PRICE $2.00

HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT

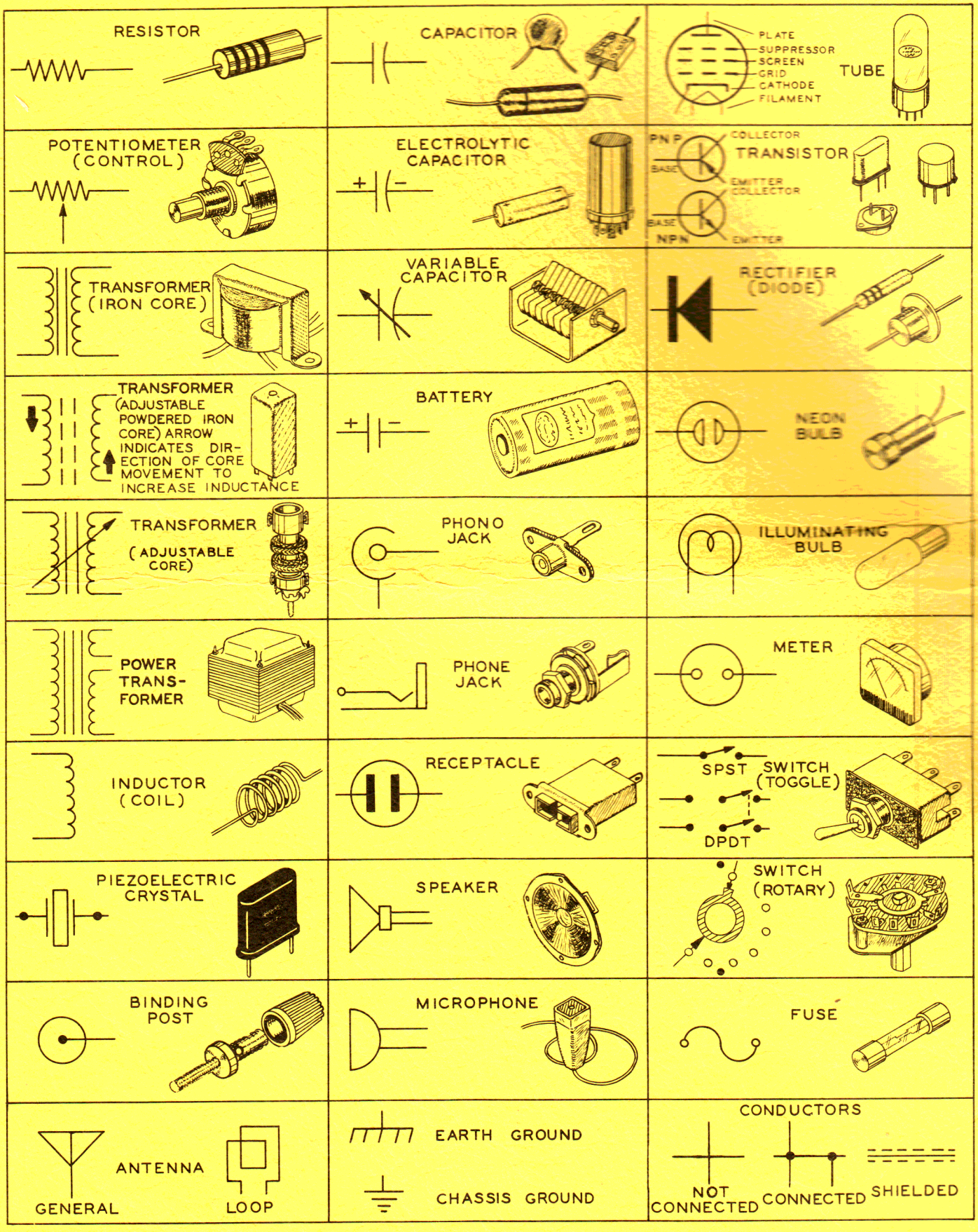
1-15 VDC REGULATED POWER SUPPLY

MODEL IP-18

595-983-01
6-20-69

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



Assembly
and
Operation
of the

HEATHKIT

1-15 VDC REGULATED POWER SUPPLY

MODEL IP-18

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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model IP-18 1-15 VDC Regulated Power Supply is a convenient source of voltage-regulated and current-controlled DC power. It will furnish DC voltages between 1 and 15 volts at up to 500 milliamperes of current.

Among the features of the Power Supply are all-solid-state design and circuit board construction for compact size, reliability, and ease of assembly. The output voltage and current are adjustable from the front panel, and the "floating" ground system enables the Supply to furnish either positive or negative output voltages.

The Programming terminals on the rear of the cabinet enable you to use an AC or DC voltage from another source to control the output age of this Power Supply. The 3-wire line protects you from the danger of electrical s due to a "hot" chassis.

This handy, compact Regulated Power Su will fill most of your low voltage power su needs. You will find it especially useful DC power source for the design, testing, repair of solid-state devices.

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

PARTS LIST

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

NOTE: The numbers in parentheses are keyed to the numbers on the Parts Pictorial (fold-out from Page 3).

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
(1) 1-9	1	1000 Ω (brown-black-red) 1/2 watt
1-93	1	1800 Ω (brown-gray-red) 1/2 watt
1-14	1	3300 Ω (orange-orange-red) 1/2 watt
1-23	1	27 kΩ (red-violet-orange) 1/2 watt
(2) 1-3-1	1	3300 Ω (orange-orange-red) 1 watt
(3) 1-13-2	1	220 Ω (red-red-brown) 2 watt
3-6-2	1	.51 Ω (green-brown-silver-gold) 2 watt (same size as 1 watt)
(4) 3-20-5	1	5 Ω 5 watt
CONTROLS		
(5) 10-250	1	100 Ω
10-249	1	5000 Ω
ELECTROLYTIC CAPACITORS		
(6) 25-126	1	50 μF
25-146	1	100 μF
25-202	1	250 μF
(7) 25-154	1	2500 μF

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Nc

DIC

(8) 56-

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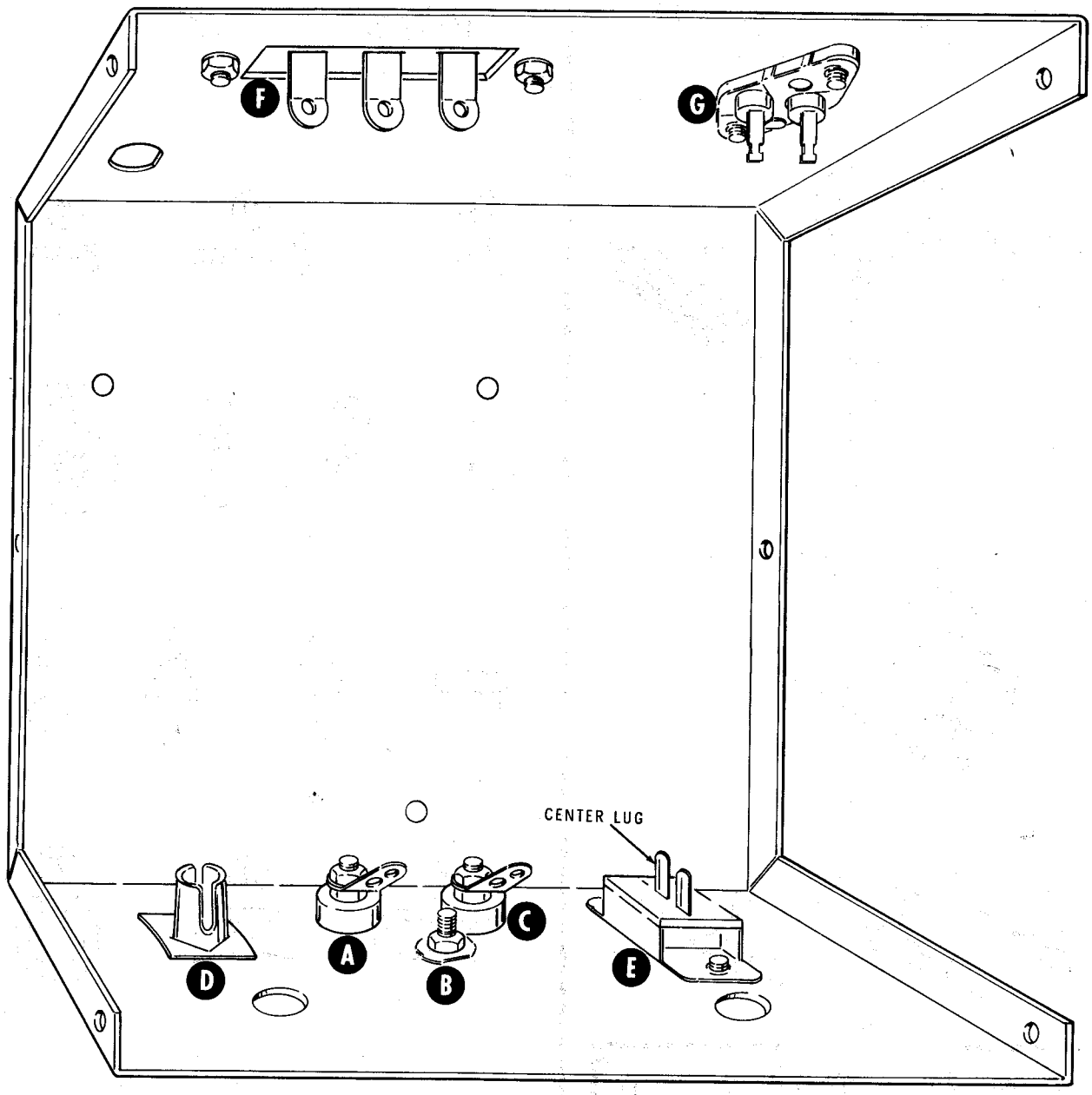

PICTORIAL 4

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(23) 250
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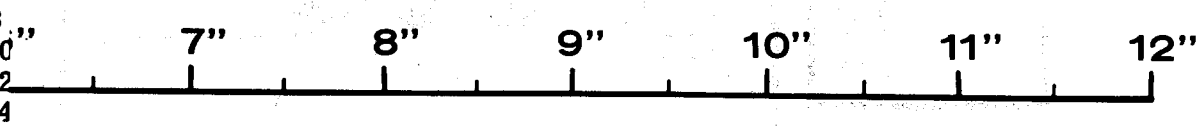


DIODES-TRANSISTORS-LAMP

PART No.	PARTS Per Kit	DESCRIPTION
(8) 56-26	1*	Germanium diode (brown-white-brown)
(9) 57-29	3*	Silicon diode
(10) 56-45	1*	Zener diode
(11) 417-109	1**	2N3566 transistor
(12) 417-118	2	2N3393 transistor
(13) 417-140	1**	Field-effect transistor (FET)
(14) 417-162	1	Power transistor
(15) 412-15	1	NE-2H neon lamp

*Appearance of diodes may vary. Check part number carefully.

**Transistors may appear as one of the two types illustrated in the chart on the Parts Pictorial. When identifying each transistor, look for the part number or type number printed on the case. EXAMPLE: Transistor number 417-109 may be marked 417-109, 2N3566, or 417-109/2N3566 (or in this last case, where 417-109 is also on the transistor, another number may be used in place of 2N3566).

HARDWARE

#6 Hardware

(16) 250-56	6	6-32 x 1/4" screw
(17) 250-26	2	6-32 x 5/8" screw
(18) 250-8	6	#6 x 3/8" sheet metal screw
(19) 252-3	8	6-32 nut
(20) 254-1	8	#6 lockwasher
(21) 259-1	2	#6 solder lug
(22) 254-27	1	#6 internal-external lockwasher

#8 Hardware

(23) 250-137	2	8-32 x 3/8" screw
(24) 252-4	2	8-32 nut
(25) 254-2	2	#8 lockwasher (1 spare)
(26) 259-2	1	#8 solder lug

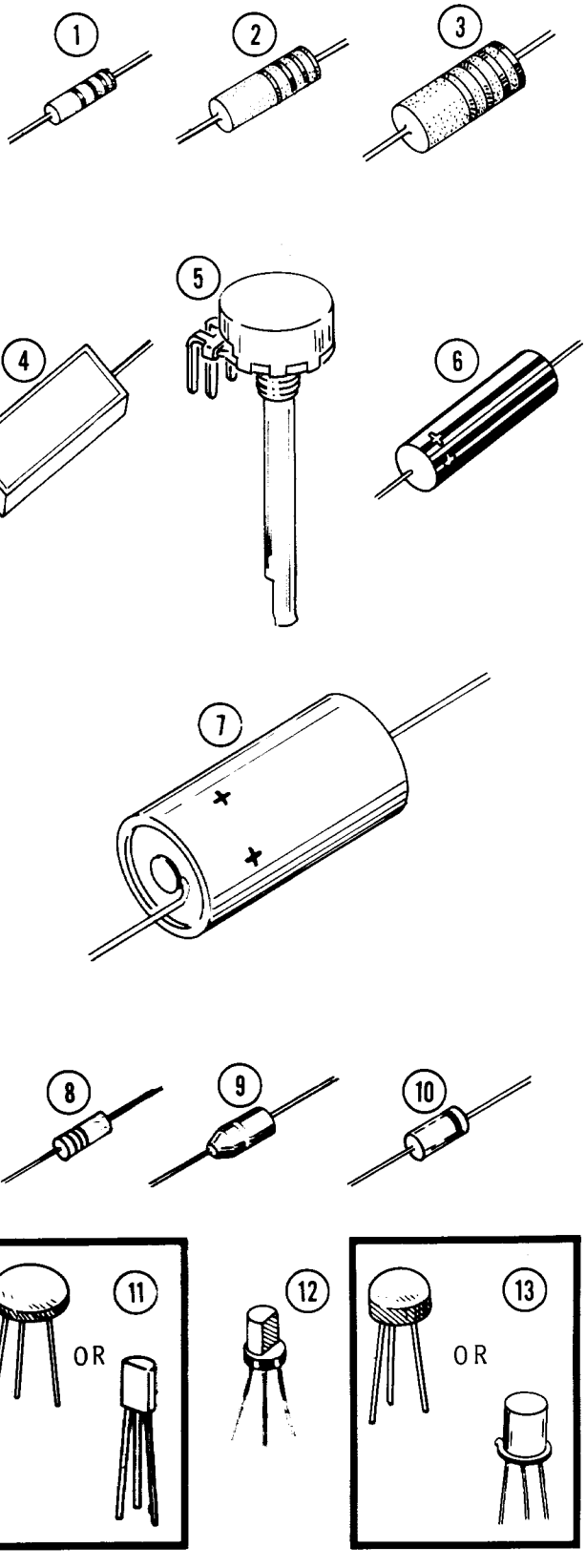
Other Hardware

(27) 259-25	1	Double solder lug
(28) 252-32	1	Speednut
(29) 252-7	2	Control nut
(30) 253-10	2	Control flat washer
(31) 255-1	2	1/8" spacer
(32) 255-74	2	1/16" spacer
(33) 255-89	2	Control spacer

MISCELLANEOUS

(34) 54-212	1	Power transformer
(35) 60-1	1	Slide switch
(36) 75-17	5	Binding post bushing
(37) 427-3	3	Binding post base
(38) 100-16-2	1	Black binding post cap
100-16-18	1	Red binding post cap
100-699	1	Green binding post cap
(39) 75-71	1	Strain relief (flat cord)
75-30***	1	Strain relief (round cord)
(40) 75-60	1	Mica insulator
(41) 75-88	1	Transistor case insulator
(42) 434-117	1	Transistor socket
85-259-1	1	Circuit board
(43) 204-9	1	L bracket
(44) 259-20	25	Solder pins (4 extra)
(45) 431-8	1	Terminal strip (3-lug screw-type)
(46) 413-10	1	Neon lamp lens
(47) 455-50	2	Knob bushing
(48) 462-245	2	Knob
(49) 261-29	4	Plastic foot
(50) 90-402-1	1	Top cabinet shell
(51) 90-403	1	Bottom cabinet shell
344-56	1	Blue wire
89-23	1	Line cord
(52) 432-27	1	Line cord adapter
391-34	1	Blue and white label
(53) 490-5	1	Nut starter
490-19	1	End wrench, 1/4"
597-260	1	Parts Order Form
597-308	1	Kit Builders Guide
	1	Manual (See front cover for part number.)
		Solder

*** This strain relief is supplied to be used in areas mainly outside the U.S. where round line cords are required.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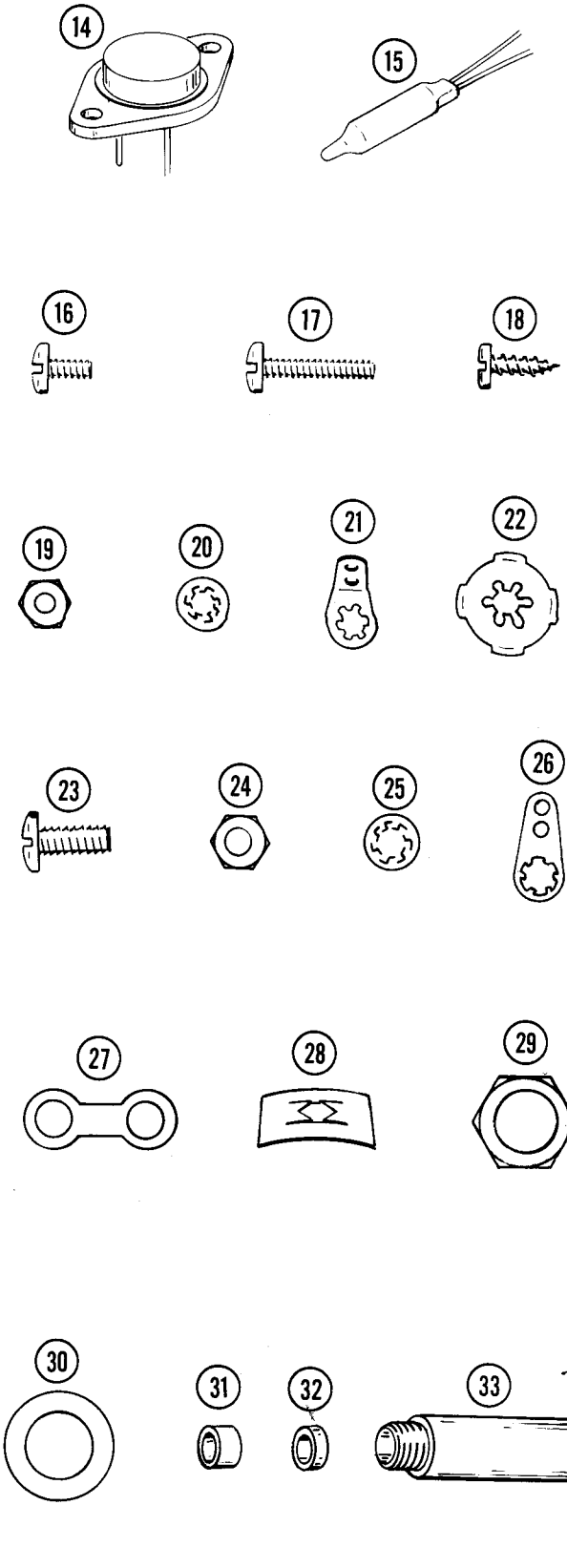
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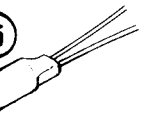
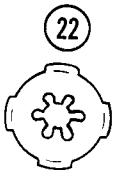
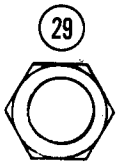
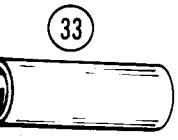
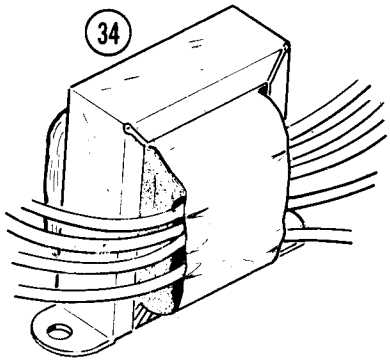
PARTS PICTORIAL

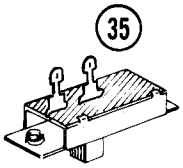


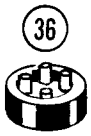


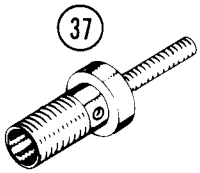


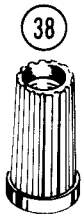


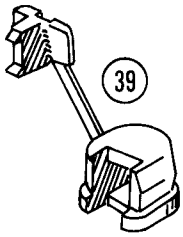


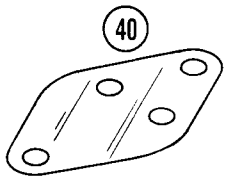


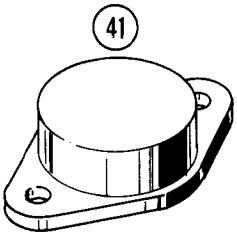


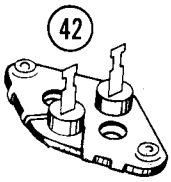


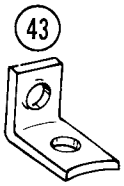


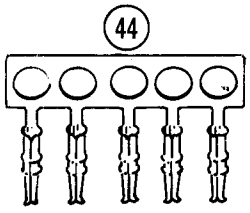


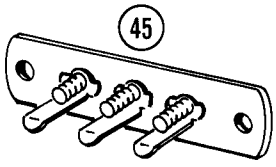


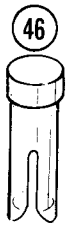


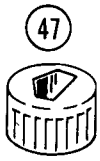


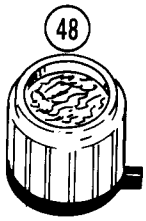


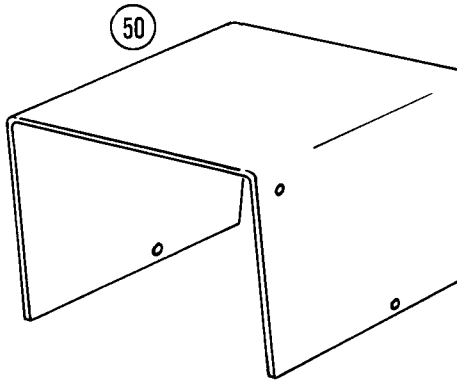


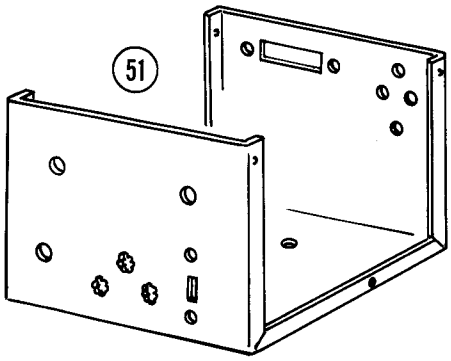


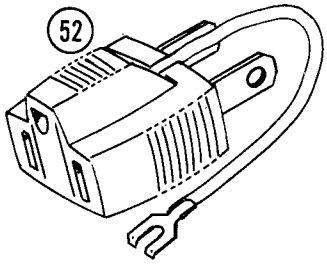


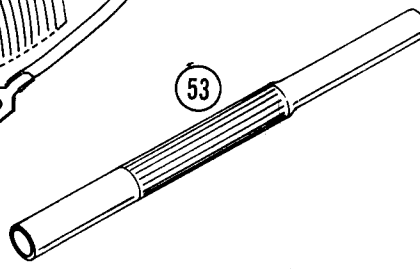


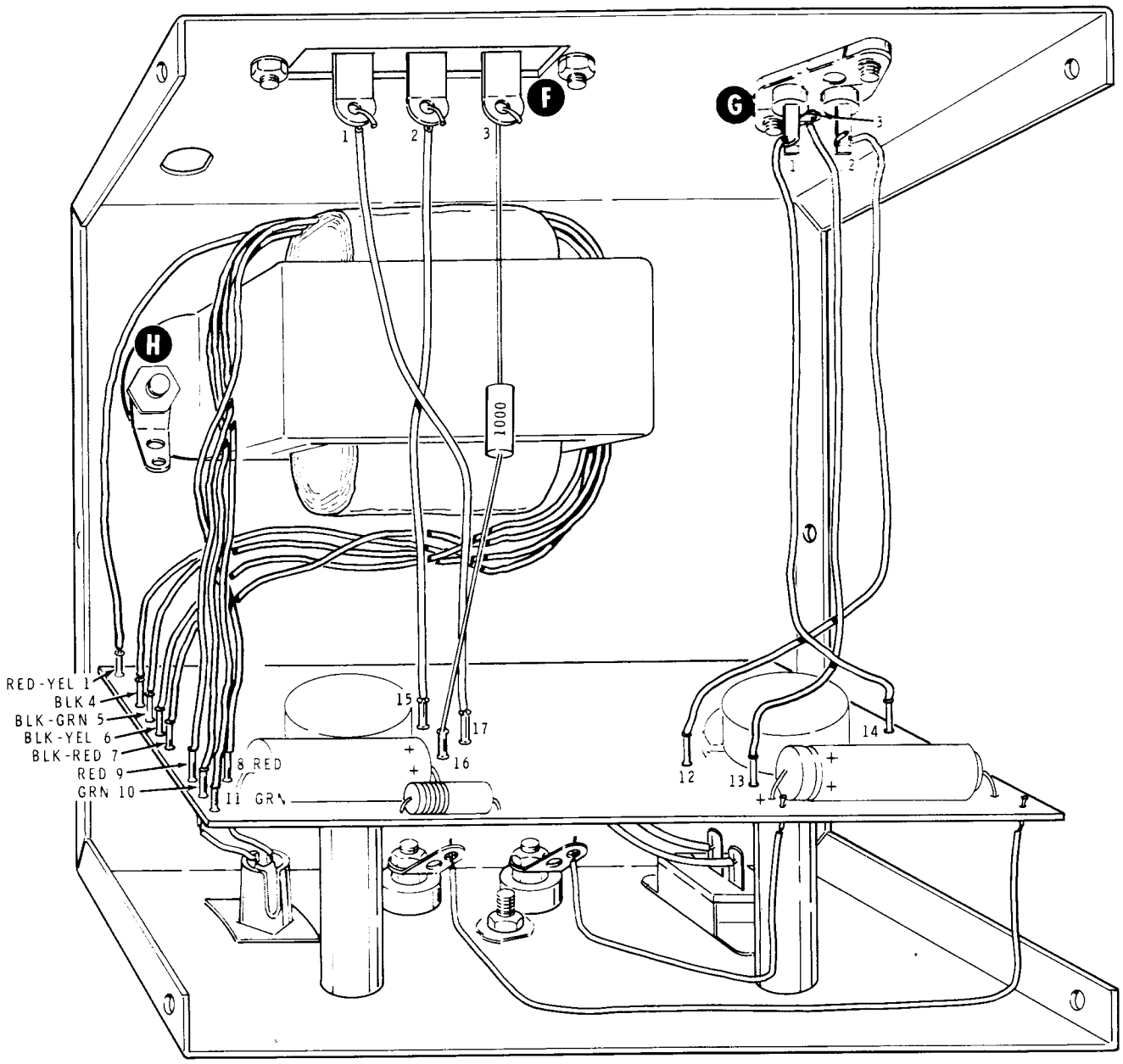








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PICTORIAL 6


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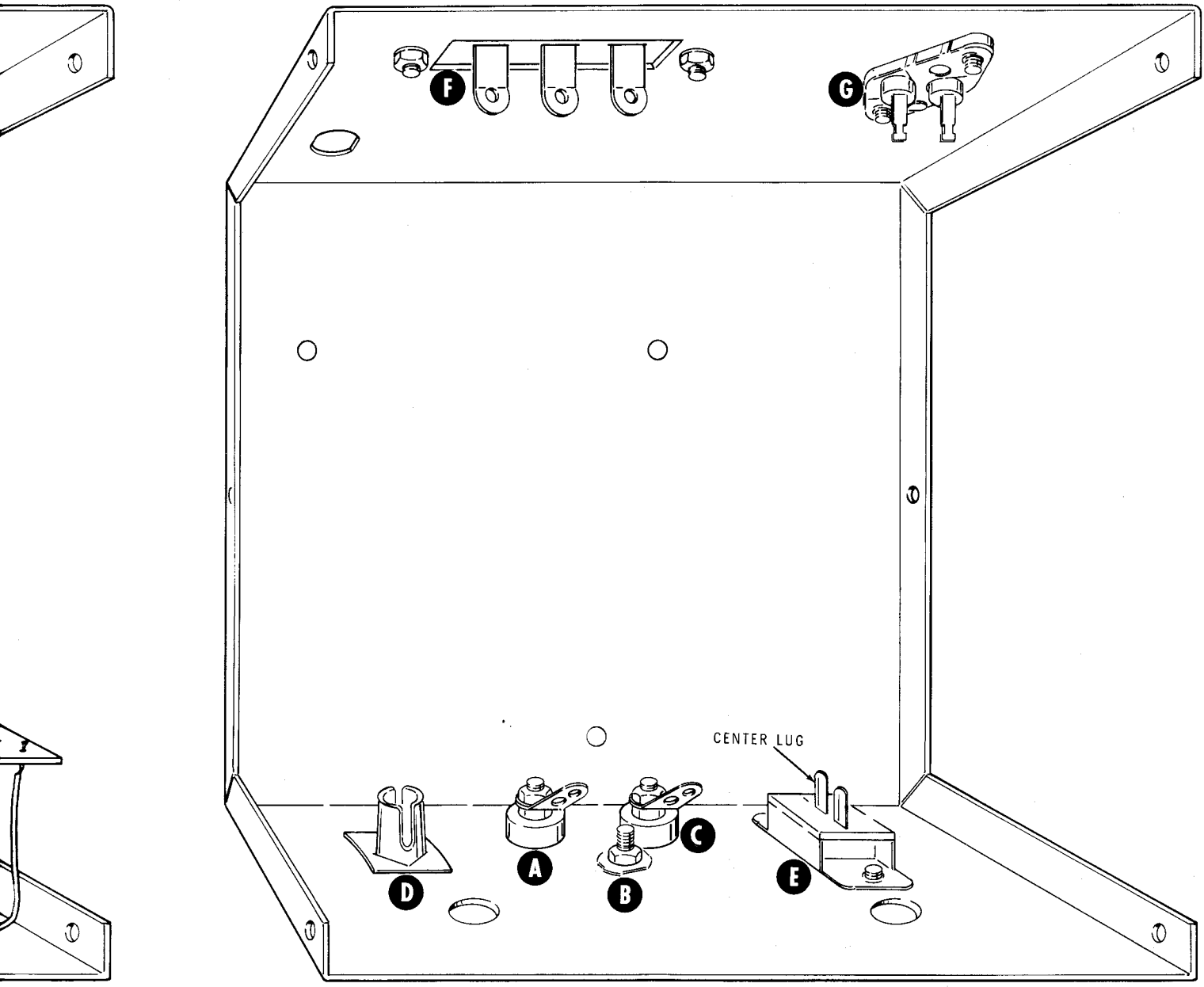


PICTORIAL 4

STEP-BY-STEP ASSEMBLY

Before you begin to assemble the Power Supply, read the Kit Builders Guide for complete information on wiring, soldering and step-by-step assembly procedures.

Components will be installed on the circuit bo by following the steps on Pictorials 1 throug Position all parts as shown in the Pictori All resistors will be called out by only the sistance value (in Ω or kΩ) and the color c for color-coded resistors. Use 1/2 w resistors unless the step directs otherwi Capacitors will be called out by the capa tance value and type.

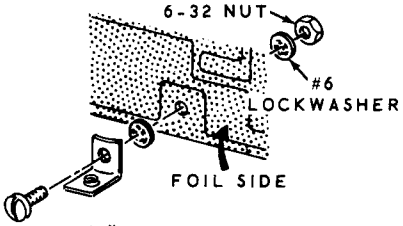
START

( ) Position the circuit board (#85-259-1) lettered side up as shown in Pictorial 1. Then perform the following steps. Do not solder or cut off any leads until you are directed to do so.

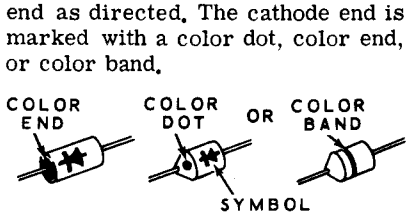
( ) Germanium diode (#56-26) (brown-white-brown). Position the cathode end as shown.

( ) 1800 Ω (brown-gray-red).

( ) L bracket. Be sure to install it on the foil side of the board and to use the unthreaded hole. Do not overtighten.



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



( ) Silicon diode. Note cathode lead.

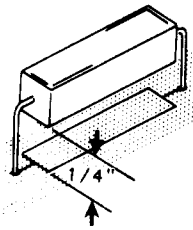
( ) Silicon diode. Note cathode lead.

( ) Silicon diode. Note cathode lead.

( ) Solder all connections and cut off the excess lead lengths.

CONTINUE

( ) 5 Ω 5 watt. Position 1/4" abo the circuit board as show



( ) 3300 Ω (orange-orange-red).

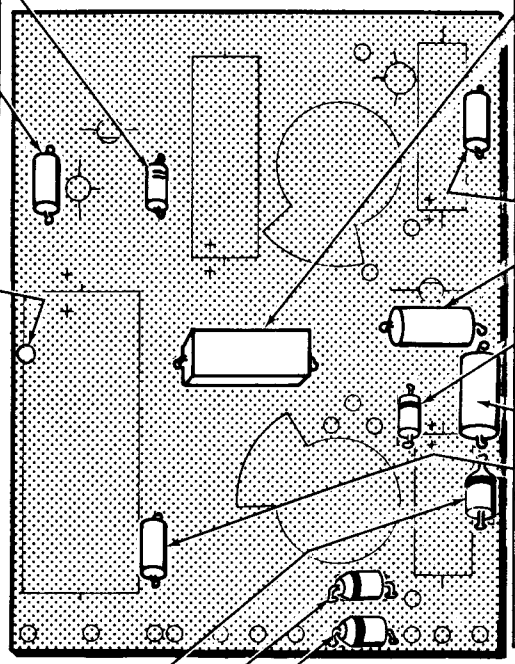
( ) .51 Ω 2 watt (green-brow silver-gold).

( ) Zener diode (#56-45). No cathode lead.

( ) 3300 Ω 1 watt (orange-orang red).

( ) 27 kΩ (red-violet-orange).

( ) Solder all connections and c off the excess lead length Save two 1" lengths of ba wire for use in the 120 or 2 volt wiring steps.

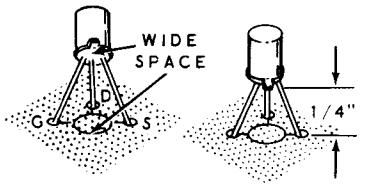


PICTORIAL 1

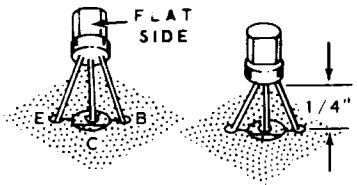
START

The transistors will be installed in the following steps. Position the transistors 1/4" above the circuit board. Solder all leads after each transistor is installed; then clip off the excess lead lengths. Save two 1" lengths of bare wire for use in the 120 or 240 volt wiring steps.

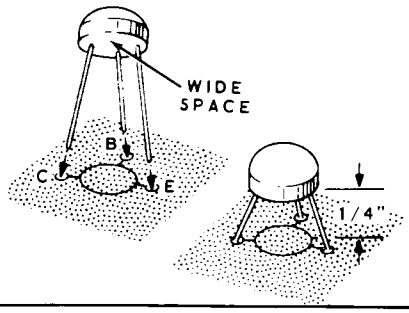
( ) Install the FET (#417-140) at Q1. Place the source (S), drain (D), and gate (G) leads in their proper holes as shown below.

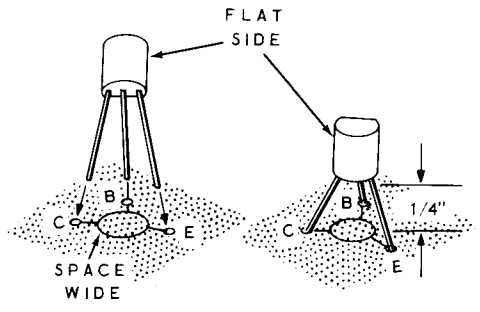


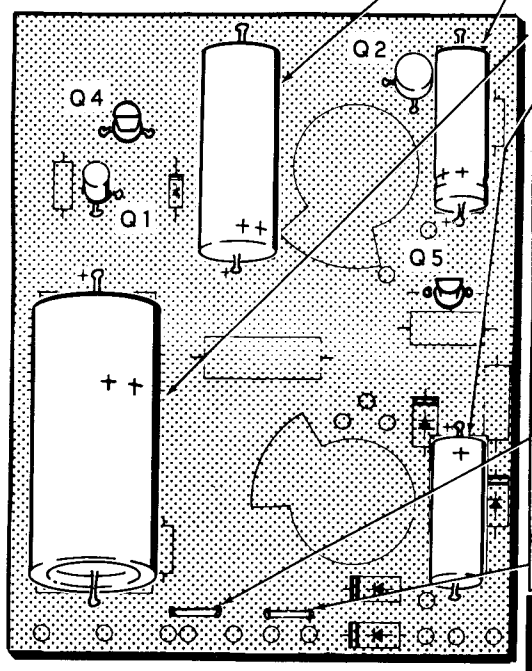
( ) Install 2N3393 (#417-118) transistors at Q4 and Q5. Match the flat side of each transistor with the outline of the flat on the circuit board; then insert the emitter (E), base (B), and collector (C) leads into their proper holes.



( ) Install transistor #417-109 at Q2. NOTE: Identify the transistor by its part number or type number printed on the case. Identify the transistor type and position it as shown below. Then insert the emitter (E), base (B), and collector (C) leads into their proper holes.







CONTINUE

( ) 250 µF electrolytic. Position the positive (+) end as shown.

( ) 100 µF electrolytic. Position the positive (+) end as shown.

( ) 2500 µF electrolytic. Position the positive (+) end as shown.

( ) 50 µF electrolytic. Position the positive (+) end as shown.

NOTE: The Power Supply can be wired for use with 120 volts AC power or 240 volts AC power. Follow either the 120 VOLT WIRING steps or the 240 VOLT WIRING step, whichever corresponds to the line voltage in your area.

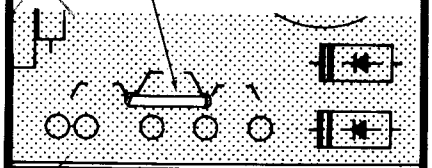
120 VOLT WIRING

( ) 1" bare wire. Use excess lead cut from the circuit board previously. Note the measuring scale on the fold-out from Page 4.

( ) 1" bare wire.

240 VOLT WIRING

( ) 1" bare wire.



( ) Solder all connections and cut off the excess lead lengths.

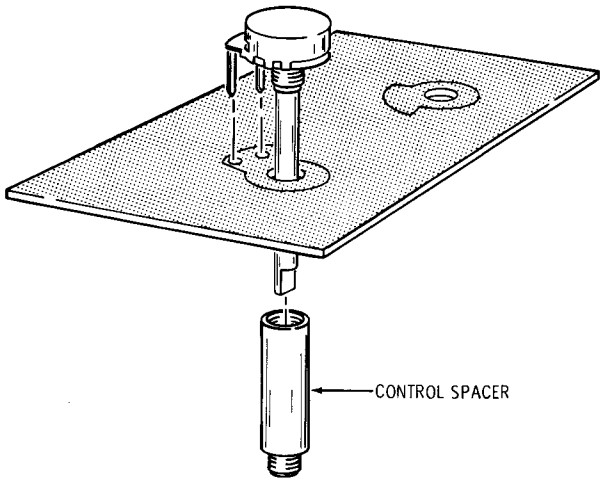
PICTORIAL 2

Refer to Pictorial 3 for the following steps.

NOTE: Do not solder the control lugs until you are directed to do so.

( ) Refer to Detail 3A and install the 5000 Ω control (#10-249) on the circuit board at the control location shown. Insert the control shaft and lugs through the board from the lettered side. Then install a control spacer on the control bushing. Solder the three lugs to the foil.

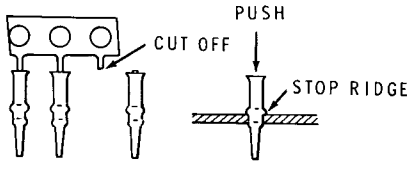
( ) In a like manner, install the 100 Ω control at the remaining control location on the circuit board. Solder the control lugs to the foil.



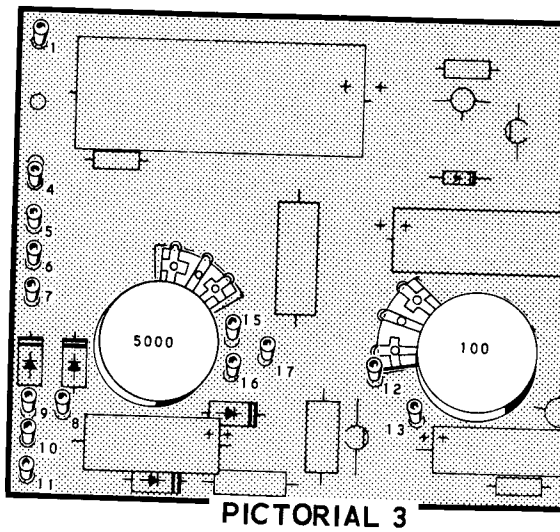
Detail 3A

CAUTION: In the following step, there will be a sharp metal edge where each solder pin is cut off. Watch your fingers!

(✓) Refer to Detail 3B. Then cut off and install solder pins in the following numbered holes on the lettered side of the circuit board; do NOT solder the pins yet: 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17.

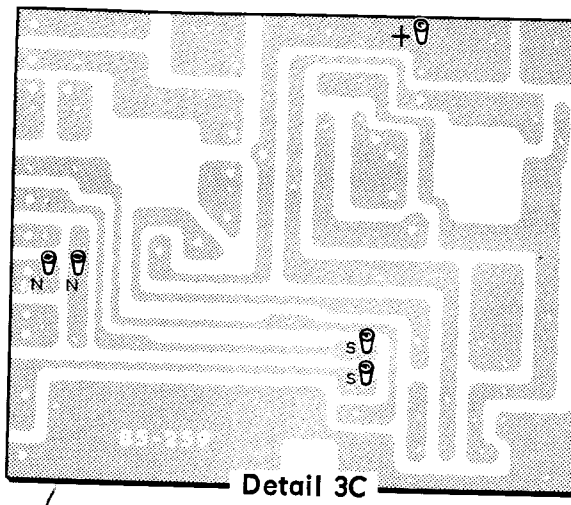


Detail 3B



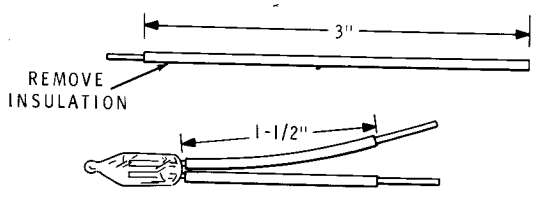
PICTORIAL 3

(✓) Refer to Detail 3C and in a like ma install solder pins in holes "-", "+", N, and N on the foil side of the circuit b

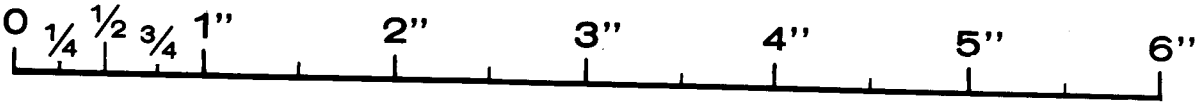


Detail 3C

(✓) Refer to Detail 3D and cut a 3" leng blue wire. Remove the insulation in piece. Cut this piece into two 1-1/2" leng and place one length on each lead of neon lamp.



Detail 3D

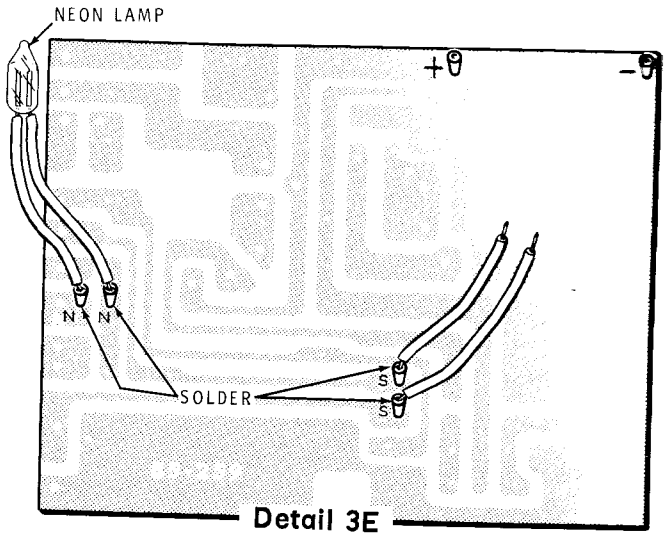


( ) Refer to Detail 3E and connect one lead of the neon lamp to either one of the solder pins N. Solder this lead to the solder pin and the solder pin to the foil.

( ) In a like manner, connect and solder the other neon lamp lead to the remaining solder pin N.

( ) Cut two 2" lengths of blue wire and remove 1/4" of insulation from each end of each wire.

( ) Refer to Detail 3E and connect one end of each of these 2" blue wires to a solder pin S. At each pin, simultaneously solder the wire to the pin and the pin to the foil.



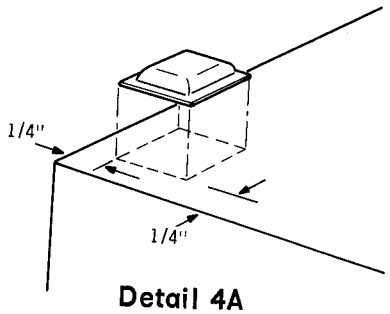
Detail 3E

Set the circuit board aside temporarily.

PARTS MOUNTING

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

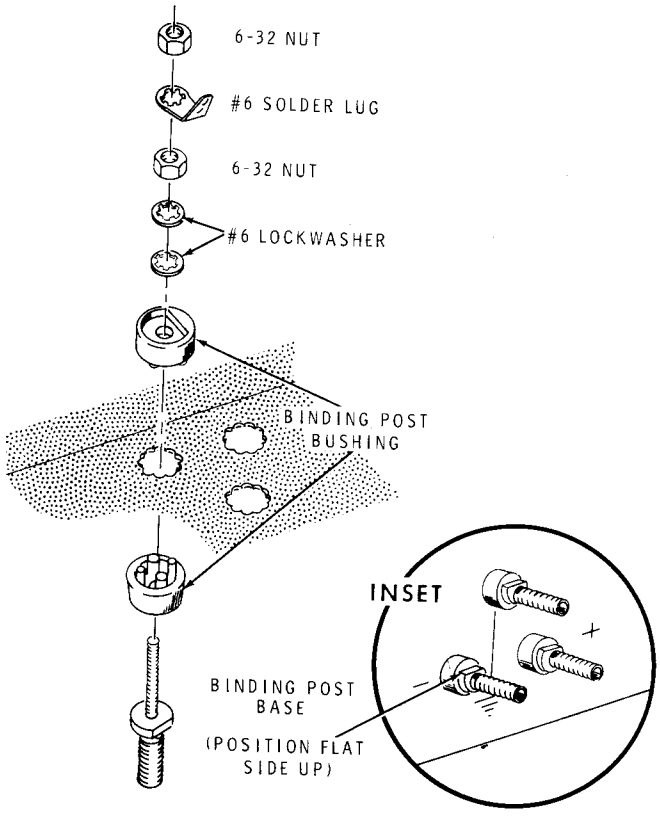
( ) Refer to Detail 4A and install the four plastic feet on the bottom cabinet shell by peeling away the protective paper from the adhesive and pressing the feet into position. The feet are difficult to move if not positioned correctly before they contact the shell.



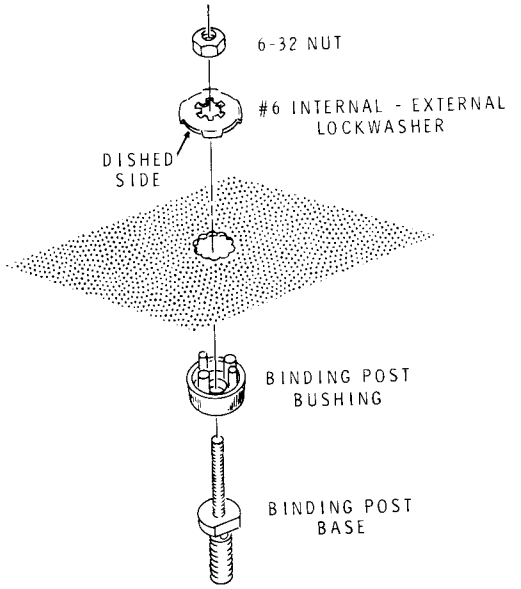
Detail 4A

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

( ) Refer to Detail 4B and install binding post bases at A and C on the cabinet bottom shell. Use two binding post bushings, two #6 lockwashers, two 6-32 nuts, and a #6 solder lug for each. Position the flat side of each binding post base as shown. Use the wrench provided to tighten the first nut before you install the solder lug and second nut on each binding post.



Detail 4B



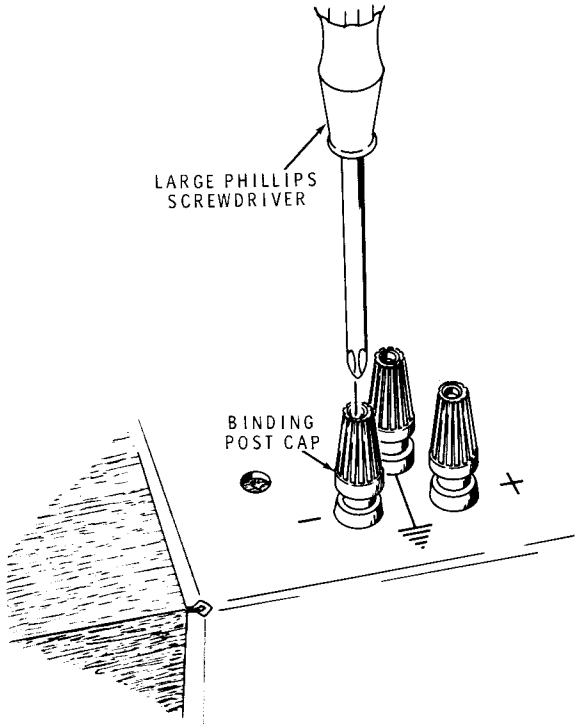
Detail 4C

( ) Refer to Detail 4C and install a binding post base at B. Use a binding post bushing, a #6 internal-external lockwasher and a 6-32 nut. Be sure the dished side of the lockwasher faces the inside surface of the front panel, and that the flat side of the binding post base is positioned as before.

( ) Install the black binding post cap on binding post A (-), the green cap on B (ground), and the red cap on C (+).

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

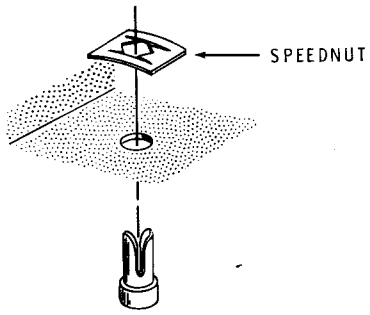
( ) Refer to Detail 4D and place the tip of a large phillips screwdriver through the opening in the end of each binding post cap and against the hollow end of the binding post base. Support the binding post base with a block of wood or a thick magazine to avoid bending the panel.



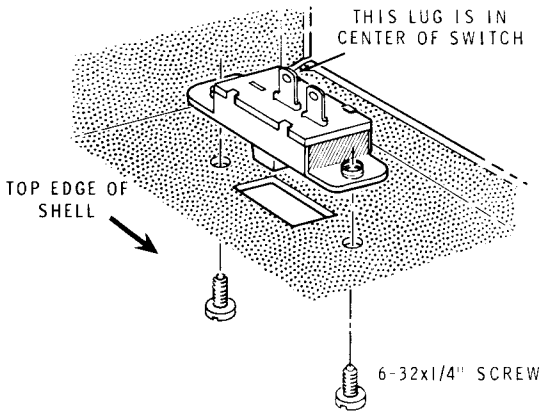
Detail 4D

( ) Now tap the handle end of the phillips scre driver sharply with a small hammer to pand the hollow end of the binding post ba The binding post base should be expan only enough to prevent the caps from com off.

( ) Refer to Detail 4E and install the neon la lens with a speednut at D.



Detail 4E

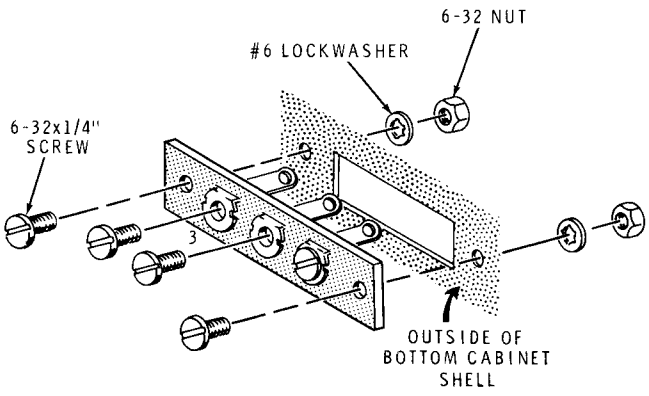


Detail 4F

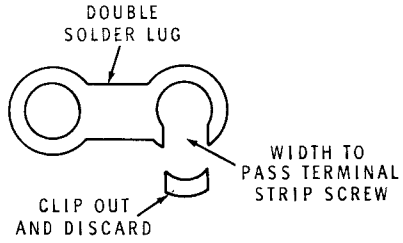
( ) Refer to Detail 4F and install the slide switch at E. Use 6-32 x 1/4" screws and be sure to position the switch lugs as shown in the Pictorial.

( ) Install the terminal strip at F on the outside of the bottom cabinet shell as shown in Detail 4G. Use 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts. Be sure to position the solder lugs of the terminals as shown.

( ) Temporarily remove screw 3 from terminal strip F, and loosen screw 2.



Detail 4G

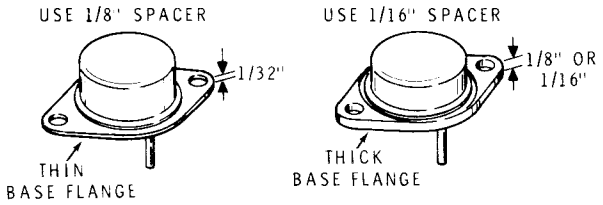


Detail 4H

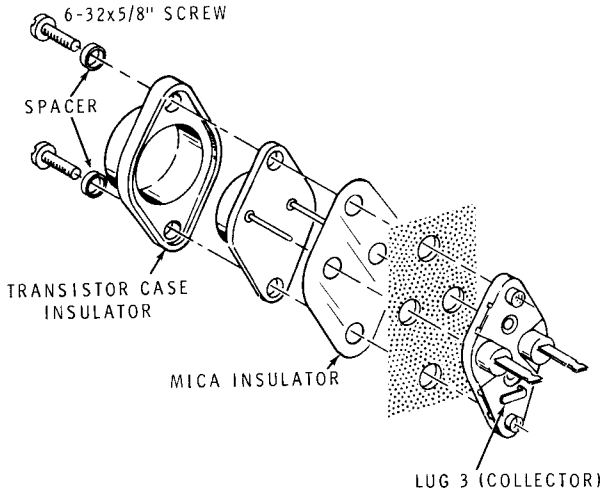
( ) Refer to Detail 4H and prepare the double solder lug as shown. Use diagonal cutters to clip out enough of the lower edge of one lug to allow it to pass freely over the threaded portion of one of the terminal strip screws.

( ) Mount the uncut end of this double solder lug on the screw at 3 and the cut end on the other screw at 2 of terminal strip F.

NOTE: Refer to Detail 4J and determine whether the power transistor (#417-162) included in your kit has a thick or a thin base flange. Use 1/8" spacers if the transistor has a thin base flange. Use 1/16" spacers if the transistor has a thick base flange.



Detail 4J



Detail 4K

(✓) Refer to Detail 4K and install the power transistor at G with 6-32 x 5/8" screws, two spacers, a transistor case insulator, a mica insulator and a transistor socket. Note that lug 3 is down. Be sure the socket is fully seated in the mounting holes; then tighten the screws securely. Tighten until the screw heads are fully seated in the recessed holes on the insulator.

PRELIMINARY WIRING

Refer to Pictorial 5 for the following

NOTE: In the following step, you will be d to "prepare" wires for use. To prepare cut it to the stated length and then remov of insulation from one end and 1/4" of ins from the other. The wires are listed in the in which they are used.

(✓) Prepare the following lengths of blu

6-1/2"	3-1/2"
4-1/2"	4"
4-1/2"	4-1/2"
3-1/2"	

NOTE: Most wire lengths are longe needed. To do a neater wiring job, it is r mended that you use square corners (90 bends) when positioning the wires.

Connect only the 1/4" bared end of the pr wires as directed in the following step other end of each wire will be connected

(✓) 6-1/2" to binding post A (S-1).

(✓) 4-1/2" to binding post C (S-1).

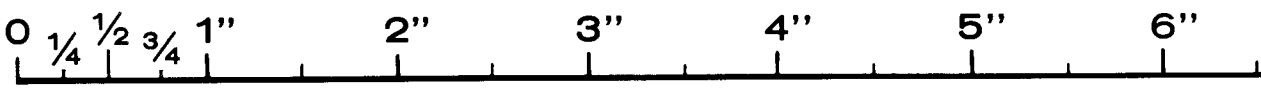
(✓) 4-1/2" to lug 1 of terminal strip E

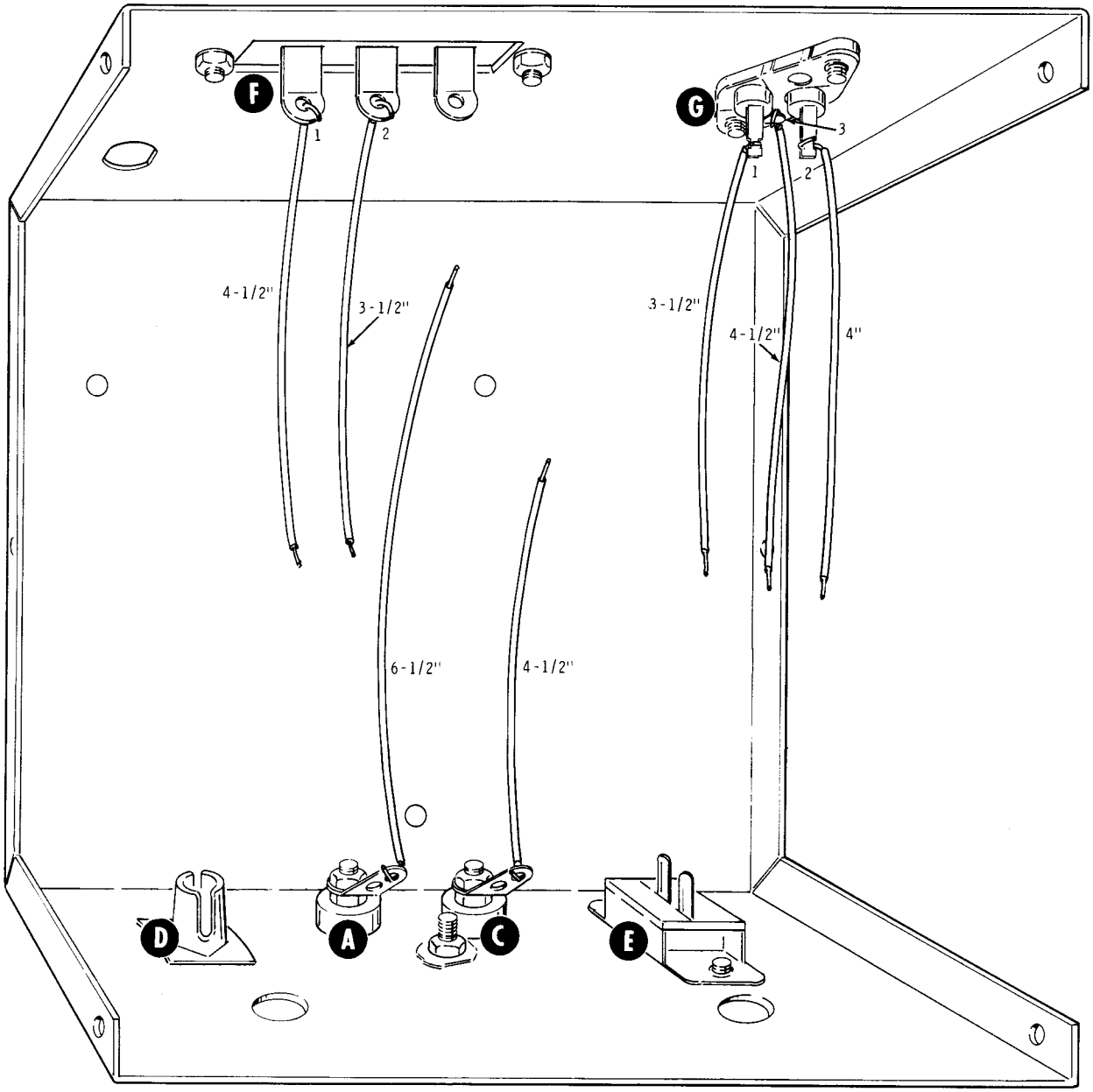
(✓) 3-1/2" to lug 2 of terminal strip E

(✓) 3-1/2" to lug 1 of socket G (S-1).

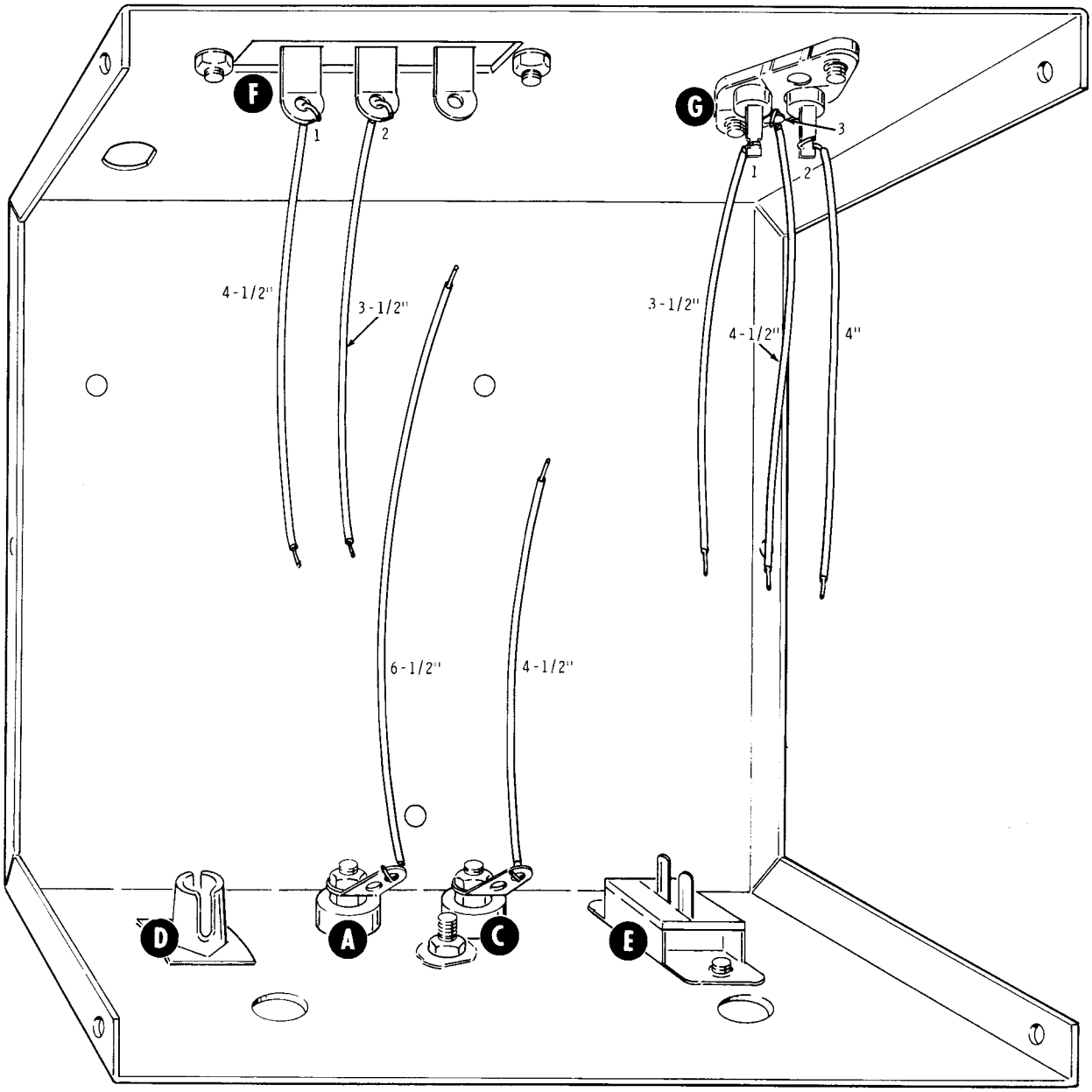
(✓) 4" to lug 2 of socket G (S-1).

(✓) 4-1/2" to lug 3 of socket G (S-1).





PICTORIAL 5

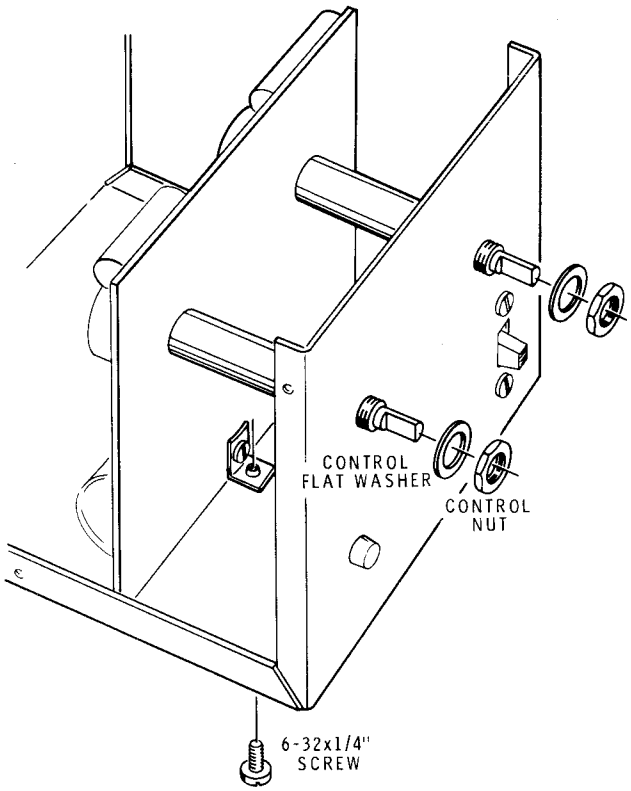


PICTORIAL 5

CIRCUIT BOARD INSTALLATION AND WIRING

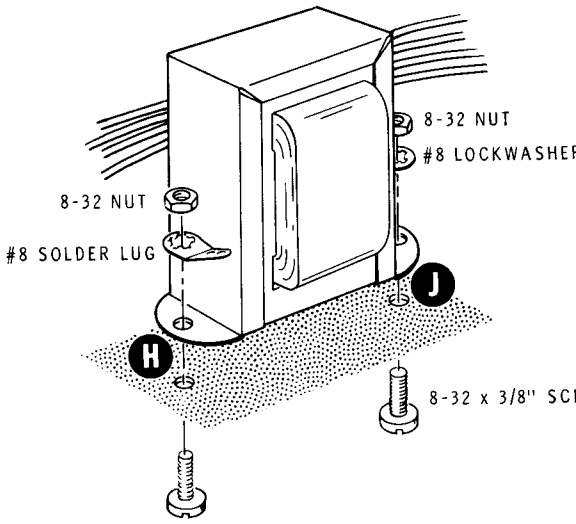
Refer to Pictorial 6 (fold-out from Page 4) for the following steps. Route all wires as shown.

( ) Refer to Detail 6A and install the circuit board in the cabinet bottom shell. Use control nuts, control flat washers, and a 6-32 x 1/4" screw. As you mount the circuit board, insert the neon lamp into the rear of the lamp lens at D on the cabinet bottom shell. Push it in as far as possible.



Detail 6A

( ) Install the power transformer as shown Detail 6B. Use an 8-32 x 3/8" screw, a solder lug, and an 8-32 nut at H. Use an 8- x 3/8" screw, a #8 lockwasher and an 8- nut at J. Bend the solder lug up and aw from the transformer foot after tighten the screws. Be sure the transformer lea are positioned as shown in the Pictori

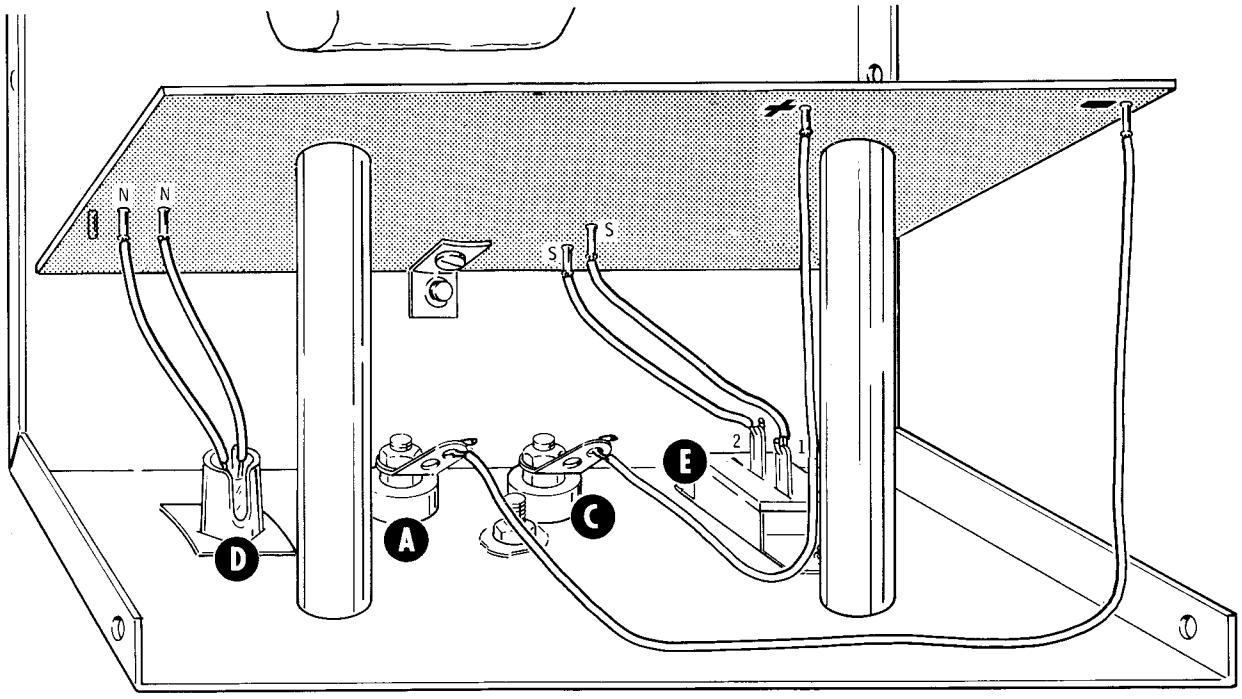


Detail 6B

NOTE: In the following steps, twist together the wires in each group of leads coming from the transformer before connecting the ends of the leads. This will keep the wires together and improve the appearance of the wiring.

In the following steps, push each wire into the solder pin at the designated hole until the tip of the wire appears at the other end of the pin. Then solder the wire to the pin and the pin to the foil in one operation. After the solder has cooled, pull on each wire to make sure you have a good solder connection.

COLOR	COMING FROM	CONNECT TO HOLE
( ) Red-yellow	transformer	1 (S-1).
( ) Black	transformer	4 (S-1).
( ) Black-green	transformer	5 (S-1).
( ) Black-yellow	transformer	6 (S-1).
( ) Black-red	transformer	7 (S-1).
( ) Either red	transformer	8 (S-1).
( ) Other red	transformer	9 (S-1).
( ) Either green	transformer	10 (S-1).
( ) Other green	transformer	11 (S-1).
( ) Blue	lug 2 of socket G	12 (S-1).
( ) Blue	lug 3 of socket G	13 (S-1).
( ) Blue	lug 1 of socket G	14 (S-1).
( ) Blue	lug 2 of terminal strip F	15 (S-1).
( ) Blue	lug 1 of terminal strip F	17 (S-1).



Detail 6C

Refer to Detail 6C and connect the indicated wires to the terminals on the foil side of the circuit board as follows:

	COLOR	COMING FROM	CONNECT TO
( )	Blue	binding post A	"-" (S-1).
( )	Blue	binding post C	"+" (S-1).

( ) Refer to Detail 6C and connect the two blue wires coming from solder pins S to switch E. Connect the lower wire to lug 2 (S-1) and the upper wire to lug 1 (S-1) of switch E.

( ) Twist together the small strands of wire at the end of each line cord lead. Then melt a small amount of solder on the end of each lead to hold the separate strands together.

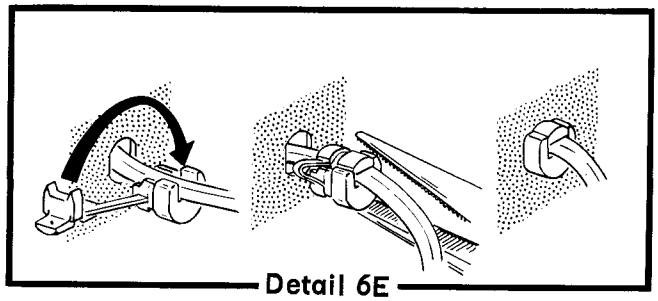
Refer to Detail 6D for the following st

( ) Insert the line cord through hole K in rear of the cabinet bottom shell.

NOTE: Observe that the two edges of the line cord are different. One edge is smooth the other edge is ribbed for identificat

( ) Connect the green (center) line cord lea solder lug H (S-1).

( ) Connect the ribbed line cord lead to ho (S-1) and the other lead to hole 2 (S-1 the circuit board. Refer to the inset drav on Detail 6D.



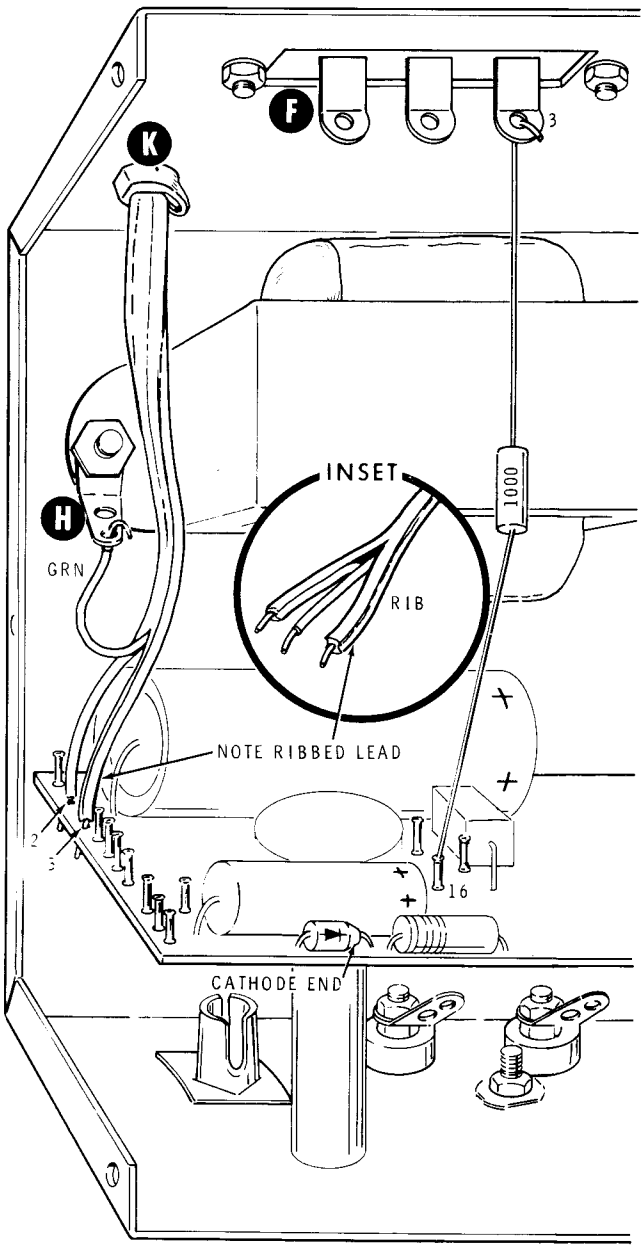
Detail 6E

(✓) Install the proper strain relief in hole K. Detail 6E shows the strain relief (#75-71) for the flat line cord supplied with the kit. If a round line cord is used, install the other strain relief.

( ) Connect a 1000 Ω (brown-black-red) resistor from terminal 16 on the component side of the circuit board (S-1) to lug 3 of terminal strip F (S-1).

This completes the wiring of the Power Supply. One 220 Ω (red-red-brown) resistor should remain. It will be used later.

Carefully inspect your work to make sure that all connections are soldered and that there are no loose components, faulty solder connections or solder bridges on the circuit board foil. Disregard the four unused holes. Shake out any wire clippings or solder splashes. Then proceed to the Resistance Checks if an ohmmeter is available, or directly to Final Assembly if one is not available.



Detail 6D

RESISTANCE CHECKS

If you have an ohmmeter available, make the following resistance measurements. These measurements will help you determine if you made any construction errors. NOTE: If you do not obtain readings within 20% of the values given in the following steps, refer to the In Case Of Difficulty section on Page 24. Before doing any actual troubleshooting, however, complete all the checks. The resistance readings thus obtained may establish a pattern which will make the difficulty easier to locate.

	FROM	TO	RESIST-ANCE
(✓)	Lug 1	ground (⏚) binding post	infinity (
(✓)	Lug 2	ground (⏚) binding post	infinity (
(✓)	Lug 3	ground (⏚) binding post	infinity (

(✓) Turn the VOLTAGE and CURRENT co to MIN.

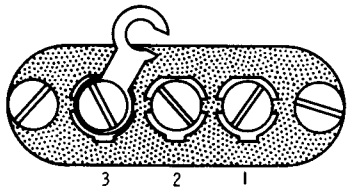
Make the following resistance tests at the power transistor socket (socket G). A reading of infinity at all three points indicates that the transistor assembly was properly installed. A reading of zero ohms at any of the points indicates a short circuit to the chassis; in this case you should remove the transistor assembly and carefully reinstall it as directed on Page 10. Then repeat the resistance checks.

Make the following resistance measure by connecting the ohmmeter leads to the bi posts marked as shown in the Meter columns. The first two checks indica absence of short circuits. In the third t meter reading in the megohms range s that there is no unintended leakage betwee circuit and the metal shell of the Power Su Be sure the ohmmeter range switch is pro set.

Common (Negative) Meter Lead To	Plus (Positive) Meter Lead To	Ohmmeter Range	Resistance
(✓) -	+	R x 100	Over 700 Ω
(✓) +	-	R x 100	Over 2000 Ω
(✓) ⏚	+ or -	R x 1 M	Infinity

IMPORTANT The letter "D" in the Resistance column of the following chart indicates that a diode is in the circuit under test. Therefore, the measured resistance can vary due to the forward current of the diode, and depending on the range setting of the ohmmeter. In some ohmmeters the battery polarity is reversed and erroneous readings will be obtained. Try reversing the ohmmeter leads if the measurements do not check out correctly the first time.

Make the following resistance measurements between the Programming terminals on the back of the bottom cabinet shell. Identify the terminal numbers from the drawing at the right. Disconnect the jumper between terminals 2 and 3 before making these measurements.



Common (Negative) Meter Lead To	Plus (Positive) Meter Lead To	Ohmmeter Range	Resistance
( ) 1	2	R x 100	4500 Ω
( ) 2	3	R x 100	10 kΩ "D"
( ) 3	2	R x 10 k	*over 1 MΩ "D"

*Wait for needle to come to rest.

( ) Reconnect the jumper between terminals 2 and 3.

( ) Set the ohmmeter range switch to R x 100.

( ) Refer to the X-Ray View on Page 30 and connect the common lead of the meter to the soldering pin for the red-yellow transformer lead. Connect the plus lead of the meter to the positive lead of C1 and allow time for the meter needle to come to rest. The resistance should be over 3000 Ω. There is a diode in the circuit.

( ) Reverse the connections of the meter leads. The resistance should be 500 Ω.

( ) Connect the common lead of the meter to the solder pin of either green transformer lead. Connect the plus meter lead to the cathode end of D3. The meter should read over 5000 Ω.

This completes the Resistance Checks.

FINAL ASSEMBLY

Refer to Pictorial 7 for the following steps.

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 knobs on the two control shafts as shown in Detail 7A. 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 two control shafts; the spring tab on the bushing should face outward.

( ) Turn each control shaft to its full counter-clockwise position.

( ) Press knobs firmly onto the control bushings with the pointers at the letter N in "MIN."

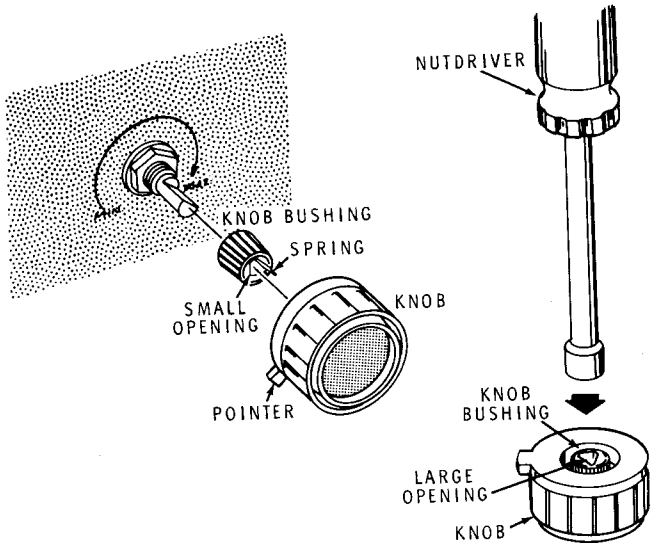
( ) Remove the knobs with the bushings inserted in them; then drive the bush into the knobs. Use a nutdriver, or c appropriate size tool, as shown.

( ) Reinstall each knob on the proper co shaft.

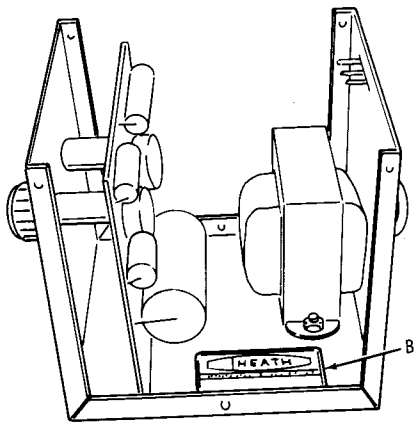
( ) Refer to Detail 7B and install the blu white label inside the cabinet bottom sh carefully peeling away the backing pape pressing the label into position. NOTE fer to the numbers on this label in any munications that you have with Heath pany concerning this kit.

( ) Install the cabinet top shell. Use #6 x sheet metal screws, and be sure to mou top shell with the angled edge above the panel.

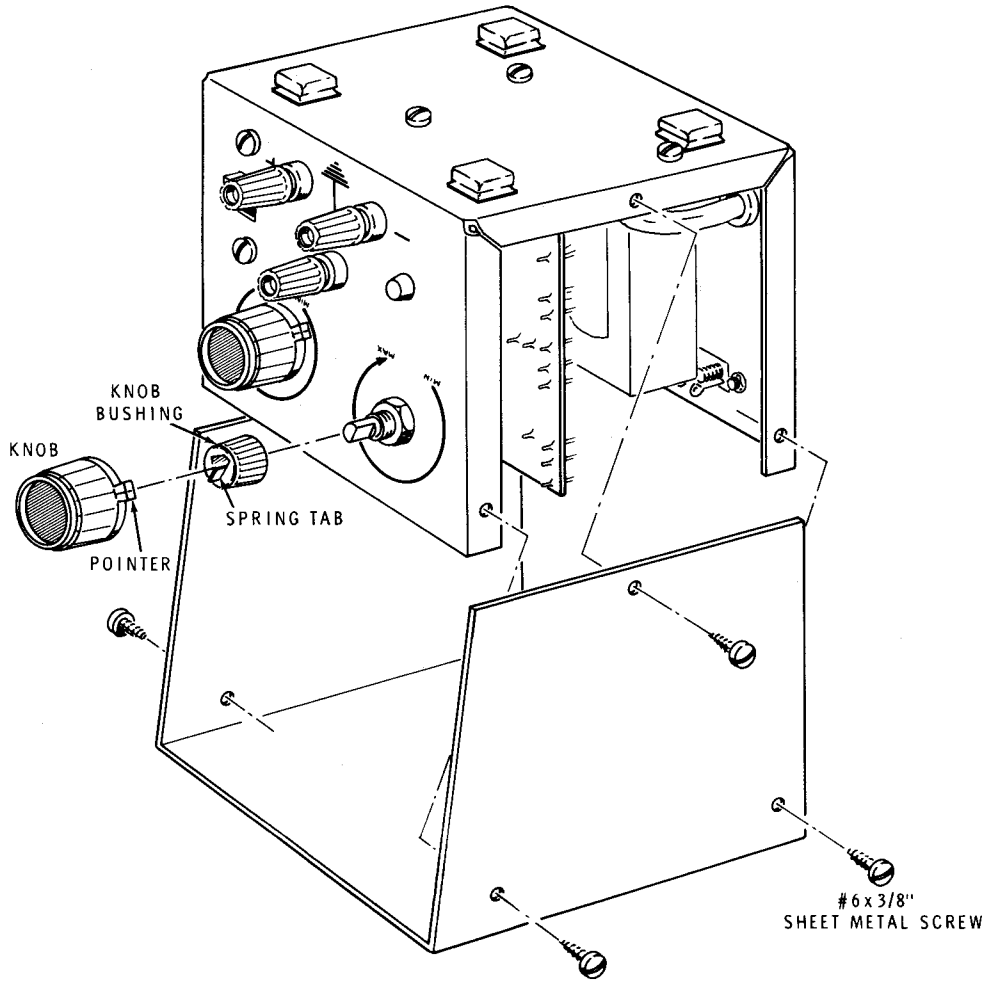
This completes the assembly of the Power S



Detail 7A



Detail 7B


KNOB
BUSHING
KNOB
SPRING TAB
POINTER
#6 x 3/8"
SHEET METAL SCREW

PICTORIAL 7

OPERATION

Refer to Figure 1 for control functions and connecting information.

The output of this Power Supply is "floating" above chassis ground, which is brought out to a separate terminal on the front panel. This has been done so you can operate the Power Supply with circuits requiring either a positive or negative ground.

A 220 Ω, 2 watt (red-red-brown) resistor has been furnished for you use in checking out this Power Supply. Whenever you are instructed to "connect the load", connect the leads of this resistor to the - and + (the black and the red) binding posts. Make sure the leads do not touch the cabinet shell.

The jumper between the terminals marked AC on the rear of the cabinet must be connected for all types of operation except Remote Programming (described on Page 22).

CONSTANT VOLTAGE OPERATION

For use when maximum current is not impor tant. In this type of service, only the output volt age is controlled.

1. Preset the controls as follows:

VOLTAGE	MIN
CURRENT	MAX
Power Switch	OFF

2. Connect the load to the front panel negativ (-) and positive (+) terminals.

3. Turn the Power switch ON and advance th VOLTAGE control until the desired volt age is reached.

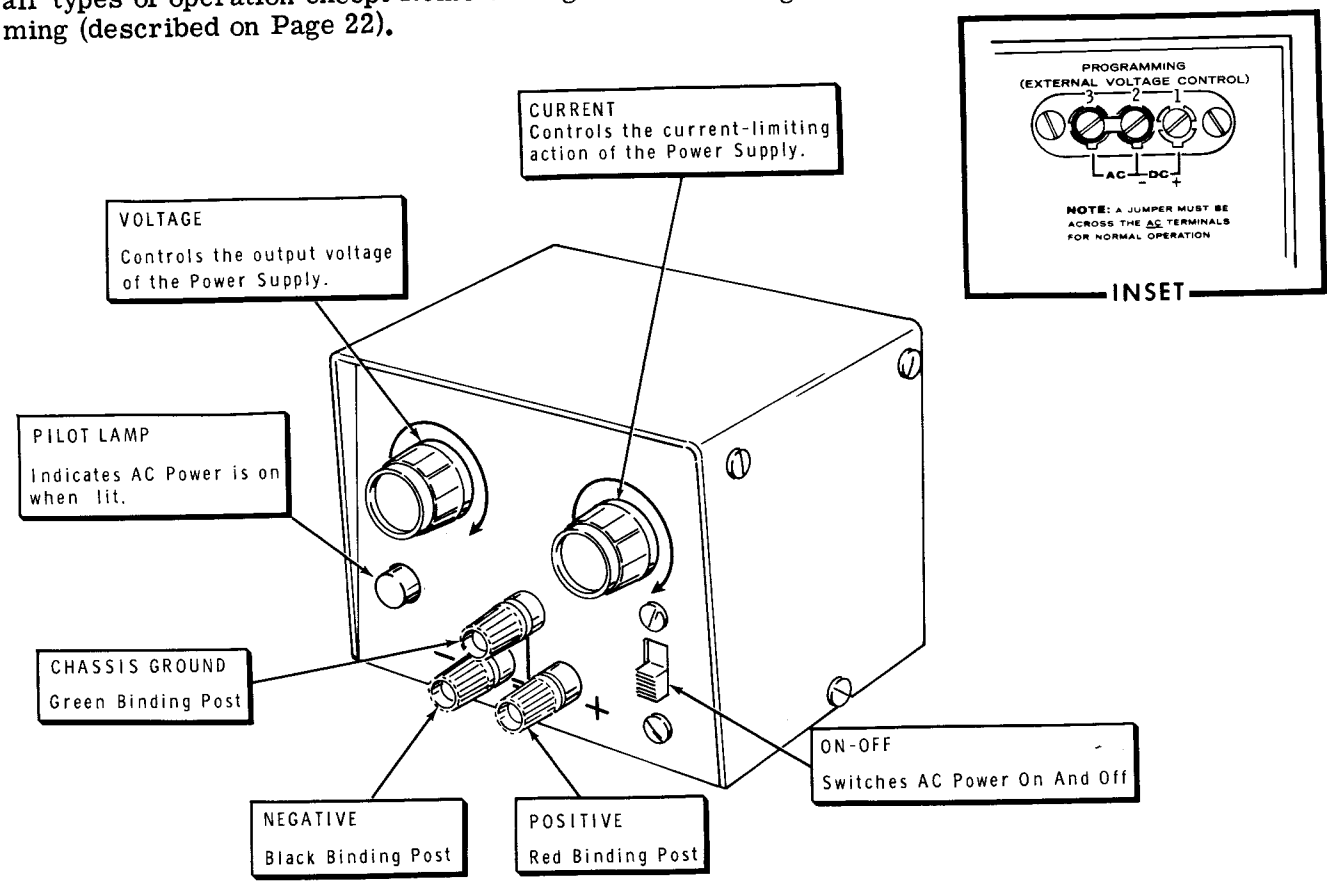


Figure 1

LIMITED CURRENT OPERATION

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

1. Preset the controls as follows:

   VOLTAGE MIN

   CURRENT MIN

   Power Switch OFF

2. Turn the Power switch ON and, with a voltmeter, set the VOLTAGE control for the desired voltage. Then turn the Power switch OFF.

3. Connect the load to the front panel negative (-) and positive (+) terminals.

4. Turn the Power switch ON.

5. Advance the CURRENT control to a point just past where the preset voltage is obtained.

OPERATIONAL EXAMPLE

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

Use the 220 ohm 2-watt resistor supplied for the following demonstration:

1. Set the output voltage, without load, to 10 volts.
2. Turn the CURRENT control to its maximum clockwise position. The values of voltage and current are shown in Figure 2.

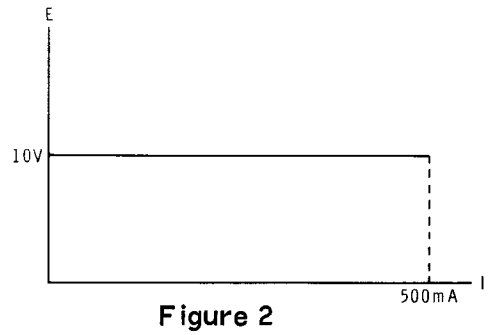


Figure 2

3. Turn the Power Supply off.
4. Connect 220 ohm load.
5. Turn the Power Supply on.
6. Turn the CURRENT control counterclockwise until the voltage just starts to decrease. (See Figure 3) The current is now limited to 10/220 = 45 mA.

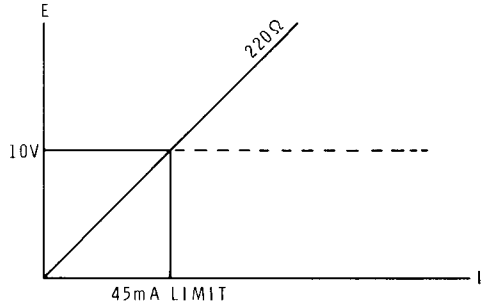


Figure 3

7. Turn the VOLTAGE control clockwise. Note that the voltage does not increase perceptibly. The supply is now current-limited. (See Figure 4).

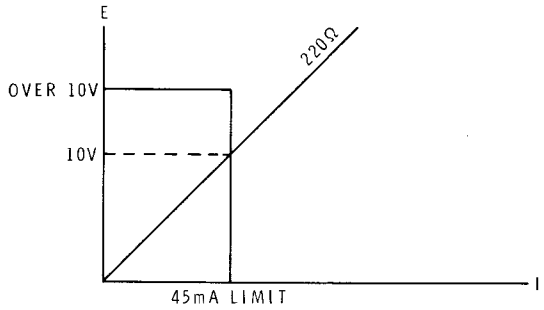


Figure 4

8. Turn the VOLTAGE control below 10 volts and note that voltage (and current) decreases (See Figure 5).

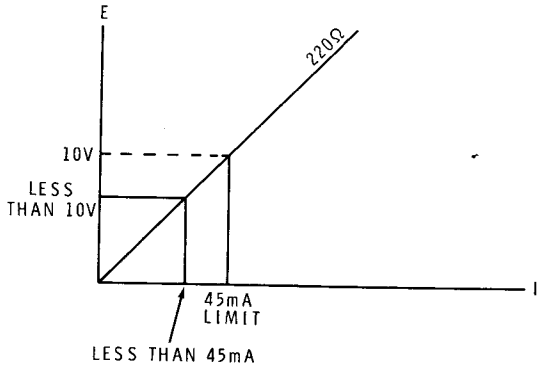


Figure 5

For heavier leads (lower resistance) the current drain will be higher than the example and the limit could be set higher, or the output voltage will drop rapidly to a value appropriate for the current limit selected. Further experiments will increase your understanding of the characteristics of this supply.

CAUTION: Do not apply a load to the Power Supply that will draw more than .5 ampere. To do so will result in loss of regulation and possible overheating of the Power Supply.

REMOTE PROGRAMMING

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

DC Programming

1. Remove the jumper from between the AC lugs on the Programming terminal strip.

2. Connect the leads supplying the desired DC control voltage to the DC terminals on the rear of the cabinet. Be sure to observe proper polarity, and do not use a control voltage which exceeds the capabilities of the Power Supply (15 VDC) or damage may result.

3. Set the VOLTAGE control to MAX and CURRENT control as in Constant Volta Limited Current Operation. The out voltage will now follow the voltage appl to the DC PROGRAMMING terminals. N that the VOLTAGE control can now be u to reduce the output voltage below applied control voltage.

AC Programming

1. Remove the jumper from between the lugs on the Programming terminal st

2. Connect the leads supplying the desired control voltage to these same AC termin

NOTE: The AC signal source must have a DC resistance (such as a low impedance tra former secondary) to maintain a DC out reference.

The output voltage from the Power Supply now be pulsating DC, with a modulation com nent which approximates the waveform of external AC control voltage. The VOLTAGE c trol will set the average voltage of the pulsa DC output. The CURRENT control opera normally.

NOTE: Be sure to reinstall the jumper betw the AC terminals on the Programming term strip when you disconnect the external con voltage leads.

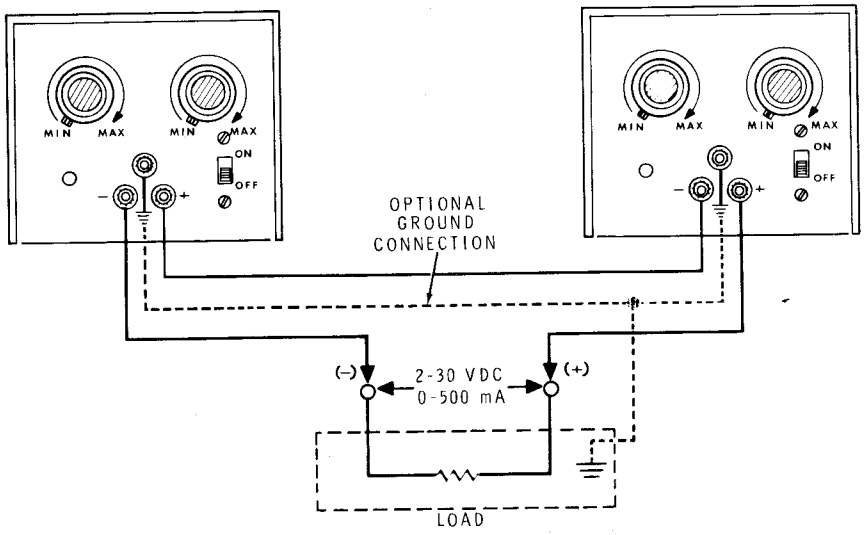


Figure 6

SERIES OPERATION

Two or more Power Supplies can be connected in series to obtain voltages greater than 15 volts. The correct method of connecting Power Supplies for series operation is shown in Figure 6. CURRENT control settings should be identical in each series unit, but VOLTAGE control settings can be distributed between the Power Supplies as desired.

PARALLEL OPERATION

For higher current loads, two or more Power Supplies can be connected in parallel, as shown in Figure 7. Use the following steps for parallel connections.

1. Determine the voltage required and, using a DC voltmeter, preadjust the VOLTAGE control of each Power Supply to this value. Do this before making any connections to any of the Power Supplies.

2. Turn the Power Supplies OFF.

3. Place a .1 Ω resistor (brown-black-silver) in series with the positive (+) lead of each Power Supply as shown. Do not connect the load at this time.

4. Connect together the negative (-) binding posts of all Power Supplies.

5. Connect the load as shown in Figure 7.

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

NOTE: It is important that approximately equal currents be drawn from each of the Power Supplies. This will occur when the voltage output of all Supplies are equal. To balance the voltage outputs, connect a DC voltmeter between the positive (+) binding posts of adjacent Supplies, and adjust the VOLTAGE control of either Supply until a zero indication is obtained. Repeat this procedure with all connected Supplies.

REFERENCE

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

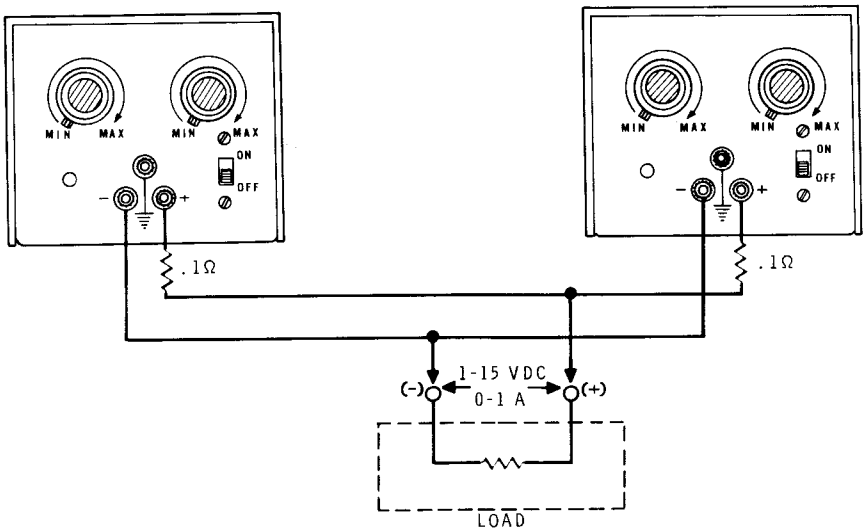


Figure 7

IN CASE OF DIFFICULTY

NOTE: Refer to the Kit Builders Guide for Service and Warranty information.

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 t the proper parts have been wired into e circuit, as shown in the Pictorial diagra and as called out in the wiring instructio

4. Check for bits of solder, wire ends or ot foreign matter which may be lodged in wiring.

5. If, after careful checks, the trouble is s not located and a voltmeter is availa check voltage readings against those sh on the Schematic Diagram. NOTE: All v age readings were taken with an 11 meg input voltmeter. Voltages may vary as m as ±10%.

6. A review of the Circuit Description may you locate the trouble.

Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE
No output voltage (pilot lamp lights).	1. Diodes D1 and D2 faulty. 2. Transistor Q3 faulty or shorted to chassis. If faulty, also check Q2 and Q4. 3. Capacitors C1, C2, C3, or C4 shorted or faulty. 4. Transformer T1 faulty or improperly wired.
Low output voltage (no voltage control).	1. Diode D3 faulty. 2. Diode D4 shorted. 3. Diode D5 open. 4. Transistor Q4 faulty. If faulty, also check D5. 5. Transistor, Q3 faulty or shorted to chassis. If faulty, also check Q2 and Q4. 6. Transistor Q2 faulty. 7. Capacitor C2 shorted.
High output voltage (no voltage control).	1. Transistor Q4 faulty. If faulty, also check D5. 2. Transistor Q2 faulty. 3. Transistor Q3 faulty or shorted to chassis. If faulty, also check Q2 and Q4.
No current output (voltage normal).	1. Transistor Q5 faulty. 2. Transistor Q1 faulty. 3. Control R6 open. 4. Resistor R7 open.
Current limiting inoperative.	1. Control R6 shorted. 2. Transistor Q5 faulty.
Excessive ripple.	1. Capacitor C1, C2, or C3 faulty.
Low output voltage with ripple.	1. Diodes D1 or D2 open. 2. Capacitors C1, C2, or C3 leaky.
Poor regulation.	1. Diode D4 open (line regulation only). 2. Transistor Q4 faulty (load regulation only). 3. Transistor Q1 faulty (line and load regulation). 4. Transistor Q2 faulty (line and load regulation). 5. Transistor Q3 faulty (line and load regulation).

SPECIFICATIONS

Voltage Output	1-15 VDC, continuously adjustable.
Load Regulation	Less than 50 mV variation from no load to f load.
Line Regulation	Less than 50 mV variation in output voltage a 10% change in line voltage.
Ripple And Noise	Less than 5 mV.
Current Output	500 mA maximum continuous load.
Current Limiting	Adjustable from 10 mA to over 500 mA.
Transient Response	25 μs.
Output Impedance	.5 Ω or less to 100 kHz.
Power Requirements	105 to 125 or 210-250 VAC, 50/60 Hz, 15 watts at full load.
Dimensions	5-1/2" wide x 4-3/8" high x 5-3/4" d
Net Weight	3-1/4 lbs.

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

THEORY OF OPERATION

Qualifications for a perfect power supply would include zero internal resistance, a 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 drain by the starter motor. This reduced voltage causes the lights to dim.

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

In Figure 8, 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.

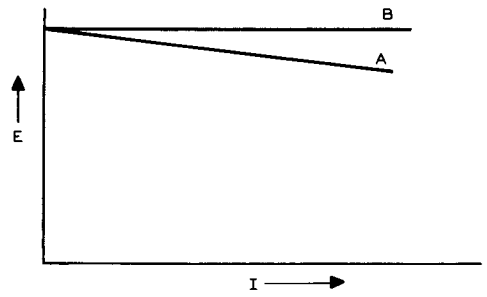


Figure 8

Figure 9 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.

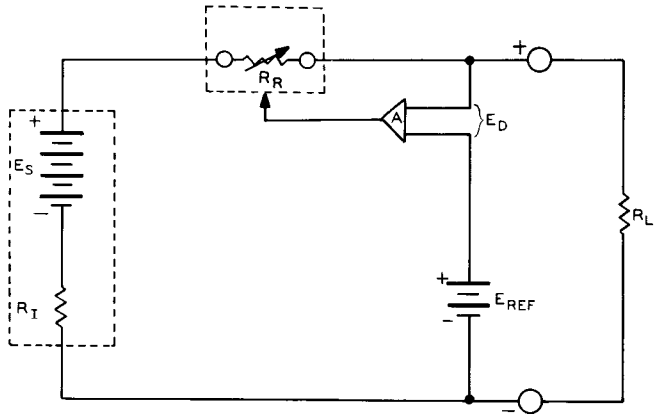


Figure 9

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 10, where the voltage remains constant for all currents up to a predetermined value and then drops, while the current remains nearly constant.

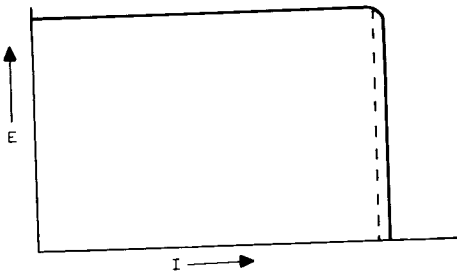


Figure 10

CIRCUIT DESCRIPTION

This Regulated Power Supply consists of four sections: the power source, the reference voltage source, regulator circuit, and the current limiter. Each of these sections will be described separately in this Circuit Description. Refer to the Schematic Diagram (fold-out from Page 31) while you read this Description.

POWER SOURCE

Transformer T1 is equipped with a dual primary winding which can be wired to operate from either a 120 VAC or a 240 VAC, 50/60 Hz power source. The primary windings are connected in parallel for 120 VAC operation and in series for 240 VAC operation.

The output voltage source consists of a full wave rectifier circuit composed of diodes D1 and D2, and a pi-type filter composed of capacitors C1 and C3, and resistor R1.

REFERENCE VOLTAGE SOURCE

The reference voltage source consists of a half-wave rectifier and filter system composed of diode *D3*, *capacitor* C2, resistor R2, and a voltage-regulating zener diode, D4. Provisions are made, through the Programming terminal strip, for the substitution of an external reference voltage source, and for the use of AC programming.

REGULATOR CIRCUIT

Transistors Q2 and Q3 are directly connected in a so-called Darlington circuit, which results in a sensitive, high-gain amplifier. They may be considered as a single high-power, high-gain transistor.

This transistor combination is driven, for voltage regulation purposes, by a voltage divider across the power source. One side of the divider is a constant current source composed of Q1 and R5 installed between the base of Q2 and the positive (+) side of the power sourc
The other side of the divider is formed by
installed between the base of Q2 and the neg
tive (-) side of the power source.

When Q4 is not turned on, the constant curre
source biases the pass transistor (Q2, Q3)
producing maximum output voltage. The re
erence voltage, between output terminal a
the base of Q4, provides base drive for
Some of the constant current from Q1 is pass
to the negative (-) side of the power sourc
leaving less drive for the pass transist
Transistor base current decreases and the
sistance (R_R) increases. A balanced condition
be reached, depending on the reference volta
The output voltage will be equal to the referer
voltage plus the base-emitter drop in

Increased current drain increases the volt
drop in R_R, lowering the drive to Q4
decreasing the diversion of the constant curr
flow through Q1. Thus, more drive is availa
for the pass transistor, lowering the voltage d
across R_R and returning the output voltage pra
cally to the original level.

CURRENT LIMITER

The current limiter is composed of transis
Q5, Current control R6, and resistor R7, wh
act in conjunction with transistors Q2 and

Transistor Q5 acts as a current sensing t
sistor. When sufficient current flows throug
and R7 to produce a voltage drop of .6 V
conducts and effectively shorts the base to
emitter of the Darlington pair (Q2, Q3), incr
ing the series resistance of Q3, and the
limiting the output current of the Supply.
point at which this happens is determined b
setting of Current control R6 which varies
resistance and thus the voltage drop bet
the base and emitter of Q5.

FUNCTIONAL PARTS LIST

R1 - Part of a low-pass filter consisting of C1, C3, and R1 that is used to smooth out the rectified DC. Also acts as a current limiter.

R2 - Part of a low-pass filter consisting of C2, D4, and R2. Also acts as a voltage dropping resistor for D4.

R3, R4 - Adjustable voltage divider on output of reference voltage supply. Determines the output voltage of the Power Supply. R3 serves to limit the range of R4 (Voltage control).

R5 - Source resistor for Q1. Determines the current level in Q1.

R6, R7 - Current-limiting control and resistor. Connected in series with the output, presenting a voltage drop from the base to emitter of Q5. Current limiting starts at a voltage drop of .6 volt. R7 determines the maximum current output.

R8 - Current-limiting resistor for neon lamp PL-1.

R9 - Minimum load resistor. Maintains current flow at the output at all times.

C1, C3 - Part of a low-pass filter consisting of C1, C3, and R1 that is used to smooth out the rectified DC in the main Power Supply.

C2 - Part of a low-pass filter consisting of C2, D4, and R2 that is used to smooth out the rectified DC in the reference voltage supply.

C4 - Output filter capacitor. Lowers the output impedance of the Power Supply.

D1, D2 - Silicon diodes. Connected as a full-wave rectifier for the main Power Supply.

D3 - Silicon diode. Connected as a half-wave rectifier for the reference voltage supply.

D4 - Zener diode voltage regulator for the reference voltage supply. Also simulates a capacitor in the low-pass filter consisting of C2, R2, and D4.

D5 - Germanium diode to protect Q4 against inverse base-emitter voltage.

Q1 - Field-effect transistor. Connected as a constant current source for the base of Q2.

Q2 - Driver transistor for Q3 in a Darlington circuit.

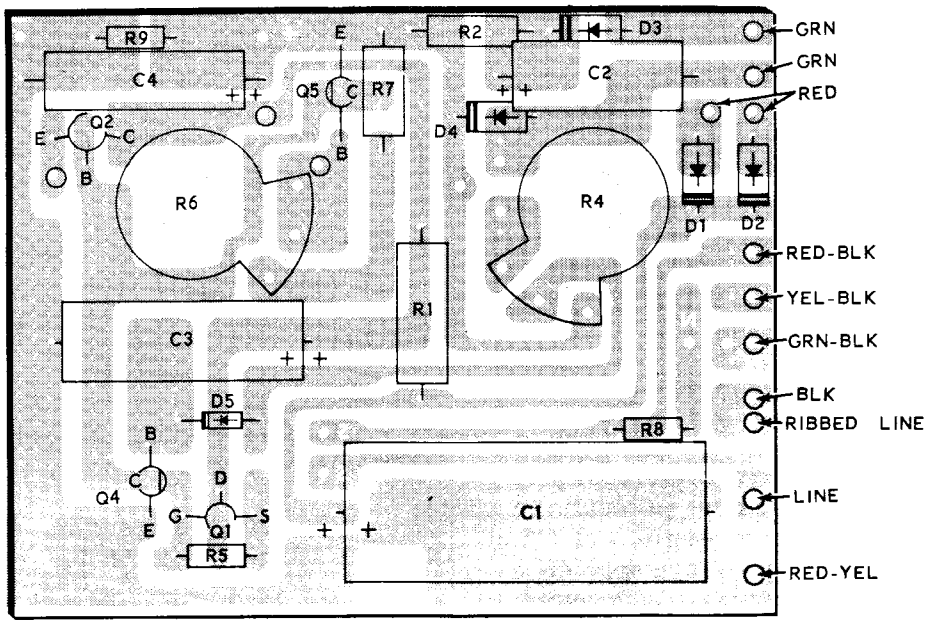
Q3 - Series regulator transistor which acts as a variable resistor to control the voltage and current output of the Power Supply.

Q4 - Error detector transistor. Senses any difference between the output voltage and the reference voltage and corrects by varying the base-bias of Q2.

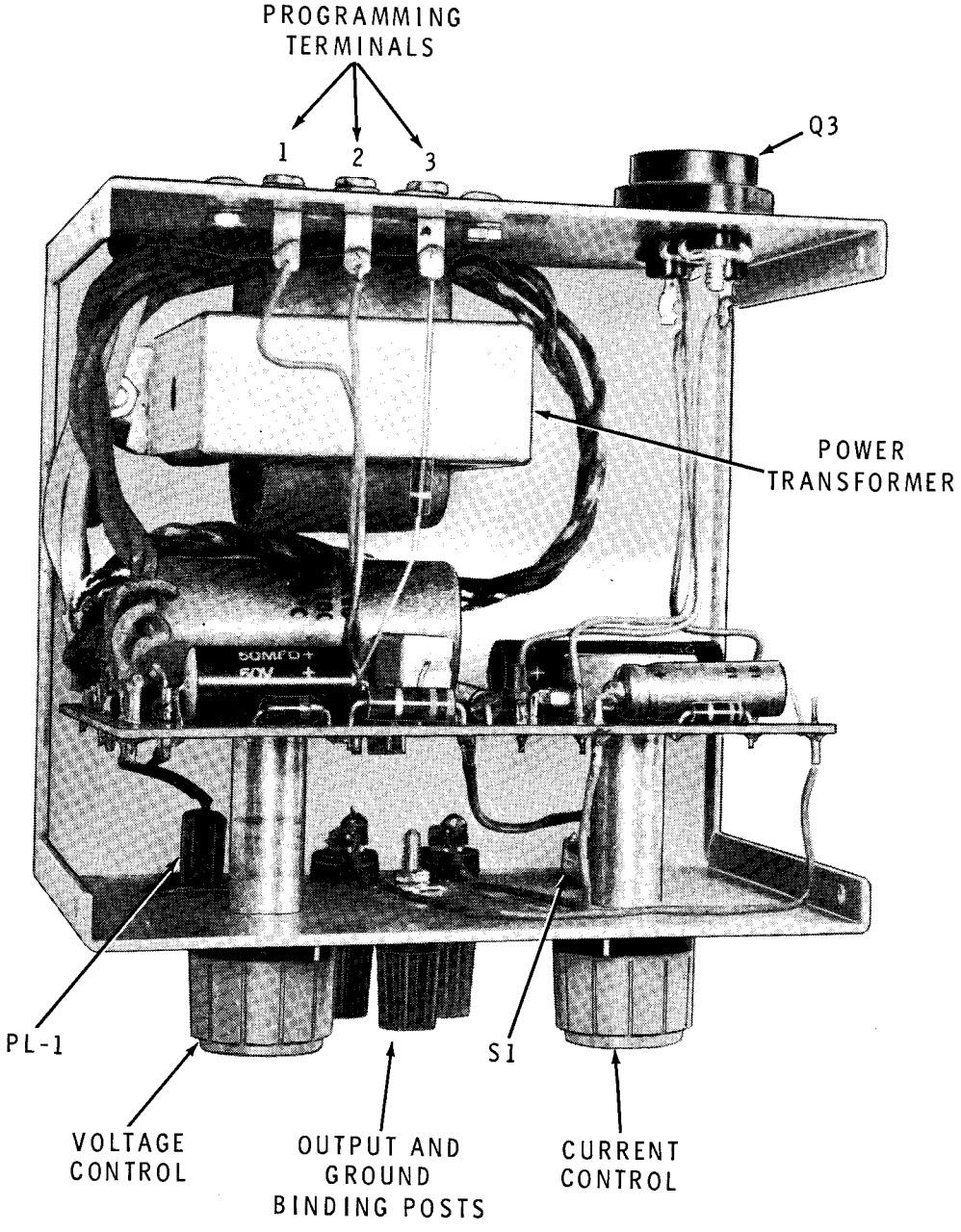
Q5 - Current sensing transistor. Conducts and switches off Q2 and Q3 when sufficient current flows through R6 and R7 to develop a voltage drop of .6 volts.

CIRCUIT BOARD X-RAY VIEW

(VIEWED FROM LETTERED SIDE)



CHASSIS PHOTOGRAPH



REPLACEMENT PARTS PRICE LIST

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

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1-9	.10	1000 Ω 1/2 watt
1-93	.10	1800 Ω 1/2 watt
1-14	.10	3300 Ω 1/2 watt
1-23	.10	27 kΩ 1/2 watt
1-3-1	.10	3300 Ω 1 watt
1-13-2	.15	220 Ω 2 watt
3-6-2	.25	.51 Ω 2 watt (same size as 1 watt)
3-20-5	.15	5 Ω 5 watt
CONTROLS		
10-250	.90	100 Ω
10-249	.65	5000 Ω
ELECTROLYTIC CAPACITORS		
25-126	.50	50 μF
25-146	.45	100 μF
25-202	.60	250 μF
25-154	1.35	2500 μF
DIODES-TRANSISTORS-LAMP		
56-26	.25	Germanium diode
57-29	.40	Silicon diode
56-45	1.00	Zener diode
417-109	.55	2N3566 transistor
417-118	.40	2N3393 transistor
417-140	1.50	Field-effect transistor (FET)
417-162	2.10	Power transistor
412-15	.20	NE-2H neon lamp

PART No.	PRICE Each	DESCRIPTION
HARDWARE		
#6 Hardware		
250-56	.05	6-32 x 1/4" screw
250-26	.05	6-32 x 5/8" screw
250-8	.05	#6 x 3/8" sheet metal screw
252-3	.05	6-32 nut
254-1	.05	#6 lockwasher
259-1	.05	#6 solder lug
254-27	.05	#6 internal-external lockwasher
#8 Hardware		
250-137	.05	8-32 x 3/8" screw
252-4	.05	8-32 nut
254-2	.05	#8 lockwasher (1 spare)
259-2	.05	#8 solder lug
Other Hardware		
259-25	.05	Double solder lug
252-32	.05	Speednut
252-7	.05	Control nut
253-10	.05	Control flat washer
255-1	.05	1/8" spacer
255-74	.05	1/16" spacer
255-89	.35	Control spacer

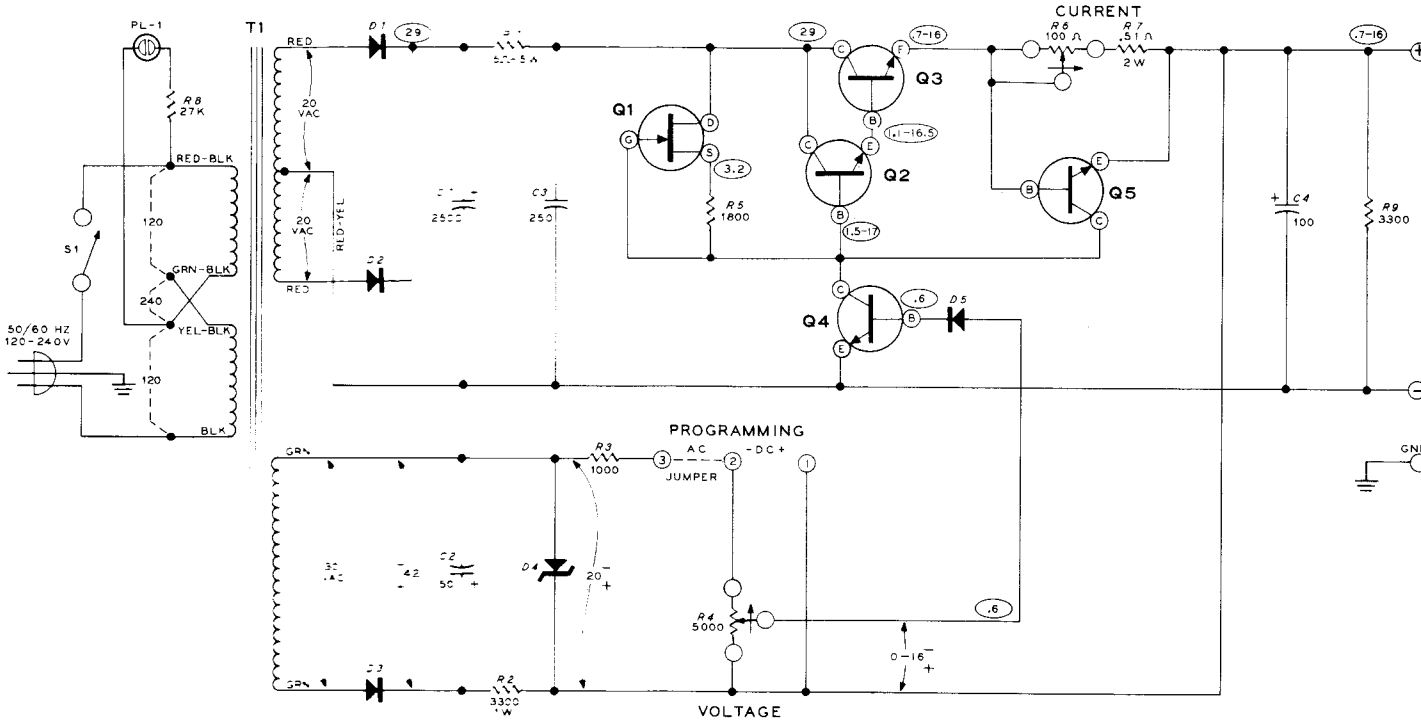
MISCELLANEOUS

PART No.	PRICE Each	DESCRIPTION
54-212	4.30	Power transformer
60-1	.20	Slide switch
75-17	.10	Binding post bushing
427-3	.10	Binding post base
100-16-2	.10	Black binding post cap
100-16-18	.10	Red binding post cap
100-699	.15	Green binding post cap
75-30	.10	Strain relief (round cord)
75-71	.10	Strain relief (flat cord)
75-60	.10	Mica insulator
75-88	.10	Transistor case insulator
434-117	.20	Transistor socket
85-259-1	.75	Circuit board
204-9	.10	L bracket
259-20	.05	Solder pins

Miscellaneous (cont'd.)

PART No.	PRICE Each	DESCRIPTION
431-8	.10	Terminal strip (3-lug screw type)
413-10	.10	Neon lamp lens
455-50	.10	Knob bushing
462-245	.25	Knob
261-29	.05	Plastic foot
90-402-1	.95	Top cabinet shell
90-403	1.20	Bottom cabinet shell
344-56	.05/ft	Blue wire
89-23	.75	Line cord
432-27	.40	Line cord adapter
331-6	.15	Solder
490-5	.10	Nut starter
490-19	.40	End wrench, 1/4"
	2.00	Manual (See front cover for part number.)

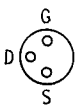
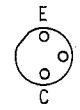
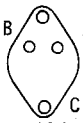
To order parts, use the Parts Order Form furnished with this kit. If Parts Order Form is not available, refer to Replacement Parts in the Kit Builders Guide.

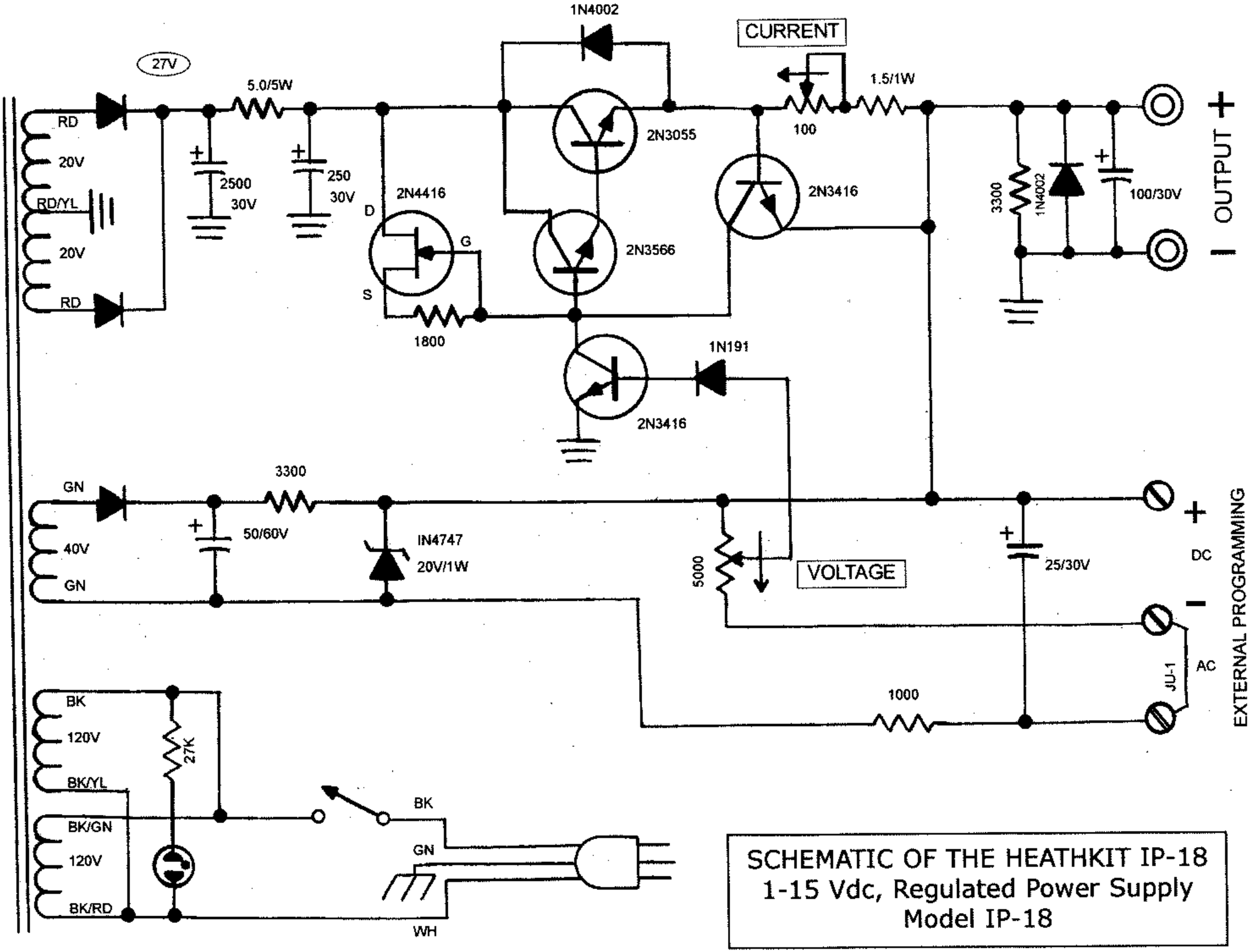


NOTES:

1. ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE MARKED.
2. ALL CAPACITORS ARE IN μF.
3. ⬭ INDICATES A DC VOLTAGE MEASUREMENT FROM POINT INDICATED TO NEGATIVE (-) OUTPUT TERMINAL. WHERE TWO VOLTAGES ARE SHOWN, THE VOLTAGE PRESENT DEPENDS UPON THE SETTING OF THE VOLTAGE CONTROL.
4. ALL VOLTAGES WERE MEASURED WITH NO LOAD ON THE OUTPUT TERMINALS AT 117 VAC 60 Hz INPUT.
5. VOLTAGE MEASUREMENTS WERE MADE WITH AN 11 MEGOHM INPUT VOLTMETER AND MAY VARY ±10%.
6. ARROWS ON CONTROLS INDICATE CLOCKWISE ROTATION.

SCHEMATIC OF THE HEATHKIT®
1-15 VDC REGULATED POWER SUPPLY
MODEL IP-18

PART NO.	COMPONENT	MAY BE REPLACED WITH	BASE DIAGRAM
417-140	Q1	2N4304	
417-109	Q2	2N3566	
417-162	Q3	2N3055	
417-118	Q4, Q5	2N3393	
57-29	D1, D2, D3	SILICON, 100 PIV, 750 MA	
56-45	D4	SARKES VR20, 1WATT	
56-26	D5	1N191	
412-15	PL-1	NE2H	



SCHEMATIC OF THE HEATHKIT IP-18
1-15 Vdc, Regulated Power Supply
Model IP-18