

MODEL

# IP-27 Regulated Low Voltage Power Supply **HEATHKIT**<sup>®</sup> ASSEMBLY MANUAL

Model IP-27 Regulated Low Voltage Power Supply

HEATH COMPANY • BENTON HARBOR, MICHIGAN



PRICE \$2.00



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595-859-09



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Sincerely,

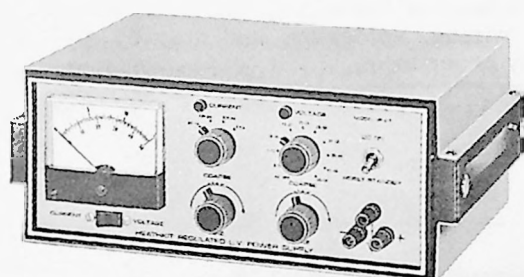
HEATH COMPANY  
Benton Harbor, Michigan 49022

# Assembly and Operation of the



## REGULATED LOW VOLTAGE POWER SUPPLY

Model IP-27



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## INTRODUCTION

The Heathkit Model IP-27 Regulated Low Voltage Power Supply is a convenient source of low voltage DC power. It will furnish DC voltages between .5 and 50 volts, and DC current up to 1.5 amperes. The large front panel meter can be switched to measure either the output voltage or the output current; indicator lights show which function is being monitored.

Output voltage is selected in 5-volt increments by the Coarse Voltage switch, and vernier adjustments can be made with the Fine Voltage control. Output current limiting is also selected in fixed ranges by the Coarse Current switch, and the Fine Current control is used for vernier adjustments.

Output is taken from the positive (+) and negative (-) front panel binding posts, which are completely isolated from the chassis. A separate binding post is provided for making connections to the chassis. The Power Supply is protected against overloads by the automatic current limiter and the overload relay circuits.

The Power Supply is designed to match other Heathkit equipment lines in practical, low-profile styling, including feet for convenient stacking, and handles on each side of the cabinet for portability. The cabinet surface is easily cleaned with soap and water. Since all regulation and calibration controls are on the rear panel, they are accessible without removing the cover.

Other features include: Meter scales that are color matched to the Coarse Voltage and Current range switch markings; the latest features in solid-state circuitry for cool, dependable operation; and four-step current limiting, covering a range of 50 milliamperes to 1.5 amperes. Higher output capabilities can also be obtained by connecting additional IP-27 Power Supplies in series or parallel. The attractive styling of this Power Supply and the excellent regulation make it an ideal instrument for both the laboratory and the modern repair shop.

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



## PARTS LIST

The numbers in parentheses are keyed to the numbers on the Parts Pictorial (fold-out from Page 5).

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

### RESISTORS

#### 1/2 Watt 10%

(1) 1-41	2	10 $\Omega$ (brown-black-black)
1-13	1	2700 $\Omega$ (red-violet-red)
1-16	1	4700 $\Omega$ (yellow-violet-red)
1-23	2	27 K $\Omega$ (red-violet-orange)
1-27	1	150 K $\Omega$ (brown-green-yellow)

#### 1/2 Watt 5%

1-130	1	8.2 $\Omega$ (gray-red-gold)
1-54	2	15 $\Omega$ (brown-green-black)
1-136	2	160 $\Omega$ (brown-blue-brown)
1-137	18	200 $\Omega$ (red-black-brown)
1-80	2	1200 $\Omega$ (brown-red-red)

#### 2 Watt 10%

(2) 1-19-2	1	1200 $\Omega$ (brown-red-red)
1-17-2	1	6800 $\Omega$ (blue-gray-red)

#### 2 Watt 5%

(3) 3-2-2*	3	.33 $\Omega$ (orange-orange-silver-gold)
3-1-2	1	.82 $\Omega$ (gray-red-silver-gold)
3-3-2	1	2.7 $\Omega$ (red-violet-gold-gold)

\*NOTE: These resistors are 2 watt wire-wound resistors, but are the same size as 1 watt composition resistors.

#### Precision 1/2 Watt 1%

(4) 2-94	1	.1 $\Omega$
2-130	1	.2 $\Omega$
2-163	1	.7 $\Omega$
2-229	1	2.0 $\Omega$
2-259	1	97 $\Omega$
2-165	1	4950 $\Omega$
2-50	1	10 K $\Omega$
2-166	1	35 K $\Omega$

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

PART No.	PARTS Per Kit	DESCRIPTION
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### Other Resistors

(5) 3-1-5	1	2500 $\Omega$ 5% 7 watt wire-wound resistor
(6) 9-9	1	500 $\Omega$ thermistor

### CAPACITORS

(7) 21-16	1	.01 $\mu$ fd disc
(8) 27-34	1	.2 $\mu$ fd resin
(9) 25-56	1	100 $\mu$ fd electrolytic, 10 V
(10) 25-128	1	100 $\mu$ fd electrolytic, 50 V
(11) 25-131	1	250 $\mu$ fd electrolytic, 25 V
(12) 25-121	1	500 $\mu$ fd electrolytic, 50 V
(13) 25-177	1	3000 $\mu$ fd electrolytic, 75 V
(14) 25-178	1	100-40-40 $\mu$ fd electrolytic

### WIRE-WOUND CONTROLS

(15) 11-77	1	30 $\Omega$
11-76	1	240 $\Omega$
(16) 11-74	1	50 $\Omega$
11-44	2	1000 $\Omega$

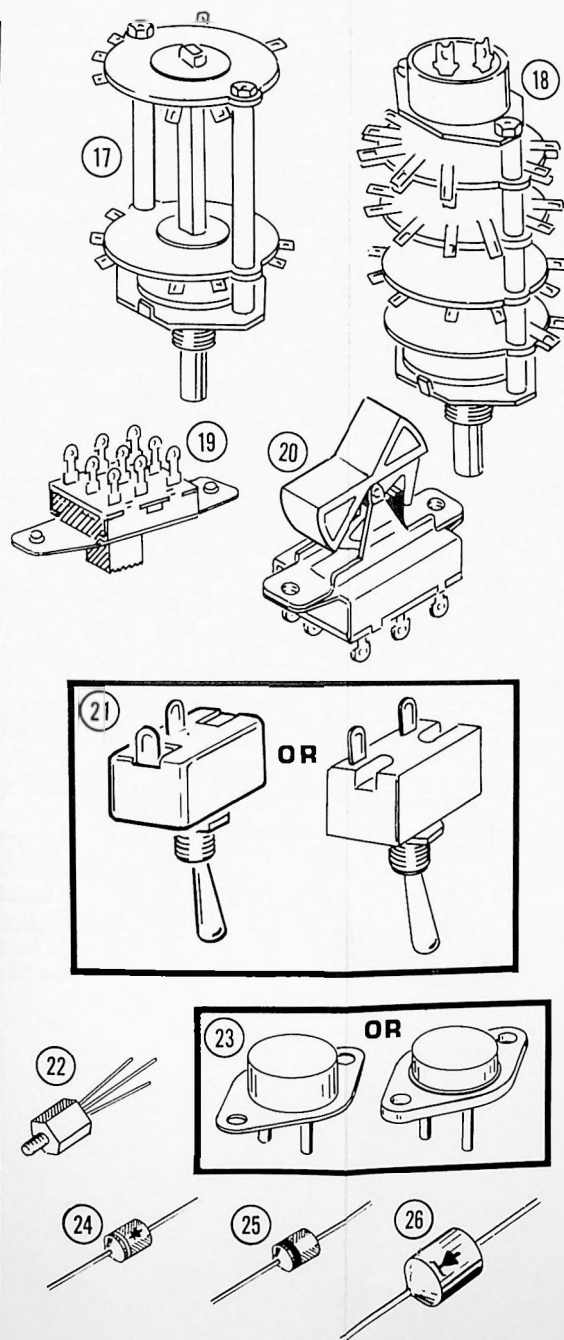
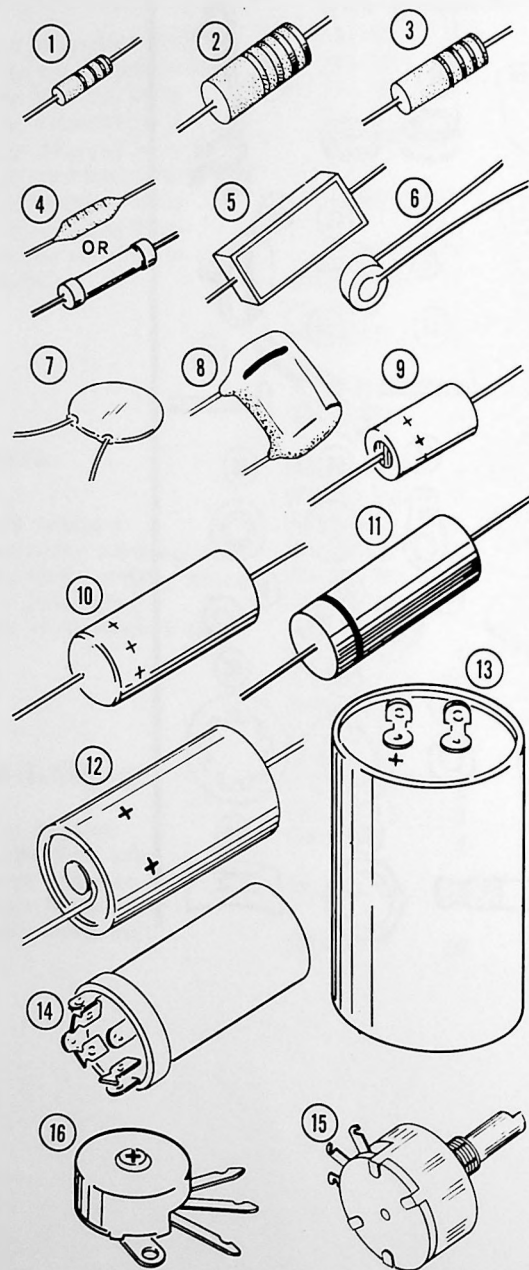
### SWITCHES

(17) 63-437	1	4-position 2-wafer rotary
(18) 63-438	1	11-position 4-wafer rotary
(19) 60-20	1	TPDT slide
(20) 60-34	1	TPDT rocker
(21) 61-9	1	SPST toggle (with two 1/2" nuts and a lockwasher)

### TRANSISTORS-DIODES

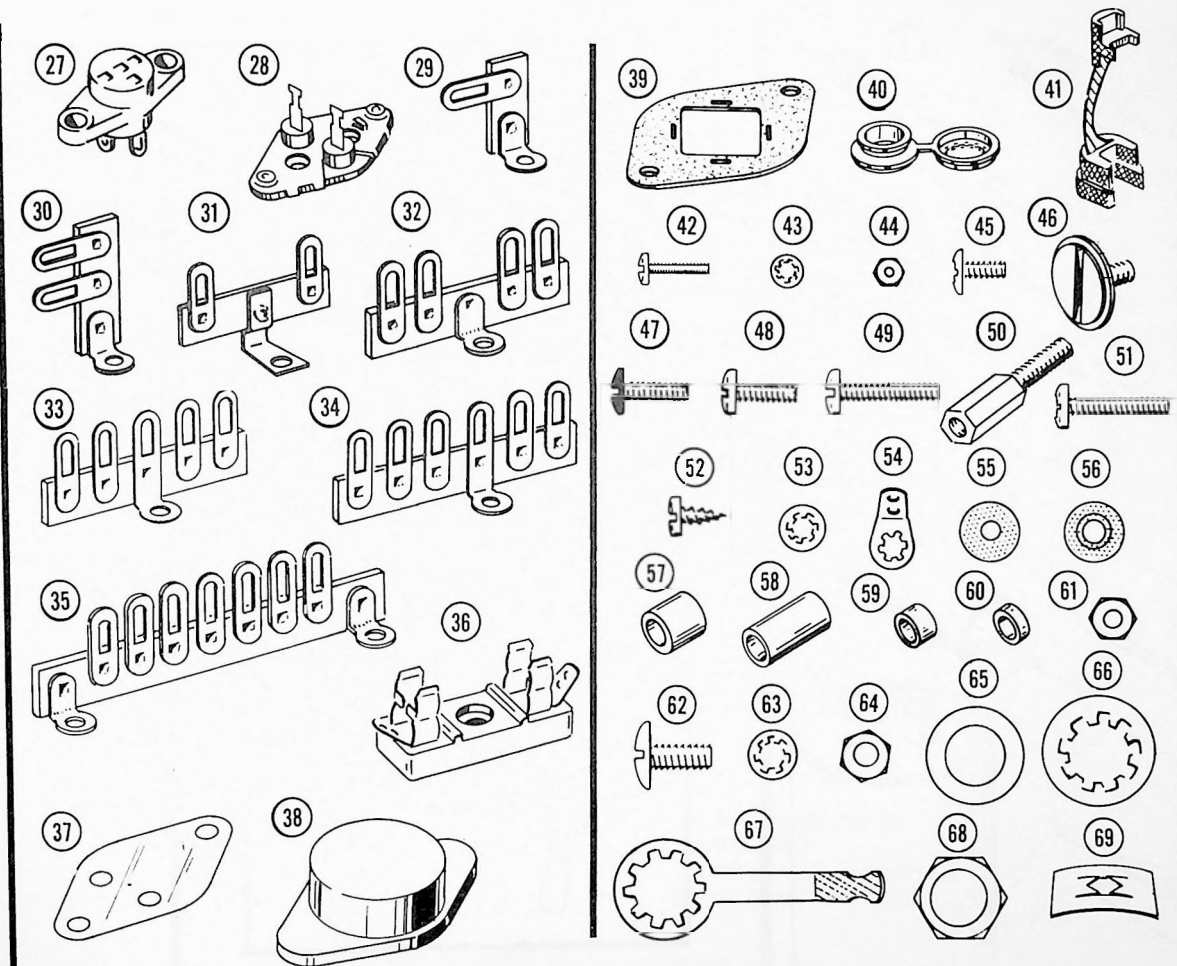
(22) 417-20	2	2N2553/R265A/2N1039-1 transistor
(23) 417-141	2	2N2869/2N301 transistor
417-142	1	DTG-600 transistor
(24) 57-27	8	Silicon diode
(25) 56-618	1	56 V zener diode
56-68	1	68 V zener diode
(26) 56-48	1	110 V zener diode

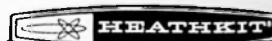
## PARTS PICTORIAL





## PARTS PICTORIAL





PART No.	PARTS Per Kit	DESCRIPTION
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**SOCKETS-TERMINAL STRIPS-FUSEHOLDER**

(27) 434-102	2	Small transistor socket
(28) 434-117	3	Large transistor socket
(29) 431-50	1	1-lug terminal strip
(30) 431-51	1	2-lug terminal strip
(31) 431-41	1	2-lug terminal strip
(32) 431-5	2	4-lug terminal strip
(33) 431-11	1	5-lug terminal strip
(34) 431-45	2	6-lug terminal strip
(35) 431-35	1	7-lug terminal strip
(36) 422-1	1	Fuseholder

PART No.	PARTS Per Kit	DESCRIPTION
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**Wire Harness-Wire-Sleeving (cont'd.)**

344-52	1	Small red wire
344-54	1	Small yellow wire
344-56	1	Small blue wire
340-2	1	Bare wire
346-1	1	Sleeving

**HARDWARE****#2 Hardware**

(42) 250-175	11	2-56 x 3/8" screw
(43) 254-7	11	#3 lockwasher
(44) 252-51	11	2-56 nut

**#6 Hardware**

(45) 250-229	8	6-32 x 1/4" phillips head screw
(46) 250-535	4	6-32 x 1/4" decorative screw
(47) 250-270	4	6-32 x 3/8" black screw
(48) 250-89	21	6-32 x 3/8" screw
(49) 250-26	13	6-32 x 5/8" screw
(50) 250-304	4	6-32 x 3/8" stud
(51) 250-227	2	6-32 x 7/8" phillips head screw
(52) 250-365	4	#6 x 1/4" sheet metal screw
(53) 254-1	38	#6 lockwasher
(54) 259-1	4	#6 solder lug
(55) 253-1	1	#6 flat fiber washer
(56) 253-2	1	#6 shoulder fiber washer
(57) 255-13	2	#6 x 1/4" spacer
(58) 255-15	2	#6 x 1/2" spacer
(59) 255-1	4	Insulator case spacer (thick)
(60) 255-74	6	Insulator case spacer (thin)
(61) 252-3	29	6-32 nut

**INSULATORS-GROMMETS**

(37) 75-60	3	Mica insulator
(38) 75-88	3	Transistor insulator case
(39) 481-3	1	Capacitor mounting wafer
(40) 73-45	2	1/2" grommet
(41) 75-71	1	Line cord strain relief

**WIRE HARNESS-WIRE-SLEEVEING**

134-151	1	Wire harness
344-2	1	Large black wire
344-3	1	Large red wire
344-31	1	Large brown wire
344-50	1	Small black wire



PART No.	PARTS Per Kit	DESCRIPTION
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### #8 Hardware

(62)250-137	6	8-32 x 3/8" screw
(63)254-2	6	#8 lockwasher
(64)252-4	6	8-32 nut

### Other Hardware

(65)253-10	4	Control washer
(66)254-4	3	Control lockwasher
(67)259-10	1	Control solder lug
(68)252-7	4	Control nut
(69)252-32	2	Push-on speednut

## METAL PARTS

### Chassis-Cabinet Parts

(70)203-476	1	Front panel
(71)203-477	1	Rear panel
(72)200-484	1	Chassis
(73)204-767	2	Siderail
(74)204-759-1	4	End cap
(75)90-350-2	2	Cabinet half shell
(76)210-35	1	Bezel

### Other Metal Parts

(77)205-545	1	Heat sink plate
(78)204-565	1	Relay mounting bracket
(79)207-2	1	Capacitor mounting clamp
(80)260-30	1	Diode clip

PART No.	PARTS Per Kit	DESCRIPTION
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## MISCELLANEOUS

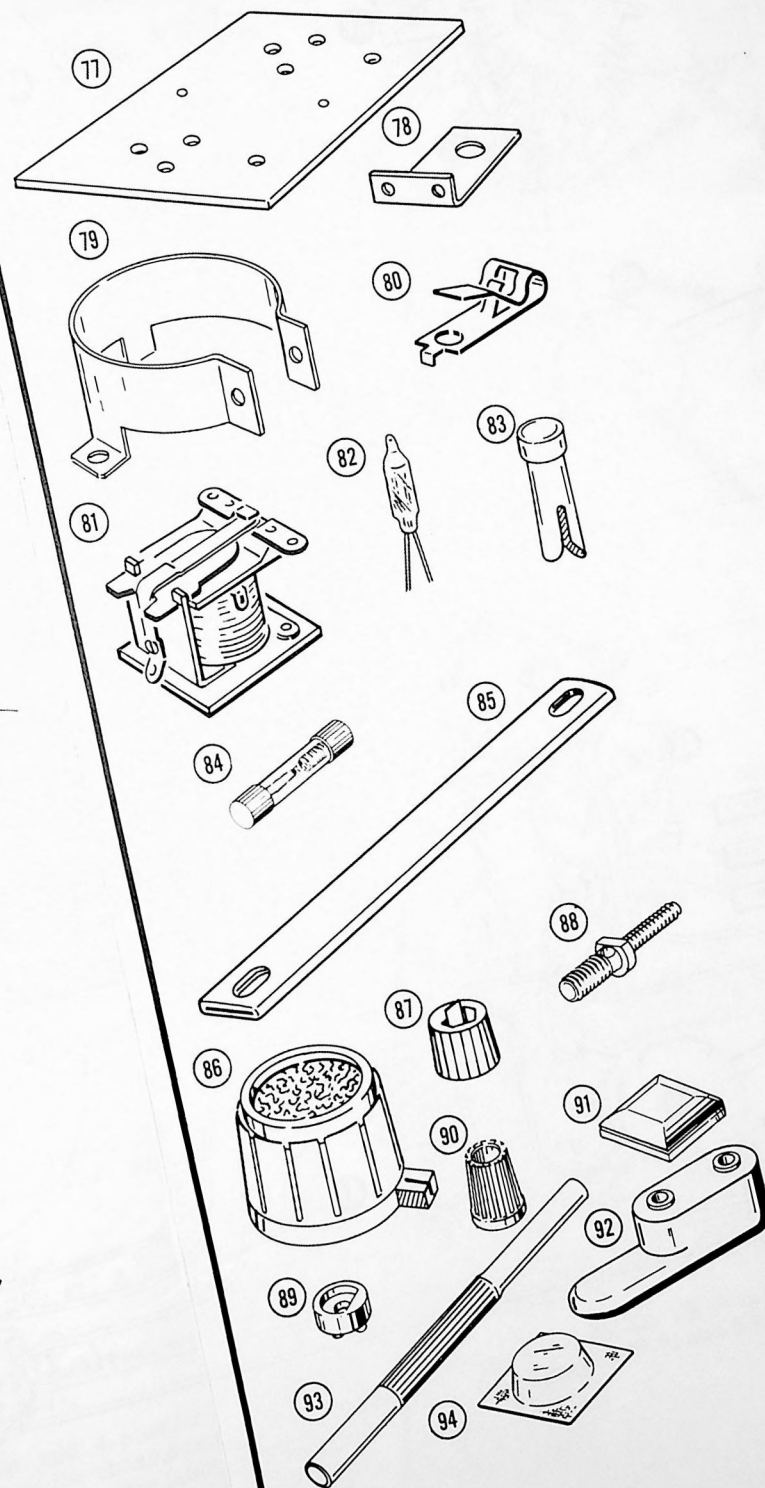
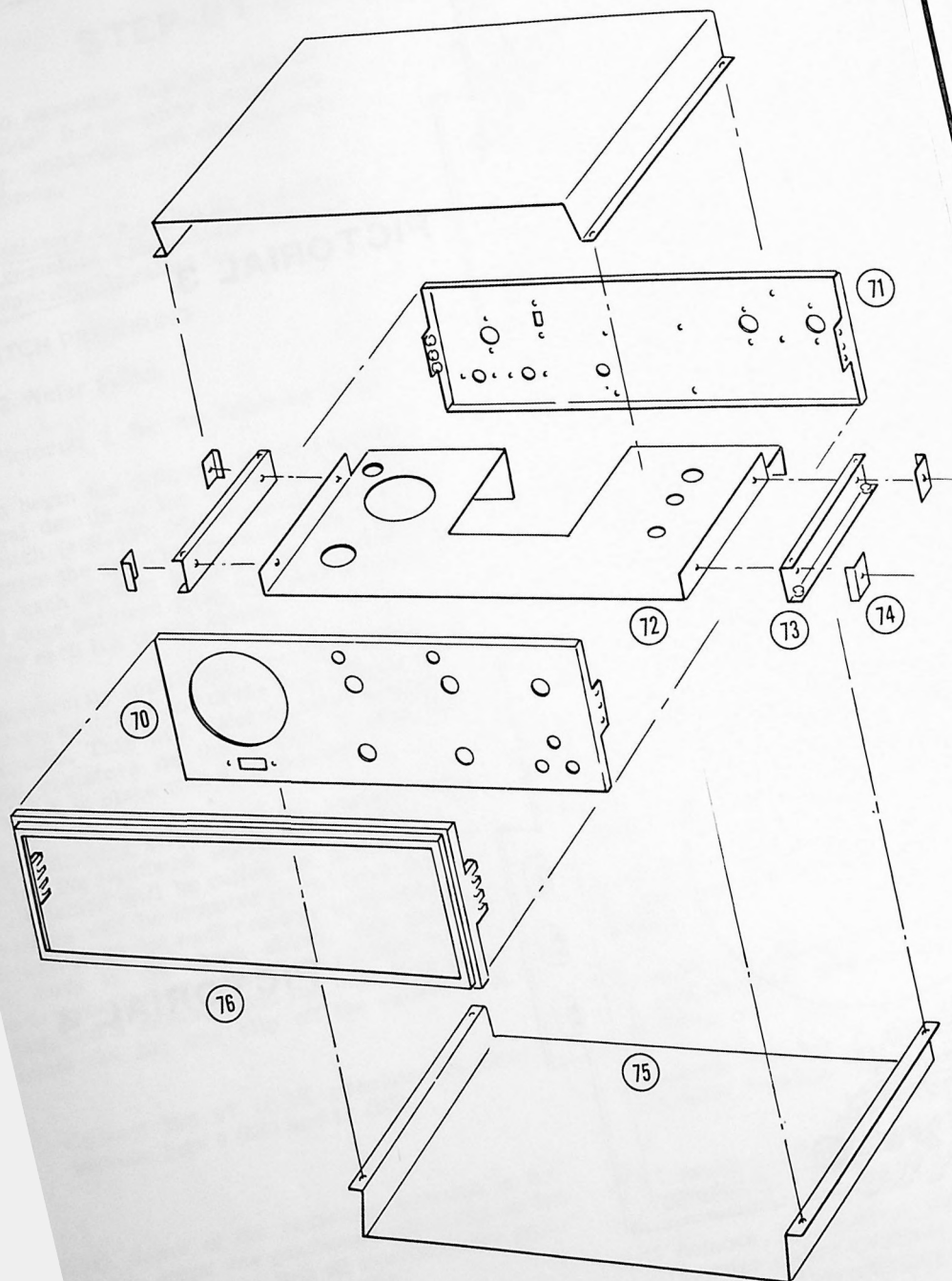
### Electrical Components

54-180	1	Power transformer
(81)69-71	1	Relay
407-120	1	Meter
(82)412-15	2	Neon lamp
(83)413-10	1	Red lens
413-14	1	Amber lens
(84)421-25	1	1-1/2 ampere slow-blow fuse
89-23	1	Line cord
432-27	1	Line cord adapter

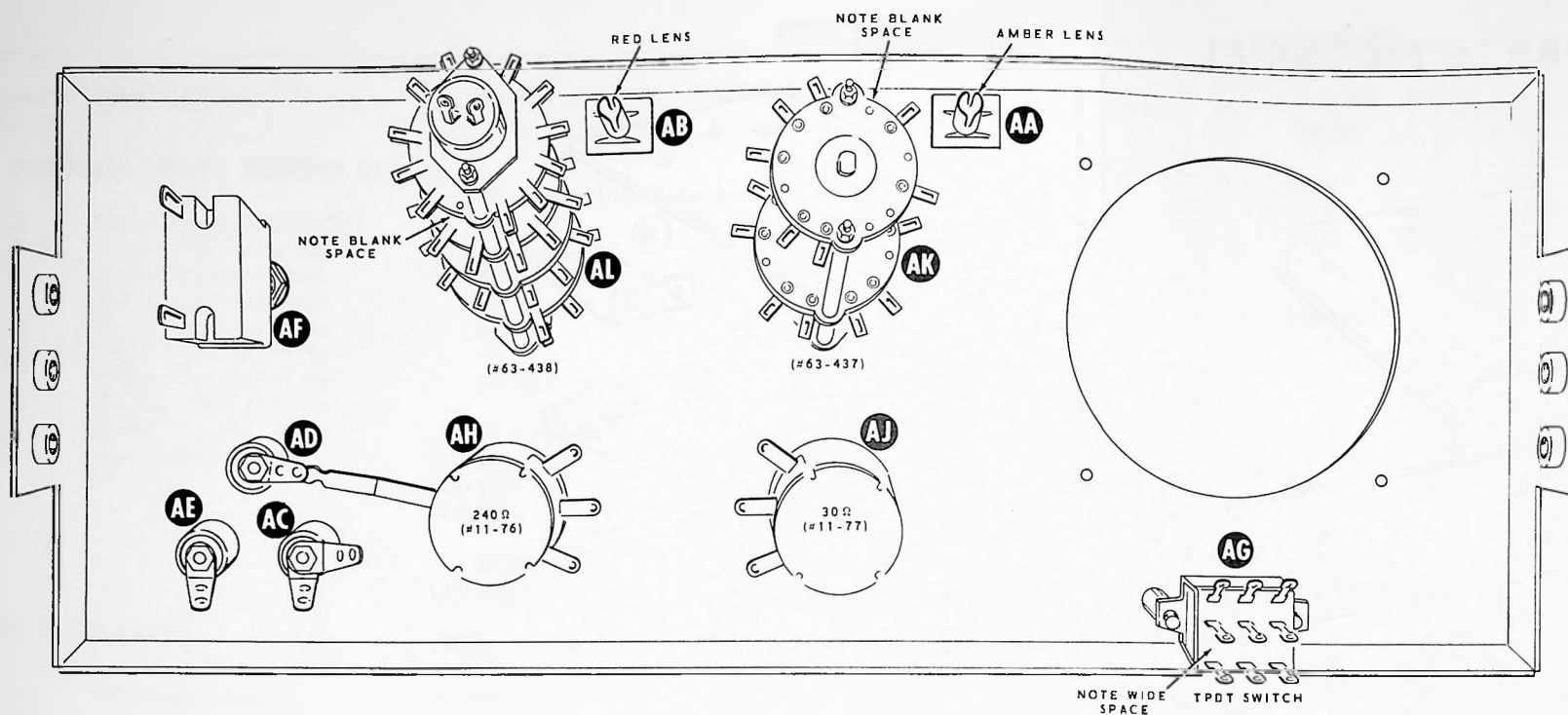
### Other Components

(85)211-33	2	Handle
(86)462-245	4	Knob
(87)455-50	4	Knob bushing
(88)427-3	3	Binding post base
(89)75-17	6	Binding post bushing
(90)100-16-2	2	Binding post cap (black)
100-16-18	1	Binding post cap (red)
(91)261-28	4	Stick-on rubber foot
(92)261-30	2	Line cord retainer
(93)490-5	1	Nut starter
(94)352-13	1	Silicone grease
597-260	1	Parts Order Form
597-308	1	Kit Builders Guide
391-34	1	Blue and white label
	1	Manual (See front cover for part number.)
		Solder

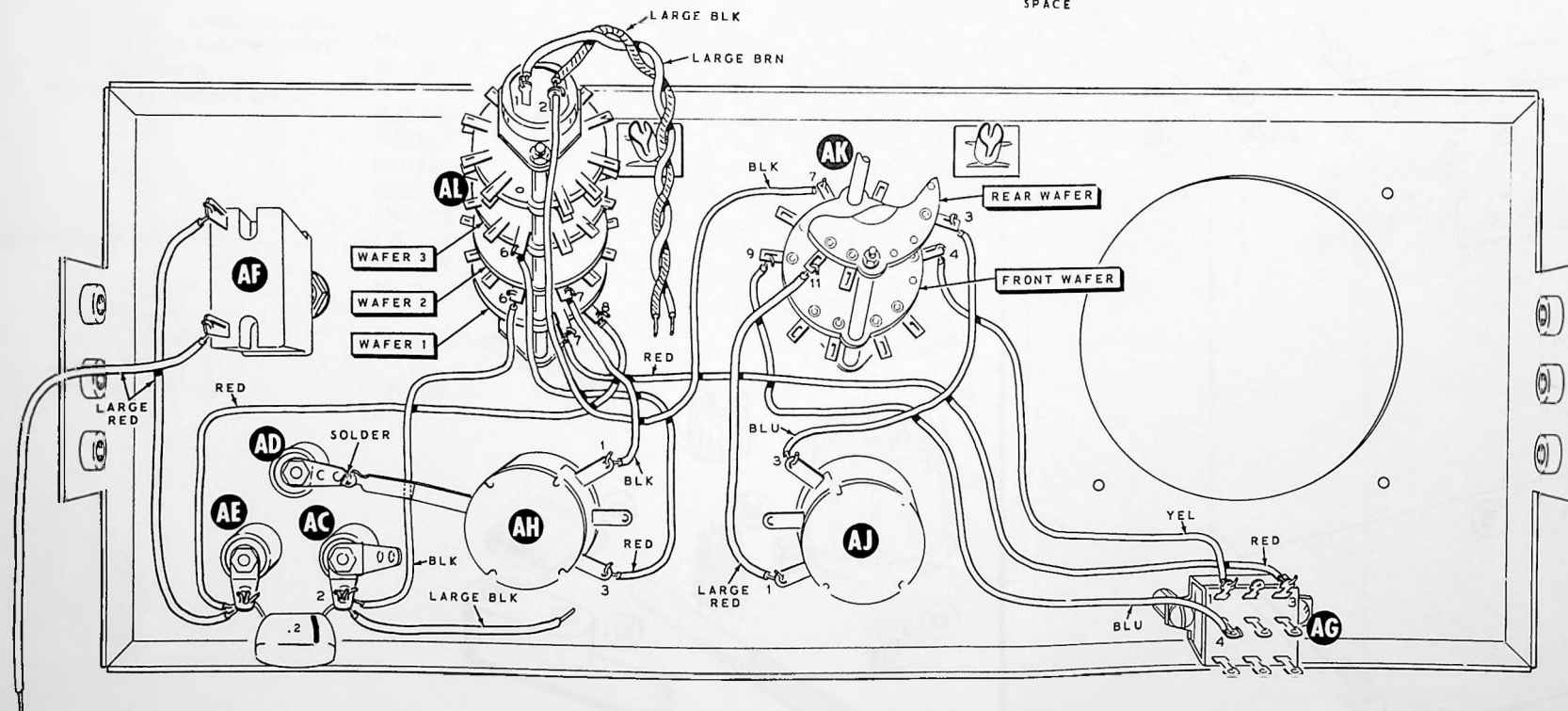
# PARTS PICTORIAL







PICTORIAL 3



PICTORIAL 4

## STEP-BY-STEP ASSEMBLY

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

NOTE: When resistors are called for in a step, use 1/2 watt resistors unless larger wattage resistors are specifically called for.

### ROTARY SWITCH PREWIRING

#### 4-Position, 2-Wafer Switch

Refer to Pictorial 1 for the following steps.

Before you begin the following steps, compare the physical details of the 4-position 2-wafer rotary switch (#63-437) with Pictorial 1 so you can recognize the exact locations of the contacts. Note that each contact location has a number, even if it does not have a lug. This will help you to identify each lug on the switch.

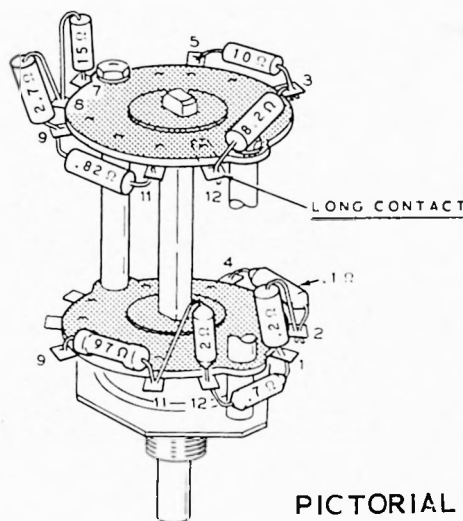
( ) Temporarily install the 4-position 2-wafer rotary switch in one of the 3/8" holes in the chassis. This will make it easier to mount the resistors on the switch. Fasten the switch in place with a control nut.

In the following steps, only the resistor value and the lug numbers where the resistor is to be connected will be called out. In these steps, resistors will be mounted on the front wafer of the switch. Mount each resistor by first bending its leads in the shape shown; then push the leads through the lugs until the resistor body is positioned as shown. Bend the end of each lead around the lug and clip off the excess lead.

(✓) Connect the 97  $\Omega$  1% precision resistor between lugs 9 (NS) and 11 (NS).

NOTE: Some of the resistors mounted in the following steps are positioned vertically on the wafers. Make sure that all resistors are positioned as shown in the Pictorial.

(✓) Connect the 2  $\Omega$  1% precision resistor between lugs 11 (S-2) and 12 (NS).



PICTORIAL 1

(✓) Connect the .7  $\Omega$  1% precision resistor between lugs 12 (S-2) and 1 (NS).

(✓) Connect the .2  $\Omega$  1% precision resistor between lugs 1 (S-2) and 2 (NS).

(✓) Connect the .1  $\Omega$  1% precision resistor between lugs 2 (S-2) and 4 (NS).

NOTE: In the following steps, mount the resistors on the rear wafer of the 4-position rotary switch.

(✓) Connect a 15  $\Omega$  (brown-green-black) resistor between lugs 7 (S-1) and 8 (NS).

(✓) Connect the 2.7  $\Omega$  (red-violet-gold-gold) 2 watt resistor between lugs 8 (S-2) and 9 (NS).

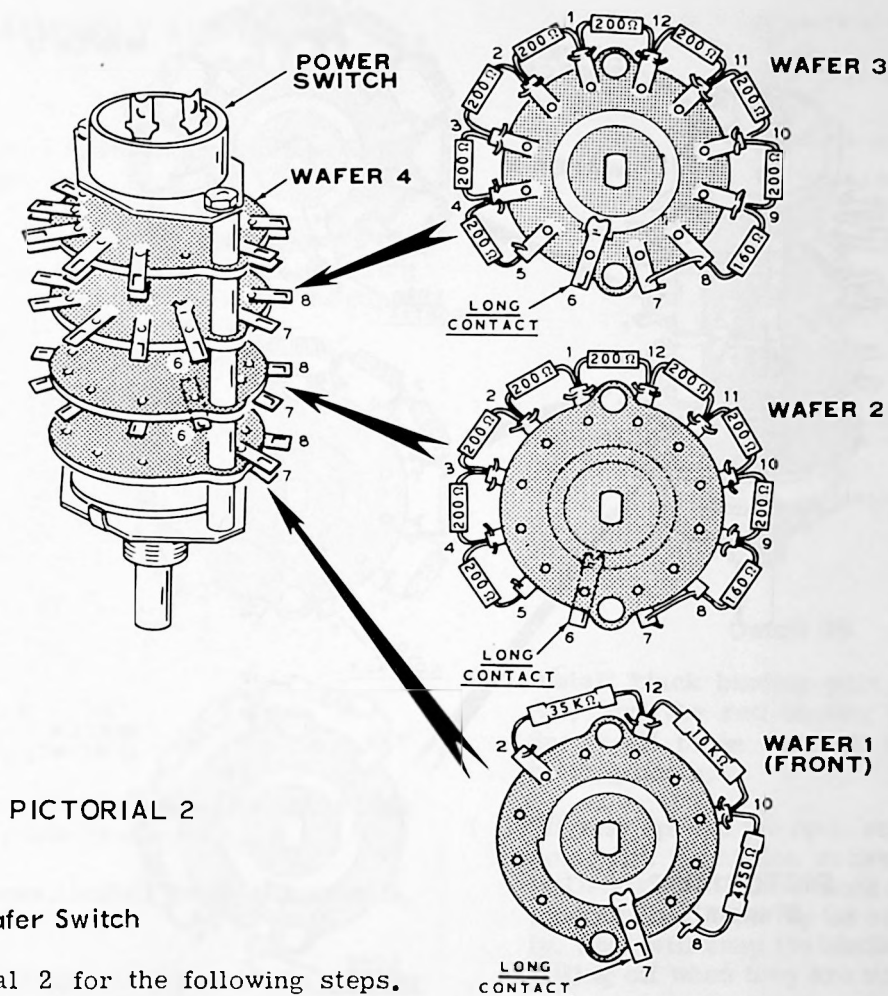
(✓) Connect the .82  $\Omega$  (gray-red-silver-gold) 2 watt resistor between lugs 9 (S-2) and 11 (NS).

(✓) Connect the 8.2  $\Omega$  (gray-red-gold-gold) resistor between lugs 12 (NS) and 3 (NS).

(✓) Connect a 10  $\Omega$  (brown-black-black) resistor between lugs 3 (NS) and 5 (S-1).

(✓) Remove the control nut and 4-position, 2-wafer rotary switch from the chassis and set them aside until they are called for later.





PICTORIAL 2

### 11-Position, 4-Wafer Switch

Refer to Pictorial 2 for the following steps.

- ( ) Temporarily install the 11-position, 4-wafer rotary switch (#63-438) in one of the 3/8" holes in the chassis. Fasten the switch with a control nut.

NOTE: Each of the following steps will identify only the resistor value and the lug numbers where the resistor is to be connected to the rotary switch.

#### Wafer #1 Wiring

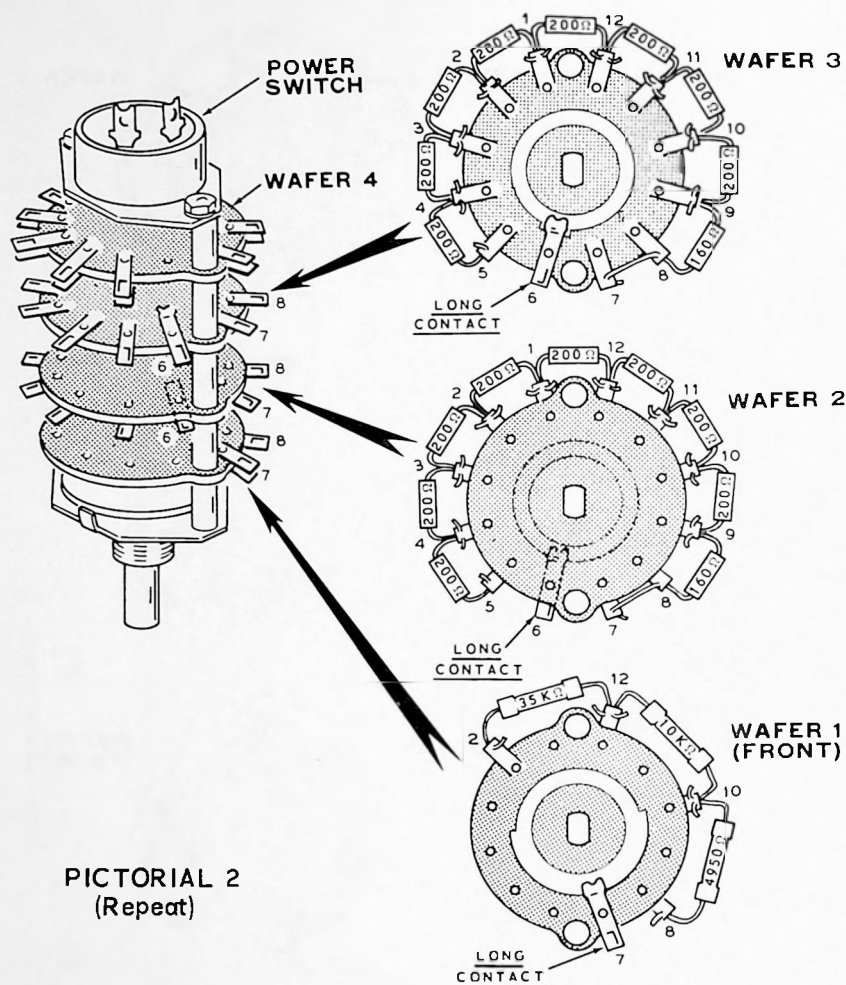
- ( ) Connect the 4950  $\Omega$  1% precision resistor between lugs 8 (NS) and 10 (NS).
- ( ) Connect the 10 K $\Omega$  1% precision resistor between lugs 10 (S-2) and 12 (NS).
- ( ) Connect the 35 K $\Omega$  1% precision resistor between lugs 12 (S-2) and 2 (S-1).

#### Wafers #2 and #3 Wiring

Resistors are mounted on wafers #2 and #3 by identical steps. Perform each of the following steps twice; first for wafer #2 using the left-hand checkoff spaces, and then for wafer #3 using the right-hand checkoff spaces.

NOTE: Where a wire 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.

- ( ) ( ) Pass one lead of a 160  $\Omega$  (brown-blue-brown) resistor through lug 8 (S-2) to lug 7 (NS). Connect the other lead to lug 9 (NS).



PICTORIAL 2  
(Repeat)

- (✓) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 9 (S-2) and 10 (NS).
- (✓) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 10 (S-2) and 11 (NS).
- ( ) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 11 (S-2) and 12 (NS).
- (✓) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 12 (S-2) and 1 (NS).
- (✓) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 1 (S-2) and 2 (NS).
- (✓) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 2 (S-2) and 3 (NS).

- (✓) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 3 (S-2) and 4 (NS).
- (✓) (✓) Connect a 200 Ω (red-black-brown) resistor between lugs 4 (S-2) and 5 (NS).
- (✓) Solder lug 5 on wafer #2 (S-1).
- (✓) Solder lug 7 on wafer #3 (S-1).

NOTE: Wafer #4 and the AC power switch will not be wired at this time.

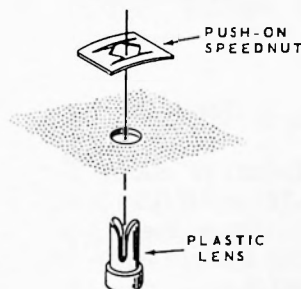
- (✓) Remove the control nut and 11-position, 4-wafer rotary switch from the chassis and set them aside until they are called for later.

## FRONT PANEL ASSEMBLY AND WIRING

### Initial Assembly

Refer to Pictorial 3 (fold-out from Page 6) for the following steps.

- ( ) Position the front panel as shown in the Pictorial so you can identify all the mounting holes. Place a towel or cloth under the panel to avoid scratching its surface.



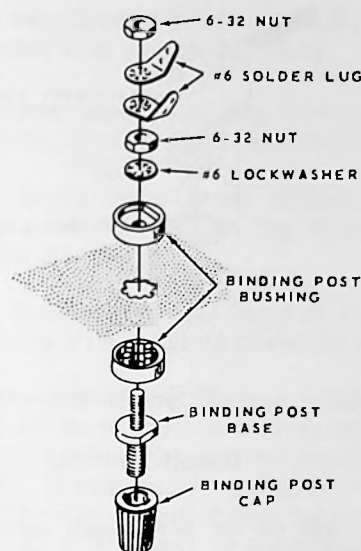
Detail 3A

- ( ) Refer to Detail 3A and install an amber lens at AA with a push-on speednut.
- ( ) In a like manner, install the red lens at AB.

NOTE: The Heath Company has provided a plastic nut starter with this kit. Use the nut starter to hold and start 6-32 and 2-56 nuts on screws. Refer to Page 3 of the Kit Builders Guide for further information.

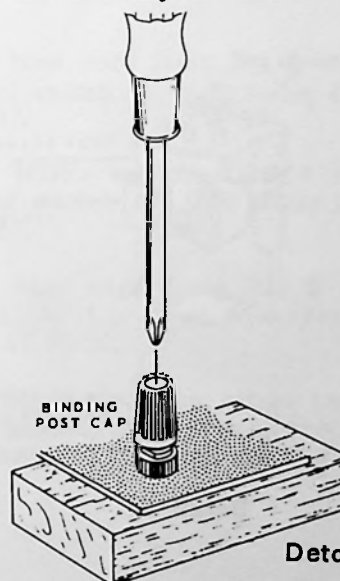
- ( ) Refer to Detail 3B and install a binding post at AC. Use a binding post base, two binding post bushings, a #6 lockwasher, two #6 solder lugs, and two 6-32 nuts. Position the flat side of the binding post base toward the bottom of the front panel. Position the solder lugs as shown in Pictorial 3.

- ( ) In a similar manner, install binding posts at AD and AE. At each location, use a binding post base, two binding post bushings, a #6 lockwasher, a #6 solder lug, and two 6-32 nuts. Position each solder lug as shown.



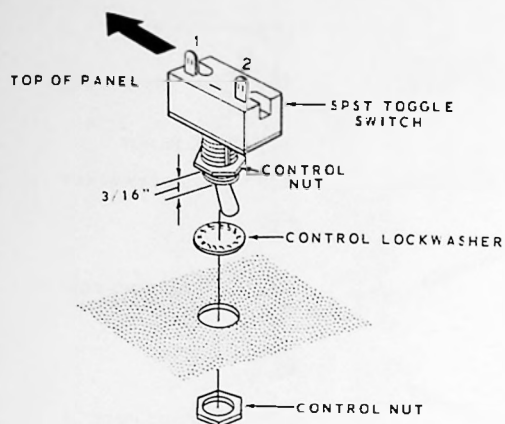
Detail 3B

- ( ) Install black binding post caps at AC and AD, and the red binding post cap at AE. Screw all three caps all the way onto the binding posts.
- ( ) Slightly spread the open end of each binding post with a phillips screwdriver as shown in Detail 3C. Place a block of wood under the binding post; then tap the screwdriver lightly. This will keep the binding post caps from falling off when they are unscrewed.



Detail 3C

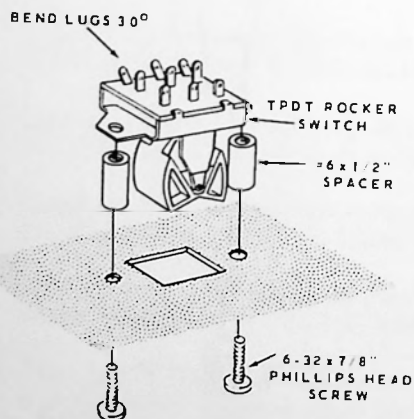




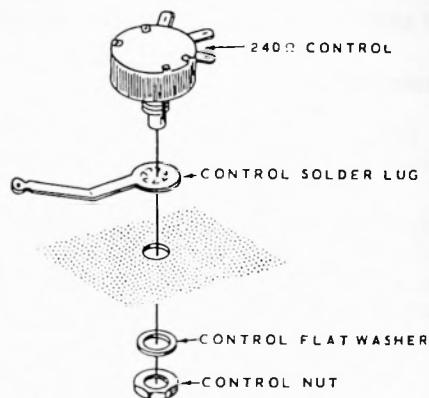
Detail 3D

NOTE: The lugs on the SPST toggle switch, called for in the following step, may be arranged different from those shown.

- (✓) Mount the SPST toggle switch at AF. Use the hardware that came with the switch, and install the first control nut 3/16" from the end of the bushing as shown in Detail 3D.
- (✓) Refer to Detail 3E and mount a TPDT rocker switch at AG. Use two #6 x 1/2" spacers and two 6-32 x 7/8" phillips head screws. Position the switch as shown and bend the upper row of lugs about 30 degrees.

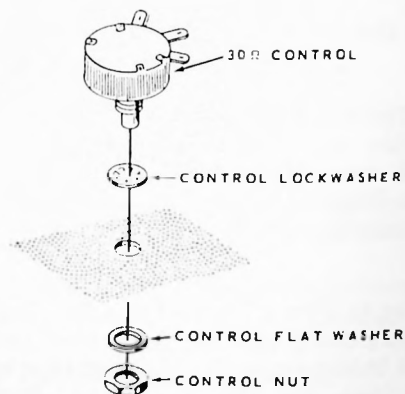


Detail 3E



Detail 3F

- (✓) Refer to Detail 3F and mount the 240  $\Omega$  control (#11-76) at AH. Use a control solder lug, a control flat washer, and a control nut. Position the control and solder lug as shown in Pictorial 3.
- (✓) Refer to Detail 3G and mount the 30  $\Omega$  control (#11-77) at AJ. Use a control lockwasher, a control flat washer, and a control nut. Position the control as shown.



Detail 3G



( ) Mount the prewired 4-position, 2-wafer rotary switch at AK, using a control lock-washer, a control flat washer, and a control nut. Position the switch as it is shown in Pictorial 3.

( ) In a like manner, mount the prewired 11-position, 4-wafer rotary switch at AL. Position the switch as shown in Pictorial 3.

The meter and 2-lug terminal strip will be installed later to avoid damage to the meter.

### Initial Wiring

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

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

( ) Prepare the following lengths of small wire:

COLOR	LENGTH
Red	9"
Red	6"
Red	4-3/4"
Black	4-3/4"
Black	2-1/4"

NOTE: Most wire lengths are longer than needed to reach their terminating points. Therefore, position the wires down against the panel or chassis. Use square corners (bent 90 degrees) when positioning the wires to make the kit as neat as possible when it is completed.

Connect the prepared small wires in the following steps.

( ) 9" red wire from lug 7 on wafer 1 of switch AL (S-1) to lug 3 of switch AG (S-1). Be sure that the wire is soldered to both tabs on lug 7 of wafer 1. Position the wire as shown.

( ) 6" red wire from binding post AE (NS) to lug 8 on wafer 1 of switch AL (S-2).

( ) 4-3/4" red wire from lug 3 of control AH (S-1) to lug 6 on wafer 3 of switch AL (S-1).

( ) 4-3/4" black wire from solder lug 2 on binding post AC (NS) to lug 6 on wafer 2 of switch AL (S-1).

( ) 2-1/4" black wire from lug 1 of control AH (S-1) to lug 7 on wafer #2 of switch AL (S-2).

( ) Bend the end of the control solder lug on control AH so it touches and exerts a slight pressure against the solder lug on binding post AD. (Temporarily position the small black wire that is under this lug away from the lug so it will not be scorched.) Solder the tips of the two solder lugs together.

( ) Prepare the following lengths of small wire:

COLOR	LENGTH
Blue	7-1/2"
Yellow	5-3/4"
Blue	4-3/4"
Black	7-3/4"

Connect the prepared small wires in the following steps.

( ) 7-1/2" blue wire from lug 9 on the front wafer of switch AK (S-2) to lug 4 on switch AG (S-1).

( ) 5-3/4" yellow wire from lug 4 on the front wafer of switch AK (NS) to lug 1 of switch AG (S-1).

( ) 4-3/4" blue wire from lug 3 of control AJ (S-1) to lug 3 on the rear wafer of switch AK (S-3).

( ) 7-3/4" black wire from either lug of power switch AL (NS) (at the rear of rotary switch AL) to lug 7 on the front wafer of switch AK (NS).

- ( ) Prepare the following lengths of large wire. First cut the lengths indicated and remove 1/4" of insulation from each end. Then twist the ends of the wire and apply a thin film of solder to hold the strands together.

COLOR	LENGTH
Red	4-1/4"
Red	5"
Red	6-1/2"
Black	2-1/2"
Black	8"
Brown	7"

Connect the prepared large wires in the following steps.

NOTE: You may find the large wires easier to insert in the switch and control lugs if you first squeeze the end of the wire flat with a pair of pliers.

- ( ) 4-1/4" red wire from lug 1 of control AJ (NS) to lug 11 on the rear wafer of switch AK (S-2).
- ( ) 5" red wire from the solder lug on binding post AE (NS) to either lug on switch AF (S-1).
- ( ) One end of the 6-1/2" red wire to the remaining free lug of switch AF (S-1). The other end of this wire will be connected later.
- ( ) One end of the 2-1/2" black wire to solder lug 2 on binding post AC (NS). The other end of this wire will be connected later.
- ( ) One end of the 8" black wire to the lug with the previously connected black wire on Power switch AL (S-2).
- ( ) One end of the 7" brown wire to the other lug of Power switch AL (S-1).
- ( ) Twist together the large 8" black and 7" brown wires you just installed, as shown in Pictorial 4. Then carefully bend these wires as shown in the Pictorial. The other ends of these wires will be connected later.

- ( ) Connect the .2  $\mu$ fd resin capacitor from the solder lug at AE (S-3) to solder lug 2 on binding post AC (S-3). Position the banded end of the capacitor as shown on the Pictorial.

### Harness Wiring

Refer to Pictorial 5 (fold-out from Page 17) for the following steps.

- ( ) Locate the wire harness. Extend the ends of the harness so that you can recognize the five wire breakouts along its length.
- ( ) Position the harness on the front panel so the end which contains the large black and large orange wires (breakout #1) is to the left. Place breakout #2 midway between controls AH and AJ, and carefully form the harness inside the edges of the front panel as shown in Pictorial 5.

The wires from breakout #2 will be connected in the following steps.

NOTE: Since the large wires have been pretinned, it may be difficult to insert them into the lugs. Therefore, you may find it easier if you flatten the ends of the wires with a pair of pliers.

- ( ) Connect the two large black wires to solder lug 1 on binding post AC (S-2). Position these two wires between control AH and the harness.
- ( ) Connect the small white/green wire to lug 2 on control AH (S-1).
- ( ) Connect the large green wire to lug 1 of control AJ (S-2).
- ( ) Connect the large blue wire to lug 12 on the rear wafer of switch AK (S-2).
- ( ) Connect the large gray wire to lug 7 on wafer 4 of switch AL (S-1). Be sure the wire is soldered to both tabs of the lug.
- ( ) Connect the small violet wire to lug 5 on wafer 3 of switch AL (S-2).



- (✓) Connect the large yellow wire to lug 4 on the front wafer of switch AK (S-3).
- (✓) Connect the large orange wire to lug 5 on the front wafer of switch AK (S-1).
- (✓) Locate the small yellow wire extending from breakout #3 of the harness. Connect this wire to lug 2 of switch AG (S-1).
- (✓) Connect the small brown wire from breakout #3 to lug 5 on switch AG (S-1).

### Lamp And Meter Installation

- (✓) Install the neon lamps (#412-15) in the red and amber lenses at AA and AB. Carefully push each lamp all the way into its lens.

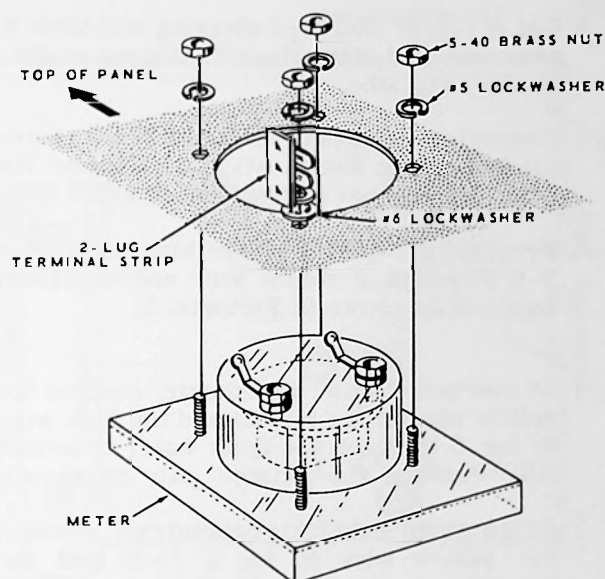
NOTE: The leads from neon lamps AA and AB will be connected to lugs on the front wafer of switch AK in the following steps. Be sure the leads are not crossed at the base of either lamp.

- (✓) Place a 1-3/4" length of sleeving on one lead from lamp AB. Connect this lead to lug 7 (NS).
- (✓) Place a 1-1/2" length of sleeving on the other lead from lamp AB and connect this lead to lug 8 (NS).
- (✓) Place a 3/4" length of sleeving on one lead from lamp AA. Connect this lead to lug 7 (S-3).
- (✓) Place a 1/2" length of sleeving on the other lead from lamp AA and connect this lead to lug 6 (NS).

Refer to Detail 5A for the following steps.

CAUTION: Be careful not to overtighten the nuts while mounting the meter in the following step, or you may crack the meter case.

- (✓) Mount the meter at AP on the front panel as shown in Detail 5A. Use the four nuts and lockwashers that were supplied with the meter. Be sure to mount the 2-lug terminal strip at AN between the lockwashers, and position as shown.



Detail 5A

- (✓) Tape a protective cover over the meter face; this will keep the meter face from being scratched. A piece of the corrugated cardboard that was in the box can be used for this purpose.
- (✓) Push the harness down carefully between switch AG and the meter, and route the harness up along the edge of the front panel.

### Final Front Panel Wiring

NOTE: There may be a shorting wire between the two meter terminals. If so, be sure to remove the wire before you make the following connections.

- (✓) Connect the white/red wire from harness breakout #3 to the positive (+) terminal of the meter (S-1).
- (✓) Connect the blue wire from breakout #3 to the negative (-) terminal of the meter (S-1).
- (✓) Cut a 1/2" length of sleeving and slide it over one lead of a 27 K $\Omega$  (red-violet-orange) resistor.
- (✓) Connect the sleeved lead of the 27 K $\Omega$  resistor to lug 7 on switch AG (S-1). Connect the other lead to lug 1 on terminal strip AN (NS).

- ( ) Cut a 1-1/8" length of sleeving and slide it over one lead of the other 27 K $\Omega$  (red-violet-orange) resistor.
- ( ) Connect the sleeved lead of this 27 K $\Omega$  resistor to lug 9 on switch AG (S-1). Connect the other lead to lug 2 on terminal strip AN (NS).
- ( ) Prepare a 7-5/8" length of blue wire and a 7-5/8" length of yellow wire, and twist them together as shown in Pictorial 5.
- ( ) At one end of this twisted pair, connect the yellow wire to lug 8 (S-2) and the blue wire to lug 6 (S-2) on the front wafer of switch AK. Position the twisted pair as shown.
- ( ) At the other end of this twisted pair, connect the yellow wire to lug 2 (S-2) and the blue wire to lug 1 (S-2) of terminal strip AN.
- ( ) Prepare a 2" length of yellow wire. Then connect one end of this wire to lug 2 of control AJ (S-1). The other end will be connected later.

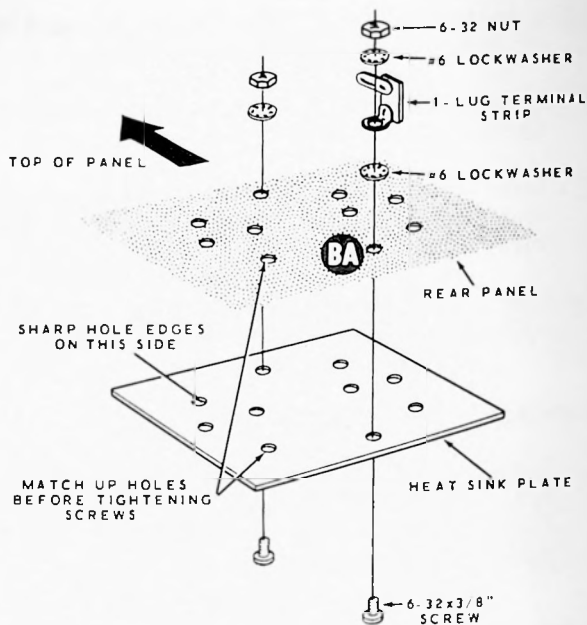
This completes the assembly and wiring of the front panel section. Set the front panel aside until it is called for later.

#### REAR PANEL ASSEMBLY

Refer to Pictorial 6 for the following steps.

NOTE: When hardware is called for in a step, only the screw size may be given. For instance, if 6-32 x 3/8" hardware is called for, it means that a 6-32 x 3/8" screw, one or more #6 lockwashers, and a 6-32 nut should be used. (Do not use the black 6-32 x 3/8" screws until they are specifically called for.) The Detail referred to in the step will show the proper number of lockwashers to use.

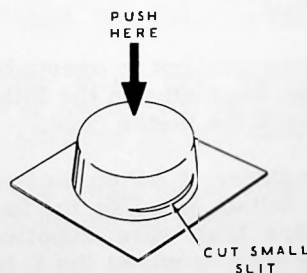
CAUTION: When you install the heat sink plate in the next step, be sure to position it with its sharp hole edges against the rear panel. (A sharp edge facing out could cut through a mica insulator and short out a transistor.) The holes in the heat sink plate should line up with the holes in the rear panel.



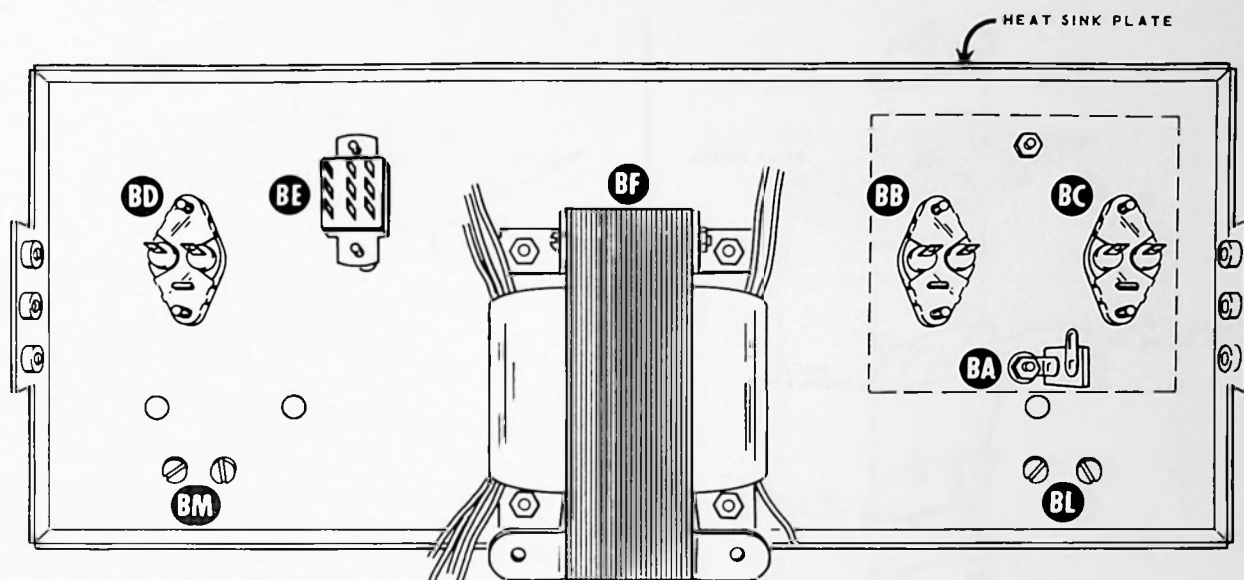
Detail 6A

- ( ) Refer to Detail 6A and install the heat sink plate on the lettered side of the rear panel with 6-32 x 3/8" hardware. Install the 1-lug terminal strip with two #6 lockwashers at BA.
- ( ) Cut a small slit in the side of the silicone grease container as shown in Detail 6B.

NOTE: Before you install the transistor in each of the next few steps, first spread a coating of silicone grease on the flat surface of the transistor. Then place the mica insulator on this greased surface and spread more silicone grease on the other side of the insulator. The grease will help conduct heat from the transistor to the chassis.

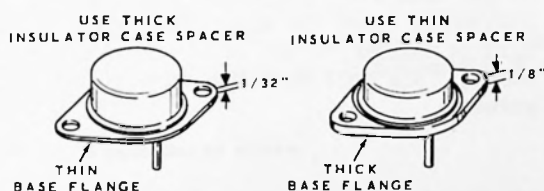


Detail 6B



PICTORIAL 6

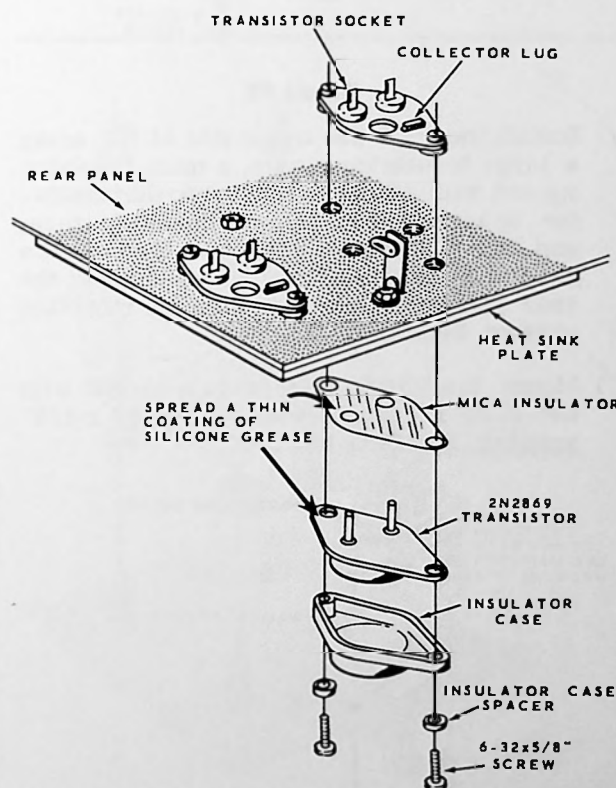
NOTE: Study the base flange of each transistor before you install it in the following steps. Refer to Detail 6C. Use thick insulator case spacers (#255-1) for a transistor with a thin base flange. Use thin spacers (#255-74) for a transistor with a thick base flange. Extra spacers are supplied for mounting either type of transistor. You may wish to save these for possible future use.



Detail 6C

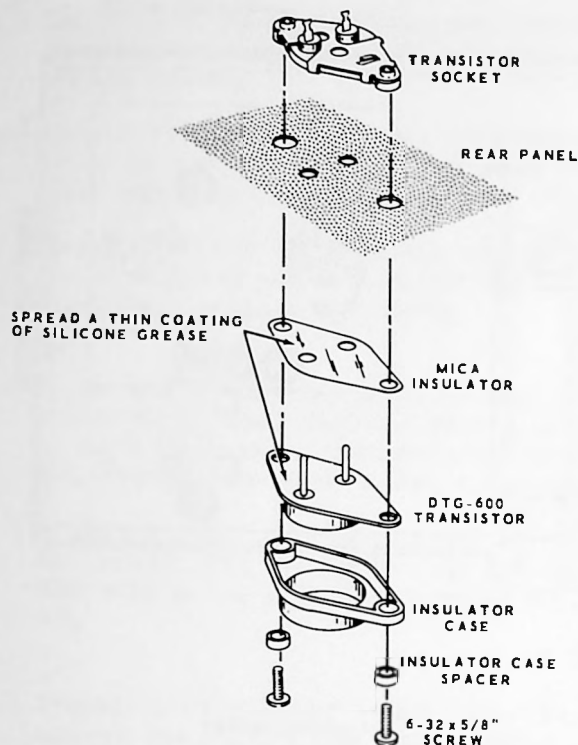
( ) Mount a 2N2869 transistor at BB, as shown in Detail 6D, with a large transistor socket, a mica insulator, an insulating case, two insulator case spacers, and two 6-32 x 5/8" screws. Be sure the shoulders on the socket are seated in the rear panel holes, then tighten the screws so their heads sink deeply into the recesses in the insulator case.

( ) In a like manner, mount the second 2N2869 transistor at BC. Be sure the shoulders on the socket are seated in the rear panel holes before tightening the screws.



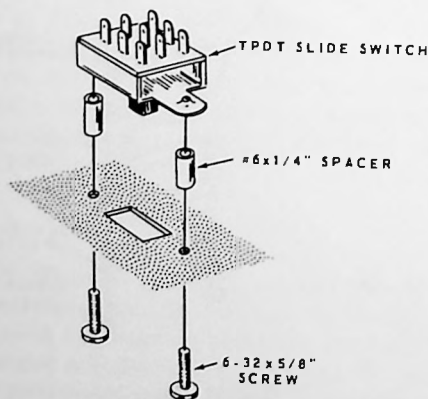
Detail 6D



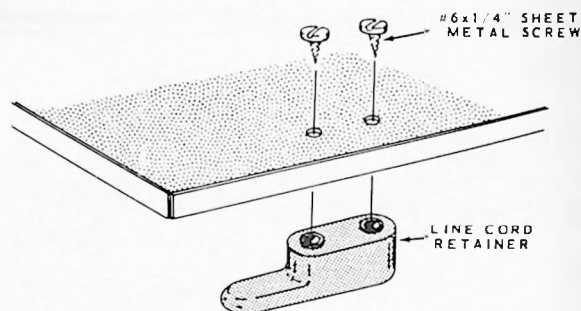


Detail 6E

- (✓) Install the DTG-600 transistor at BD, using a large transistor socket, a mica insulator spread with silicone grease, two thin insulator spacers (#255-74), an insulator case, and two 6-32 x 5/8" screws. Be sure the shoulders on the socket are seated in the rear panel before you tighten the mounting screws. See Detail 6E.
- (✓) Mount the TPDT slide switch at BE with two 6-32 x 5/8" screws and two #6 x 1/4" spacers. See Detail 6F.



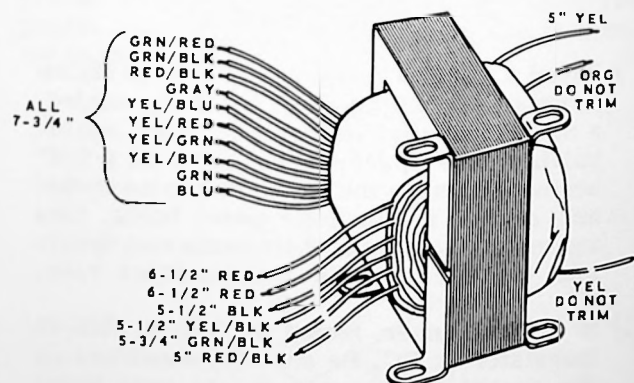
Detail 6F



Detail 6G

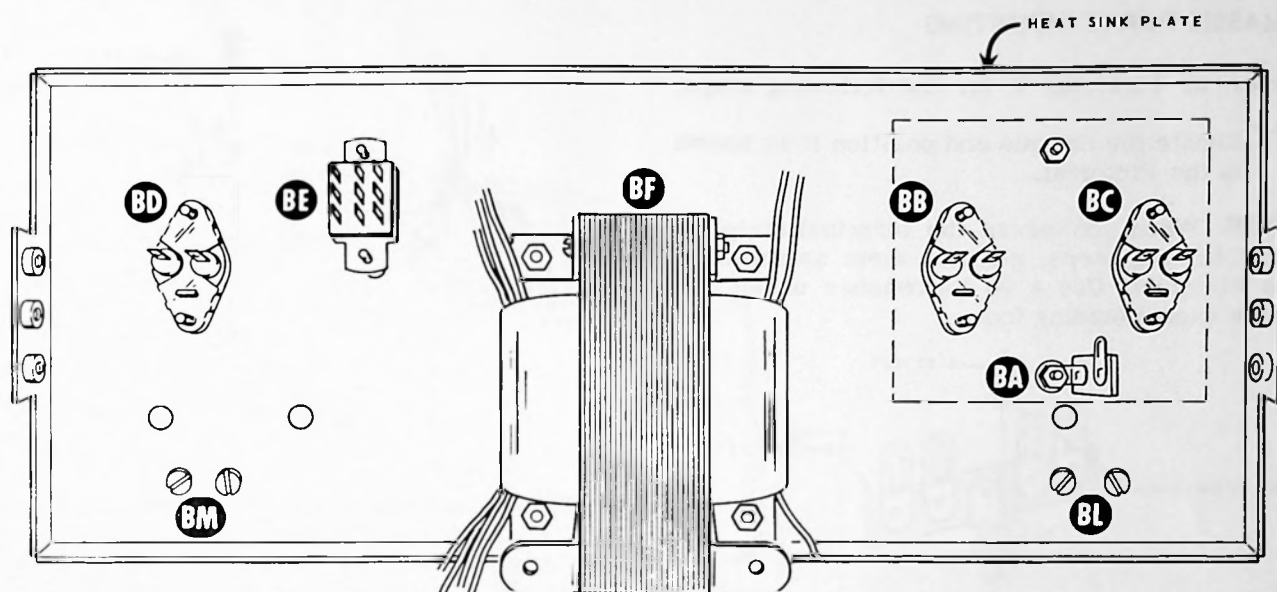
- (✓) Mount a line cord retainer at BL on the outside of the rear panel. Use two #6 x 1/4" sheet metal screws as shown in Detail 6G.
- (✓) In a like manner, mount the other line cord retainer at BM.
- (✓) Locate the power transformer and measure its lead lengths. If the leads are within 1/2" of the lengths shown in Detail 6H, do not cut them and omit the following step.
- ( ) If the power transformer leads are more than 1/2" longer than shown in Detail 6H, prepare them as follows: First cut each lead to the indicated length and remove 1/4" of insulation from its end. Then apply a thin film of solder to the ends of any stranded leads. This will hold the wire strands together.

POWER TRANSFORMER



MEASURE ALL LEADS FROM WHERE THEY BREAK OUT OF THE TRANSFORMER

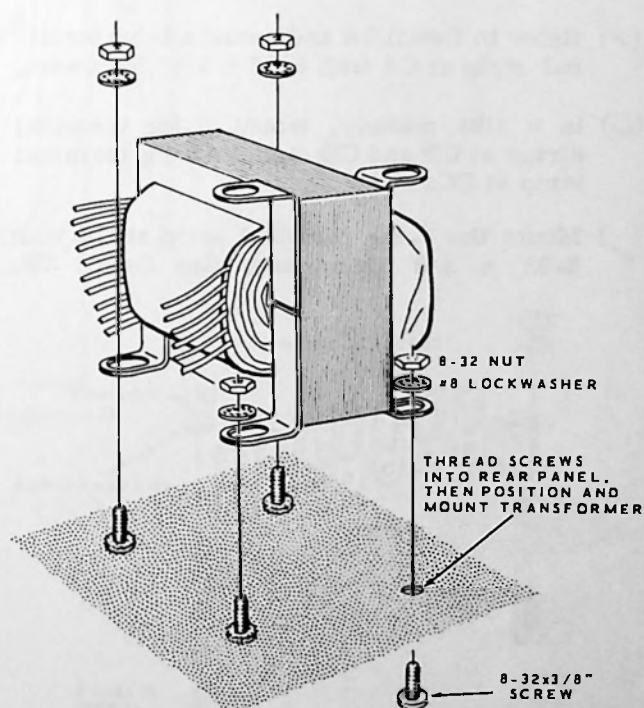
Detail 6H



PICTORIAL 6  
(Repeat)

- (✓) Mount the power transformer at BF with 8-32 x 3/8" hardware. Thread the 8-32 screws into and through the mounting holes in the rear panel, then mount and secure the transformer. Position the transformer so the ten 7-3/4" leads on one side of the transformer winding are next to switch BE. Refer to Detail 6J.

This completes the assembly of the rear panel. Lay the rear panel aside until it is called for later.

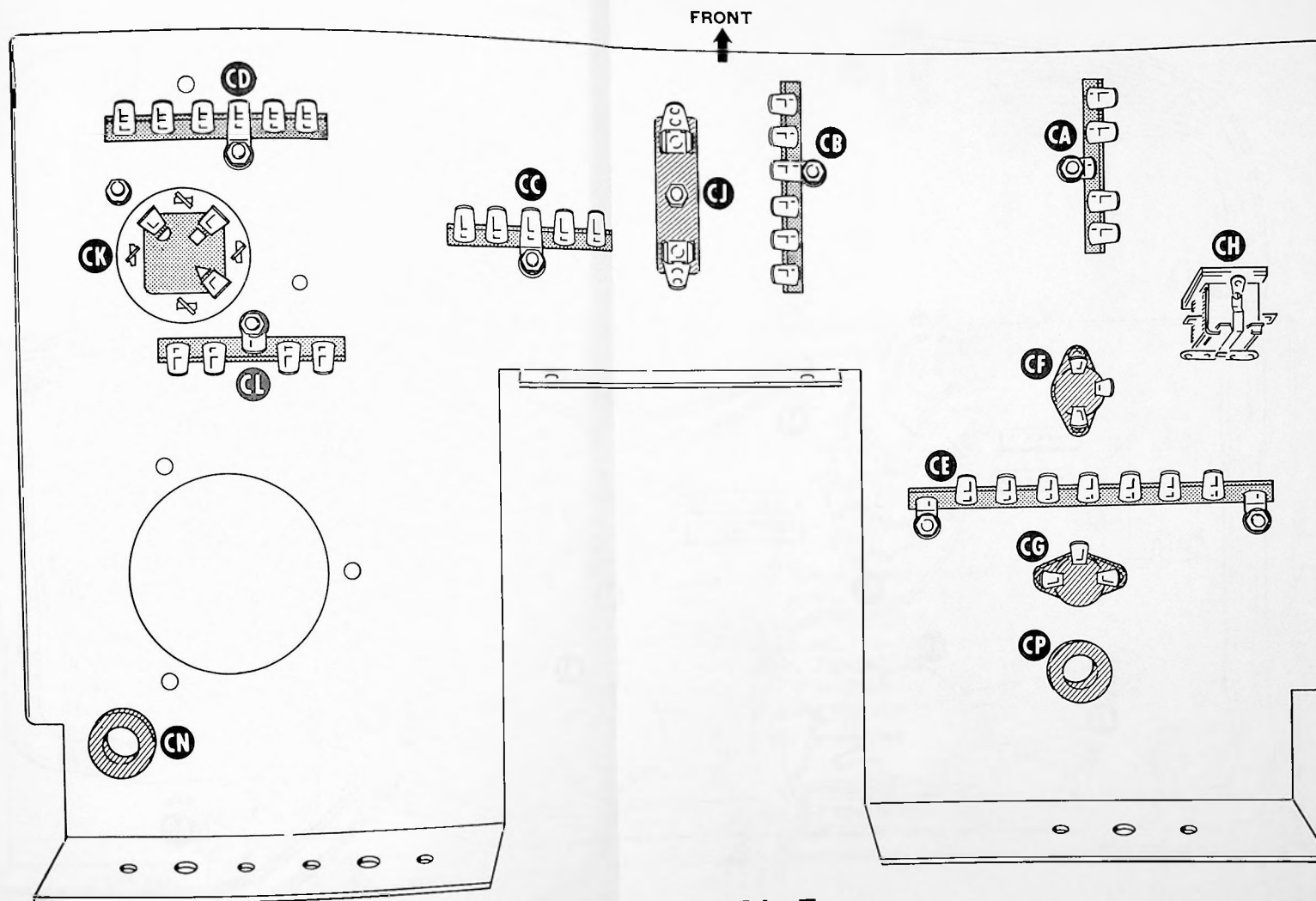


Detail 6J



## PICTORIAL 5





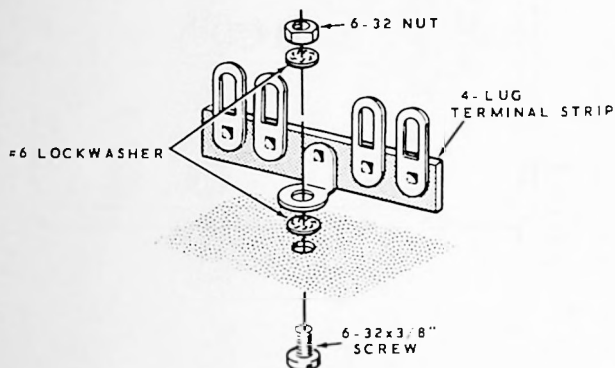
PICTORIAL 7

## CHASSIS PARTS MOUNTING

Refer to Pictorial 7 for the following steps.

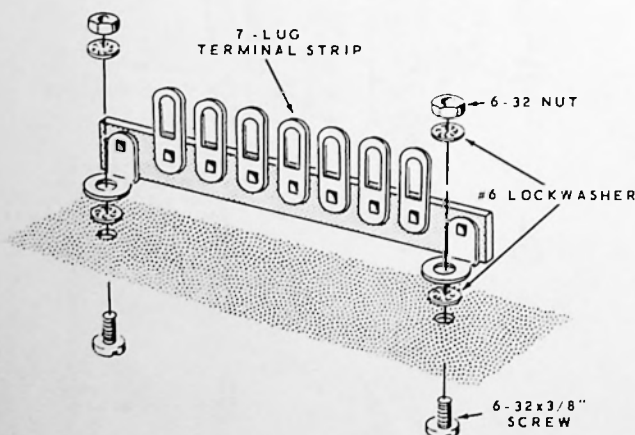
- (✓) Locate the chassis and position it as shown in the Pictorial.

NOTE: When you mount the terminal strips in the following steps, position them as shown in the Pictorial. Use a #6 lockwasher under and above each mounting foot.

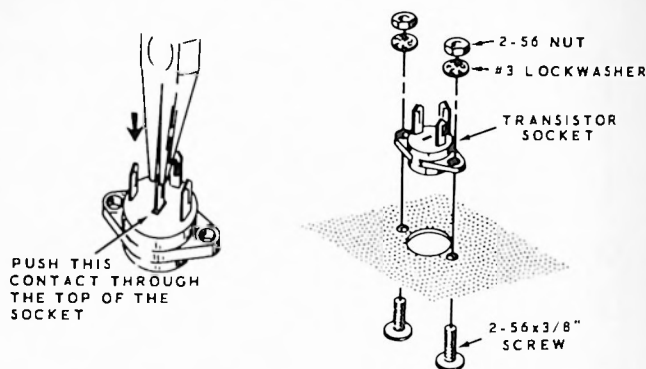


Detail 7A

- (✓) Refer to Detail 7A and mount a 4-lug terminal strip at CA with 6-32 x 3/8" hardware.
- (✓) In a like manner, mount 6-lug terminal strips at CB and CD, and the 5-lug terminal strip at CC.
- (✓) Mount the 7-lug terminal strip at CE with 6-32 x 3/8" hardware. See Detail 7B.



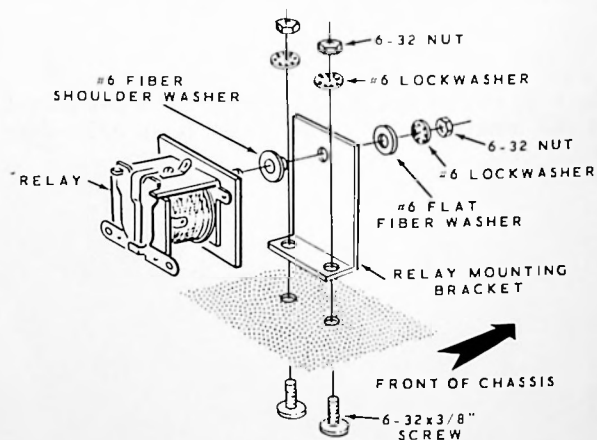
Detail 7B



Detail 7C

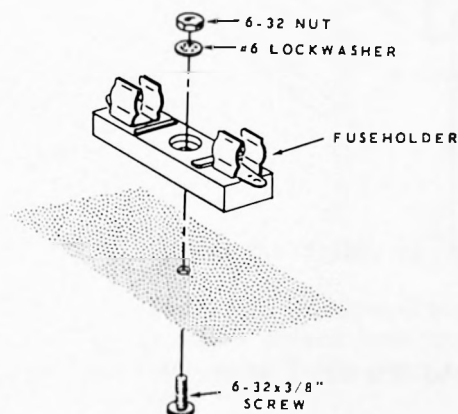
NOTE: Before mounting the transistor sockets at CF and CG in the following steps, remove the center lug from each socket as shown in Detail 7C. This lug is not used in this application. (The lug may have been twisted slightly, and may need to be straightened before it will push out of the socket.)

- (✓) Refer to Detail 7C and mount small transistor sockets at CF and CG. Use 2-56 x 3/8" screws, #3 lockwashers, and 2-56 nuts. Position the lugs as shown in the Pictorial.
- (✓) Mount the relay mounting bracket (#204-565) at CH with 6-32 x 3/8" hardware as shown in Detail 7D.

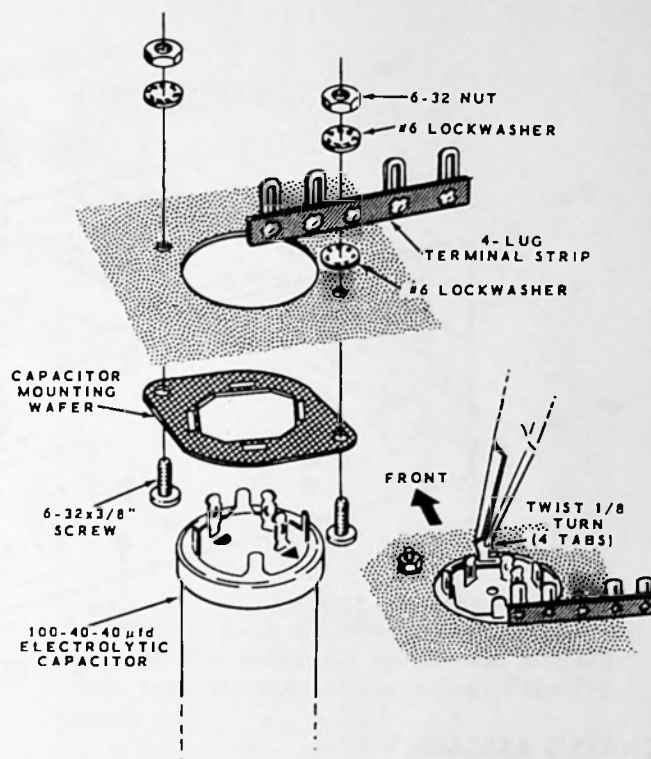


Detail 7D

- ( ) Mount the relay (#69-71) on the L-bracket at CH. Use a #6 shoulder washer, a #6 flat fiber washer, a #6 lockwasher, and a 6-32 nut as shown. Be sure that the shoulder washer is seated on the hole.
- ( ) Mount the fuseholder at CJ with 6-32 x 3/8" hardware as shown in Detail 7E.

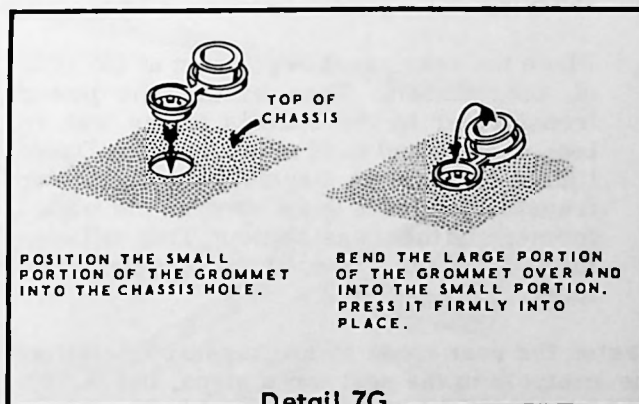


Detail 7E

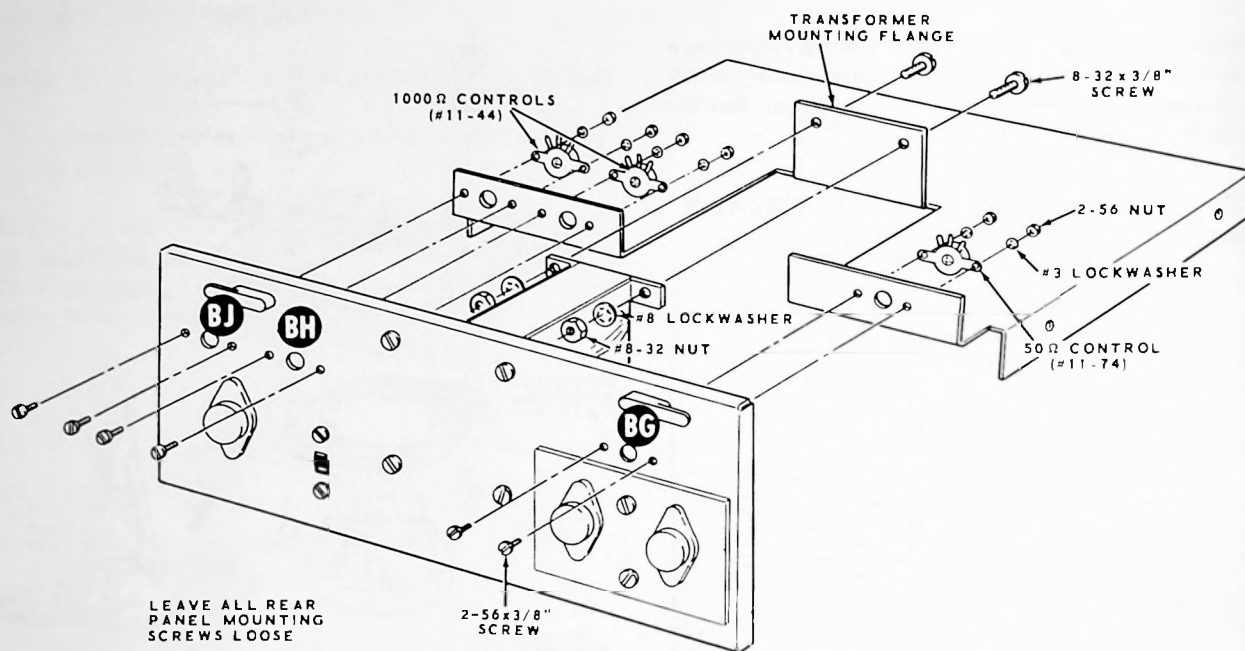


Detail 7F

- ( ) Install the capacitor mounting wafer on the top of the chassis at CK as shown in Detail 7F. Mount a 4-lug terminal strip at CL on the bottom of the chassis. Use 6-32 x 3/8" hardware.
- ( ) Install the 100-40-40 µfd electrolytic capacitor on the capacitor mounting wafer with the lugs positioned as shown in Pictorial 7. Twist each mounting tab 1/8 turn to lock the capacitor in place.
- ( ) Install 1/2" grommets at CN and CP from the top of the chassis as shown in Detail 7G.



Detail 7G



PICTORIAL 8

## CHASSIS ASSEMBLY

Refer to Pictorial 8 for the following steps.

- (✓) Screw two 8-32 x 3/8" screws into the holes in the transformer mounting flange on the chassis.
- (✓) Place the rear panel in position at the rear of the chassis. Then secure the power transformer to the chassis flange with #8 lockwashers and 8-32 nuts as shown. Do not tighten the screws. Carefully push all power transformer leads down between the transformer and the chassis cutout. This will keep them out of the way until they are connected later.

Fasten the rear panel to the chassis by installing the controls in the next three steps. Use 2-56 x 3/8" screws, #3 lockwashers, and 2-56 nuts, but do not tighten the screws until directed to later.

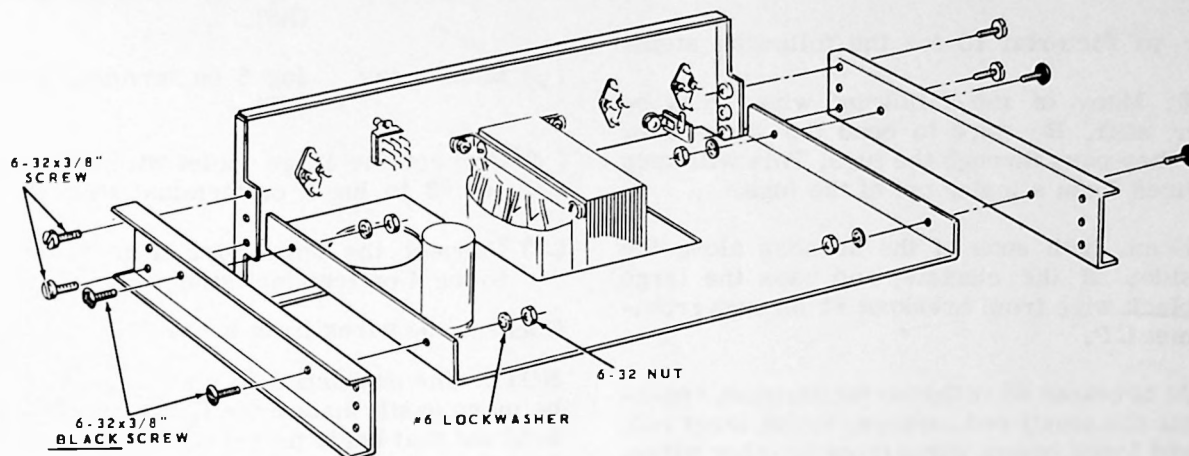
- (✓) 50  $\Omega$  control (#11-74) at BG.
- (✓) 1000  $\Omega$  control (#11-44) at BH.
- (✓) 1000  $\Omega$  control (#11-44) at BJ.

Refer to Pictorial 9 for the following steps.

NOTE: The holes in the siderails are arranged so that you may install the rails with either end forward on the chassis.

- (✓) Position the chassis as shown and fasten the siderails to the chassis using two 6-32 x 3/8" black screws, two #6 lockwashers, and two 6-32 nuts on each rail. Do not tighten the screws at this time.
- (✓) Fasten the siderails to the rear panel. Use two 6-32 x 3/8" screws on each rail.
- (✓) Tighten all siderail mounting screws and all the screws used to mount controls BG, BH, and BJ.
- (✓) Now tighten the two 8-32 screws that fasten the power transformer to the chassis apron.

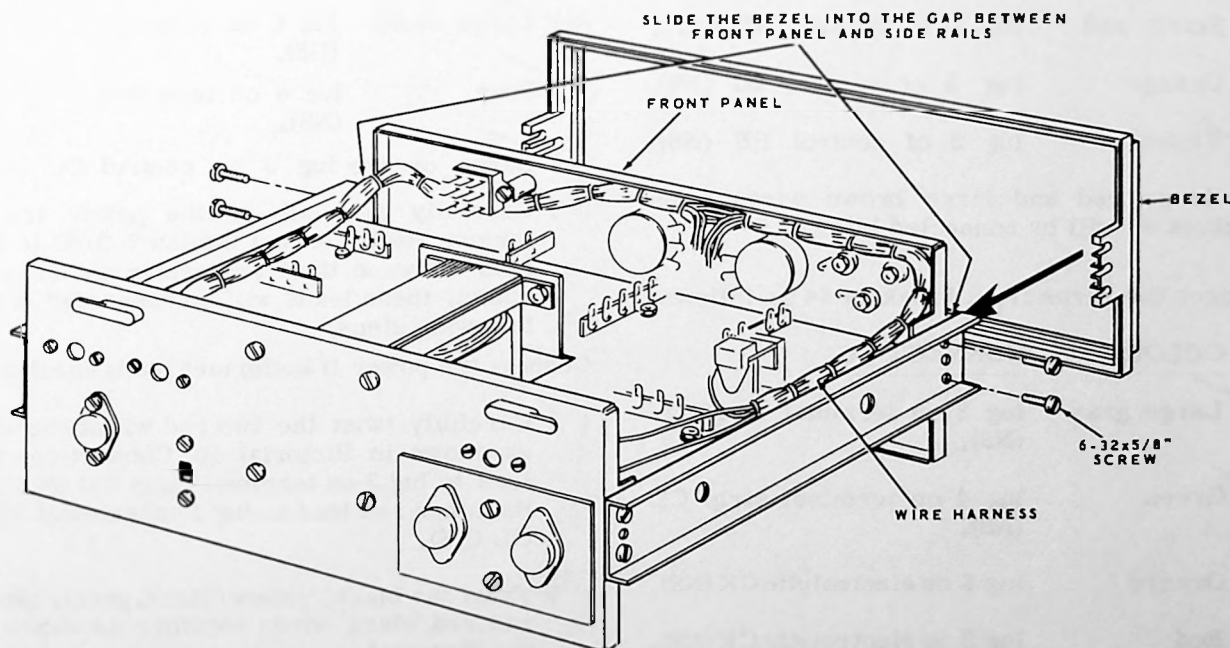




PICTORIAL 9

Refer to Detail 9A for the following steps.

- (✓) Position the chassis and front panel with the bottom sides up; then extend both ends of the wire harness toward the rear of the chassis as shown.
- (✓) Insert four 6-32 x 5/8" screws through the holes in the siderails as shown, and start them into the nuts at the sides of the front panel.
- (✓) Push the bezel into position over the front panel. Then tighten the four 6-32 x 5/8" screws.



Detail 9A



## PICTORIAL 10

## BOTTOM OF CHASSIS WIRING

Refer to Pictorial 10 for the following steps.

NOTE: Many of the following wires may be rather stiff. Be sure to bend the wires over after they pass through the lugs. This will keep the wires from slipping out of the lugs.

(✓) Form both ends of the harness along the sides of the chassis, and pass the large black wire from breakout #1 through grommet CP.

(✓) At breakout #5 of the wiring harness, separate the small red, orange, violet, large red, and large brown wires from the other wires. Then insert all the other wires at this breakout through grommet CN.

NOTE: As you connect the harness wires to the chassis in the following steps, position each wire against the chassis as shown in Pictorial 10 so the wires will not interfere with the mounting of other parts later.

Connect the wires from breakout #5 as follows:

<u>COLOR</u>	<u>CONNECT TO</u>
(✓) Small red	lug 1 of control BJ (S-1).
(✓) Orange	lug 3 of control BJ (NS).
(✓) Violet	lug 3 of control BH (NS).

The large red and large brown wires from breakout #5 will be connected later.

Connect the wires from breakout #4 as follows:

<u>COLOR</u>	<u>CONNECT TO</u>
(✓) Large gray	lug 2 on terminal strip CL (NS).
(✓) Green	lug 4 on terminal strip CL (NS).
(✓) Orange	lug 3 on electrolytic CK (NS).
(✓) Red	lug 2 on electrolytic CK (NS).
(✓) Large black	lug 6 on terminal strip CD (NS).

(✓) Small black lug 6 on terminal strip CD (NS).

(✓) Small gray lug 5 on terminal strip CD (NS).

(✓) Connect the large violet wire from breakout #2 to lug 2 on terminal strip CB (NS).

(✓) Connect the white wire from breakout #2 to lug 4 on terminal strip CB (NS).

Connect the wires from breakout #1 as follows:

NOTE: The connection to lug 4 of relay CH may be more easily made if you first loosen the single 6-32 nut that holds the relay to the bracket. Then turn the relay slightly and make the connection. Be sure to reposition the relay and tighten the nut after soldering the connection.

<u>COLOR</u>	<u>CONNECT TO</u>
(✓) Large green	lug 4 on relay CH (S-1).
(✓) Large red	lug 1 on relay CH (NS).
(✓) White/green	lug 3 on relay CH (NS).
(✓) Large brown	lug 1 on terminal strip CE (NS).
(✓) Large violet	lug 6 on terminal strip CE (NS).
(✓) Gray	lug 4 on terminal strip CE (NS).
(✓) Large orange	lug 3 on control BG (NS).
(✓) Carefully pull all of the power transformer leads, except the ten 7-3/4" leads, from between the transformer and chassis cutout; these leads will be connected in the following steps.	

Connect the power transformer leads as follows:

(✓) Carefully twist the two red wires together as shown in Pictorial 10. Connect one red lead to lug 3 on terminal strip CD (NS) and the other red lead to lug 1 on terminal strip CL (NS).

(✓) Twist the black, yellow/black, green/black, and red/black wires together as shown on the Pictorial.

(✓) Connect the red/black wire to lug 1 of terminal strip CC (NS).

- (-) Connect the yellow/black wire to lug 2 of terminal strip CC (NS).
- (-) Connect the green/black wire to lug 4 of terminal strip CC (NS).
- (-) Connect the black wire to lug 5 of terminal strip CC (NS).
- (-) Connect the short yellow wire to lug 6 on terminal strip CB (NS).
- (-) Twist the remaining yellow wire and the orange wire together. Route the wires as shown and connect the orange wire to lug 3 on terminal strip CL (NS). The yellow wire will be connected later.

- (-) Prepare the following lengths of wire:

<u>COLOR</u>	<u>LENGTH</u>
Small blue	4-1/2"
Small black	2-1/4"
Large brown	1-5/8"

- (-) Connect the 4-1/2" small blue wire from lug 8 of switch AG (S-1) to lug 2 of terminal strip CC (NS). Connect the wire carefully at switch AG so it does not short to other lugs on the switch.
- (-) Connect the 2-1/4" small black wire from lug 6 of switch AG (S-1) to lug 6 of terminal strip CD (NS).
- (-) Connect the 1-5/8" large brown wire from lug 3 of terminal strip CD (NS) to lug 4 of capacitor CK (S-1).

NOTE: When connecting the wires in the following steps, you may wish to refer back to Pictorial 4 (fold-out from Page 6) to help locate front panel wires.

- (-) Locate the twisted-together large brown and large black wires that come from power switch AL (at the rear of rotary switch AL). At the free end of this twisted pair, connect the large brown wire to lug 1 of fuseholder CJ (S-1) and connect the large black wire to lug 5 of terminal strip CC (NS).
- (-) Connect the free end of the large red wire coming from switch AF on the front panel to lug 2 on terminal strip CB (NS).

- (-) Connect the free end of the large black wire coming from binding post AC on the front panel to lug 1 on terminal strip CA (NS).

- (-) Connect the free end of the yellow wire coming from lug 2 of control AJ to lug 1 of terminal strip CB (NS).

- (-) Prepare the following lengths of wire:

<u>COLOR</u>	<u>LENGTH</u>
Red	2-1/4"
Red	1-3/4"
Blue	2-1/4"
Yellow	2-5/8"
Yellow	1-1/2"

Connect the prepared wires in the following steps:

- (-) 2-1/4" red from lug 1 of socket CF (S-1) to lug 6 of terminal strip CE (NS).

- (-) 1-3/4" red from lug 6 (NS) to lug 3 (NS) of terminal strip CE.

- (-) 2-1/4" blue from lug 1 of socket CG (S-1) to lug 2 of terminal strip CE (NS).

- (-) 2-5/8" yellow from lug 2 of relay CH (NS) to lug 5 of terminal strip CE (NS).

- (-) 1-1/2" yellow from lug 2 of socket CF (S-1) to lug 5 of terminal strip CE (NS).

- (-) Prepare the following lengths of wire:

<u>COLOR</u>	<u>LENGTH</u>
Yellow	5"
Black	3-1/4"
Blue	5-1/2"
Large brown	4-1/2"
Large red	4"

Connect the prepared wires in the following steps:

- (-) 5" yellow from lug 7 of terminal strip CE (NS) to lug 2 of control BG (S-1).

- (-) 3-1/4" black from lug 3 of socket CG (S-1) to lug 1 of terminal strip CE (NS).

- (-) 5-1/2" blue to lug 2 of terminal strip CE (NS). Insert the other end through grommet CP. It will be connected later.



- ( / ) 4-1/2" large brown to lug 1 of terminal strip CE (S-3). Insert the other end of the wire through grommet CP. It will be connected later.
- ( / ) 4" large red wire from lug 3 of terminal strip CE (NS) to lug 1 on control BG (NS).
- ( / ) Connect a .33  $\Omega$  (orange-orange-silver-gold) 2 watt resistor from lug 1 (S-2) to lug 3 (S-2) of control BG.
- ( / ) Cut a 2" length of bare wire and a 1/2" length of sleeving for use in the following step.
- ( / ) Pass one end of the 2" bare wire through lug 4 of terminal strip CE (NS) to lug 2 of socket CG (S-1). Wrap the free end of this wire once around lug 4 of terminal strip CE and place the 1/2" length of sleeving on the wire; then connect the wire to lug 3 of socket CF (S-1).
- ( / ) Connect a 3/4" bare wire between lug 2 (S-1) and lug 3 (S-2) of control BH.
- ( / ) Connect one end of a 1-3/4" bare wire to lug 1 of control BH (S-1). Pass the other end of the wire around lug 3 (S-3) to lug 2 (S-1) of control BJ.

### TOP OF CHASSIS WIRING

Refer to Pictorial 11 (fold-out from Page 25) for the following steps.

- ( / ) Position the chassis as shown. Temporarily bend the harness wires coming from grommet CN so they reach the lugs on switch BE.
- ( / ) Bend the lugs in the two outside rows of switch BE away from the center lugs.
- ( / ) Connect the remaining 10  $\Omega$  (brown-black-black) resistor from lug 1 (S-1) to lug 3 (NS) of switch BE.

- ( / ) Cut one lead of the remaining 15  $\Omega$  (brown-green-black) resistor to a length of 5/8". Pass this lead through lug 3 (S-3) to lug 6 (NS) of switch BE.

- ( / ) Pass the other lead of this resistor through lug 9 (NS), through a 1/2" length of sleeving, to lug 2 of switch BE (S-1).

The wires that come through grommet CN will be connected in the following steps.

- ( / ) Connect the large yellow wire to lug 2 of transistor socket BD (S-1).
- ( / ) Connect the white wire to lug 1 of transistor socket BD (S-1).
- ( / ) Connect the large blue wire to lug 3 of transistor socket BD (S-1).

Connect the following wires from grommet CN to switch BE:

- ( / ) White/red to lug 4 (S-1).
- ( / ) Yellow to lug 7 (S-1).
- ( / ) Brown to lug 8 (S-1).
- ( / ) Blue to lug 5 (S-1).
- ( / ) Black to lug 9 (S-3).
- ( / ) Green to lug 6 (S-2).

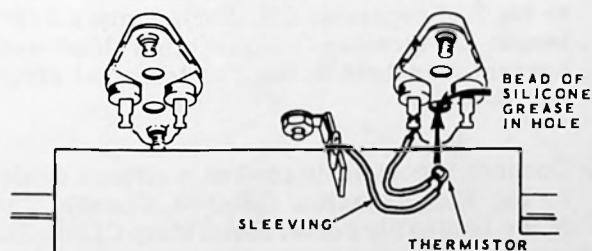
- ( / ) Carefully form all of the wires from grommet CN that were just connected into a neat bundle and push the longer wires against the rear panel as shown.

- ( / ) Cut a 2-5/8" length of large brown wire and remove 3/8" of insulation from each end. Connect this wire from lug 2 of socket BB (NS) to lug 2 of socket BC (S-1).

- (✓) Connect the large brown wire coming through grommet CP to lug 2 on transistor socket BB (S-2).
- (✓) Connect a .33  $\Omega$  (orange-orange-silver-gold) 2 watt resistor from lug 3 of socket BB (S-1) to the lug on terminal strip BA (NS). Carefully bend the resistor leads as shown.
- (✓) Connect the remaining .33  $\Omega$  (orange-orange-silver-gold) 2 watt resistor from lug 3 of socket BC (S-1) to the lug on terminal strip BA (NS).
- (✓) Connect the large black wire that comes through grommet CP to the lug of terminal strip BA (NS). Dress this wire neatly against the chassis.

NOTE: The thermistor that is installed in the following step is somewhat delicate. When forming the leads, be careful to make gradual bends, and do not bend the leads right at the thermistor.

- (✓) Strip two 1" lengths of insulation from the blue hookup wire. Then place one piece of this insulation on each lead of the 500  $\Omega$  thermistor (#9-9).
- (✓) Connect the thermistor from the lug on terminal strip BA (S-4) to lug 1 on socket BC (NS).
- (✓) Place a bead of silicone grease in the lower hole of transistor socket BC. Then push the thermistor body fully into the greased hole. See Detail 11A.



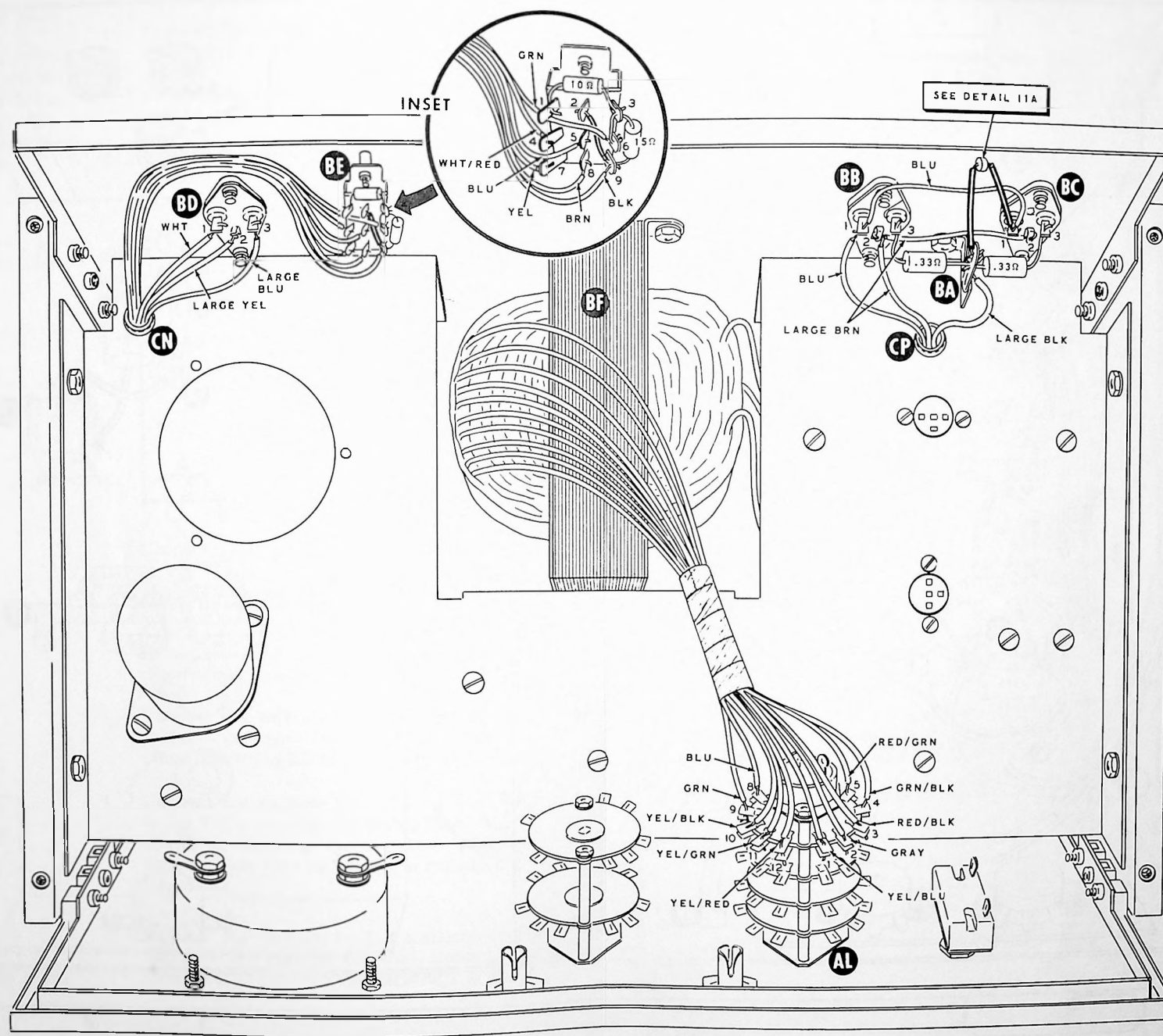
Detail 11A

NOTE: Be sure the body of the thermistor is fully inserted in the greased hole of the transistor socket. The silicone grease aids in transferring heat from the transistor (this thermistor provides temperature compensation).

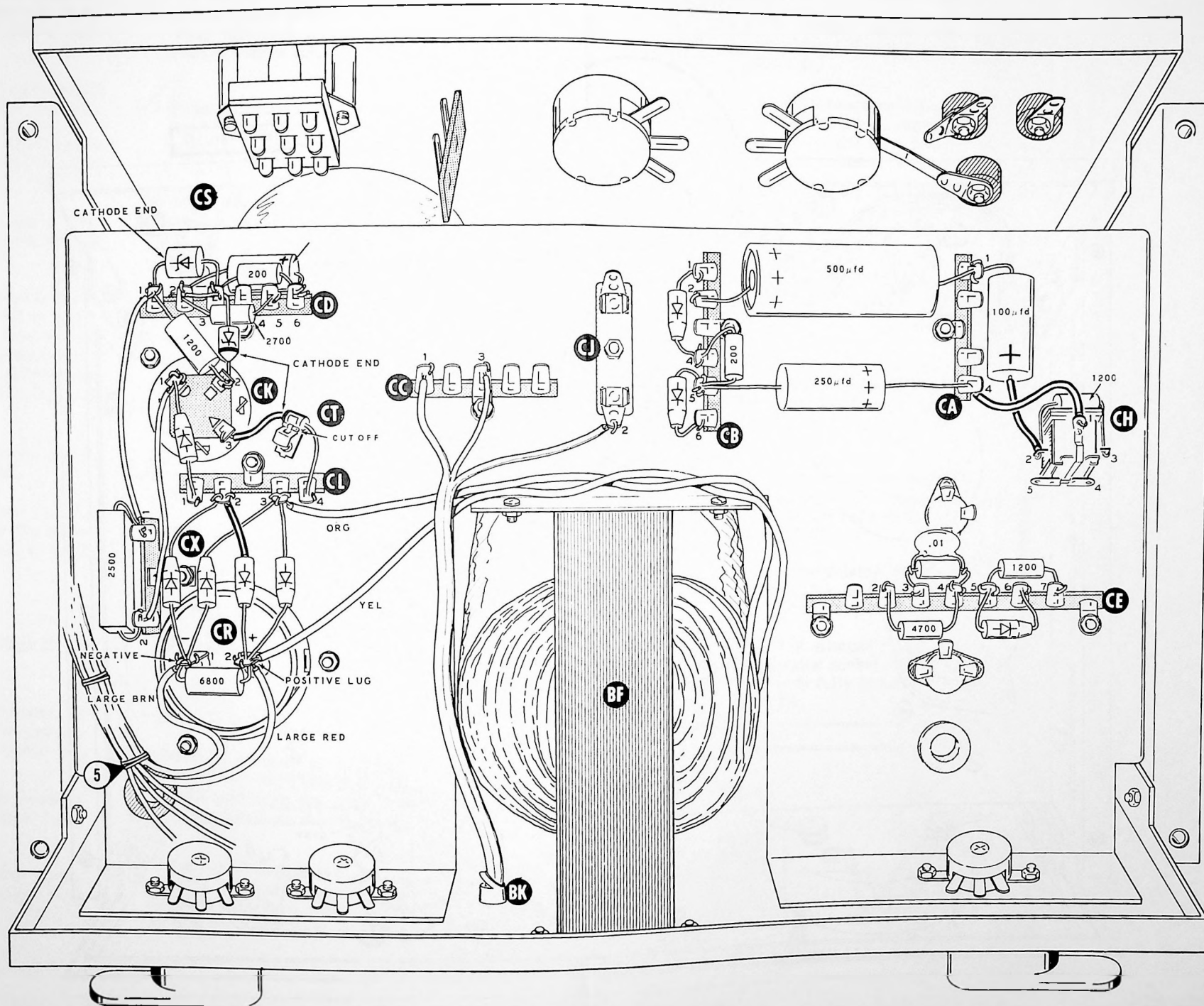
- (✓) Prepare a 3-1/2" blue wire and connect it from lug 1 on socket BB (NS) to lug 1 on socket BC (S-2).
- (✓) Connect the free end of the 5-1/2" blue wire coming through grommet CP to lug 1 on socket BB (S-2).

NOTE: In the following steps, you will connect the power transformer leads to the rear wafer of switch AL. Make sure that each transformer lead is passed through both holes in the double lugs, and that solder is bridged between both halves of the lug and the wire.

POWER TRANSFORMER LEAD	CONNECT TO AL, REAR WAFER
(✓) Blue	lug 8 (S-1).
(✓) Green	lug 9 (S-1).
(✓) Yellow/black	lug 10 (S-1).
(✓) Yellow/green	lug 11 (S-1).
(✓) Yellow/red	lug 12 (S-1).
(✓) Yellow/blue	lug 1 (S-1).
(✓) Gray	lug 2 (S-1).
(✓) Red/black	lug 3 (S-1).
(✓) Green/black	lug 4 (S-1).
(✓) Red/green	lug 5 (S-1).
(✓) Form the transformer leads into a round bundle. You may wish to tie the wires together with 2 or 3 short pieces of hookup wire or wrap with tape as shown in the Pictorial.	



PICTORIAL 11



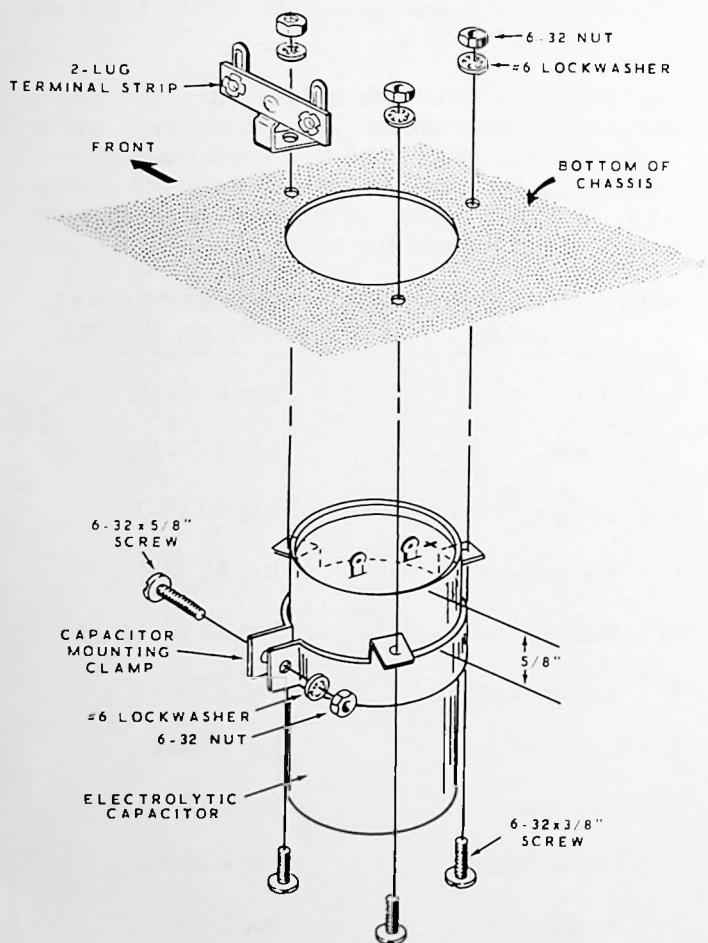
PICTORIAL 12



## FINAL WIRING

Refer to Detail 12A for the following step.

- ( ) Mount the 3000  $\mu$ fd electrolytic capacitor in the capacitor mounting clamp. Note the correct position of the positive lug. This lug is marked with either a red dot or a (+) sign. Use 6-32 x 5/8" hardware to secure the clamp, but do not overtighten.



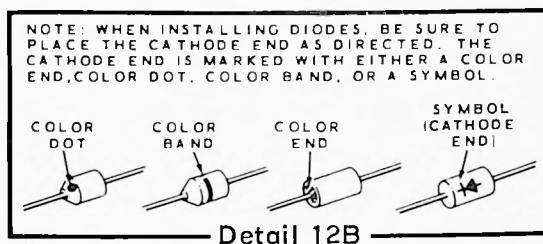
Detail 12A

Refer to Pictorial 12 for the following steps and position the chassis as shown.

- ( ) Mount the 3000  $\mu$ fd capacitor to the top of the chassis at CR with the positive lug as shown in Pictorial 12 and the 2-lug terminal strip at CX. Use 6-32 x 3/8" hardware.

- ( ) Connect the large brown wire from breakout #5 to lug 1 of capacitor CR (NS).  
 ( ) Connect the large red wire from breakout #5 to lug 2 of capacitor CR (NS).  
 ( ) Connect the long yellow power transformer lead to lug 2 of capacitor CR (NS).  
 ( ) Connect the 6800  $\Omega$  (blue-gray-red) 2 watt resistor between lug 1 (NS) and lug 2 (NS) of capacitor CR.

NOTE: When installing diodes, as in the next step, be sure to position the cathode end as shown. See Detail 12B.



- ( ) Connect the cathode lead of a silicon diode to lug 2 of terminal strip CL (NS). Connect the other lead to lug 1 of capacitor CR (NS).  
 ( ) Connect the cathode lead of a silicon diode to lug 3 of terminal strip CL (NS). Connect the other lead to lug 1 of capacitor CR (S-4).  
 ( ) Connect the cathode lead of a silicon diode to lug 2 of capacitor CR (NS). Connect the other lead to lug 3 of terminal strip CL (S-3).  
 ( ) Connect the cathode lead of a silicon diode to lug 2 of capacitor CR (S-5). Place a 7/8" length of sleeving on the other lead and connect this lead to lug 2 of terminal strip CL (S-3).  
 ( ) Connect the cathode lead of a silicon diode to lug 1 of capacitor CK (NS). Connect the other lead to lug 1 of terminal strip CL (S-2).  
 ( ) Connect the cathode lead of a silicon diode to lug 6 of terminal strip CB (S-2). Connect the other lead to lug 5 of terminal strip CB (NS).

- ( ) Connect the cathode lead of a silicon diode to lug 4 of terminal strip CB (NS). Connect the other lead to lug 1 of terminal strip CB (S-2).
  - ( ) Connect the cathode lead of the remaining silicon diode to lug 6 of terminal strip CE (S-4). (Save the cutoff lead for use later.) Connect the other lead to lug 5 of terminal strip CE (NS).
  - ( ) Connect the cathode lead of the 110 V zener diode (#56-48) to lug 1 (NS) and the other lead to lug 3 (NS) of terminal strip CD.
  - ( ) Cut off the small end tab and then mount the diode clip at CT with 2-56 x 3/8" hardware as shown in Detail 12C.
  - ( ) Insert the 56 V zener diode (#56-618) into the clip. Position the diode in the clip with its cathode end as shown.
  - ( ) Push down on the diode clip and insert the previously saved cutoff lead into the clip lock. Then cut off the ends of this locking lead close to the diode clip as shown in the Pictorial.
  - ( ) Install a 1" length of sleeving on the cathode lead of the 56 V zener diode and connect this lead to lug 3 of capacitor CK (S-2). Connect the other lead to lug 4 of terminal strip CL (S-2).
  - ( ) Connect the positive (+) lead of a 100  $\mu$ fd 10 V electrolytic capacitor to lug 6 (NS) and the other lead to lug 2 (NS) of terminal strip CD.
  - ( ) Connect one lead of a 200  $\Omega$  (red-black-brown) resistor to lug 6 of terminal strip CD (S-5). Pass the other lead through lug 3 (NS) to lug 2 (NS) of terminal strip CD.
  - ( ) Connect the cathode lead of the 68 volt zener diode to lug 2 of capacitor CK (NS).
  - ( ) Connect the other lead of the 68 volt zener diode to lug 3 of terminal strip CD (S-6).
  - ( ) Connect a 2700  $\Omega$  (red-violet-red) resistor from lug 5 (S-2) to lug 2 (S-3) of terminal strip CD.
  - ( ) Connect a 1200  $\Omega$  (brown-red-red) 2 watt resistor from lug 2 of electrolytic capacitor CK (S-3) to lug 1 of terminal strip CD (NS).
  - ( ) Connect a 2500  $\Omega$  7 watt resistor between lug 1 (NS) and lug 2 (NS) of terminal strip CX.
  - ( ) Prepare the following lengths of wire:
    - Blue 4-3/4"
    - Blue 2-1/2"
  - ( ) Connect a 4-3/4" blue wire from lug 1 of terminal strip CD (S-3) to lug 1 of terminal strip CX (S-2).
  - ( ) Connect a 2-1/2" blue wire from lug 1 of capacitor CK (S-2) to lug 2 of terminal strip CX (S-2).
  - ( ) Connect the remaining 200  $\Omega$  (red-black-brown) resistor from lug 5 (NS) to lug 4 (S-3) of terminal strip CB.
- 2-56 X 3/8" SCREW

CATHODE END

ZENER DIODE

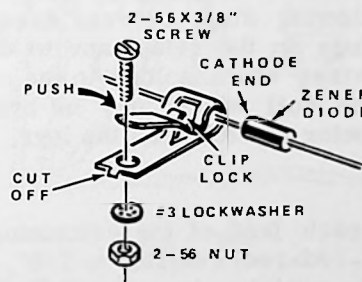
PUSH

CUT OFF

CLIP LOCK

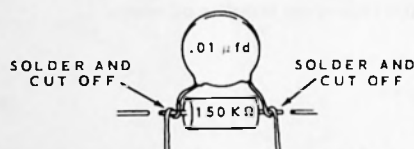
= 3 LOCKWASHER

2-56 NUT
- Detail 12C**



### Detail 12C

- (✓) Connect a 4700  $\Omega$  (yellow-violet-red) resistor from lug 2 (S-3) to lug 4 (NS) of terminal strip CE.
- (✓) Connect a 1200  $\Omega$  (brown-red-red) resistor from lug 7 (S-2) to lug 5 (S-4) of terminal strip CE.
- (✓) Refer to Detail 12D and prepare a resistor-capacitor combination as shown, with a .01  $\mu$ fd disc capacitor and a 150 K $\Omega$  (brown-green-yellow) resistor.



Detail 12D

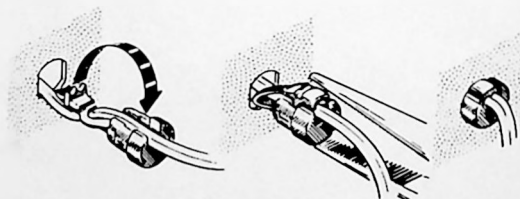
- (✓) Connect this resistor-capacitor combination from lug 4 (S-5) to lug 3 (S-3) of terminal strip CE. Position the combination as shown.

CAUTION: When installing the 1200  $\Omega$  resistor in the following step, be very careful not to bend the lugs on the relay, nor to disturb the fine coil wires which solder to the ends of the lugs. These coil wires may be broken quite easily by being stretched on the lugs.

- (✓) Trim each lead of the remaining 1200  $\Omega$  (brown-red-red) resistor to 7/8", and connect the resistor from lug 3 (S-2) to lug 2 (NS) of relay CH. Position the resistor so it does not touch the relay contacts.
- (✓) Install a 1" length of sleeving on the positive (+) lead of the 100  $\mu$ fd 50 V electrolytic capacitor. Connect this lead to lug 2 of relay CH (S-3). Connect the other lead of the capacitor to lug 1 of terminal strip CA (NS).
- (✓) Pass the positive (+) lead of a 250  $\mu$ fd electrolytic capacitor through lug 4 of terminal strip CA (NS), and through a

1-1/8" length of sleeving to lug 1 of relay CH (S-2). Now solder lug 4 of terminal strip CA (S-2).

- (✓) Connect the other lead of this capacitor to lug 5 of terminal strip CB (S-3).
- (✓) Connect the positive (+) lead of a 500  $\mu$ fd electrolytic capacitor to lug 2 of terminal strip CB (S-3). Connect the other lead to lug 1 of terminal strip CA (S-3).
- (✓) Separate the three wires of the line cord for about 2". Twist the ends of each wire and apply a thin film of solder to each end to hold the wire strands together.
- (✓) Pass the end of the line cord through the hole in the rear panel at BK.
- (✓) Connect the green line cord wire to lug 3 of terminal strip CC (S-1).
- (✓) Connect either of the other line cord wires to lug 2 of fuseholder CJ (S-1).
- (✓) Connect the other line cord wire to lug 1 of terminal strip CC (NS).
- (✓) Refer to Detail 12E and install the line cord strain relief in the hole at BK from the outside of the rear panel.
- (✓) Wrap the line cord around the two line cord retainers on the outside of the rear panel.



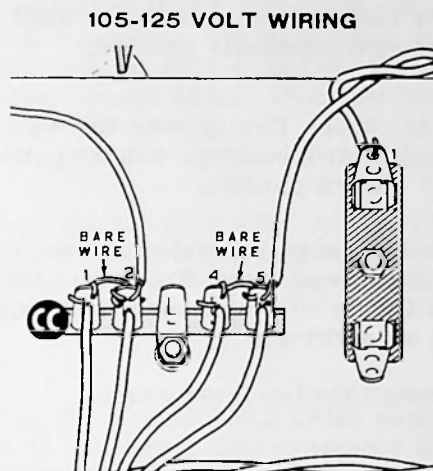
Detail 12E

NOTE: The Regulated Power Supply can be wired for operation from either a 105 to 125 volt AC line, or from a 210 to 250 volt AC line. Use only the steps that are appropriate for the line voltage in your area.

### 105-125 Volt Wiring

Refer to Detail 12F for the following steps.

- (✓) Connect a 1" bare wire from lug 1 (S-3) to lug 2 (S-3) of terminal strip CC.
- (✓) Connect another 1" bare wire from lug 4 (S-2) to lug 5 (S-3) of terminal strip CC.
- (✓) Install the 1-1/2 ampere slow-blow fuse at CJ.

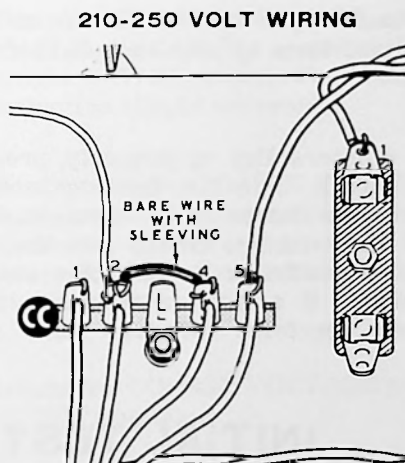


Detail 12F

### 210-250 Volt Wiring

Refer to Detail 12G for the following steps.

- ( ) Slide a 1" length of sleeving on a 1-1/2" bare wire. Then connect this wire from lug 2 (S-2) to lug 4 (S-2) of terminal strip CC.
- ( ) Solder all wires on lugs 1 (S-2) and 5 (S-2) of terminal strip CC.



Detail 12G

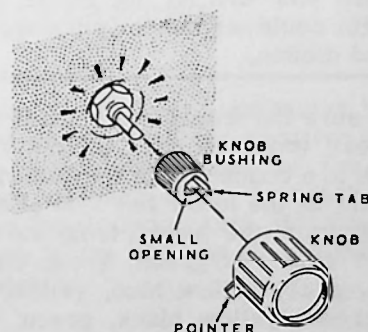
NOTE: The 1-1/2 ampere slow-blow fuse that is supplied with the kit is the correct value for 105-125 VAC operation. If your kit is to be operated from a 210-250 VAC source, a 1 ampere slow-blow fuse (not supplied with this kit) should be used.

### KNOB INSTALLATION

The knobs supplied with this kit use knob bushings that provide permanent positive action without the use of setscrews.

In the following steps you will install a knob on each switch shaft as shown in Detail 13A. Perform these steps carefully, since it is difficult to remove a bushing from a knob once it is fully inserted.

- ( ) Place a knob bushing on each of the switch and control shafts; the spring tab on the bushing should face outward.



Detail 13A





- (✓) Turn each control and switch shaft to its full counterclockwise position.
- (✓) Press knobs firmly onto the two lower (Fine) control bushings with the pointers at the 7 o'clock position.
- (✓) With the bushings installed on them, remove the two lower knobs. Press the knob bushings firmly into these knobs with the handle of a screwdriver.
- (✓) Reinstall the two lower knobs.
- (✓) Install a knob lightly on each of the two upper controls (Coarse) with the pointer at the full counterclockwise position.
- (✓) Turn each upper knob clockwise to see if the pointer lines up with each switch marking.
- (✓) If the pointers line up properly, press the knobs firmly onto the bushings and then remove the knobs with their bushings. Press the bushings firmly into the knobs with a screwdriver handle, then reinstall the knobs. If a pointer does not line up properly, perform the next three steps.

NOTE: It is not necessary to perform the next three steps if the pointer lines up properly at each switch marking.

1. ( ) Turn the knob pointer to a mid-position marking on the panel.
  2. ( ) Remove the knob from the bushing and turn it slightly to line up the pointer with the mid-position marking.
  3. ( ) Press the knob slightly onto the knob bushing. Then turn the knob to each switch position and recheck the pointer alignment. If more than a slight error is noticed at either end position, repeat these three steps.
- ( ) When the pointer lines up properly with the switch positions, remove the knob and bushing together and press the bushing firmly into the knob with a screwdriver handle. Then replace the knob on the shaft.

This completes the assembly of your Heathkit Regulated Low Voltage Power Supply. Carefully inspect all connections for loose wires or unsoldered joints. Remove any wire clippings or solder splashes that may be lodged in the wiring. Do not install the two R255A transistors until you are instructed to do so. Proceed to the Initial Tests And Adjustments section.

## INITIAL TESTS AND ADJUSTMENTS

### RESISTANCE TESTS

**CAUTION:** Be sure to make each of the following tests before you turn on the Power Supply. A wiring error could permanently damage the transistors and diodes.

- (✓) Make sure the transformer leads that go to the rear wafer on the COARSE VOLTAGE switch are connected in the following order: Starting at the lower left side of the switch as you view the switch from the rear, you should find red/green, green/black, red/black, gray, yellow/blue, yellow/red, yellow/green, yellow/black, green, and blue. The blue lead should be followed by the large gray harness wire.

Refer to Figures 1 and 2 (fold-out from Page 43) for location of the controls on the front and rear panels of the Power Supply.

- (✓) Set the front panel controls of the Power Supply as follows:

COARSE VOLTAGE: AC OFF.

COARSE CURRENT: 1.5 a.

FINE VOLTAGE: fully counterclockwise.

FINE CURRENT: fully counterclockwise.

RESET-STANDBY: down.

CURRENT-VOLTAGE: VOLTAGE.

- (✓) Place the rear panel METER switch in NORMAL position.

If the resistance readings you obtain in the initial tests are not within  $\pm 20\%$  of the values given in the steps, refer to the In Case Of Difficulty section of this Manual. After the difficulty has been located and repaired, return to this part of the Manual and complete the Resistance Tests.

NOTE: A Power Supply front panel meter indication will be given in each of the next few steps. This meter indication is for VTVM and volt-ohm-milliammeter readings only. If a Heathkit Model IM-25 Solid-State VOM is being used, the Power Supply meter will only show a slight upward deflection for each of these measurements because the Ohms test voltage is very low.

IMPORTANT: Since you will be measuring resistance in semiconductor circuits, you must be sure of the polarity of your ohmmeter test leads. To do this, perform the next four steps.

1. Turn your ohmmeter range switch to its highest resistance range; then connect its test leads to the terminals on the meter in the Power Supply.
  2. Change the ohmmeter range switch to successively lower ranges until the Power Supply meter begins to deflect in either direction.
  3. If the Power Supply meter deflects up-scale, the lead that is connected to the + meter terminal is the positive ohmmeter lead, and the other is the negative ohmmeter lead. If the meter deflects to the left, the ohmmeter leads are reversed.
  4. Disconnect the ohmmeter leads from the Power Supply meter.
- ( / ) Place the ohmmeter on the RX1000 scale.
- ( / ) Connect the negative ohmmeter lead to the negative (-) Power Supply binding post, and connect the positive ohmmeter lead to the positive (+) Power Supply binding post. The ohmmeter should indicate  $4700\ \Omega$  and the Power Supply meter should deflect upwards to about one-fourth of full scale.
- ( / ) Turn the COARSE VOLTAGE switch to the .5-5 V position. The resistance should remain around  $4700\ \Omega$  and the Power Supply meter should deflect about the same as in the previous step.
- ( / ) Turn the COARSE VOLTAGE switch to the 5-10 V range. Resistance should increase to  $15\ \text{K}\Omega$  and the Power Supply meter reading should decrease.
- ( / ) Turn the COARSE VOLTAGE switch to the 10-15 V position. The resistance indication and the Power Supply meter reading should remain about the same.
- ( / ) Turn the COARSE VOLTAGE switch to the 15-20 V position. The resistance should increase to  $47\ \text{K}\Omega$ , and the Power Supply meter deflection should decrease.
- ( / ) Slowly turn the COARSE VOLTAGE switch through each of the remaining positions. The resistance should remain at  $47\ \text{K}\Omega$  and the Power Supply meter reading should remain about the same.
- ( / ) Return the COARSE VOLTAGE switch to the AC OFF position.
- ( / ) Place the RESET-STANDBY switch in the DC ON position. The ohmmeter reading should decrease to around  $500\ \Omega$ , then slowly increase to over  $1100\ \Omega$  as  $500\ \mu\text{fd}$  capacitor C9 charges.
- ( / ) Connect the negative ohmmeter lead to the chassis and touch the positive ohmmeter lead alternately to one of the mounting screws on each of the transistors on the Power Supply rear panel. Readings from all screws to the chassis should show infinite resistance.

- ( ) Touch the positive ohmmeter lead to the positive (+) Power Supply binding post. Resistance should again be infinite.
- (✓) Check the resistance across 3000  $\mu$ f electrolytic capacitor C5. With the ohmmeter leads properly polarized, resistance should be very low at first, and then increase to over 1400  $\Omega$  as C5 becomes charged.
- ( ) Connect the negative ohmmeter lead to the negative (-) Power Supply binding post.

NOTE: In the following tests, you will check the resistance at each lug on terminal strip CE. Refer to Pictorial 12 (fold-out from Page 26) to identify the terminal strip lug numbers. All resistance values are in ohms.

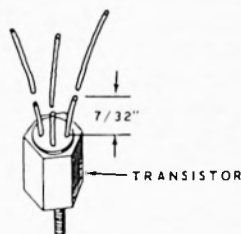
The following resistance checks can be made with the ohmmeter in an 11 megohm input VTVM, or the ohmmeter in a 20,000  $\Omega$ /volt-ohm-milliammeter. The Heathkit Model IM-25 Solid-State VOM may also be used. You will note that different resistance readings are shown, in some instances, for each type of ohmmeter. These differences are due to the semiconductors in the Power Supply, which respond with different resistances as they are activated by the different test voltage from each type of ohmmeter.

LUG NUMBER	OHMMETER RANGE	RESISTANCE VALUES, AS MEASURED ON:		
		VTVM	20,000 $\Omega$ /Volt VOM	HEATHKIT IM-25
( ) 1	RX 1	40	35	75
( ) 2	RX 100	450	425	325
( ) 3	RX 100	500-1600	500-1200	500-1300
( ) 4	RX 100	2000	1800	1900
( ) 5	RX 100	340	350	375
( ) 6	RX 100	500-1600	500-1200	500-1300
( ) 7	RX 100	1100	1200	1300

This completes the Resistance Tests. Disconnect the ohmmeter from the Power Supply.

## CALIBRATION ADJUSTMENTS

- ( ) Cut each lead of two R265A transistors (#417-20) to a length of  $7/32$ " from the transistor body as shown in Detail 13B.



Detail 13B

- ( ) Install the two R265A transistors in the sockets at Q2 and Q3. See Figure 1 (fold-out from Page 43).

- ( ) Set the front panel controls and switches of the Power Supply as follows:

COARSE VOLTAGE: AC OFF.

COARSE CURRENT: 1.5 a.

FINE VOLTAGE: center of rotation.

FINE CURRENT: fully clockwise.

CURRENT-VOLTAGE: VOLTAGE.

RESET-STANDBY: down.

- ( ) Set the controls and switches on the rear panel as follows:

ZENER CURRENT - fully counterclockwise.

VOLTAGE CALIBRATE - center of rotation.

METER - ZENER CURRENT position.

DC REGULATION -  $1/8$  turn from full clockwise position.

- ( ) Adjust the meter pointer to zero, if necessary, with a small screwdriver.

- ( ) Plug the line cord into a standard AC outlet. Turn the COARSE VOLTAGE switch to the .5-5 volt position.

NOTE: When the METER switch is in its present ZENER CURRENT position, the front panel meter will indicate 5 milliamperes of current at its full scale position.

- ( ) Adjust the ZENER CURRENT control for a reading of approximately 4 milliamperes on the meter. This setting is not critical because there may be some warm-up drift.

- ( ) Press the rear panel METER switch to NORMAL and the RESET-STANDBY switch to DC ON.

- ( ) Turn the FINE VOLTAGE control back and forth and watch the meter. The voltage reading should swing from almost zero to more than full scale. If operation appears normal, continue with the following steps. If there appears to be any difficulty, refer to the In Case Of Difficulty section of the Manual.

- ( ) Set the FINE VOLTAGE control at the full clockwise position.

- ( ) Place the COARSE VOLTAGE switch in the 45-50 V position. Then adjust the VOLTAGE CALIBRATE control for a full scale reading on the meter.

- ( ) Place the rear panel METER switch in the ZENER CURRENT position.

- ( ) Adjust the ZENER CURRENT control for a current of 5 milliamperes, as indicated on the meter.

NOTE: The setting of the ZENER CURRENT control is not critical. The current may vary, depending on line voltage, warm up, and loads on the Power Supply.

- ( ) Return the rear panel METER switch to the NORMAL position. If necessary, readjust the VOLTAGE CALIBRATE control for a full scale reading. Repeat this step and previous two steps until each position of the meter switch gives the correct indication. Leave the METER switch in NORMAL position.

- ( ) Return the COARSE VOLTAGE switch to the AC OFF position.



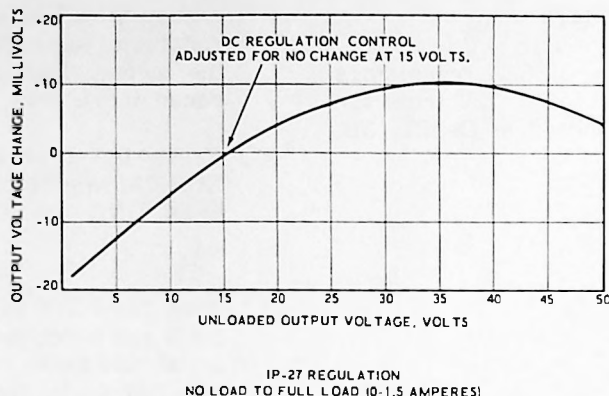


Figure 3

### DC REGULATION CONTROL ADJUSTMENT

The following method of setting the DC REGULATION control will provide a degree of stability that is adequate for all but the most exacting requirements. When adjusted by this method, the Power Supply's regulation characteristics are as shown in Figure 3. If greater accuracy is desired, you can obtain it by using a differential voltmeter, instead of the front panel meter, to measure the output voltage in the following steps.

- (✓) Locate a load that will withstand 1.5 amperes at 15 volts. This load value is equal to a 10  $\Omega$  resistor rated at 22-1/2 watts or greater. If such a resistor is not available, an ordinary electric flatiron will present a load that is sufficiently correct for this purpose (10 to 15  $\Omega$ ).

- (✓) Connect the load between the negative (-) and positive (+) terminals of the Power Supply.

- (✓) Set the front panel controls of the Power Supply as follows:

COARSE VOLTAGE: 10-15.

COARSE CURRENT: 1.5 a.

FINE CURRENT: maximum clockwise.

CURRENT-VOLTAGE: VOLTAGE.

- (✓) Adjust the DC REGULATION control on the rear panel until there is no difference in the meter reading between loaded and unloaded conditions. This is the point of optimum regulation.

This completes the Calibration procedure.

## FINAL ASSEMBLY

Refer to Pictorial 14 for the following steps.

- (✓) Thread four 6-32 x 3/8" studs into the unused holes in the siderails. Tighten the studs fully.
- (✓) Remove the tape from a plastic handle. Then install the handle on one siderail with the grain side out. Use two 6-32 x 1/4" decorative screws and two end caps, as shown in the Pictorial. Tighten the decorative screws with a penny.

- (✓) In a like manner, install the other handle and end caps on the opposite side of the case.

- (✓) Install four rubber feet on a cabinet half shell as shown in the Pictorial. Remove the paper backing from the feet just before mounting them on the half shell.

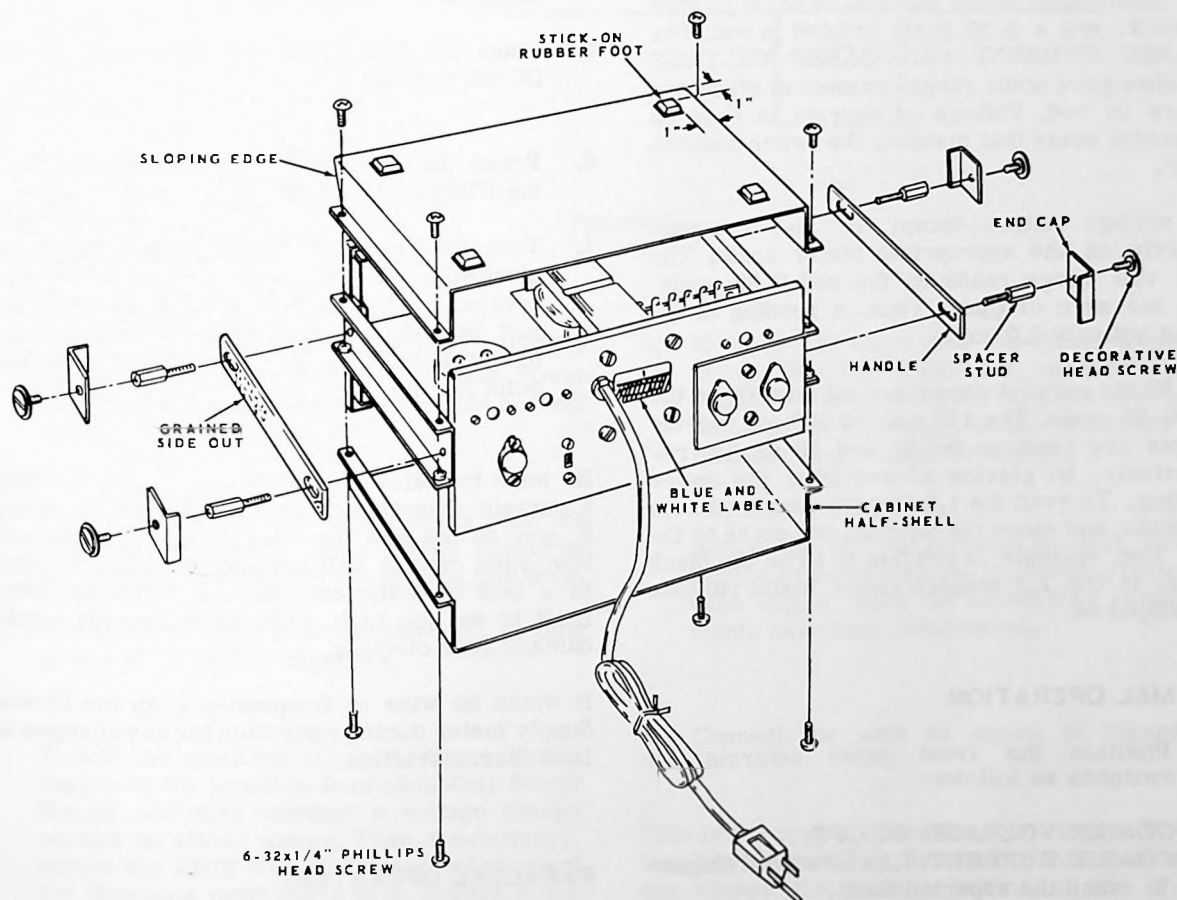
- (✓) Position the cabinet half shell, with the sloping edge toward the front, on the bottom of the Power Supply. Fasten it with four 6-32 x 1/4" phillips head screws.

(✓) In a like manner, install the top cabinet half shell as shown on the Pictorial.

NOTE: The blue and white identification label that is installed in the next step shows the Model number and Production Series number of your kit. Refer to these numbers in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

(X) Carefully peel away the paper backing from the blue and white identification label. Then press the label firmly into place on the rear panel.

This completes the Final Assembly of your Regulated Power Supply.



PICTORIAL 14

## OPERATION

Before you attempt to use your Regulated Low Voltage Supply, be sure to become familiar with its operating characteristics and features. This will help you put the Power Supply to its fullest use. It would also be helpful to read the Circuit Description.

### READING THE METER

The front panel meter has a 0-15 scale printed in black, and a 0-50 scale printed in red. The COARSE CURRENT and COARSE VOLTAGE switches have some ranges printed in black and others in red. Voltage or current is read on the meter scale that matches the switch position color.

All voltage ranges except the .5-5 are read directly on the appropriate meter scale. The .5-5 volt range reads on the red 0-50 scale, with the zero dropped. Thus, a reading of 40 would indicate 4.0 volts.

The 50 ma current range is read directly on the red 0-50 scale. The 150 ma and 500 ma current ranges are read on the 15 and 50 scales, respectively, by placing a zero after the meter reading. To read the 1.5 ampere range, use the 15 scale and move the decimal one place to the left. For example, a reading of 10 on the black scale, in the 1.5 ampere range, would indicate 1.0 amperes.

### NORMAL OPERATION

1. Position the front panel controls and switches as follows:

COARSE VOLTAGE: AC OFF.

COARSE CURRENT: 1.5 a (or slightly higher than the expected load).

FINE VOLTAGE: full counterclockwise.

FINE CURRENT: full clockwise.

CURRENT-VOLTAGE: VOLTAGE.

RESET-STANDBY: DC ON.

2. Adjust the COARSE VOLTAGE and the FINE VOLTAGE for the exact voltage you desire, as indicated on the meter.
3. Place the RESET-STANDBY in the RESET-STANDBY position.
4. Connect the load to the positive (+) and negative (-) binding posts.
5. Place the RESET-STANDBY switch in the DC ON position.
6. Press the CURRENT-VOLTAGE switch to the CURRENT position.
7. Turn the FINE CURRENT control counterclockwise until the current begins to decrease. Then turn the control clockwise to just beyond the point where current begins to decrease. This is the correct operating point for the load.

Be sure to follow each voltage adjustment with a current adjustment, as in the previous step. If you do not and the current limit is set too low, your circuit will not operate properly due to a lack of sufficient current. If the current limit is set too high, current overloads could damage your circuits.

It would be wise to frequently scan the Power Supply meter during operation for any changes in load characteristics.

### PARALLEL OPERATION

For higher current loads, two or more Power Supplies can be connected in parallel as shown in Figure 4. Parallel connection is accomplished as described in the following steps.

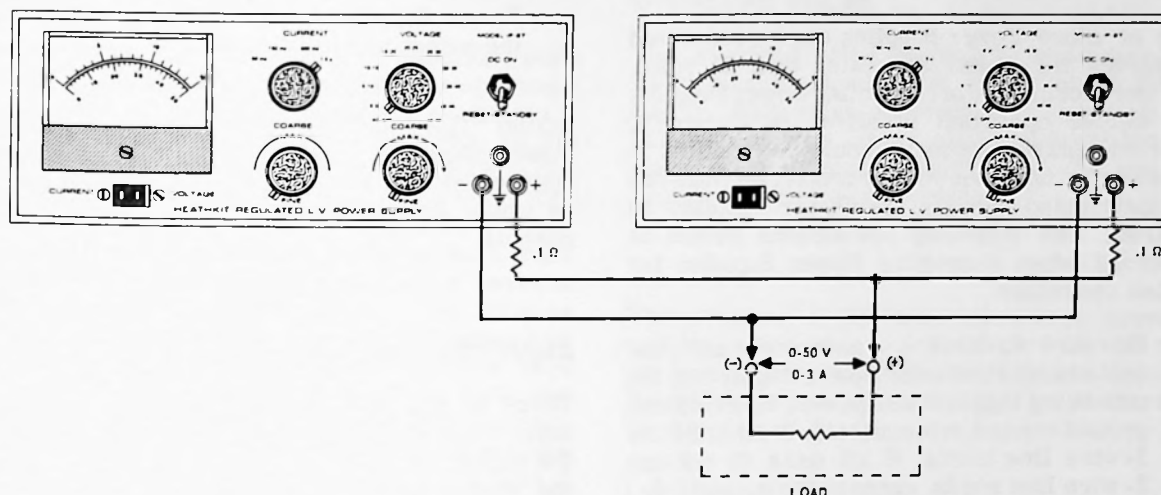


Figure 4

1. Set the COARSE VOLTAGE and CURRENT switches to identical ranges on each Power Supply. The range should match the current and voltage to be supplied.
2. Place a  $.1 \Omega$  resistor in series with the positive (+) lead of each Power Supply as shown. Do not connect the load at this time.
3. Connect together the negative (-) binding posts of all Power Supplies.
4. Touch the positive (+) lead of one Power Supply to the positive lead of another Power Supply and note whether a voltage change occurs on either meter. Then, if necessary, adjust the FINE VOLTAGE control on one of the Supplies until there is no change in the voltage indication, on either meter, between the connected and disconnected condition of the positive leads.
5. If there are more than two Power Supplies being connected in parallel, repeat the previous step until all Power Supplies have been adjusted for no change in the connected and disconnected voltage indication.
6. Adjust the current controls on each Power Supply so as to split the load evenly between each supply, once the known load requirements have been established.
7. Connect the load as shown in Figure 4.

This is the proper operating condition for Power Supplies in parallel. 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 or one Power Supply may load the others.



## SERIES OPERATION

Two or more Power Supplies can be connected in series for voltages greater than 50 volts. The correct method of connecting Power Supplies for series operation is shown in Figure 5. Current control settings should be identical in each series unit, but voltage control settings can be distributed between the Power Supplies as desired. The following precautions should be observed when connecting Power Supplies for series operation:

1. Be sure to have a common ground connection between each Power Supply and the unit being supplied with power. This common ground occurs automatically if all units use 3-wire line cords. If all units do not use 3-wire line cords, connect the ground ( $\perp$ ) binding post of each Power Supply to the chassis of the unit being supplied with power.

2. Use the RESET-STANDBY switch in both Power Supplies to turn on or to interrupt the output voltage and current.

NOTE: The "hot" end of a series string of Power Supplies can be at either the most positive or the most negative point, depending on which Power Supply lug is connected to the chassis.

## AMMETER CORRECTION FACTOR

There is a 2 ma offset in current meter readings. While this is a relatively small error on the higher current ranges, it is worth considering when reading currents of less than 150 ma. The actual current supplied is 2 ma less than that read on the meter.

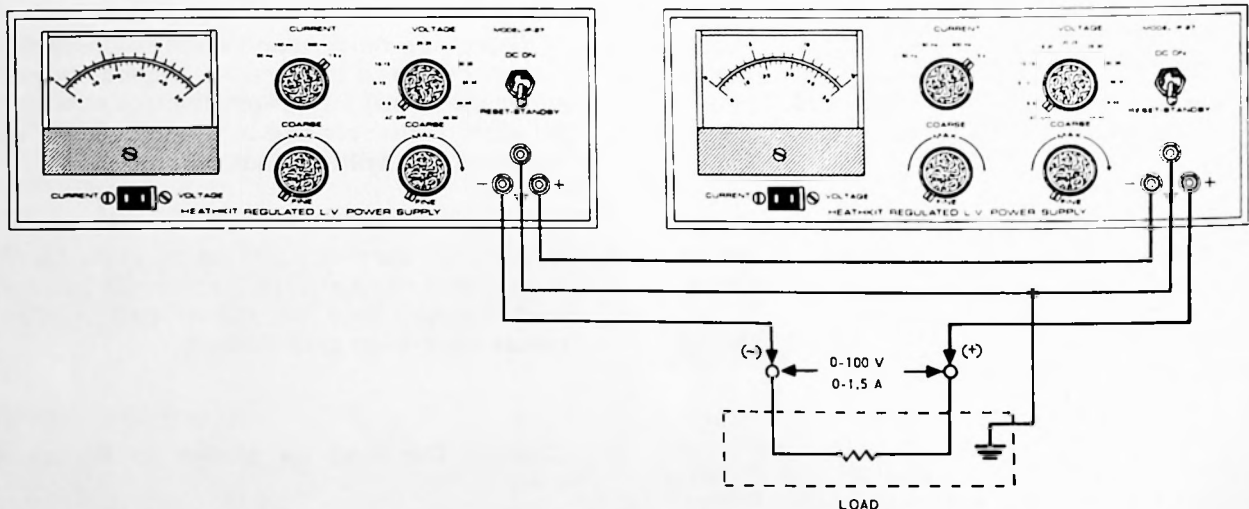


Figure 5

## CURRENT LIMITER USE

The Power Supply will furnish a maximum current of 1.5 amperes. This means that you should not attempt to operate a load that requires 1.5 amperes under "no signal" conditions, as the current limiter circuit in the Power Supply would automatically cut the Power Supply off as the load began drawing more than 1.5 amperes under signal conditions. For example, assume that a transistorized audio amplifier requires 1.0 amperes under no-signal conditions. If a sine wave is applied to the amplifier, the current demand on the Power Supply will also vary in a sine wave fashion. With a 1.0 ampere no-signal level, the current drain can vary .5 ampere without limiting in the Power Supply. However, should the signal vary the current demand more than .5 ampere, the Power Supply will clip. This condition can be minimized by connecting a very large capacitor (1000  $\mu$ fd or more) across the output of the Power Supply. The capacitor will discharge into the load during the limiting period and, therefore, reduce the clipping action.

**CAUTION:** When using the large capacitor, the capacitor must be completely discharged before it is connected across the output of the Power Supply. Always start the Power Supply with the COARSE VOLTAGE switch at the lowest range and slowly increase the voltage to the desired level. This will prevent any high current surge that may cause the overload relay in the Power Supply to open.

## OVERLOAD RELAY

The overload relay keeps low resistance and short circuited loads from damaging the Power Supply. This relay automatically opens up the DC current path (ahead of the current limiter stage) in the Power Supply when the current limiter transistor is overloaded.

The overload relay may not always operate, and its action is not needed, below 10 volt output levels. Any overloads that begin to occur at these low levels can be handled by the current limiter circuit.

## DC REGULATION CONTROL

On rare occasions, at some specific voltage, it may be desirable to have a voltage regulation that will produce less than the specified  $\pm 15$  millivolts change in output voltage from no load to full load. In this event, simply adjust the DC REGULATION control at the desired voltage for identical readings at the no load and full load conditions. This setting of the control will sacrifice regulation at other voltages, so be sure to return the control to its original setting after this application is completed.

## 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.
5. 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 an 11 megohm input vacuum tube voltmeter. Voltages may vary as much as  $\pm 10\%$ .
6. 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 Customer Service information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

## TROUBLESHOOTING CHART

TROUBLE	POSSIBLE CAUSE
Neither pilot lamp will light.	<ol style="list-style-type: none"> <li>1. Blown fuse.</li> <li>2. AC Power switch.</li> </ol>
High output voltage, or no response from FINE VOLTAGE control.	<ol style="list-style-type: none"> <li>1. Faulty transistor Q2 or Q3.</li> <li>2. Zener diode Z1.</li> <li>3. Zener diode Z2.</li> </ol>
Normal output voltage with no load, dropping to a low value or zero with load.	<ol style="list-style-type: none"> <li>1. Faulty transistor Q3.</li> </ol>
Low output voltage, or no response from FINE VOLTAGE control.	<ol style="list-style-type: none"> <li>1. Zener diode Z1.</li> <li>2. Zener diode Z2.</li> <li>3. Transistor Q2.</li> <li>4. Diodes D1, D2, D3, D4, D5, or D6.</li> <li>5. Bias supply for transistor Q1.</li> </ol>
No output voltage.	<ol style="list-style-type: none"> <li>1. Transistors Q1, Q2, Q4, or Q5.</li> </ol>
High zener current or low zener current.	<ol style="list-style-type: none"> <li>1. Zener diode Z1.</li> <li>2. Zener diode Z2.</li> <li>3. High or low line voltage.</li> <li>4. Resistors R1, R2.</li> </ol>
Loss of current limiting.	<ol style="list-style-type: none"> <li>1. Transistor Q1.</li> <li>2. Diode D7.</li> </ol>
Relay pulls in on any load at over 6 volts.	<ol style="list-style-type: none"> <li>1. Transistor Q2.</li> </ol>
Relay chatters or clicks on and off.	<ol style="list-style-type: none"> <li>1. Transistor Q4 or Q5.</li> <li>2. Transistor Q2.</li> </ol>
Relay will not operate.	<ol style="list-style-type: none"> <li>1. Diode D8.</li> <li>2. Relay coil open.</li> </ol>
Power supply oscillates.	<ol style="list-style-type: none"> <li>1. Capacitor C9.</li> </ol>
Resistor R12 (.82 $\Omega$ ) burns.	<ol style="list-style-type: none"> <li>1. Transistors Q1, Q4, or Q5 shorted to chassis through mica insulator.</li> <li>2. Short circuit at output binding posts.</li> <li>3. Capacitor C9.</li> </ol>
Poor or no regulation.	<ol style="list-style-type: none"> <li>1. Diode D7.</li> <li>2. Transistor Q2.</li> <li>3. Transistor Q3.</li> <li>4. Transistors Q1, Q4, or Q5 shorted to chassis through mica insulator.</li> </ol>





## SPECIFICATIONS

Load Regulation. . . . .	Output variation less than $\pm 15$ millivolts from no load to full load, for output of .5 to 50 volts DC. Can be adjusted for no variation at a given voltage.
Line Regulation. . . . .	Less than .05% change in output voltage with a 5% change in line voltage.
Ripple and Noise. . . . .	250 microvolts maximum.
Transient Response. . . . .	Less than 25 microseconds at 1 kHz.
Output Impedance. . . . .	Less than .075 $\Omega$ from DC to 10 kHz. Less than .3 $\Omega$ above 10 kHz.
Meter Size. . . . .	3-1/2".
Meter Current Ranges. . . . .	50 ma, 150 ma, 500 ma, 1.5 a.
Meter Voltage Ranges. . . . .	15 and 50 volts.
Power Requirements. . . . .	105-125 volts, or 210-250 volts, 50/60 Hz, 135 watts at full load (50 V at 1.5 a).
Dimensions. . . . .	5-1/8" high x 13-1/4" wide x 9" deep.
Net Weight. . . . .	12 lbs.

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

## THEORY OF OPERATION

Qualifications for a perfect power supply would include zero internal resistance, a feature 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. A common example of this loss due to the internal resistance of a power

supply 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 enough internal resistance to present reduced voltage to the car during the heavy current drainage from 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.

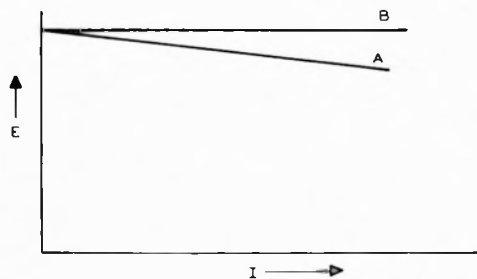


Figure 6

In Figure 6, 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 7 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.

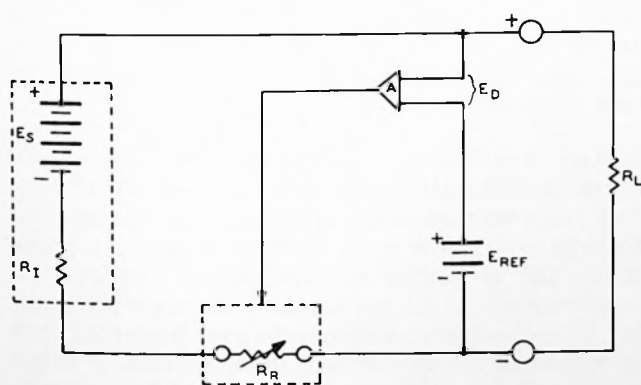


Figure 7

At the same time, the difference voltage,  $E_D$ , occurs at the input of amplifier A. This difference 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.

Now, 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.

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  $R_I$ .

It is desirable to limit the current that can be drawn from a regulated power supply in order to protect both the load and the supply. The current curve for such a condition is shown in Figure 8, where the voltage remains constant for all currents up to a predetermined value and then drops, while the current remains nearly constant.

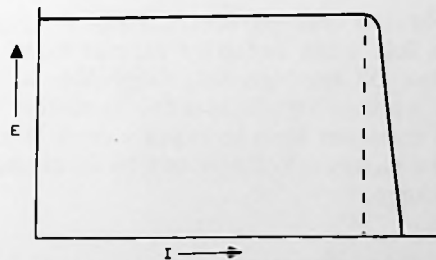
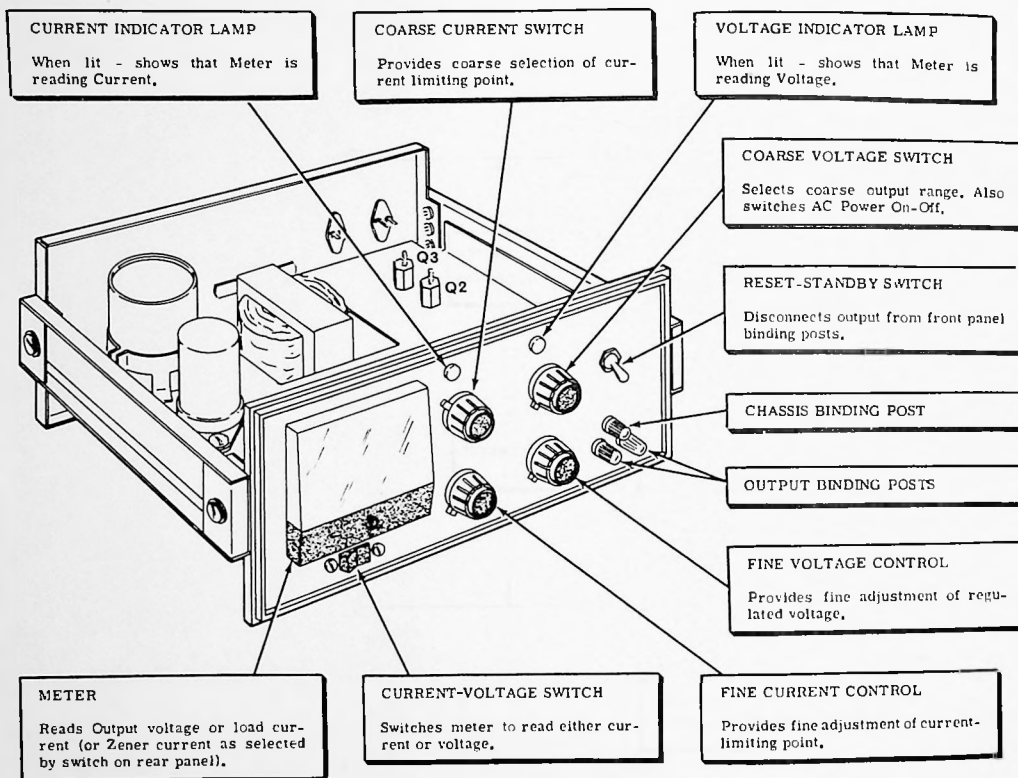
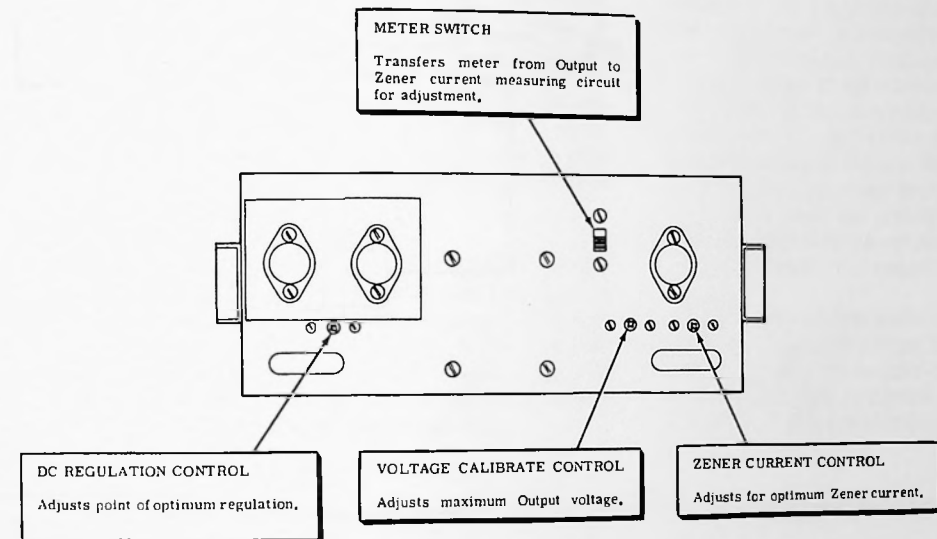


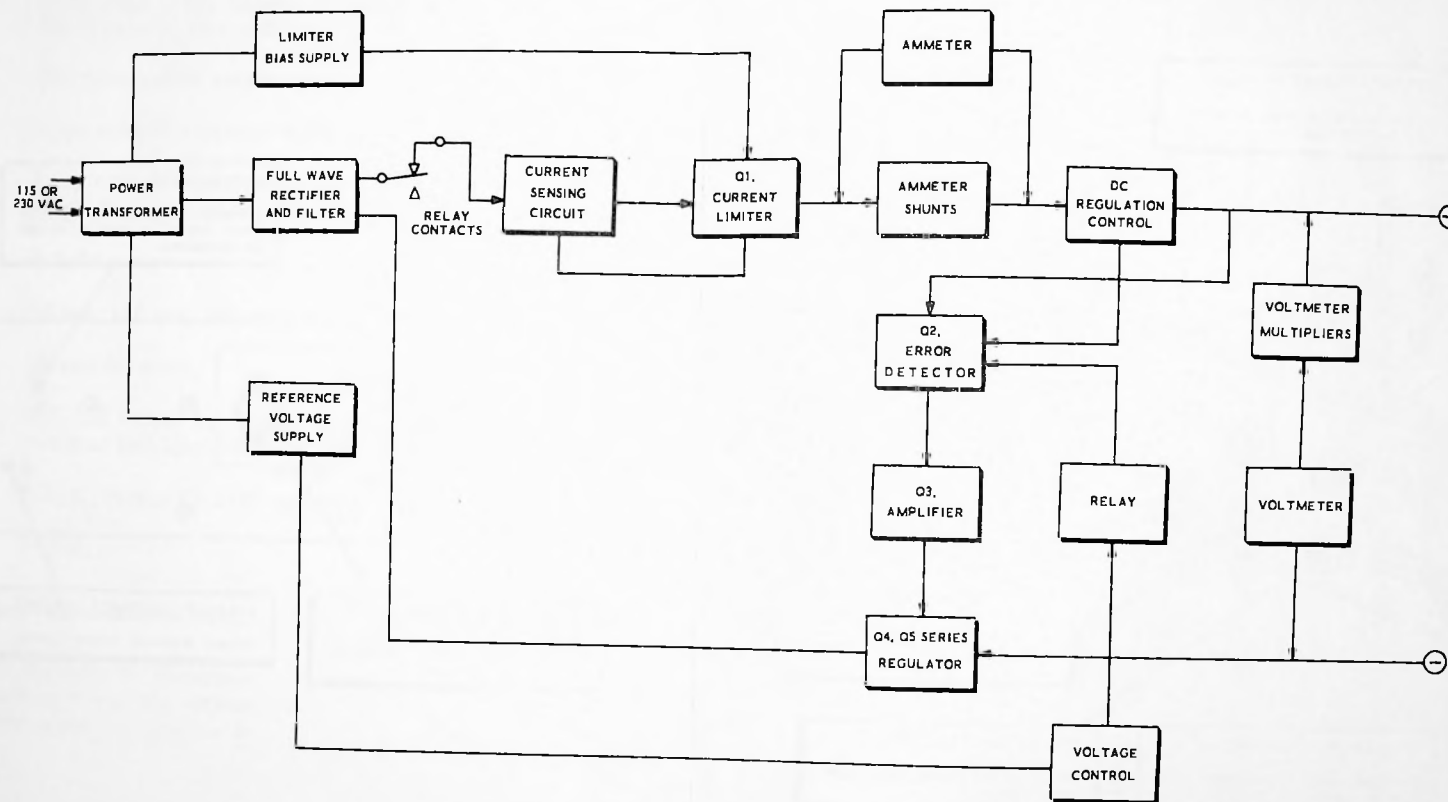
Figure 8



**FIGURE 1**



**FIGURE 2**



**BLOCK DIAGRAM**



## CIRCUIT DESCRIPTION

The Regulated Low Voltage Power Supply consists of the following five major circuits:

1. Power source
2. Current limiter
3. Voltage regulator
4. Reference voltage source
5. Metering circuits

Each of these circuits will be described separately. Refer to the Block Diagram (fold-out from this Page), and to the Schematic Diagram (fold-out from Page 51), while you read this Circuit Description.

### POWER SOURCE

The primary windings of the power transformer may be connected in parallel for operation from a 105 to 125 volt or in series for operation from a 210 to 250 volt 50/60 Hz AC source.

A multi-tap secondary winding on the transformer supplies the voltage and current that later becomes the regulated output. The taps are selected by one section of the Coarse Voltage switch (CV-4FR). The voltage at any given tap is higher than the output voltage for that switch position, since there is some power dissipation in the regulator circuits.

Power dissipation is minimized by controlling the source voltage with the 10-step Coarse Voltage switch. Thus, the regulator circuits need only operate over a small range in any switch position.

The selected transformer voltage is changed to DC in a full-wave rectifier circuit that consists of diodes D3 through D6. Capacitor C5 filters the DC voltage, while bleeder resistor R6 provides a constant load to rapidly drop the voltage when the Coarse Voltage switch is changed to a lower range.

### CURRENT LIMITING

The current limiting circuit uses a familiar transistor characteristic: the resistance (and the current flow) between the emitter and collector of the transistor can be controlled by its

base voltage. The emitter to collector resistance remains very low up to a certain point, and then increases very rapidly as the base voltage decreases.

Figure 9 is a simplified schematic of the current limiting circuit. In this diagram, the Coarse Current switch and resistors R7, R8, R10, R11, and R12, are represented by Rcc. The limiter bias supply that consists of a 7-volt winding on transformer T1, diode D2, filter capacitor C4, and resistor R4, provides a bias voltage to the base of transistor Q1 for normal operation.

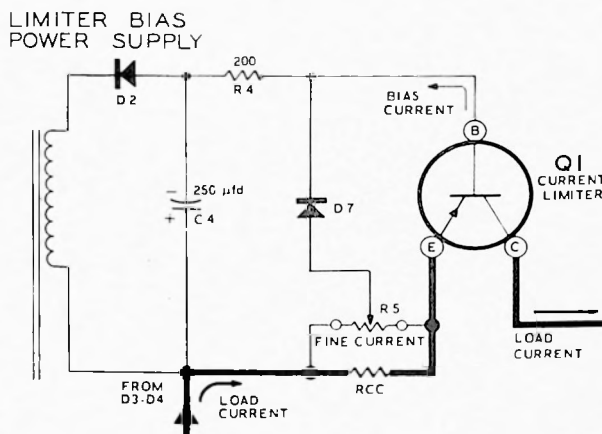


Figure 9

During normal operating conditions, the voltage drop from emitter to collector of Q1 is very small while across the base to emitter the drop is .2 volt. Diode D7 will not conduct unless .6 volt appears across it.

If the current drain from the main voltage source rises sufficiently to cause a drop of .4 volt across Rcc, this voltage adds to the .2 volt from emitter to base in Q1. Now, with the total of .6 volt across diode D7, it begins to conduct and reduces the base voltage of Q1 sufficiently to cause its emitter to collector resistance to rise sharply. This increase in the resistance (and the voltage drop) across the emitter to collector of Q1 reduces the current flow, and current limiting occurs.

The Coarse Current switch is used to select the proper resistance for Rcc to set one of four current ranges, while Fine Current control R5 is

used to adjust the current within the range selected by the switch. Note that  $R_{cc}$  is shown in parallel with the Fine Current control in Figure 9 to simplify the description. The schematic shows this to be a parallel circuit for some ranges, and series for others.

The current limiting circuit and transistor Q1 will handle overloads that are small or at low voltage settings. However, the heat caused by severe overloads could quickly destroy Q1, therefore a protective relay is used. The coil of this relay is connected between the reference voltage power supply and the output terminal. If the output voltage drops, due to the limiting action of transistor Q1, diode D8 conducts current from the reference voltage power supply through the relay coil. When sufficient current flows to produce about 4 volts across the coil, the relay contacts open the source voltage circuit ahead of the current limiter.

When the overload is removed, or the DC switch is changed to the Reset-Standby position, capacitor C8 charges to operating voltage from the reference voltage power supply. Without a sufficient voltage drop across the relay coil, its contacts return to normal and reconnect the main voltage supply to the output terminals.

## VOLTAGE REGULATOR

In the voltage regulator circuit shown in Figure 10, the voltage from the main power supply is compared with a constant reference voltage in an error detector transistor. Any difference between the supply and reference voltage is amplified by transistor Q3, which controls a pair of series regulator transistors to restore the correct voltage output.

Error detector transistor Q2 has its emitter connected to the main supply voltage, and its base connected to a constant reference voltage. If the main supply voltage decreases, the collector current in Q2 also decreases. This causes a proportionate voltage decrease at the base and emitter of Q3, and at the bases of series regulator transistors Q4 and Q5. With the decreased base voltage on these transistors, the effective resistance (and the voltage drop) between their emitters and collectors decreases to restore the output voltage to nearly its original value.

An increase in the main supply voltage would cause the opposite action to occur to reduce the output voltage to nearly its original value. In either case, the regulator action takes place in a matter of microseconds.

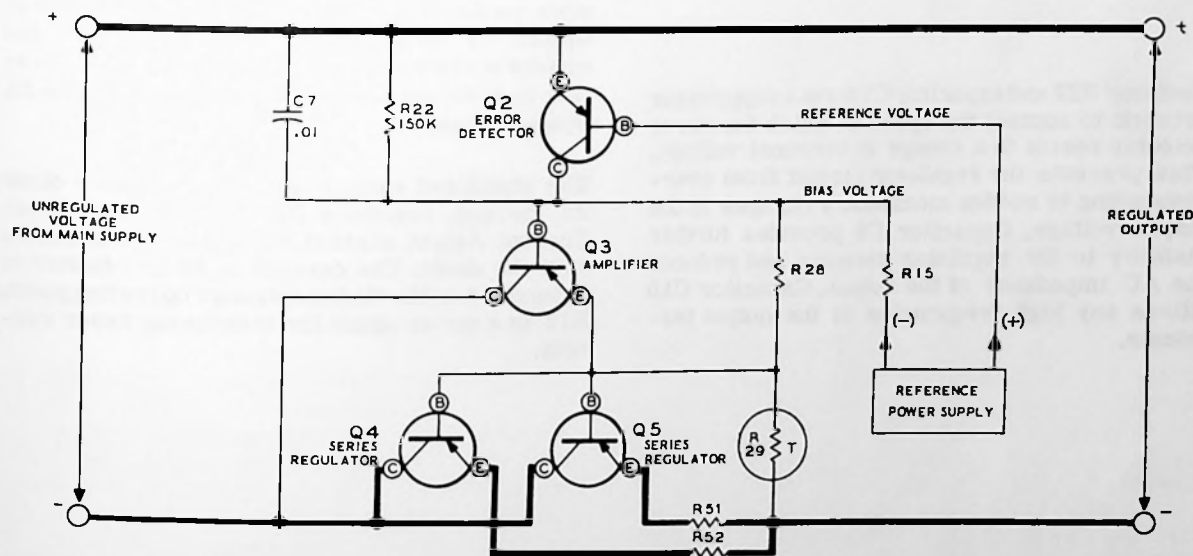


Figure 10

An increase in current drain could still cause a decrease in the voltage output because of the internal resistance of the regulator circuit. Therefore, positive feedback (regeneration) is used to further reduce the effective internal resistance to zero under this condition.

The circuit shown in Figure 11 provides positive feedback around error detector transistor Q2 in the following manner: An increase in load current causes a greater voltage difference across resistor R24 and DC Regulation control R23. A portion of this voltage difference is coupled through R25 to the base of Q2 which in turn decreases the internal resistance of the Power Supply by reducing the series resistance of regulator transistors Q4 and Q5. The DC Regulation control is adjusted to provide a balanced output voltage under full current load and minimum current load conditions.

Resistor R28 and thermistor R29 supply the proper bias to transistors Q4 and Q5. The thermistor is physically located to sense any temperature changes in Q5, and automatically adjusts the bias to compensate for these changes. Resistor R51 and R52 help to equalize the emitter currents in Q4 and Q5.

Resistor R22 and capacitor C7 form a suppressor network to control the speed at which the error detector reacts to a change in terminal voltage. This prevents the regulator circuit from over-responding to sudden momentary changes in the output voltage. Capacitor C9 provides further stability to the regulator circuits and reduces the AC impedance of the output. Capacitor C10 filters any high frequencies at the output terminals.

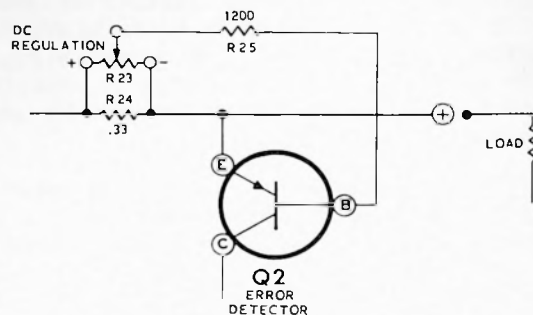


Figure 11

### REFERENCE VOLTAGE POWER SUPPLY

A DC reference of 50 volts is produced by the reference voltage power supply. Voltage regulation in this supply is obtained from zener diodes Z1, Z2, and Z3. The regulated DC voltage from the reference supply is used primarily to furnish error detector transistor Q2 with a reference voltage. This standard voltage is used to sense incorrect output from the power supply and regulate the voltage drop across transistors Q4 and Q5.

The AC voltage from the reference voltage winding of the power transformer is rectified by diode D1 and filtered by capacitor C1 and resistor R1. The DC voltage is first regulated at 110 volts by zener diode Z1, then at 68 volts by zener diode Z3, and given additional filtering by resistor R2, capacitors C2 and C3.

The stabilized voltage is applied to zener diode Z2 through resistors R9 and R13, and Zener Current Adjust control R3, which are in series with the diode. The current in Z2 is adjusted to around 5 ma, the diodes optimum operating point. R13 is a meter shunt for measuring zener current.



The regulated voltage across diode Z2 and resistor R13 is then applied to Voltage Calibrate control R14. Control R14 is adjusted so exactly 50 volts is applied across wafer CV-3R of the Coarse Voltage switch, Fine Voltage control R31, and wafer CV-2F of the Coarse Voltage switch, which is connected to the negative (-) output terminal. These two switch sections select any 6 volt portion of the 50 volts and apply it across the Fine Voltage control. The desired reference voltage is then coupled from the arm of this control, through the relay coil, to the base of error detector transistor Q2, where the output voltage of the Power Supply is regulated to essentially the same voltage level.

### METER CIRCUIT

The meter is used to monitor either the output voltage, the output current, or the zener diode (Z2) current. Two switches, the Meter switch on the rear panel and the Current-Voltage switch on the front panel, determine which function the meter will measure. The meter is first controlled by the rear panel Meter switch, which has two positions. In the Normal position, the meter is connected to the Current-Voltage switch. In

the Zener Current position, the meter with resistor R32 in series with it, is connected in parallel with resistor R13 to measure the current of zener diode Z2.

The Current-Voltage switch in the Current position, connects the meter across wafer CC-1 of the Coarse Current switch. This wafer selects the proper milliammeter shunt resistors (R16 through R21) for each of the four current ranges: 50 ma, 150 ma, 500 ma, and 1.5 a.

In the Voltage position of the Current-Voltage switch, sections CV-1F and CV-1R of the Coarse Voltage switch select the proper calibrating resistors for each voltage range. The proper resistors are then connected in series with the meter between the negative (-) and the positive (+) output terminals.

A separate section of the Current-Voltage switch applies 120 VAC across either the current or voltage front panel indicator lamp. This section of the switch has shorting type (make before break) contacts so that at least one lamp is on whenever the Power Supply is on.



## REPLACEMENT PARTS PRICE LIST

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

PART No.	PRICE Each	DESCRIPTION
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### RESISTORS

#### 1/2 Watt 10%

1-41	.10	10 $\Omega$
1-13	.10	2700 $\Omega$
1-16	.10	4700 $\Omega$
1-23	.10	27 K $\Omega$
1-27	.10	150 K $\Omega$

#### 1/2 Watt 5%

1-130	.10	8.2 $\Omega$
1-54	.10	15 $\Omega$
1-136	.10	160 $\Omega$
1-137	.10	200 $\Omega$
1-80	.15	1200 $\Omega$

#### 2 Watt 10%

1-19-2	.20	1200 $\Omega$
1-17-2	.20	6800 $\Omega$

#### 2 Watt 5%

3-2-2	.25	.33 $\Omega$
3-1-2	.25	.82 $\Omega$
3-3-2	.25	2.7 $\Omega$

#### Precision 1/2 Watt 1%

2-94	2.10	.1 $\Omega$
2-130	2.30	.2 $\Omega$
2-163	.75	.7 $\Omega$
2-229	.70	2.0 $\Omega$
2-259	.25	97 $\Omega$
2-165	.20	4950 $\Omega$
2-50	.20	10 K $\Omega$
2-166	.20	35 K $\Omega$

#### Other Resistors

3-1-5	.15	2500 $\Omega$ 5% 7 watt wire-wound resistor
9-9	1.55	500 $\Omega$ thermistor

PART No.	PRICE Each	DESCRIPTION
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### CAPACITORS

21-16	.10	.01 $\mu$ fd disc
27-34	.25	.2 $\mu$ fd resin
25-56	.45	100 $\mu$ fd electrolytic, 10 V
25-128	.95	100 $\mu$ fd electrolytic, 50 V
25-131	.90	250 $\mu$ fd electrolytic, 25 V
25-121	1.35	500 $\mu$ fd electrolytic, 50 V
25-177	4.20	3000 $\mu$ fd electrolytic, 75 V
25-178	1.75	100-40-40 $\mu$ fd electrolytic

### WIRE-WOUND CONTROLS

11-77	1.25	30 $\Omega$
11-76	1.25	240 $\Omega$
11-74	.70	50 $\Omega$
11-44	.45	1000 $\Omega$

### SWITCHES

63-437	2.40	4-position 2-wafer rotary
63-438	5.00	11-position 4-wafer rotary
60-20	.55	TPDT slide
60-34	.85	TPDT rocker
61-9	1.20	SPST toggle (with two 1/2" nuts and a lockwasher)

### TRANSISTORS-DIODES

417-20	2.70	2N2553/R265A/2N1039-1 transistor
417-141	3.15	2N2869/2N301 transistor
417-142	5.00	DTG-600 transistor
57-27	.60	Silicon diode
56-618	1.10	56 V zener diode
56-68	1.50	68 V zener diode
56-48	3.15	110 V zener diode

### SOCKETS-TERMINAL STRIPS-FUSEHOLDER

434-102	.15	Small transistor socket
434-117	.20	Large transistor socket
431-50	.10	1-lug terminal strip
431-51	.10	2-lug terminal strip
431-41	.10	2-lug terminal strip
431-5	.10	4-lug terminal strip
431-11	.10	5-lug terminal strip
431-45	.10	6-lug terminal strip
431-35	.10	7-lug terminal strip
422-1	.25	Fuseholder



PART No.	PRICE Each	DESCRIPTION
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**INSULATORS-GROMMETS**

75-60	.10	Mica insulator
75-88	.10	Transistor insulator case
481-3	.10	Capacitor mounting wafer
73-45	.10	1/2" grommet
75-71	.10	Line cord strain relief

**WIRE HARNESS-WIRE-SLEEVING**

134-151	3.15	Wire harness
344-2	.05/ft	Large black wire
344-3	.05/ft	Large red wire
344-31	.05/ft	Large brown wire
344-50	.05/ft	Small black wire
344-52	.05/ft	Small red wire
344-54	.05/ft	Small yellow wire
344-56	.05/ft	Small blue wire
340-2	.05/ft	Bare wire
346-1	.05/ft	Sleeving

**HARDWARE****#2 Hardware**

250-175	.05	2-56 x 3/8" screw
254-7	.05	#3 lockwasher
252-51	.05	2-56 nut

**#6 Hardware**

250-229	.05	6-32 x 1/4" phillips head screw
250-535	.25	6-32 x 1/4" decorative screw
250-270	.05	6-32 x 3/8" black screw
250-89	.05	6-32 x 3/8" screw
250-26	.05	6-32 x 5/8" screw
250-304	.15	6-32 x 3/8" stud
250-227	.05	6-32 x 7/8" phillips head screw
250-365	.05	#6 x 1/4" sheet metal screw
254-1	.05	#6 lockwasher
259-1	.05	#6 solder lug
253-1	.05	#6 flat fiber washer
253-2	.05	#6 shoulder fiber washer
255-13	.05	#6 x 1/4" spacer
255-15	.05	#6 x 1/2" spacer
255-1	.05	Insulator case spacer (thick)
255-74	.10	Insulator case spacer (thin)
252-3	.05	6-32 nut

PART No.	PRICE Each	DESCRIPTION
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**#8 Hardware**

250-137	.05	8-32 x 3/8" screw
254-2	.05	#8 lockwasher
252-4	.05	8-32 nut

**Other Hardware**

253-10	.05	Control washer
254-4	.05	Control lockwasher
259-10	.05	Control solder lug
252-7	.05	Control nut
252-32	.05	Push-on speednut

**METAL PARTS****Chassis-Cabinet Parts**

203-476	1.20	Front panel
203-477	1.35	Rear panel
200-484	1.15	Chassis
204-767	.40	Siderail
204-759-1	.10	End cap
90-350-2	3.40	Cabinet half shell
210-35	3.75	Bezel

**Other Metal Parts**

205-545	.20	Heat sink plate
204-565	.10	Relay mounting bracket
207-2	.20	Capacitor mounting clamp
260-30	.05	Diode clip

**MISCELLANEOUS****Electrical Components**

54-180	10.60	Power transformer
69-71	3.40	Relay
407-120	8.60	Meter
412-15	.15	Neon lamp
413-10	.10	Red lens
413-14	.30	Amber lens
421-25	.30	1-1/2 ampere slow-blow fuse
89-23	.80	Line cord
432-27	.40	Line cord adapter



<u>PART</u> <u>No.</u>	<u>PRICE</u> <u>Each</u>	<u>DESCRIPTION</u>
<b>Other Components</b>		
211-33	.40	Handle
462-245	.60	Knob
455-50	.10	Knob bushing
427-3	.15	Binding post base
75-17	.10	Binding post bushing
100-16-2	.10	Binding post cap (black)
100-16-18	.10	Binding post cap (red)

<u>PART</u> <u>No.</u>	<u>PRICE</u> <u>Each</u>	<u>DESCRIPTION</u>
<b>Other Components (cont'd.)</b>		
261-28	.10	Stick-on rubber foot
261-30	.10	Line cord retainer
490-5	.10	Nut starter
352-13	.15	Silicone grease
331-6	.15	Solder
	2.00	Manual (See front cover for part number.)

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates of exchange.

EXPEDITED PARTS ORDER FORM (FOR REPAIR PARTS ONLY)					PLEASE DO NOT WRITE IN THIS SPACE					
(1) Give Part Numbers as they are in parts list.					KIT MODEL _____ DATE OF PURCHASE _____ SERIES NUMBER _____					
(2) Include remittance or permission for C.O.D. shipment.				<input type="checkbox"/>				CASH	<input type="checkbox"/>	C.O.D.
(3) Use separate sheet of paper for all correspondence.										
(4) Prices may change to reflect current manufacturing costs.										
(5) Current HEATH account number		AA								
QTY.	PART NUMBER	DESCRIPTION	PRICE	TOTAL PRICE	MARK PROPER SPACE FOR WARRANTY PARTS ONLY					
					3 DAMAGED	2 DEFECTIVE	1 MISSING			
HEATH COMPANY BENTON HARBOR MICHIGAN 49022 PHONE 616-983-7381			NAME _____ ADDRESS _____ CITY _____ STATE _____ ZIP _____							

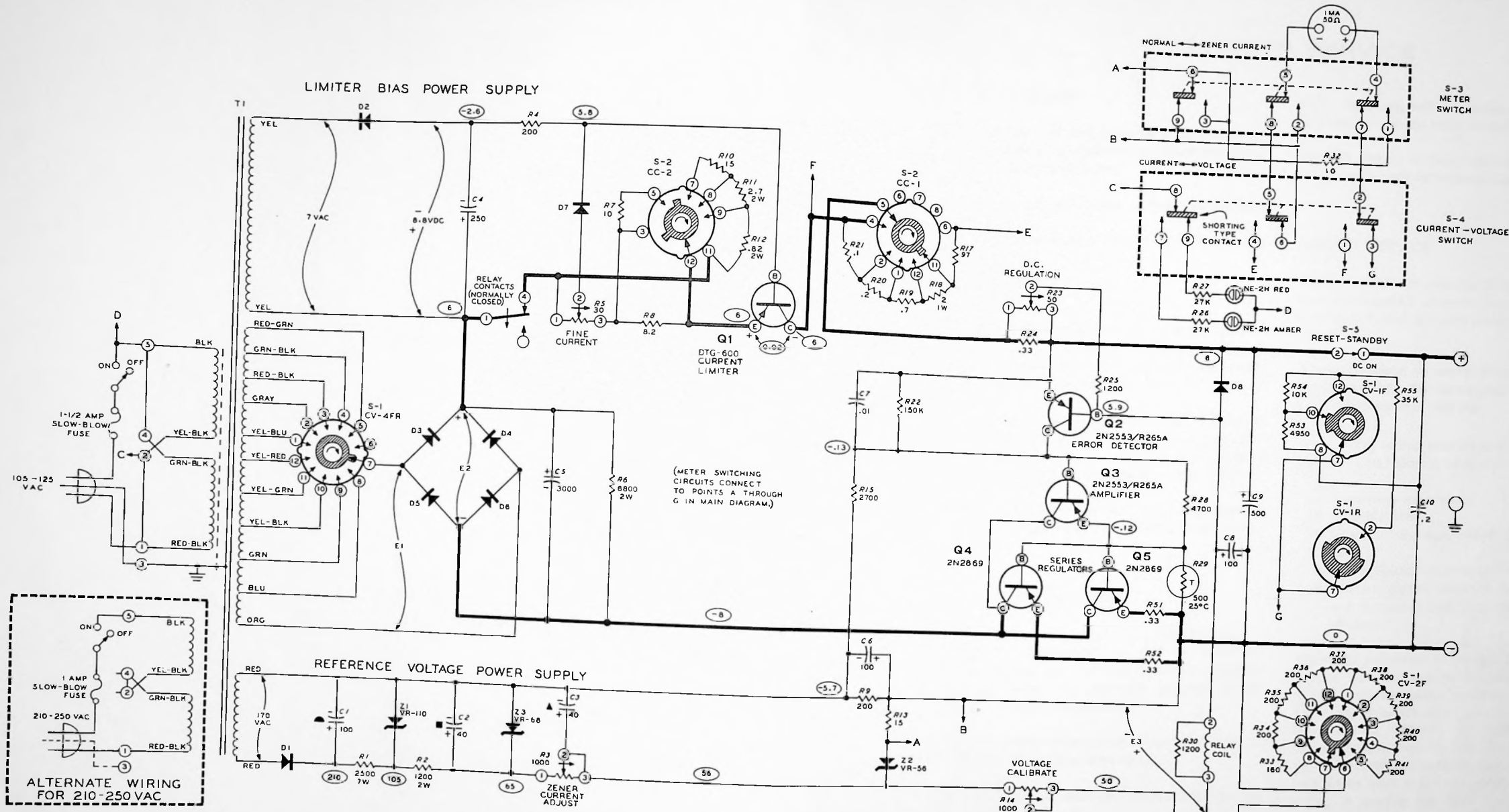
THIS FORM IS FOR U.S. CUSTOMERS ONLY. OVERSEAS CUSTOMERS SEE YOUR DISTRIBUTOR.

- CUT ALONG DOTTED LINE -

EXPEDITED PARTS ORDER FORM (FOR REPAIR PARTS ONLY)					PLEASE DO NOT WRITE IN THIS SPACE					
(1) Give Part Numbers as they are in parts list.					KIT MODEL _____ DATE OF PURCHASE _____ SERIES NUMBER _____					
(2) Include remittance or permission for C.O.D. shipment.				<input type="checkbox"/>				CASH	<input type="checkbox"/>	C.O.D.
(3) Use separate sheet of paper for all correspondence.										
(4) Prices may change to reflect current manufacturing costs.										
(5) Current HEATH account number		AA								
QTY.	PART NUMBER	DESCRIPTION	PRICE	TOTAL PRICE	MARK PROPER SPACE FOR WARRANTY PARTS ONLY					
					3 DAMAGED	2 DEFECTIVE	1 MISSING			
HEATH COMPANY BENTON HARBOR MICHIGAN 49022 PHONE 616-983-7381			NAME _____ ADDRESS _____ CITY _____ STATE _____ ZIP _____							

THIS FORM IS FOR U.S. CUSTOMERS ONLY. OVERSEAS CUSTOMERS SEE YOUR DISTRIBUTOR.





# NOTES:

- ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE MARKED.
- ALL CAPACITORS ARE IN  $\mu$ F.
- $\ominus$  INDICATES A DC VOLTAGE MEASUREMENT FROM POINT INDICATED TO NEGATIVE (-) OUTPUT TERMINAL.
- ALL VOLTAGES WERE MEASURED WITH NO LOAD ON THE OUTPUT TERMINALS WITH 117 VAC 60 Hz INPUT.
- ALL VOLTAGES WERE MEASURED WITH A VTVM, AND MAY VARY  $\pm 10\%$ .
- ALL SWITCHES ARE SHOWN IN THE FULLY COUNTERCLOCKWISE POSITION, AS VIEWED FROM THE KNOB END OF THE SHAFT.
- ARROWS ON CONTROLS AND SWITCHES INDICATE CLOCKWISE ROTATION.
- CONTROLS AND SWITCHES ARE SET AS FOLLOWS FOR VOLTAGE MEASUREMENTS:

COARSE VOLTAGE  
COARSE CURRENT  
FINE VOLTAGE  
FINE CURRENT  
RESET-STANDBY  
CURRENT-VOLTAGE SWITCH  
ZENER CURRENT SWITCH

- .5-5 VOLTS  
- 1.5A  
- MAX. CLOCKWISE  
- MAX. CLOCKWISE  
- RESET-STANDBY  
- VOLTAGE  
- NORMAL

- ROTARY SWITCHES ARE SHOWN IN MAXIMUM COUNTERCLOCKWISE POSITION, AND ARE MARKED AS IN THE FOLLOWING EXAMPLE:  
CV MEANS THIS IS A PART OF THE COARSE VOLTAGE SWITCH  
THIS NUMBER INDICATES THE SWITCH WAFER AS COUNTED FROM THE FRONT PANEL.  
F - FRONT R - REAR FR - FRONT AND REAR

POSITION OF CV SWITCH	E1 VOLTS AC	E2 VOLTS DC	E3 VOLTS DC
5-5	10	21	6
5-10	15	21	10
10-15	20	28	15
15-20	25	35	20
20-25	30	42	25
25-30	35	49	30
30-35	40	56	35
35-40	45	63	40
40-45	50	70	45
45-50	55	77	50

Set controls and switches as in NOTES except for Coarse Voltage switch.

# CUSTOMER SERVICE

## REPLACEMENT PARTS

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

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

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

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

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

## TECHNICAL CONSULTATION

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

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

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

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

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

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

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

## REPAIR SERVICE

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

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

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

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

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

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

Heath Company  
Service Department  
Benton Harbor, Michigan 49022



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