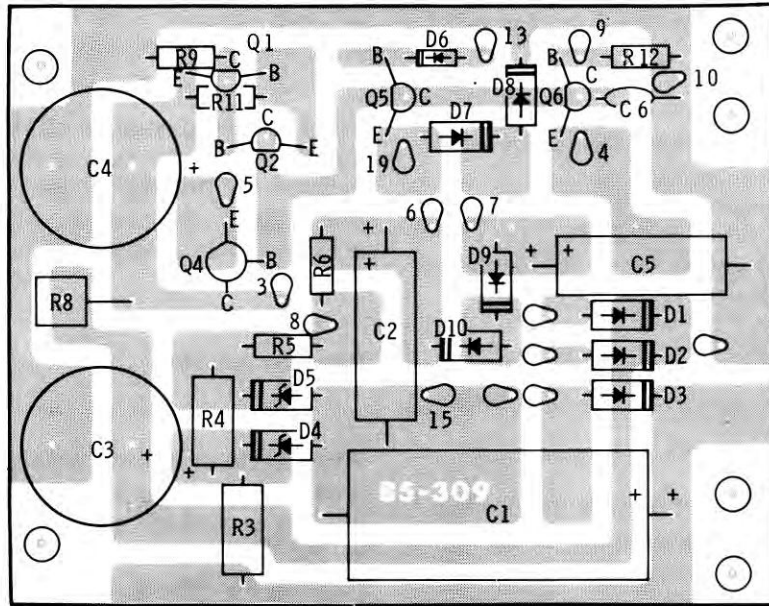
Remote Sensing

When a load draws a large amount of current from a power supply, the resistance of the leads causes a voltage drop, and the voltage is lower at the load terminals than at the power supply terminals. When remote sensing is used, the jumpers on the rear panel are removed, and wires are connected to the load as shown in Figure 10. Now the power supply voltage regulating circuits will sense the voltage applied to the terminals of the load.

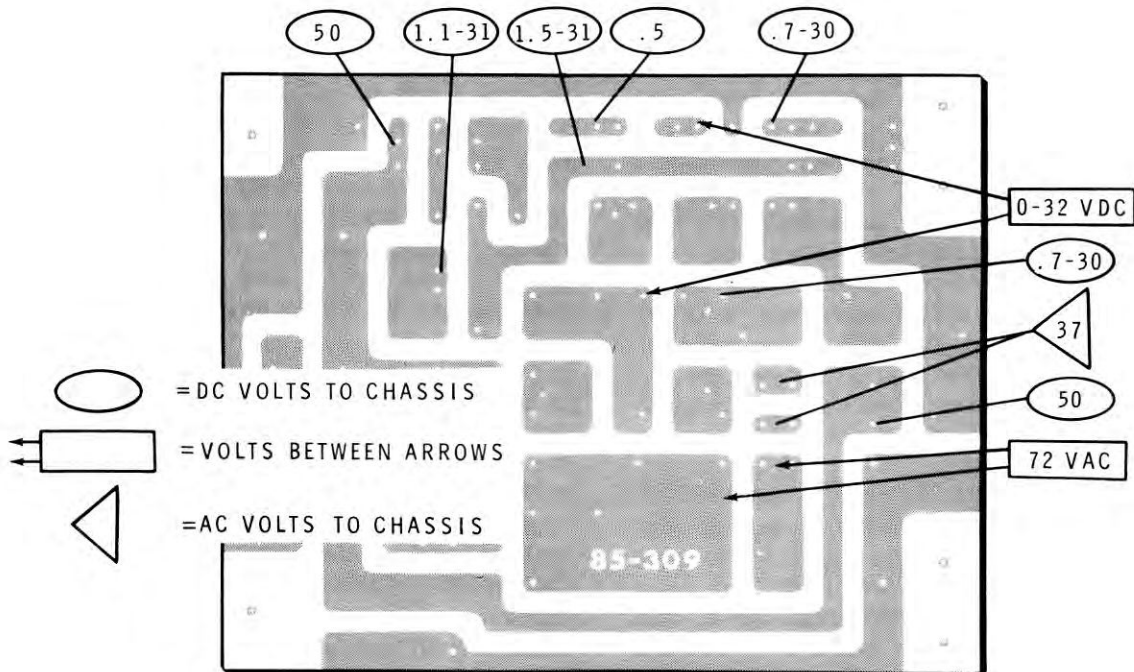
The negative Sense terminal is connected to the emitter of Q5, and the positive Sense terminal is connected to the reference voltage source. Therefore, any change in voltage on either terminal of the load will change the drive voltage to Q5. The change in drive voltage on Q5 will change the output of the Power Supply in the manner described in the Voltage Regulation section. The output will change just enough to compensate, or offset, the voltage drop.

If the external sensing wires are accidentally disconnected, voltage will not be supplied to the sense circuits. Therefore, the Power Supply will automatically try to compensate for this apparent drop in voltage at the load. The output voltage will increase immediately. However, diodes D7-D8 and D9-D10 will conduct when the increase reaches 1.2 volts and prevent the output voltage from increasing further.

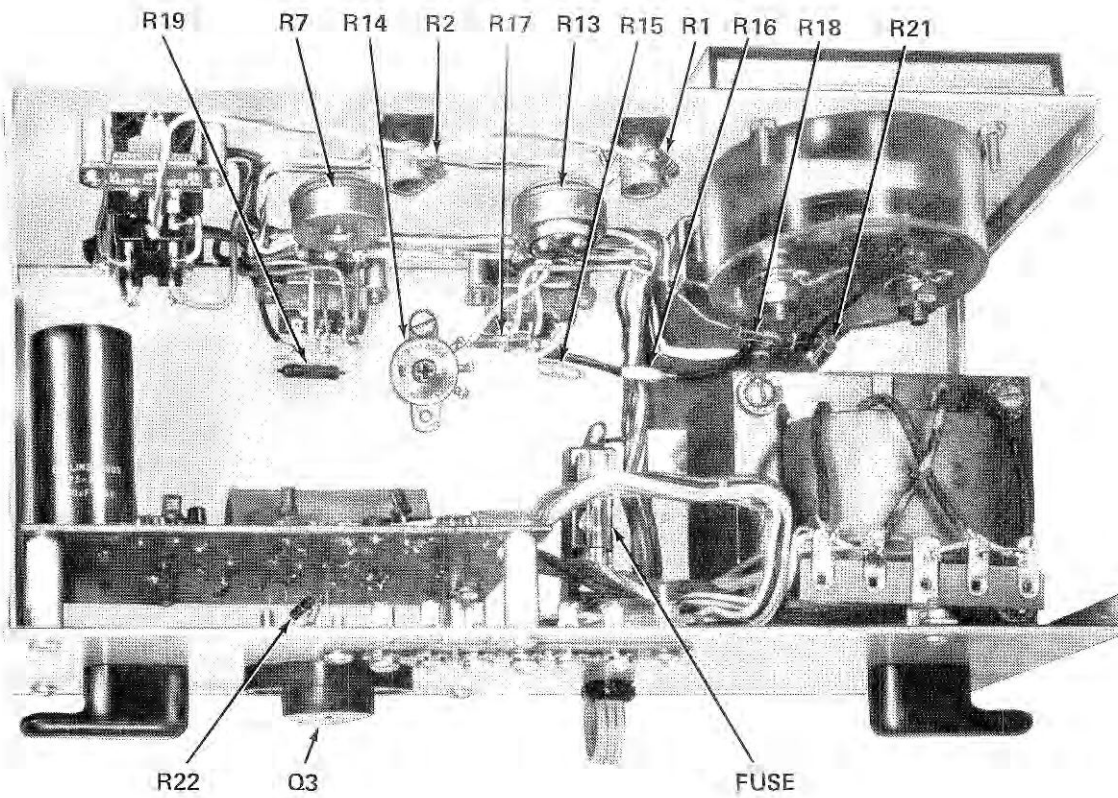
CIRCUIT BOARD X-RAY VIEW (viewed from foil side)



CIRCUIT BOARD VOLTAGES (viewed from foil side)



CHASSIS PHOTOGRAPH



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.

The following prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add

10% (minimum 25 cents) to the price when ordering from 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.

PART No.	PRICE Each	DESCRIPTION
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RESISTORS

1/2 Watt

1-6	.10	470 Ω
1-63	.10	510 Ω
1-81	.10	1500 Ω
1-14	.10	3300 Ω
1-16	.10	4700 Ω
1-20	.10	10 k Ω
1-23	.10	27 k Ω

1/2 Watt 1% Precision

2-262	.75	.505 Ω
2-167	.55	4 Ω
2-261	.20	454 Ω
2-35	.20	9000 Ω (9 k)
2-189	.20	18 k Ω

Other Resistors

1-23-1	.10	2200 Ω , 1 watt
1-3-1	.10	3300 Ω , 1 watt
1-12-2	.15	470 Ω , 2 watt
3-21-5	.15	2.6 Ω , 5 watt

CAPACITORS

21-21	.10	200 pF, disc
25-126	.50	50 μ F, 50 VDC
25-57	1.00	100 μ F, 200 VDC
25-214	1.95	500 μ F, 75 VDC

CONTROLS-SWITCHES

10-285	1.45	100 Ω control
10-203	.95	5000 Ω (5 k) control
11-124	.50	1 Ω control
60-24	.50	SPST rocker switch
60-25	.55	DPDT rocker switch
60-34	.75	TPDT rocker switch
61-3	2.85	DPST toggle switch

PART No.	PRICE Each	DESCRIPTION
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DIODES-TRANSISTORS

56-26	.25	1N191 crystal diode
57-27	.40	Silicon diode
56-55	1.00	36 V zener diode
56-13	1.10	56 V zener diode
417-135	.85	2N3859A transistor
417-201	.50	PNP transistor
417-237	.65	SE6020 transistor
417-215	2.85	2N3055 transistor

BINDING POSTS-TERMINALS

75-17	.10	Binding post bushing
427-3	.10	Binding post base
100-16-2	.10	Black binding post cap
100-16-18	.10	Red binding post cap
100-699	.15	Green binding post cap
431-50	.10	1-lug terminal strip
431-42	.10	5-lug terminal strip
431-7	.25	6-screw terminal strip
431-82	.10	Terminal collar

HARDWARE

250-56	.05	6-32 x 1/4" screw
250-365	.05	#6 x 1/4" hex head sheet metal screw
250-8	.05	#6 x 3/8" sheet metal screw
259-89	.05	6-32 x 3/8" screw
250-206	.05	6-32 x 11/16" screw
252-3	.05	6-32 nut
254-1	.05	#6 lockwasher
254-27	.05	#6 internal-external lockwasher
259-1	.05	#6 solder lug
250-137	.05	8-32 x 3/8" screw
259-25	.05	Double solder lug
252-7	.05	Control nut
253-10	.05	Control flat washer
254-5	.05	Control lockwasher



PART No.	PRICE Each	DESCRIPTION
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Hardware (cont'd.)

252-32	.05	Speednut
255-1	.05	1/8" spacer
255-74	.05	1/16" spacer
255-23	.05	15/32 long spacer tapped 6-32
255-15	.05	1/2" spacer
255-37	.15	3/4" long spacer tapped 8-32
255-21	.15	7/8" long spacer tapped 6-32

MISCELLANEOUS

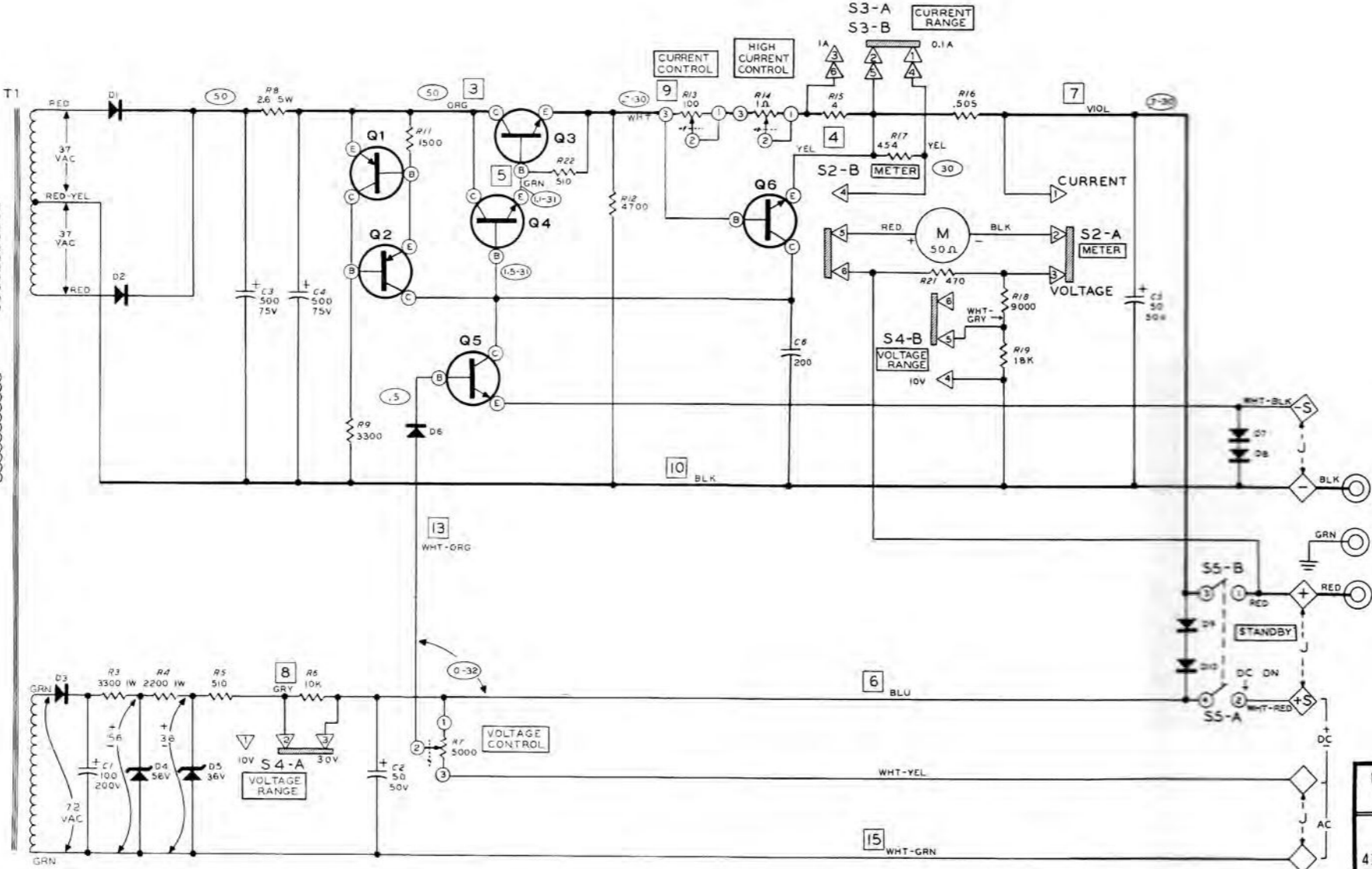
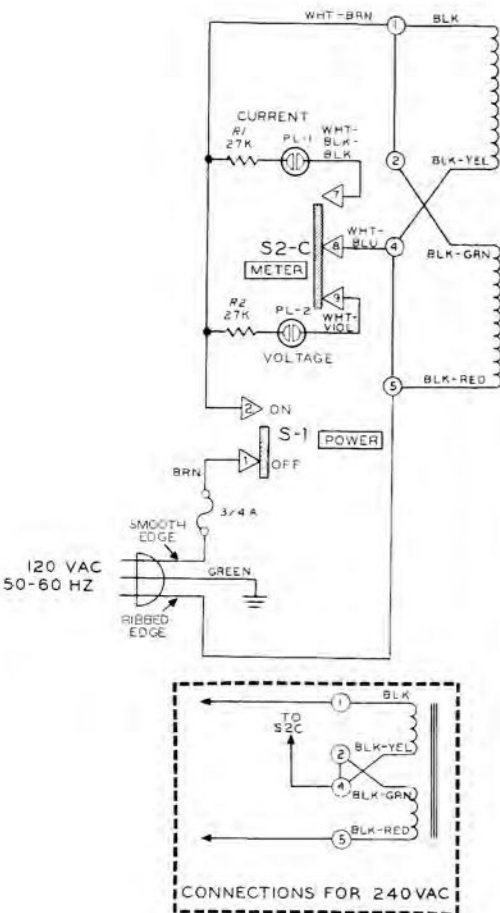
54-228	5.10	Power transformer
75-71	.10	Strain relief, flat line cord
75-30	.10	Strain relief, round line cord
89-23	.75	Line cord
75-60	.10	Mica insulator
75-88	.10	Transistor case insulator
75-108	.10	Fish paper
85-309-3	1.25	Circuit board
90-446-1	1.60	Cover
203-613	.95	Panel
203-614	1.40	Chassis

PART No.	PRICE Each	DESCRIPTION
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Miscellaneous (cont'd.)

134-198	2.40	Wiring harness
207-5	.10	Plastic cable clamp
261-29	.05	Plastic foot
261-30	.10	Line cord retainer
346-1	.05/ft	Sleeving
352-13	.15	Silicone grease
407-127	8.60	Meter
412-15	.25	NE-2H neon lamp
413-10	.10	Red lens
413-14	.15	Amber lens
421-29	.40	3/4 ampere slow-blow fuse
422-1	.25	Fuseholder
432-27	.40	Line cord adapter
434-117	.20	Transistor socket
455-50	.10	Knob bushing
462-246	.25	Knob
490-5	.10	Nut starter
331-6	.15	Solder
	2.00	Manual (See front cover for part number.)

NOTE: TRANSFORMER LEAD NUMBERS REFER TO THE LUGS OF TERMINAL STRIP AB IN THE MANUAL.



SWITCH:	SHOWN IN POSITION
S1	OFF
S2	VOLTAGE
S3	0.1A
S4	10V
S5	STANDBY

SCHEMATIC OF THE HEATHKIT®
1-30V DC REGULATED POWER SUPPLY MODEL IP-28

NOTES:

- RESISTOR VALUES ARE IN OHMS (K=1,000). RESISTORS ARE 1/2 WATT UNLESS OTHERWISE MARKED.
- CAPACITOR VALUES ARE IN MICROFARADS (μF). CAPACITOR WORKING VOLTAGES ARE INDICATED.
- THE CROSS-ARROW ON A CONTROL ARM SYMBOL INDICATES CLOCKWISE ROTATION OF CONTROL.
- DC VOLTAGE MEASUREMENTS TAKEN WITH A HIGH IMPEDANCE VOLTMETER. VOLTAGES MAY VARY ±10%.
 - ALL VOLTAGES WERE MEASURED WITH:
 - NO LOAD ON THE OUTPUT TERMINALS AND 115 VAC, 60Hz, ON THE POWER TRANSFORMER PRIMARY.
 - THE VOLTAGE CONTROL AND THE CURRENT CONTROL FULLY CLOCKWISE AND THE VOLTAGE RANGE SWITCH IN THE 30V POSITION.
 - WHERE TWO VOLTAGES ARE SHOWN, THE CIRCUIT VOLTAGE DEPENDS UPON THE SETTINGS OF THE VOLTAGE RANGE SWITCH (S-4) AND THE VOLTAGE CONTROL (R7).

SPECIAL SYMBOLS

- (numbers or letters within symbol outlines will vary.)
- SLIDE SWITCH TERMINAL
 - CIRCUIT BOARD NUMBERED HOLES
 - TRANSISTOR TERMINAL
 - CONTROL OR SWITCH TERMINAL
 - REAR APRON TERMINAL STRIP
 - PANEL BINDING POST
 - DC VOLTAGE FROM POINT SHOWN TO BLACK BINDING POST.
 - JUMPER CONNECTION ON REAR APRON

PART NO.	COMPONENT	MAY BE REPLACED WITH	BASE * DIAGRAM
417-201	Q1, Q2	2N3906	
417-215	Q3	2N3055	
417-237	Q4	SE6020	
417-135	Q5, Q6	2N3859A	
57-27	D1, D2, D3, D7, D8, D9, D10	SILICON, 600 PIV. 1A	
56-13	D4	56 V ZENER, 1W	
56-55	D5	36 V ZENER, 1W	
56-26	D6	1N191	

* VIEWED FROM BOTTOM OR LEAD SIDE