

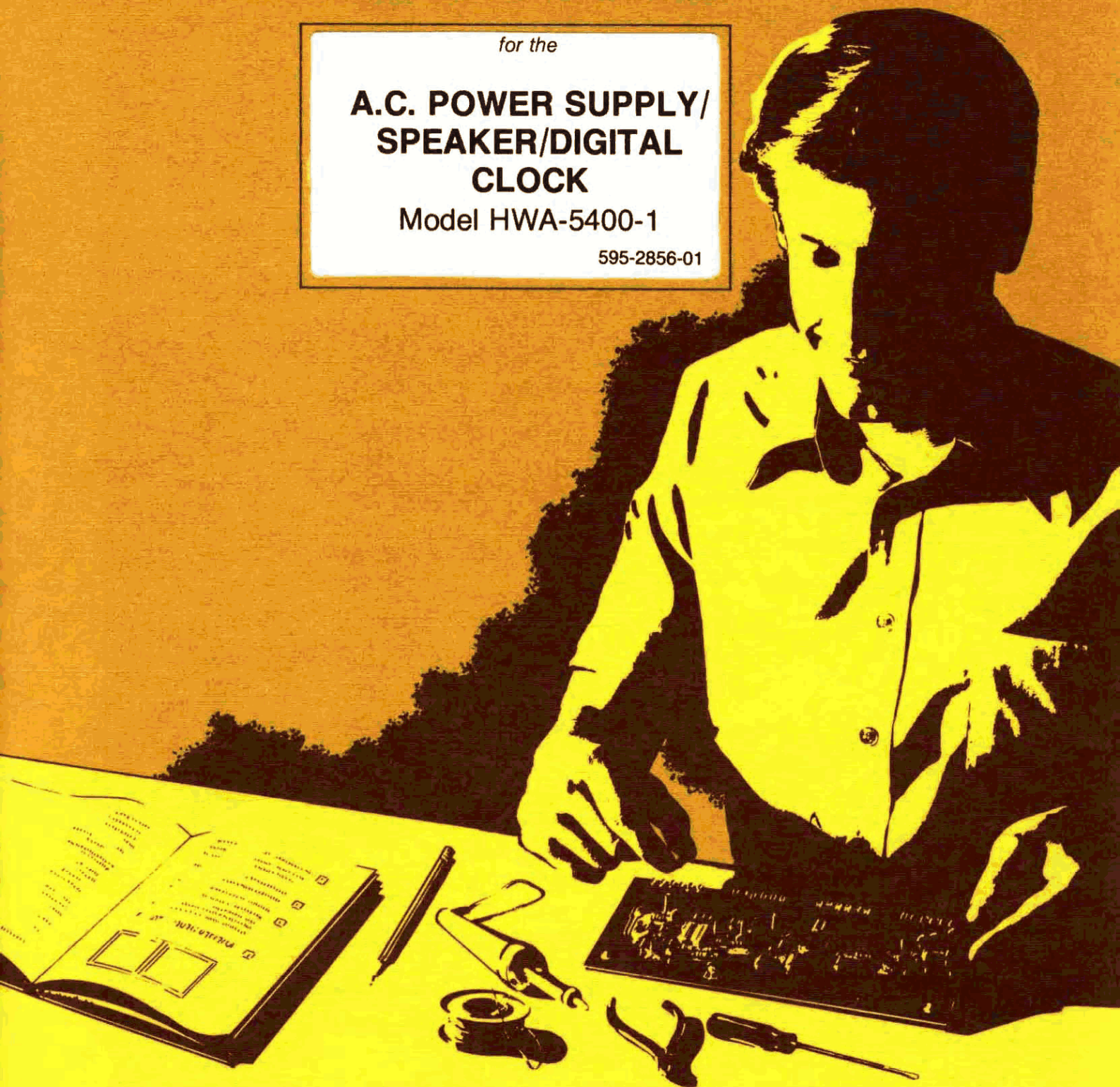
# HEATHKIT<sup>®</sup> MANUAL

*for the*

## A.C. POWER SUPPLY/ SPEAKER/DIGITAL CLOCK

Model HWA-5400-1

595-2856-01



HEATH COMPANY • BENTON HARBOR, MICHIGAN



## HEATH COMPANY PHONE DIRECTORY

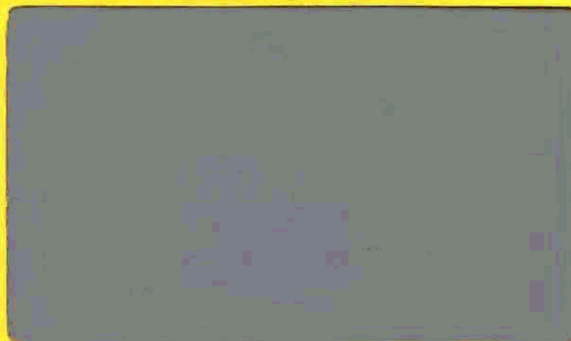
The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information ..... (616) 982-3411  
Credit ..... (616) 982-3561  
Replacement Parts ..... (616) 982-3571

### Technical Assistance Phone Numbers

8:00 A.M. to 12 P.M. and 1:00 P.M. to 4:30 P.M., EST, Weekdays Only

R/C, Audio, and Electronic Organs ..... (616) 982-3310  
Amateur Radio ..... (616) 982-3296  
Test Equipment, Weather Instruments and  
Home Clocks ..... (616) 982-3315  
Television ..... (616) 982-3307  
Aircraft, Marine, Security, Scanners, Automotive,  
Appliances and General Products ..... (616) 982-3496  
Computers — Hardware ..... (616) 982-3309  
Computers — Software:  
Operating Systems, Languages, Utilities ..... (616) 982-3860  
Application Programs ..... (616) 982-3884  
Heath Craft Wood Works ..... (616) 982-3423



## YOUR HEATHKIT 90-DAY LIMITED WARRANTY

### Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

#### Heath's Responsibility

**PARTS** — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

**SERVICE LABOR** — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic Center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

**TECHNICAL CONSULTATION** — You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

**NOT COVERED** — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component, will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORSEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

#### Owner's Responsibility

**EFFECTIVE WARRANTY DATE** — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

**ASSEMBLY** — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

**ACCESSORY EQUIPMENT** — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

**SHIPPING UNITS** — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

# **Heathkit® Manual**

*for the*

## **A.C. POWER SUPPLY/ SPEAKER/DIGITAL CLOCK**

**Model HWA-5400-1**

**595-2856-01**

**HEATH COMPANY  
BENTON HARBOR, MICHIGAN 49022**

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## INTRODUCTION

The Heathkit AC Power Supply/Speaker/Digital Clock, Model HWA-5400-1 provides a well-regulated, low-voltage source of DC power. Although it was designed to provide a 13.8-volt DC source for the HW-5400 Transceiver, you can also use it with similar units. Two cables supply the correct DC voltages to the Transceiver, speaker input to the Supply, a memory voltage, a sensor line for regulation, and remote on-off switching.

This Power Supply is designed to operate from 120- or 240-volt AC sources at either 50 or 60 Hz. During

assembly, you will install jumper wires for the correct line voltage.

An easy-to-read vacuum-tube fluorescent clock display that has line-frequency accuracy is included on the front panel. The clock has integrated circuit reliability and can be wired for either a 12- or 24-hour format.

The attractive, rugged construction and reliable performance of this Power Supply will guarantee you many years of dependable service.

## UNPACKING INSTRUCTIONS

This kit is packed in a shipping carton which has been divided into smaller compartments. Each of the compartments contains a separately marked pack which corresponds to a separate Parts List in this Manual.

Locate and remove the three smaller packs labeled Pack #1, Pack #2, and Pack #3. The remaining parts in the shipping carton will be referred to as the "Main

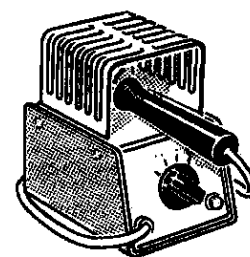
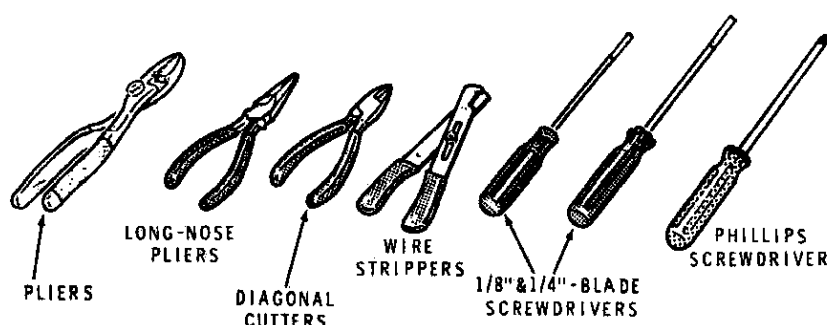
Pack." Some of the parts from the Main Pack will be used throughout the assembly of your kit.

Do not remove any parts from a Pack until you are instructed to do so. Do not discard any packing material until the kit is completed to avoid accidental loss of parts. Be sure to place small parts back in individually marked envelopes to avoid confusing them with other parts. You will begin with the Main Pack.

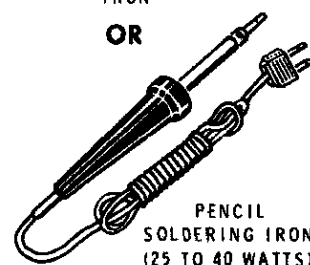
## ASSEMBLY NOTES

### TOOLS

You will need these tools to assemble your kit.



HEATHKIT  
SOLDERING  
IRON  
OR

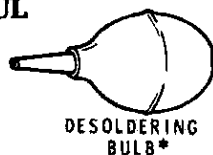


PENCIL  
SOLDERING IRON  
(25 TO 40 WATTS)

### OTHER HELPFUL TOOLS



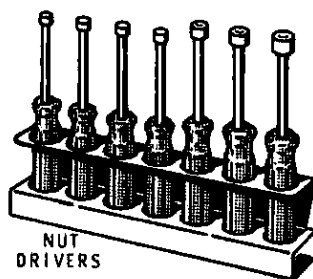
NUT STARTER  
(MAY BE SUPPLIED  
WITH KIT)



DESOLDERING  
BULB\*



DESOLDERING  
BRAID\*



NUT  
DRIVERS

\*TO REMOVE SOLDER FROM CIRCUIT CONNECTIONS.

### ASSEMBLY

- Follow the instructions carefully. Read the entire step before you perform each operation.
- The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.
- Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.
- Position all parts as shown in the Pictorials.
- Solder a part or a group of parts only when you are instructed to do so.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:
- In the Parts List,
  - At the beginning of each step where a component is installed,
  - In some illustrations,
  - In the Schematic,
  - In the section at the rear of the Manual.
7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

**SAFETY WARNING:** Avoid eye injury when you cut off excessive lead lengths. Hold the leads so they cannot fly toward your eyes.

## **SOLDERING**

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

It is easy to make a good solder connection if you follow a few simple rules:

1. Use the right type of soldering iron. A 25 to 40-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best. NOTE: You may need a heavier soldering iron for some of the steps in this kit.
2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

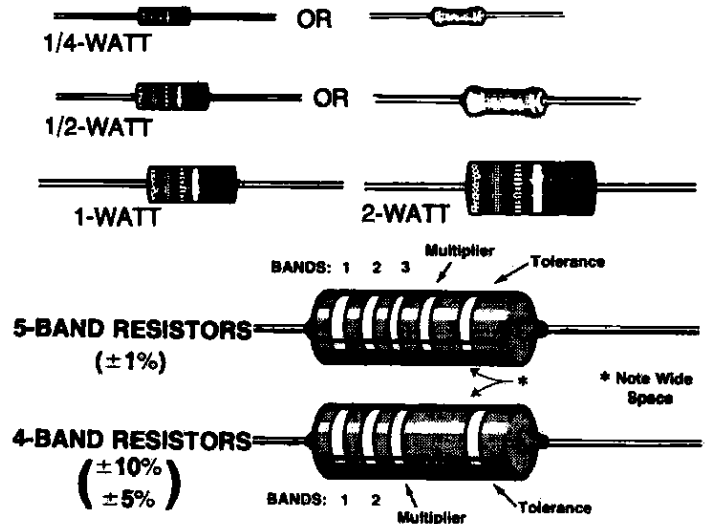
NOTE: Always use rosin core, radio-type solder (60:40 or 50:50 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.



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## PARTS

**Resistors** are identified in Parts Lists and steps by their resistance value in  $\Omega$  (ohms),  $k\Omega$  (kilohms), or  $M\Omega$  (megohms). They are usually identified by a color code and four or five color bands, where each color represents a number. These colors (except for the last band, which indicates a resistor's "tolerance") will be given in the steps in their proper order. Therefore, the following color code is given for information only. NOTE: Occasionally, a "precision" or "power" resistor may have the value stamped on it.



Band 1 1st Digit		Band 2 2nd Digit		Band 3 (if used) 3rd Digit		Multiplier		Resistance Tolerance	
Color	Digit	Color	Digit	Color	Digit	Color	Multiplier	Color	Tolerance
Black	0	Black	0	Black	0	Black	1	Silver	$\pm 10\%$
Brown	1	Brown	1	Brown	1	Brown	10	Gold	$\pm 5\%$
Red	2	Red	2	Red	2	Red	100	Brown	$\pm 1\%$
Orange	3	Orange	3	Orange	3	Orange	1,000		
Yellow	4	Yellow	4	Yellow	4	Yellow	10,000		
Green	5	Green	5	Green	5	Green	100,000		
Blue	6	Blue	6	Blue	6	Blue	1,000,000		
Violet	7	Violet	7	Violet	7	Silver	0.01		
Gray	8	Gray	8	Gray	8	Gold	0.1		
White	9	White	9	White	9				

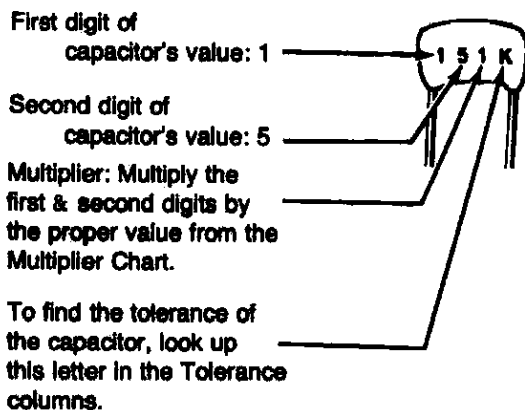
**Capacitors** will be called out by their capacitance value in  $\mu F$  (microfarads) or  $pF$  (picofarads) and type: ceramic, Mylar\*, electrolytic, etc. Some capacitors may have their value printed in the following manner:

### EXAMPLES:

$$151K = 15 \times 10 = 150 pF$$

$$759 = 75 \times 0.1 = 7.5 pF$$

NOTE: The letter "R" may be used at times to signify a decimal point: as in:  $2R2 = 2.2 (pF \text{ or } \mu F)$ .



MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10 pF OR LESS	LETTER	OVER 10 pF
0	1	$\pm 0.1 pF$	B	
1	10	$\pm 0.25 pF$	C	
2	100	$\pm 0.5 pF$	D	
3	1000	$\pm 1.0 pF$	F	$\pm 1\%$
4	10,000	$\pm 2.0 pF$	G	$\pm 2\%$
5	100,000		H	$\pm 3\%$
			J	$\pm 5\%$
8	0.01		K	$\pm 10\%$
9	0.1		M	$\pm 20\%$

\*DuPont Registered Trademark

# CHASSIS

## PARTS LIST

Unpack the Main Pack and check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until all the parts are accounted for.

The key numbers correspond to the numbers on the "Parts Pictorial" on Pages 1 and 2 in the "Illustration Booklet".

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of this Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
------------	-------------------	------	-------------	----------------------

### ELECTRONIC PARTS

A1	3-15-5	1	75 Ω, 5-watt wire-wound resistor	Test
A2	21-176	4	.01 μF ceramic capacitor	C1 thru C4
A3	25-841	1	20000 μF electrolytic capacitor	C5
A4	54-996	1	Power Transformer	T1
A5	57-88	1	Bridge rectifier	BR1
A6	69-103	1	Relay	K1
A7	401-187	1	Speaker	
A8	421-18	1	20-ampere fuse	F1

NOTE: Transistors may be marked for identification in any one of the following four ways:

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

A9	417-203	1	TA7311 transistor	Q1
A10	417-254	2	MJ802 transistor	Q301, Q302

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
------------	-------------------	------	-------------

### METAL PARTS

B1	90-1287-1	1	Cabinet top
B2	90-1288-1	1	Cabinet bottom
B3	200-1411	1	Chassis
B4	203-2110-1	1	Front panel
B5	203-2111-1	1	Rear panel
B6	204-2580	1	Display bracket
B7	204-2581	1	Left support bracket
B8	204-2582	1	Right support bracket
B9	204-2583	2	Transformer bracket
B10	207-2	1	Capacitor bracket
B11	215-44	1	Small heat sink
B12	215-666	1	Large heat sink

### PLASTIC PARTS

C1	94-629	1	Speaker baffle
C2	209-93-1	1	Perforated grille
C3	210-131	1	Bezel
C4	448-733	1	Escutcheon
C5	448-735	1	Window

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KEY No.	HEATH Part No.	QTY.	DESCRIPTION
---------	----------------	------	-------------

## INSULATORS

D1	75-736	1	Small strain relief
D2	75-123	1	Large strain relief
D3	75-44	2	Mica insulator
D4	75-704	1	Small transistor insulator
D5	75-88	2	Transistor cover
D6	73-43	1	Plastic grommet

## WIRE-CABLE-SLEEVING

89-54	1	Line cord
340-3	3-3/4"	Bare wire
343-12	93"	Small shielded cable

NOTE: The following wires are all stranded unless the description says otherwise.

344-2	15"	Large black wire
344-15	9"	Medium black wire
344-16	57"	Medium red wire
344-32	27"	Large green wire
344-54	6"	Yellow wire (solid)
344-81	60"	Medium violet wire
344-91	18"	Small brown wire
344-92	18"	Small red wire
344-93	18"	Small orange wire
344-96	6"	Small blue wire
344-97	6"	Small violet wire
344-98	6"	Small gray wire
344-155	15"	Medium green wire
346-46	12"	Heat-shrinkable sleeving
347-85	36"	Flat 4-wire cable

## HARDWARE

### #4 Hardware

E1	250-1415	1	4-40 × 3/8" screw
E2	252-99	1	4-40 nut
E3	253-198	1	Nylon shoulder washer
E4	254-34	1	#4 lockwasher

### #6 Hardware

F1	250-1428	27	6-32 × 1/4" screw
F2	250-1419	12	6-32 × 1/4" flat head screw
F3	250-270	4	6-32 × 3/8" black screw
F4	250-1429	4	6-32 × 3/8" screw
F5	250-1430	5	6-32 × 1/2" screw
F6	250-1424	4	6-32 × 1/2" flat head screw

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
---------	----------------	------	-------------

## #6 Hardware (Cont'd.)

F7	250-1426	5	6-32 × 3/4" screw
F8	250-79	2	6-32 × 1-1/4" screw
F9	252-77	20	6-32 nut
F10	253-60	12	#6 flat washer
F11	254-33	44	#6 lockwasher
F12	259-1	3	#6 solder lug

## Other Hardware

G1	250-585	4	8-32 × 1/2" screw
G2	250-1256	2	10-32 × 1/4" screw
G3	252-78	4	8-32 nut
G4	252-188	2	Push-on nut
G5	253-45	8	#8 flat washer
G6	254-2	4	#8 lockwasher
G7	259-26	2	#10 solder lug

## SPACERS

H1	255-1	4	1/8" spacer
H2	255-103	5	11/32" spacer
H3	255-21	4	7/8" spacer
H4	255-59	2	Tapered spacer

## CONNECTORS-SOCKETS

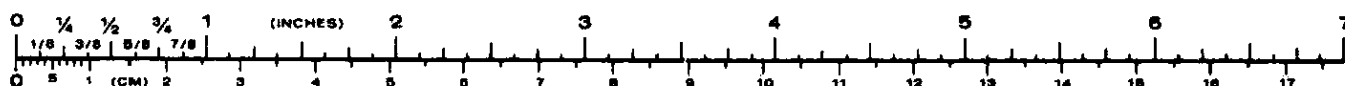
J1	432-836	1	6-pin socket
J2	432-837	1	6-pin plug
J3	432-854	6	Male connector pin
J4	432-855	6	Female connector pin
J5	434-189	2	Transistor socket

## MISCELLANEOUS

	74-34	1	1/2" × 4" double-sided tape (on cardboard backing)
	209-94	1	2-3/4" × 8" grille cloth
K1	261-9	4	Foot
K2	352-31	1	Thermal compound
K3	423-2	1	Fuseholder
K4	490-5	1	Nut starter
			Solder

## PRINTED MATERIALS

K5	390-1255	2	Fuse label
K6	390-2069	1	"Heathkit" label
K7		1	Blue and white label
	597-260	1	Parts Order Form
		1	Assembly Manual (See title page for part number.)



## STEP-BY-STEP ASSEMBLY

### MAIN CHASSIS ASSEMBLY

Refer to Pictorial 1-1 (Illustration Booklet, Page 3) for the following steps.

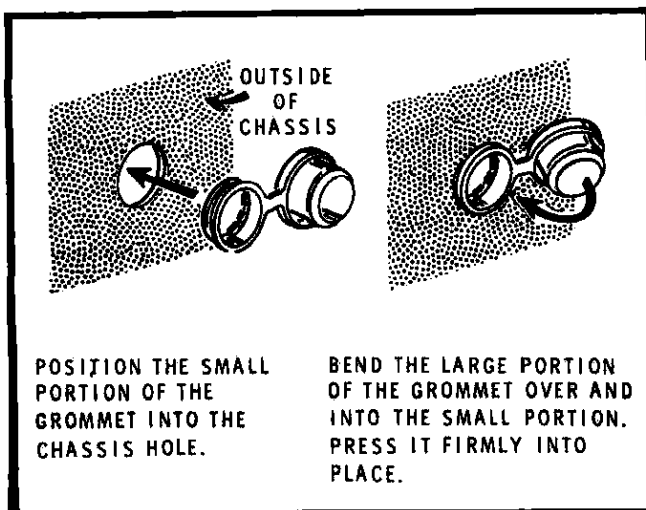
#### NOTES:

1. Use the plastic nut starter to pick up and start 4-40 and 6-32 nuts on screws.
2. When hardware is called for in a step, only the screw size will be given. For instance, if 6-32  $\times$  1/4" hardware is called for, use a 6-32  $\times$  1/4" screw, one or more #6 lockwashers, and a 6-32 nut. The Pictorial or Detail will show the number of lockwashers to use.

- ( ) Position the chassis as shown in the Pictorial.
- ( ) Refer to Detail 1-1A and mount two solder lugs on the chassis at A. Use 6-32  $\times$  1/4" hardware. Position the solder lugs as shown in the Pictorial.

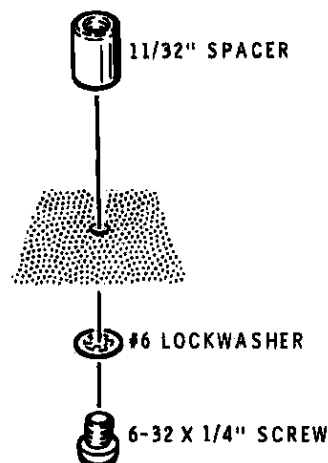


**Detail 1-1A**



**Detail 1-1B**

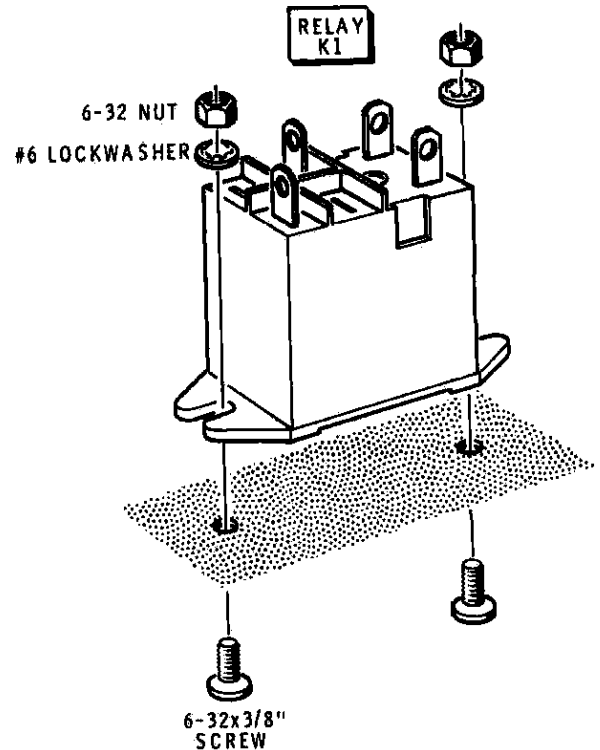
- ( ) In the same manner, mount one solder lug on the chassis at B.
- ( ) Refer to Detail 1-1B and install a plastic grommet in chassis hole C.
- ( ) Refer to Detail 1-1C and mount an 11/32" spacer on the chassis at D with 6-32  $\times$  1/4" hardware. Tighten the hardware finger tight.



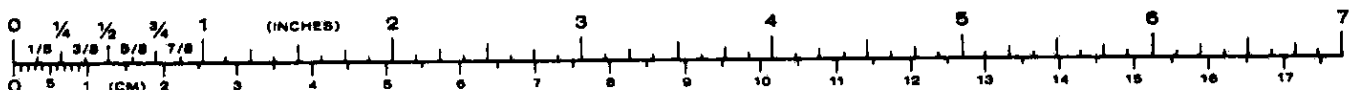
**Detail 1-1C**

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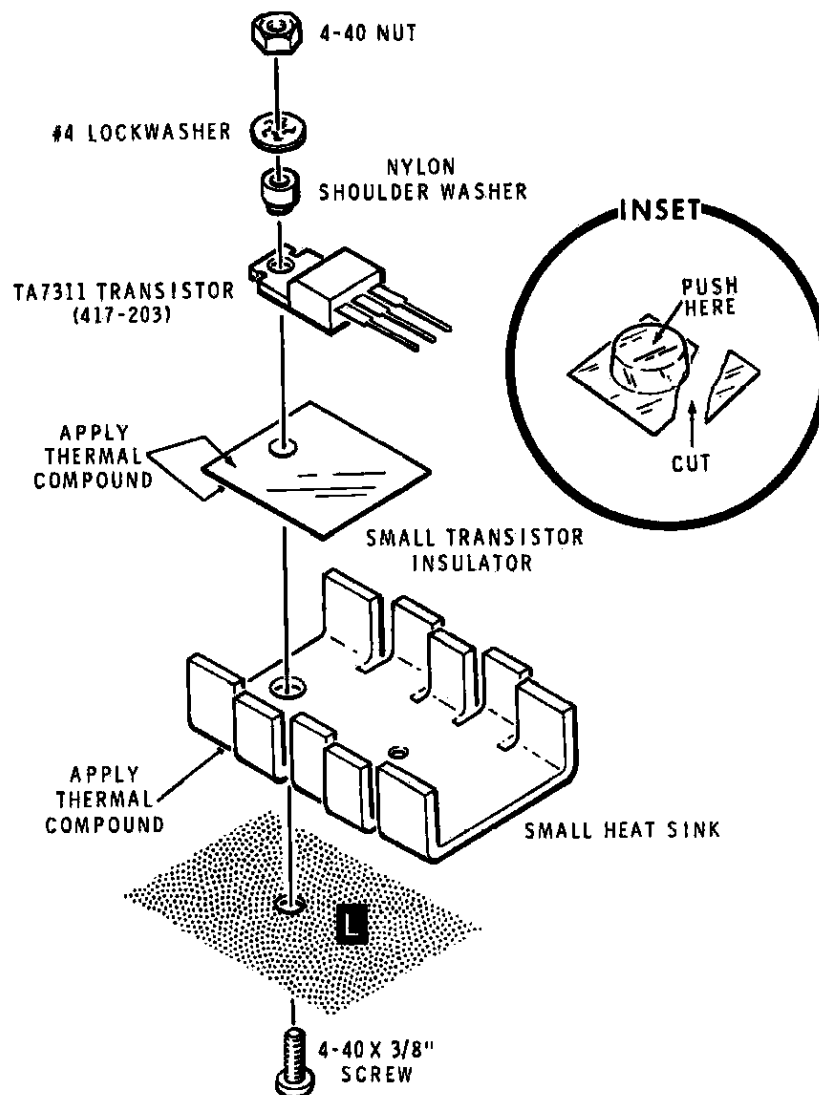
- ( ) In the same manner, mount three more 11/32" spacers at E, F, and G. Tighten the hardware finger tight.
- ( ) Locate one of the fuse labels and, if you are going to use **120-VAC**, write "(F102) 7A, 3AG, Slow-Blow" on the label in the space provided. If you are going to use **240-VAC**, write "(F102) 4A, 3AG, Slow-Blow."
- ( ) Label the second fuse label as follows: For **120-VAC**, write "(F101) 1/2A, 3AG, Slow-Blow"; for **240-VAC**, write "(F101) 1/4A, 3AG, Slow-Blow."
- ( ) Remove the paper backing from the fuse labels and press the labels in place along the inside edge of the chassis as shown in the Pictorial.
- ( ) K1: Refer to Detail 1-1D and mount the relay onto the chassis at K1 with 6-32 × 3/8" hardware. Position the relay lugs as shown in the Pictorial.



**Detail 1-1D**





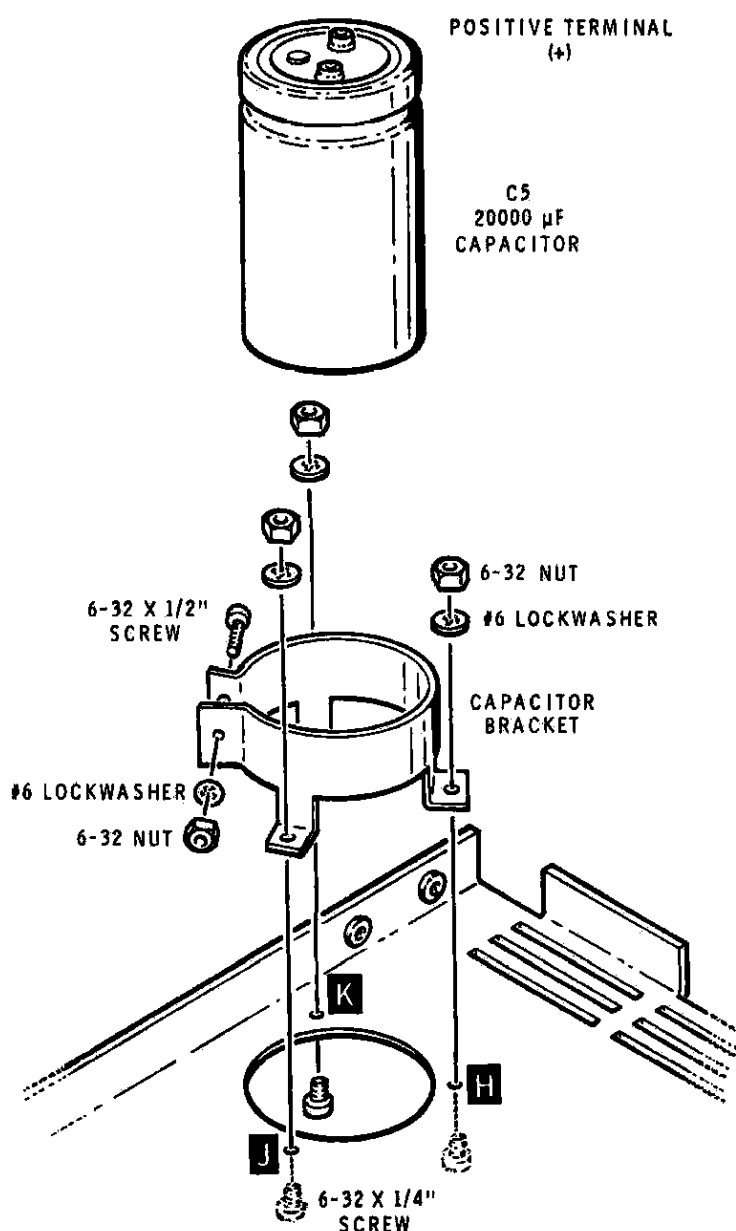


Detail 1-1E

Refer to Detail 1-1E for the next three steps.

**WARNING:** You will be using Dow Corning 340 thermal heat sink compound in the next step and in other steps in this Manual. Although the compound is not caustic, it may cause temporary discomfort if it gets into your eyes. If this happens, rinse your eyes with warm water. If the compound gets into your clothing, the clothing may require professional cleaning. The compound contains zinc oxides, SiO<sub>2</sub>, and slight traces of CO<sub>2</sub>.

- ( ) Refer to the inset drawing on Detail 1-1E and open the thermal compound pod. Spread a thin layer of thermal compound on the back of the small heat sink. Then position the heat sink on the chassis at Q1 and line up the upper heat sink hole with chassis hole L.
- ( ) Lightly coat both sides of the small transistor insulator with thermal compound and place the insulator on the small heat sink at Q1 as shown in the Detail. Save the remaining thermal compound.
- ( ) Q1: Secure a TA7311 transistor (#417-203) to the chassis and to the small heat sink at Q1 with a 4-40 X 3/8" screw, a nylon shoulder washer, a #4 lockwasher, and a 4-40 nut as shown in the Detail. Be sure to center the shoulder on the nylon washer into the transistor mounting hole. Position the transistor and heat sink as shown in Pictorial 1-1.



**Detail 1-1F**

Refer to Detail 1-1F for the next two steps.

- ( ) Loosely mount the capacitor bracket on the chassis at H, J, and K with 6-32  $\times$  1/4" hardware. Place a 6-32  $\times$  1/2" screw into the side tabs on the bracket. Then place a #6 lockwasher on the screw, and just start a nut onto the screw threads.

- ( ) C5: Position the 20000  $\mu$ F capacitor (#25-941) into the capacitor bracket at C5. Push the capacitor down so its bottom is even with the underside of the chassis. Tighten the side tab on the mounting clamp. Then tighten the three screws at H, J, and K. NOTE: Be sure to position the capacitor terminals as shown in Pictorial 1-1.

Refer to Detail 1-1G (Illustration Booklet, Page 3) for the next two steps.

**NOTE:** When you are instructed to prepare a stranded wire (or lead), as in the following step, cut the wire to the length indicated and remove 1/4" of insulation from each wire end. Then tightly twist the wire ends and add a small amount of solder to hold the fine strands together.

- ( ) Measuring from where they emerge from the power transformer, cut and prepare the power transformer leads as follows:

Black	6"
Black-yellow	6-1/2"
Black-green	7-1/4"
Black-red	7-1/4"

Do NOT cut the red transformer leads.

- ( ) T1: Position the power transformer onto the chassis as shown in Pictorial 1-1. Then secure the transformer and two transformer brackets to the chassis with 8-32 × 1/2" hardware, including eight #8 flat washers. Position the transformer brackets as shown. Tighten the hardware as securely as possible.

- ( ) Loosen the side screw on the C5 capacitor bracket and push the capacitor down so it is even with the bottom edges of the transformer mounting brackets. Tighten the side bracket screw.

Set the chassis assembly aside temporarily.

## FRONT PANEL ASSEMBLY

Refer to Pictorial 1-2 (Illustration Booklet, Page 4) for the following steps.

Refer to Detail 1-2A (Illustration Booklet, Page 5) for the following steps.

- ( ) Position the front panel as shown.
- ( ) Remove the backing from the two tapes on grille cloth and press one end of the cloth carefully onto one side of the front panel as shown. Then stretch the cloth so it covers the front panel slots; press the other end onto the panel.

- ( ) Position the front panel on your work surface as shown.

- ( ) Place the speaker baffle, countersunk holes down, onto the front panel. Then check and see if there is any part of the baffle edge overhanging the edge of the front panel. If so, remove the baffle and turn it end-for-end.

- ( ) Mark the indicated end of the speaker baffle as shown.

- ( ) Remove the baffle from the front panel and position it with its countersunk holes down.

- ( ) Mount the speaker onto the speaker baffle, making sure the speaker lugs are toward the marked end of the baffle. Use 6-32 × 1/2" hardware as shown in Detail 1-2A.

- ( ) Position the baffle and speaker assembly down onto the front panel, taking care to position the marked end as shown. Secure the assembly to the front panel with four #6 flat washers, four #6 lockwashers, and four 6-32 nuts.

Refer to Detail 1-2B (Illustration Booklet, Page 5) for the next three steps.

- ( ) 1. Position the escutcheon face down on your work area.

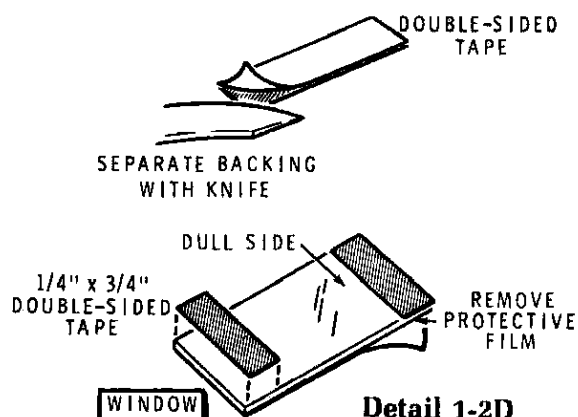
- ( ) 2. Place the perforated grille onto the escutcheon so the window cutout is over the window opening in the escutcheon.

- ( ) 3. Position the front panel assembly down onto the two escutcheon studs as shown in the Pictorial. Then secure the front panel with two press-on nuts. Use the tip of a screwdriver to make sure the nuts are seated as securely as possible.

- ( ) Cut two 3/4" pieces of double-sided tape.

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- ( ) Your window may have a thin protective film on it. If so, carefully peel this film from the window.
- ( ) From the double-sided tape, cut two  $1/4" \times 3/4"$  pieces.



- ( ) Refer to Detail 1-2D and remove the backing from one side of a  $3/4"$  piece of double-sided tape. Press the tape along one side of the window (dull side) as shown.
- ( ) In the same manner, install the other  $3/4"$  double-sided tape on the other end of the window.
- ( ) Remove the backing from the two pieces of tape on the window. Then press the window in place in the escutcheon window opening as shown in Pictorial 1-2.
- ( ) Cut a 15" length of the small shielded cable.
- ( ) Refer to Detail 1-2E and prepare the length of shielded cable in the manner shown. Be sure you do not pull the inner lead from the cable.

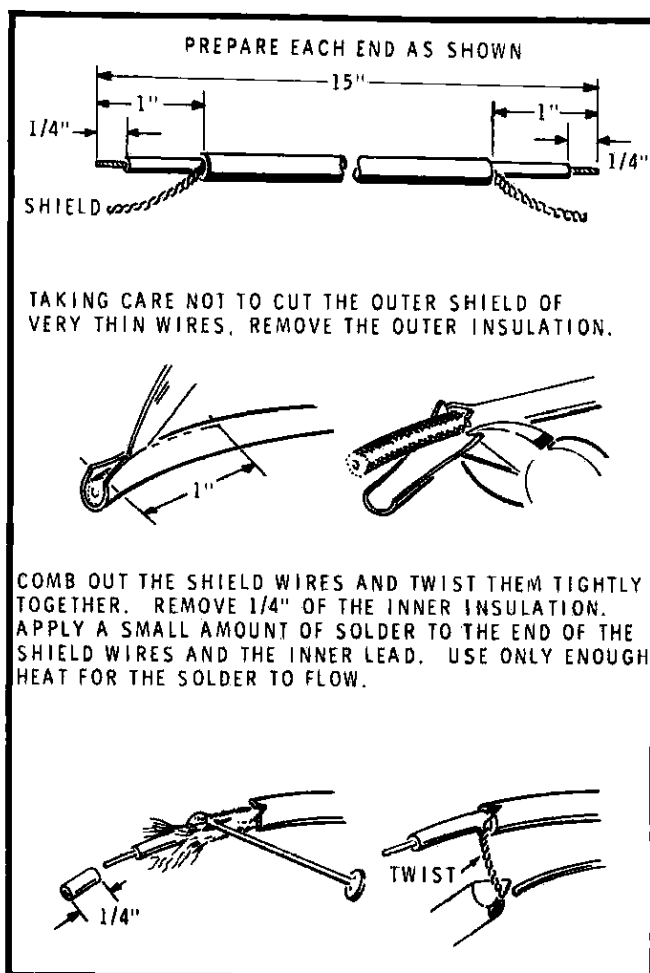
NOTE: In the following steps, (NS) means not to solder a connection because other wires will be added later. "S-" with a number, such as "(S-2)," means to solder the connection. The number following the "S" tells how many wires are at the connection.

- ( ) Connect the shielded cable inner lead to speaker lug 1 (S-1) and the shield lead to lug 2 (S-1).

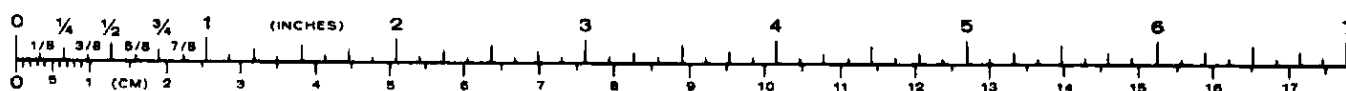
- ( ) Position the front panel assembly into the bezel as shown in the Pictorial. Be sure the cutout portion of the inner bezel flange is positioned upward. Then secure the front panel to the chassis with four 6-32  $\times 1/4"$  flat head screws.
- ( ) Route the free end of the speaker cable through chassis grommet C; it will be connected later.

NOTE: You will have a number of parts left over for further chassis assembly steps.

Set the chassis assembly aside temporarily.



Detail 1-2E



# DISPLAY CIRCUIT BOARD

## PARTS LIST

Open Pack #1 and check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until all the parts are accounted for.

The key numbers correspond to the numbers on the "Parts Pictorial" in the separate "Illustration Booklet" on Page 6.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-103-12	2	10 k $\Omega$ , 1/4-watt resistor (brn-blk-org)	R202, R203
A1	6-104-12	1	100 k $\Omega$ , 1/4-watt resistor (brn-blk-yel)	R205
A2	3-16-5	1	175 $\Omega$ , 5-watt, wire-wound resistor	R201
A3	10-312	1	10 k $\Omega$ control	
A4	21-176	1	.01 $\mu$ F ceramic capacitor	C201
A5	56-56	2	1N4149 diode	D201, D202
A6	85-2783-1	1	Display circuit board	
A7	266-986	2	Spring switch	SW201, SW202
A8	411-836	1	Display tube	V201

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
NOTE: Transistors and integrated circuits may be marked for identification in any one of the following four ways:				
1. Part number.				
2. Type number (On integrated circuits, this refers only to the numbers - the letters may be different or missing.				
3. Part number and type number.				
4. Part number with a type number other than the one listed.				
A9	417-801	1	MP5A20 transistor	Q201
A10	443-848	1	Clock IC (integrated circuit)	U201
A11	434-253	1	40-pin socket	



## STEP-BY-STEP ASSEMBLY

## CIRCUIT BOARD ASSEMBLY

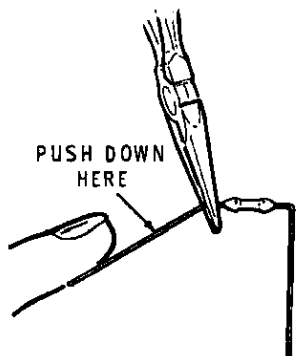
## START ➡

In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

- ( ) Position the display circuit board as shown with the printed side up.

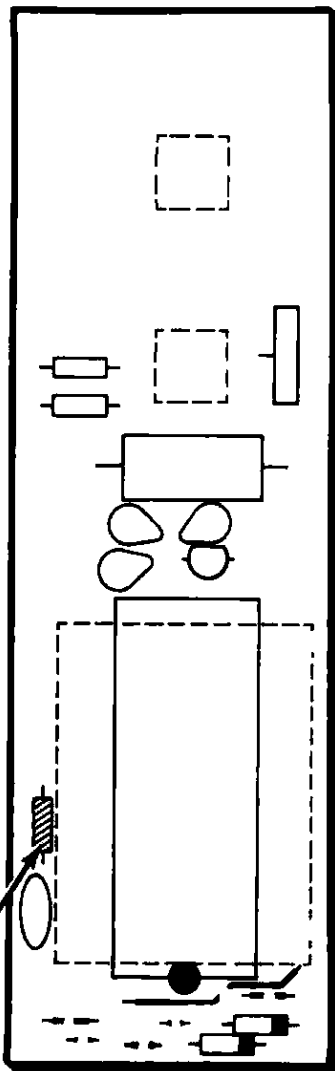
**NOTE:** When you install a component that has its value printed on it, position the value marking up, so it can be easily read. Diodes should be mounted with their type or part number up, if possible.

- ( ) Hold a 100 k $\Omega$  (brn-blk-yel) resistor with long-nose pliers and bend the leads straight down to fit the hole spacing on the circuit board.



- ( ) R205: Push the leads through the holes at the indicated location on the circuit board. The end with color bands may be positioned either way.

- ( ) Press the resistor against the circuit board. Then bend the leads outward slightly to hold the resistor in place.

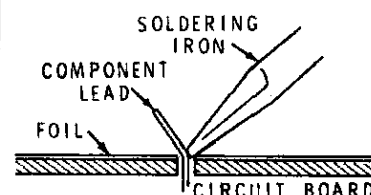


PICTORIAL 2-1

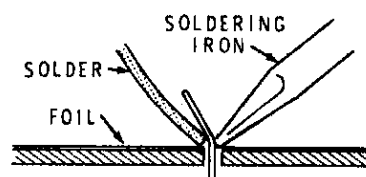
## CONTINUE ➡

- ( ) Solder the resistor leads to the circuit board as follows:

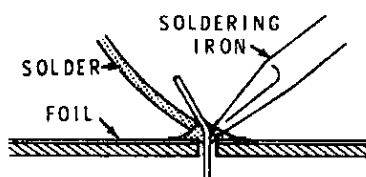
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat both for two or three seconds.



2. Then apply solder to the other side of the connection. **IMPORTANT:** Let the heated lead and the circuit board foil melt the solder.



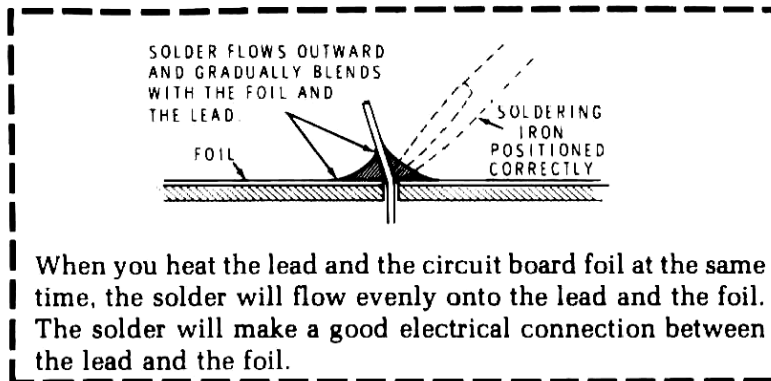
3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.



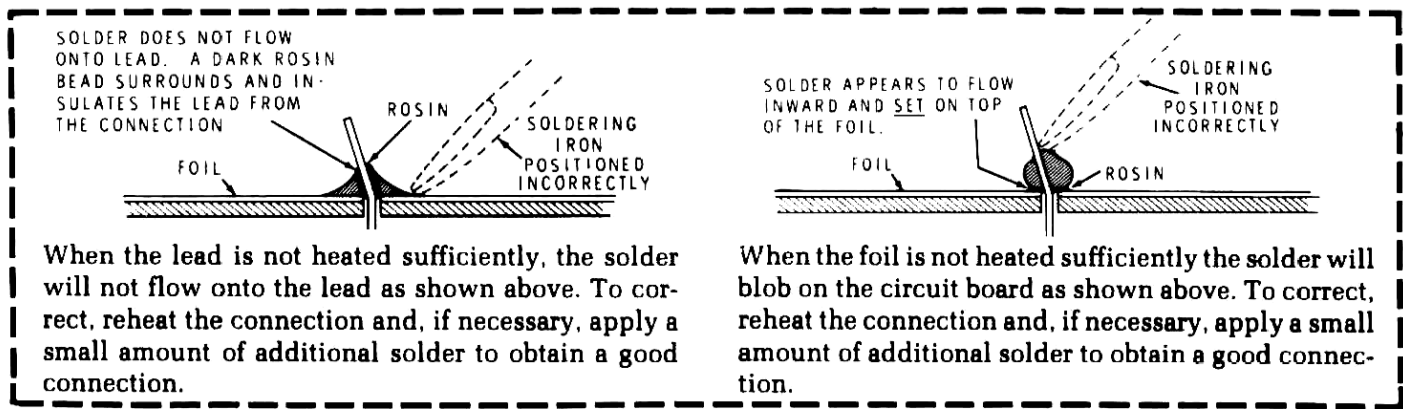
- ( ) Cut off the excess lead lengths close to the connection. **WARNING:** Clip the leads so the ends will not fly toward your eyes.

- ( ) Check each connection. Compare it to the illustrations on Page 18. After you have checked the solder connections, proceed with the assembly on Page 19. Use the same soldering procedure for each connection.

### A GOOD SOLDER CONNECTION



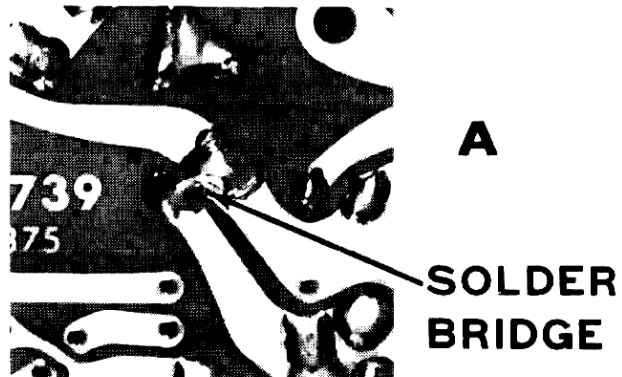
### POOR SOLDER CONNECTIONS



### SOLDER BRIDGES

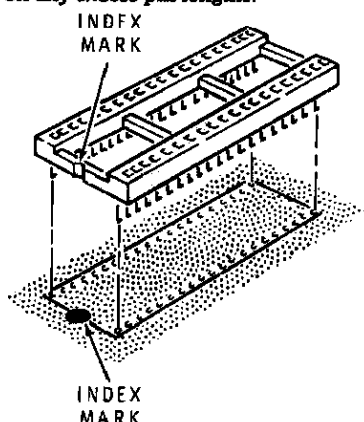
A solder bridge between two adjacent foils is shown in photograph A. Photograph B shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.

Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.



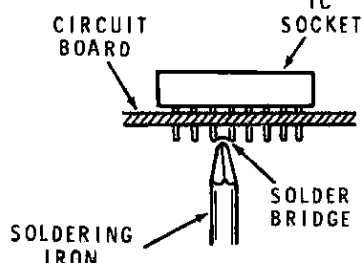
## START

**NOTE:** You will install the 40-pin IC socket in the following step. Be sure the socket pins are straight. Insert the socket pins into the holes. The index mark on the circuit board must still be visible after it is installed. Solder the pins to the foil as you install the socket and cut off any excess pin lengths.

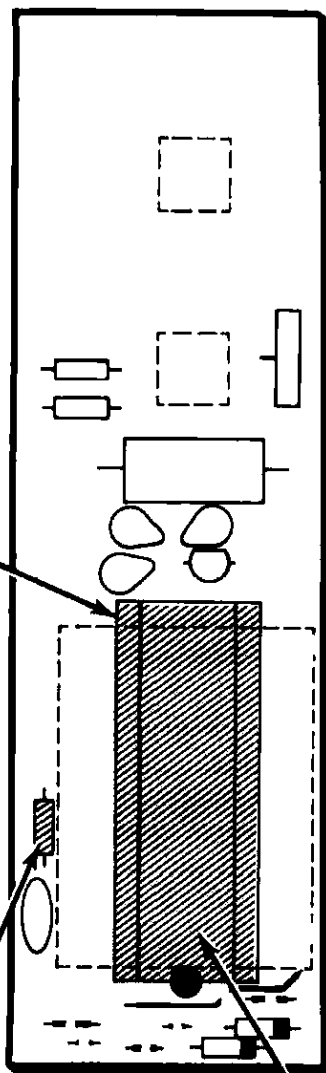


( ) 40-pin IC socket at U201.

( ) Carefully check the socket for solder bridges between pins. If a solder bridge has occurred, hold the circuit board foil-side-down as shown, and hold the soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip.



**NOTE:** Be sure you installed resistor R205 as described on Page 17.



PICTORIAL 2-2

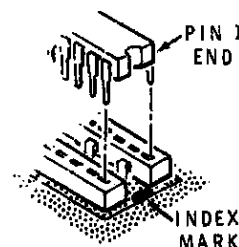
## CONTINUE

**CAUTION:** When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad, DO NOT let go of the IC. Install it as follows. Read the entire step before you pick up the IC.

1. Pick up the IC and touch the foam pad with both hands.
2. Hold the IC with one hand and remove the foam pad with the other hand.
3. Continue to hold the IC with one hand and straighten any bent pins with the other hand.
4. Pick up the circuit board in your other hand.
5. See Detail 2-2A and align the pin 1 end of the IC with the index mark on the circuit board.
6. Then push the IC pins into the IC socket. Once in the socket, the IC is protected.

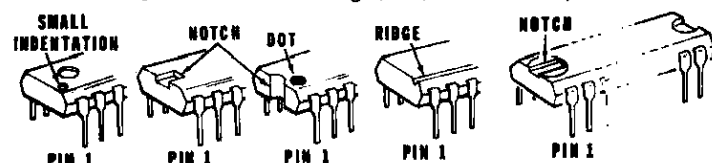
Be sure you install each IC so its pin 1 end is toward the index mark on the circuit board.

Before you apply downward pressure to an IC, make sure each pin is centered in its proper socket hole. Handle IC's with care as their pins are very easily bent.



( ) U201: Clock IC (#443-848).

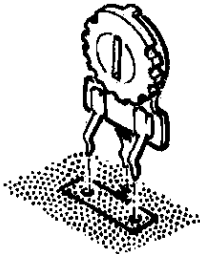
**NOTE:** The pin 1 end of the inline integrated circuits may be marked in a number of ways; with a notch, triangle, dot, the numeral 1, etc.



Detail 2-2A

**START** ➡

Install the following control as shown, and solder the lugs to the foil.



- ( ) R204: 10 k $\Omega$  control.
- ( ) R203: 10 k $\Omega$  (brn-blk-org).
- ( ) R202: 10 k $\Omega$  (brn-blk-org).
- ( ) R201: 175  $\Omega$ , 5-watt, wire-wound resistor. Position the resistor 1/16" above the top of the board.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

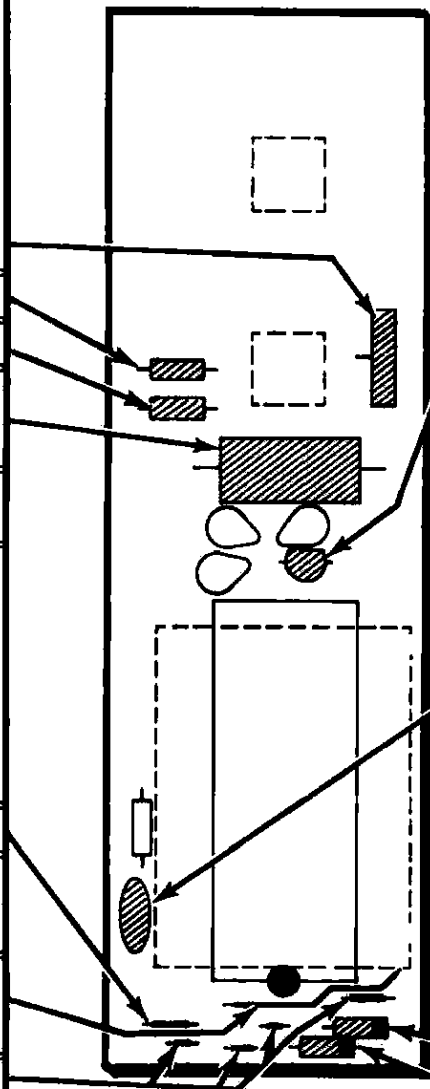
**NOTES:**

1. When a bare wire jumper is called for, remove the insulation from a piece of yellow wire.
2. Perform the next step only if your local power is 50 Hz (fifty cycles per second).

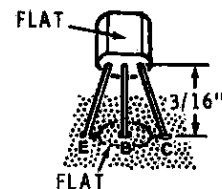
- ( ) 3/4" bare wire jumper.

**NOTE:** Perform the following steps **ONLY** if you wish to observe 24-hour time on the clock display.

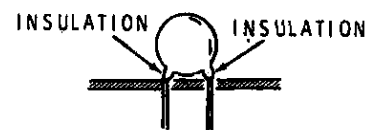
- ( ) 1-1/2" yellow wire jumper. Remove 1/4" of insulation from each wire end.
- ( ) Four 3/4" bare wire jumpers.
- ( ) Solder the wires to the foil and cut off the excess wire ends.

**PICTORIAL 2-3****CONTINUE** ➡

- ( ) Q201: MPSA20 transistor (#417-801). Line up the flat on the transistor with the outline of the flat on the circuit board and insert the leads into their corresponding holes. Solder the leads to the foil and cut off the excess lead ends.

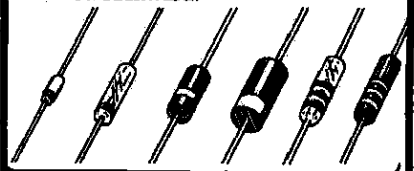


**NOTE:** When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.

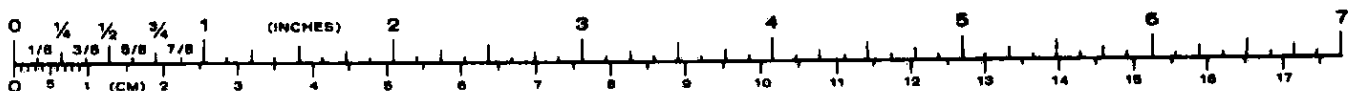


- ( ) C201: .01  $\mu$ F ceramic.

**NOTE:** When you install a diode, as in the following steps, position its banded end as shown in the Pictorial. A circuit will not operate properly if the diode is installed backward.

**BANDED END**

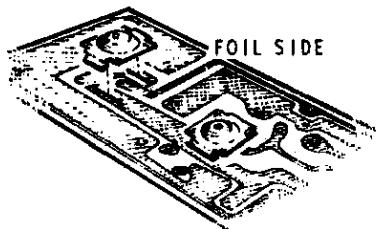
- ( ) D201: 1N4149 diode (#56-56).
- ( ) D202: 1N4149 diode (#56-56).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



## START

Turn the circuit board component side down as shown. Then proceed with the following steps.

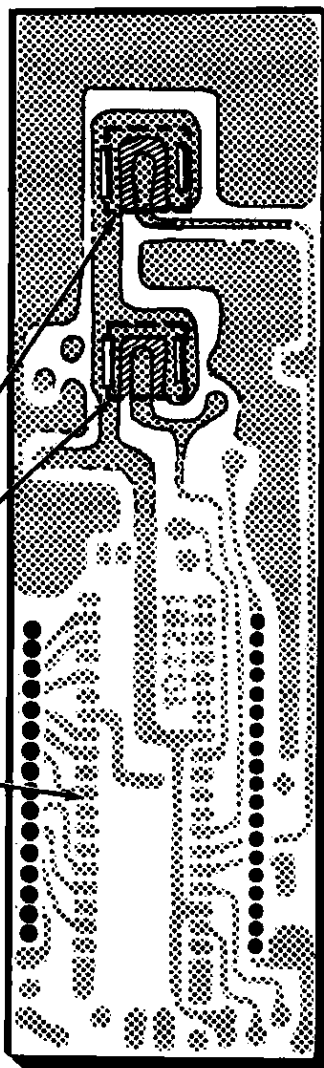
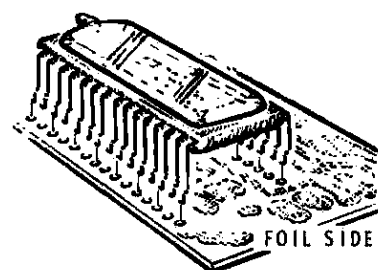
To mount a spring switch in the circuit board, position the ends of the switch into the slots; then push the switch down onto the board. Do not solder the springs to the circuit board. NOTE: If necessary, bend the spring switch tabs toward one another so the switches will not fall out when the board is inverted.



( ) Spring switch at SW202.

( ) Spring switch at SW201.

( ) V201: Position the display tube onto the circuit board as shown. Make sure all its pins are through the circuit board; then solder them to the top (printed-side) foils. NOTE: The display tube will fit correctly in the board in only one direction.



PICTORIAL 2-4

## CONTINUE

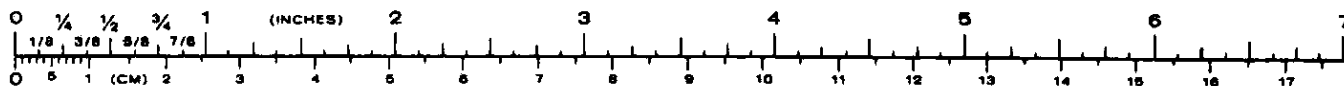
### CIRCUIT BOARD CHECKOUT

Carefully inspect the foil side of the circuit board for the following most commonly made errors.

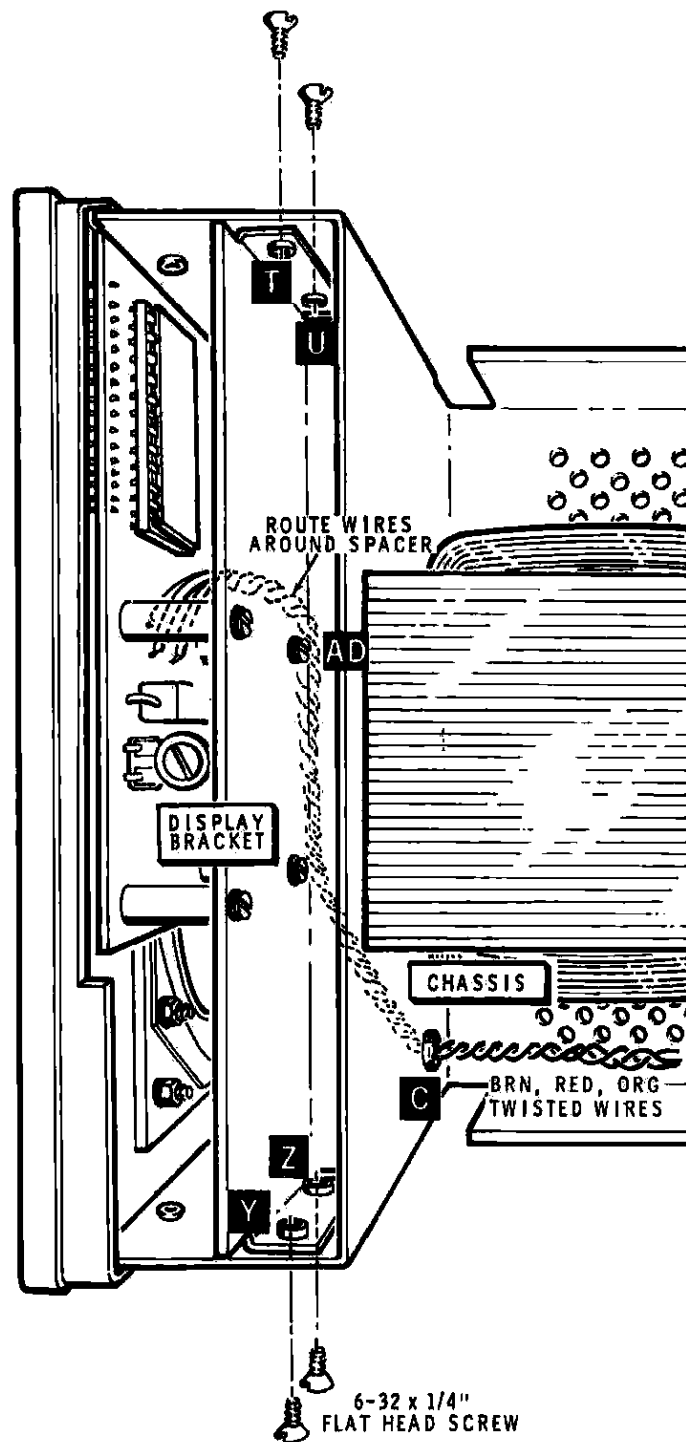
- ( ) Unsoldered connections.
- ( ) Poor solder connections.
- ( ) Solder bridges between foil patterns.
- ( ) Protruding leads which could touch together.

Refer to the illustrations where the parts were installed as you make the following visual checks.

- ( ) Transistor for proper installation.
- ( ) Integrated circuit for the proper installation.
- ( ) Display tube for the proper installation.
- ( ) Diodes for the correct position of the banded end.







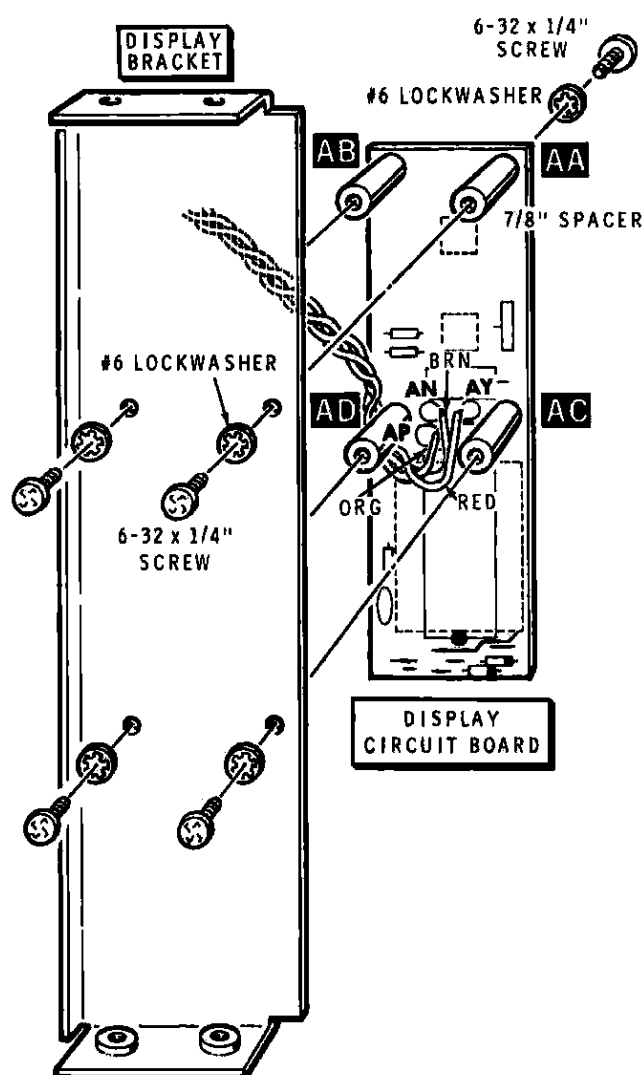
PICTORIAL 2-5

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## CIRCUIT BOARD INSTALLATION

Refer to Pictorial 2-5 for the following steps.

- ( ) In the wire pack, locate and remove the small 18" red, orange, and brown wires. Prepare one end of each of the three wires.



Detail 2-5A

Refer to Detail 2-5A for the next six steps.

NOTE: As you install the three wires in the following steps, solder the wire end to the circuit board foil and cut off the excess wire ends.

- ( ) Red wire to AY.
- ( ) Orange wire to AP.
- ( ) Brown wire to AN.
- ( ) Twist the red, orange, and brown wires about one turn per inch for their entire lengths. Cut all three wires to the length of the shortest wire; then prepare the three wire ends.
- ( ) Loosely mount a 7/8" spacer on the circuit board at AA using a #6 lockwasher and a 6-32 x 1/4" screw.
- ( ) In the same manner, install 7/8" spacers on the circuit board at AB, AC, and AD.
- ( ) Position the display circuit board spacers onto the display bracket as shown in the Detail. Then secure the spacers to the bracket with 6-32 x 1/4" screws and #6 lockwashers as shown. Tighten all eight spacer screws securely. NOTE: Be sure the edges of the circuit board and the display bracket are parallel.
- ( ) Position the display bracket into the chassis as shown in Pictorial 2-5. Then secure the bracket to the chassis at T, U, Y, and Z with 6-32 x 1/4" flat head screws.
- ( ) Route the free ends of the three small wires coming from the display circuit board around spacer AD, across the back side of the display bracket, and through chassis grommet C as shown. These free ends will be connected later.

Set the chassis assembly aside temporarily.

# REGULATOR CIRCUIT BOARD AND REAR PANEL

## PARTS LIST

Open Pack #2 and check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until all the parts are accounted for.

The key numbers correspond to the numbers on the "Parts Pictorial" in the separate "Illustration Booklet" on Page 6.

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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### RESISTORS

NOTE: The following resistors are 1/2-watt, 5% tolerance unless otherwise noted.

A1	6-222	2	2200 $\Omega$ (red-red-red)	R311, R312
A1	6-332	1	3300 $\Omega$ (org-org-red)	R309
A2	6-561-1	1	560 $\Omega$ , 1-watt (gm-blu-brn)	R301
A3	3-12-5	4	.09 $\Omega$ , 5-watt, wire-wound	R303 thru R306
A3	3-36-5	2	.42 $\Omega$ , 5-watt, wire-wound	R307, R308
A3	3-5-5	2	210 $\Omega$ , 5-watt, wire-wound	R302, R313
A4	10-318	1	2000 (2K) $\Omega$ control	R310

### CAPACITORS

B1	21-176	5	.01 $\mu$ F ceramic	C301, C302, C303, C304, C307
B2	21-192	1	.1 $\mu$ F (104M) ceramic	C308
B3	25-893	2	1000 $\mu$ F electrolytic	C305, C306
B4	25-910	1	3300 $\mu$ F electrolytic	C309

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
------------	-------------------	------	-------------	----------------------

### DIODES-TRANSISTOR

C1	56-16	1	1N5231B diode	D303
C1	56-56	1	1N4149 diode	D304
C1	57-42	2	3A1 diode	D301, D302

NOTE: The transistor may be marked for identification in any one of the following four ways:

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

C2	417-801	1	MPSA20 transistor	Q303
----	---------	---	-------------------	------

### OTHER PARTS

	85-2658-2	1	Regulator circuit board
C3	432-866	3	Spring connector
C4	432-1080	1	3-pin socket

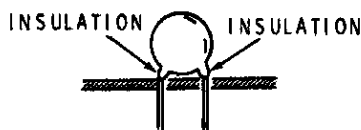
## STEP-BY-STEP ASSEMBLY

### CIRCUIT BOARD ASSEMBLY

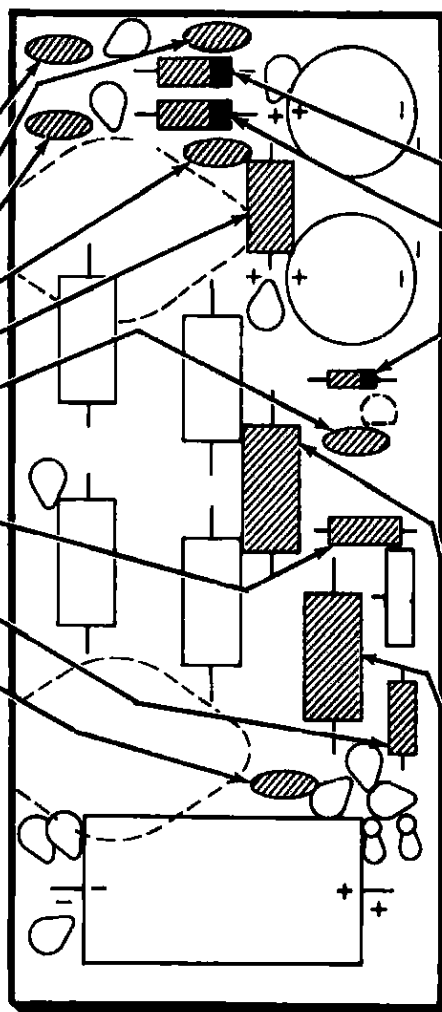
#### START

Position the regulator circuit board as shown. Then proceed with the following steps.

NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



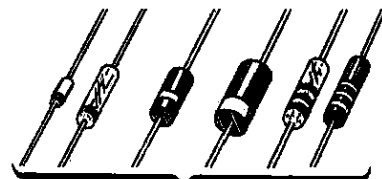
- ( ) C301: .01  $\mu$ F ceramic.
- ( ) C304: .01  $\mu$ F ceramic.
- ( ) C302: .01  $\mu$ F ceramic.
- ( ) C303: .01  $\mu$ F ceramic.
- ( ) R301: 560  $\Omega$ , 1-watt (grn-blu-brn).
- ( ) C307: .01  $\mu$ F ceramic.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) R311: 2200  $\Omega$ , 1/2-watt (red-red-red).
- ( ) R309: 3300  $\Omega$ , 1/2-watt (org-org-red).
- ( ) C308: .1  $\mu$ F (104M) ceramic.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



#### CONTINUE

NOTE: When you install a diode, as in the following steps, position its banded end as shown in the Pictorial. A circuit will not operate properly if the diode is installed backward.

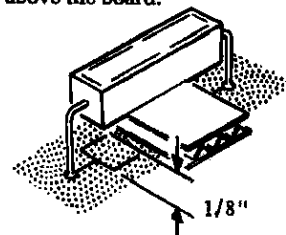
NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



BANDED END

- ( ) D301: 3A1 diode (#57-42).
- ( ) D302: 3A1 diode (#57-42).
- ( ) D303: 1N5231B diode (#58-16).

NOTE: When you install the wire-wound resistors in the following steps, use a small piece of the shipping carton to mount the resistor approximately 1/8" above the board.



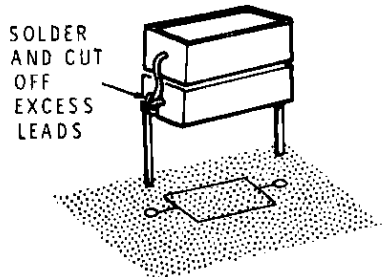
- ( ) R302: 210  $\Omega$ , 5-watt, wire-wound resistor.
- ( ) R313: 210  $\Omega$ , 5-watt, wire-wound resistor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-1

**START** ➡

NOTE: When you mount wire-wound resistors in this Pictorial, be sure to space them approximately 1/8" above the board. In this Pictorial, solder each component as it is installed on the board. Cut off all excess lead ends.

- ( ) Assemble two .09  $\Omega$ , 5-watt, wire-wound resistors together as shown.



- ( ) R303-R304: Mount the assembled .09 resistors 1/8" above the circuit board.

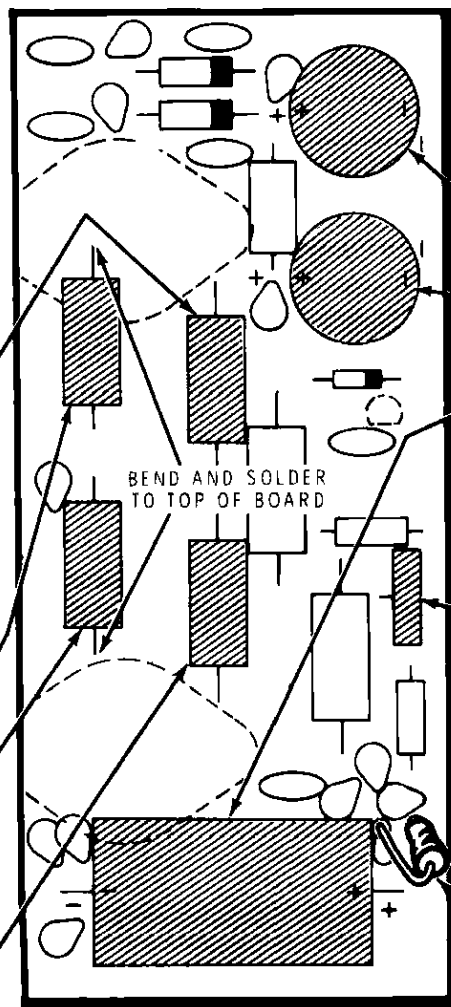
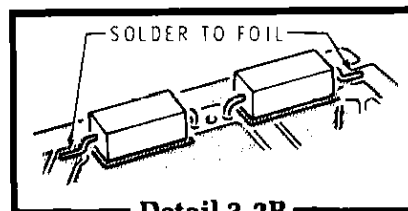
NOTE: In the next two steps, cut and bend the indicated leads. Then solder the prepared leads to the top circuit board foils as shown in Detail 3-2B. CAUTION: Be careful not to get solder onto adjacent foil pads.

- ( ) R307: .42  $\Omega$ , 5-watt, wire-wound resistor. The board may be screened .09  $\Omega$  at this location.

- ( ) R308: .42  $\Omega$ , 5-watt, wire-wound resistor. The board may be screened .09  $\Omega$  at this location.

- ( ) As in the first step in this column, assemble two .09  $\Omega$ , 5-watt, wire-wound resistors.

- ( ) R305-R306: Assembled .09  $\Omega$  resistors.

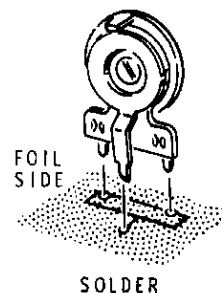
**PICTORIAL 3-2****Detail 3-2B****CONTINUE** ➡

- ( ) C305: 1000  $\mu$ F electrolytic (#25-893). See Detail 3-2A.

- ( ) C306: 1000  $\mu$ F electrolytic (#25-893). See Detail 3-2A.

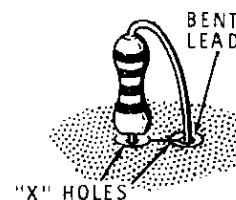
- ( ) C309: 3300  $\mu$ F electrolytic (#25-910). See Detail 3-2A.

- ( ) R309: 2000 (2K) $\Omega$  control (#10-318).

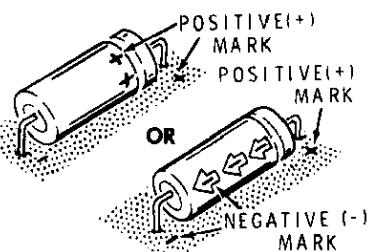
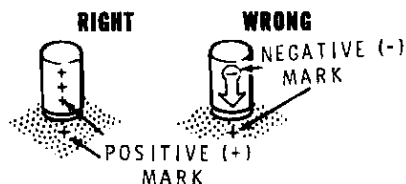


- ( ) R312: 2200  $\Omega$ , 1/2-watt (red-red-red).

Mount the resistor vertically, as shown. Bend one lead along the side of the component body. Then mount the component over the circuit board outline and push it down against the circuit board as shown.



NOTE: Before you install an electrolytic capacitor, note the position of the identified (+ or -) lead. Be sure you connect the positive (+) lead to the positive (+) marked point on the circuit board.

**Detail 3-2A**

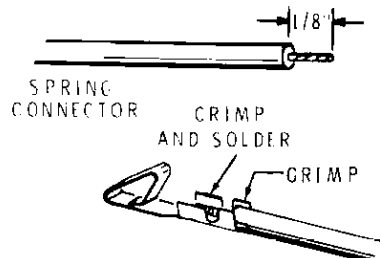


## START

- ( ) Prepare 6" lengths (one each) of small blue, gray, and violet stranded wire; remove 1/8" of insulation from one end and 1/4" of insulation from the other end of each wire.

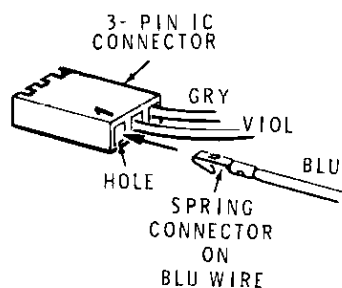
- ( ) Tightly twist the wire ends and apply a small amount of solder to each wire end to hold the fine strands together.

- ( ) Refer to the following drawing and install a spring connector (#432-866) on the 1/8" end of each wire as shown. Be very careful not to get solder into the spring-end.

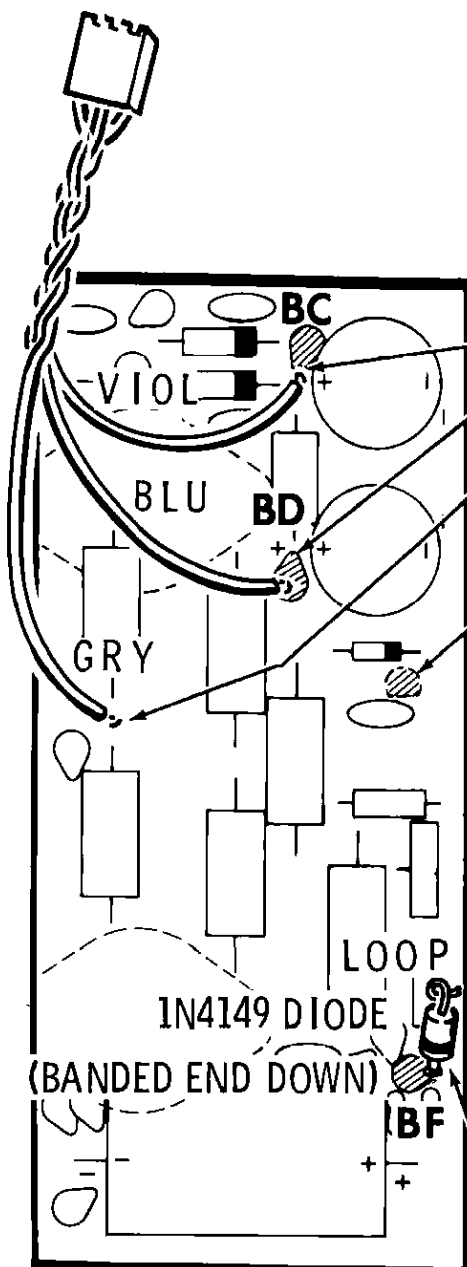


NOTE: When you perform the following step, be sure to position the 3-pin IC connector and connector pins as shown before you insert the pins into the housing. Push in on the wire until the pin snaps into place.

- ( ) Refer to the following drawing and insert the connector pin on the blue wire into hole 1 of the 3-pin connector.



- ( ) In a like manner, insert the gray and violet wires into the indicated holes in the 3-pin IC connector.



PICTORIAL 3-3

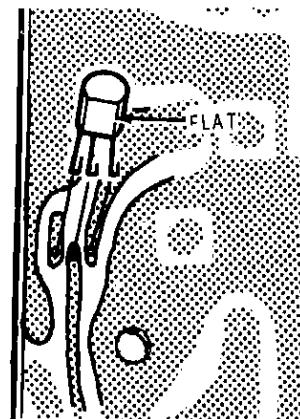
## CONTINUE

- ( ) Twist the three small wires together as shown.

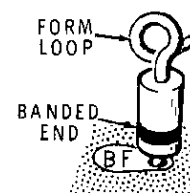
NOTE: In the following steps, when you install a wire on the circuit board, solder the wire to the foil and cut off the excess end.

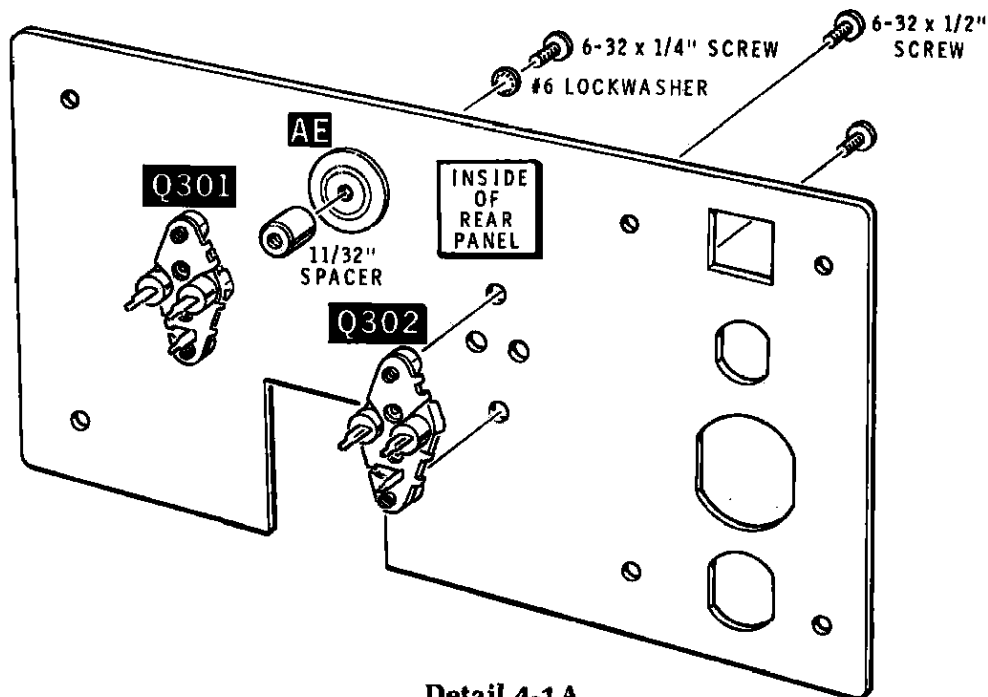
- ( ) Violet wire at BC.
- ( ) Blue wire at BD.
- ( ) Gray wire into hole BE between R307 and R308.

- ( ) Q303: Turn the circuit board over. Install an MPSA20 transistor (#417-801) on the back of the circuit board. Be sure the flat on the transistor matches the outline of the flat on the printed side of the board as shown. Mount the transistor 3/16" above the surface of the board. Carefully solder each lead to the foil.



- ( ) D304: Form a loop in the un-banded lead of a IN4149 diode (#56-56). Then mount the diode, banded end down, at BF in the manner shown. Solder the lead to the foil and cut off the excess lead length.





Detail 4-1A

## REAR PANEL ASSEMBLY

Refer to Pictorial 4-1 (Illustration Booklet, Page 7) for the following steps.

- ( ) Refer to Detail 4-1A and temporarily mount a transistor socket on the inside of the rear panel at Q301 with two 6-32  $\times$  1/2" screws. Make sure the shoulders of the socket are seated in the panel holes and that the wide space on the socket is positioned over the wide space on the panel.
- ( ) In the same manner, mount another transistor socket on the rear panel at Q302.
- ( ) Refer to Detail 4-1A and loosely mount an 11/32" spacer on the inside of the rear panel at AE. Use a 6-32  $\times$  1/4" screw and a #6 lockwasher.
- ( ) Position the regulator circuit board onto the two transistor sockets on the rear panel. Secure the board to spacer AE with a 6-32  $\times$  1/4" screw. Make sure all three socket pins at Q301, and the three pins at Q302 are positioned through their respective holes in the circuit board at Q301 and Q302.
- ( ) Tighten the mounting screws on spacer AE.

**IMPORTANT:** Make sure the regulator circuit board is parallel to the rear panel.

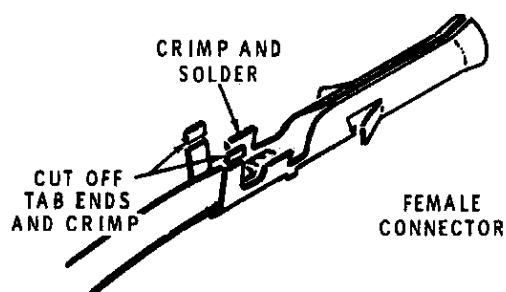
- ( ) Make sure all six transistor socket pins are through the circuit board. Then solder them to the foil on the printed side of the circuit board.
- ( ) Remove and save the spacer mounting screw from the circuit board side of spacer AE. Remove the two screws from each of the transistor sockets on the rear panel. Set the rear panel aside temporarily.

- ( ) Cut and prepare the following wires:

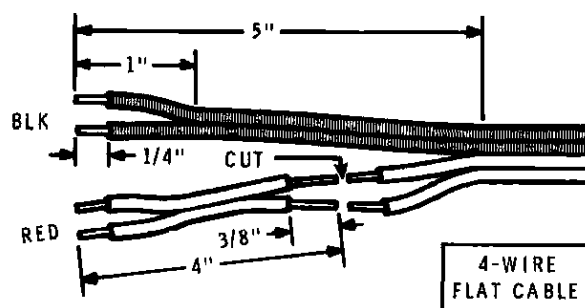
5" large green	4" large black
6" large green	4" medium red
7" large green	

**NOTE:** In the following steps, when you install a wire on the regulator circuit board, solder the wire to the circuit board foil and cut off the excess wire end.

- ( ) 5" green wire to hole BA.
- ( ) 6" green wire to hole BB.
- ( ) 7" green wire to hole BG.
- ( ) 4" large black to hole BN.



Detail 4-1B



Detail 4-1C

NOTE: In any of the following steps, when you are instructed to install a connector pin (male or female) or a spring connector on the end of a given wire, first cut the bare wire end to 1/8".

- ( ) Refer to Detail 4-1B and crimp and solder a female connector pin on one end of the 4" medium red wire as shown. Cut off the ends of the long tabs as shown. Connect the other end of the wire to the loop in the top of diode D304 (S-1), mounted at circuit board hole BF.

Refer to Detail 4-1C for the next three steps.

- ( ) 1. Locate the length of flat 4-wire cable. Using diagonal cutters, make a small separation cut between the red and the black pairs of wires. Separate the two pairs of wires for a length of 5". Then cut and remove a 4" length of the red-wire pair.
- ( ) 2. On the same end of the 4-wire cable, separate the black wire pair for a length of 1". Prepare the ends of the black wires.
- ( ) 3. Similarly, separate and prepare the ends of the shortened red pair of wires.

Connect the pair of black wires to the regulator circuit board as follows:

- ( ) One wire to hole BK.
- ( ) The other wire to hole BL.
- ( ) On the 4" red pair of wires you cut from the 4-wire cable, separate the wires at both ends for a length of 1". On one end of the pair, remove 3/8" of the insulation from each wire; and on the other end remove 1/4" of insulation. Prepare the four wire ends.

- ( ) On the 1/4" prepared end of the 4" red wire pair, install one wire in regulator circuit board hole BH and the other wire in hole BJ.

### CIRCUIT BOARD CHECKOUT

Carefully check the foil on both sides of the circuit board for the following most commonly made errors:

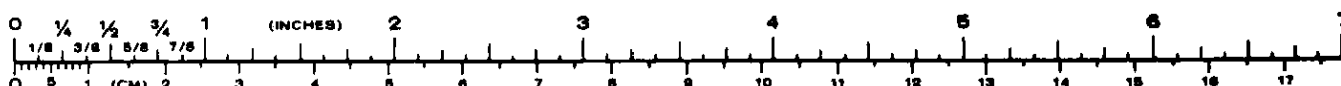
- ( ) Unsoldered connections.
- ( ) Poor solder connections.
- ( ) Solder bridges between foil patterns.
- ( ) Protruding leads which could touch together.

Refer to the illustrations where the parts were installed as you make the following visual checks:

- ( ) Transistor for proper installation.
- ( ) Diodes for correct type and position of the banded end.
- ( ) Electrolytic capacitors for the correct position of the identified (+ or -) leads.

NOTE: There are some unused holes on the regulator circuit board.

This completes the Step-By-Step assembly of the regulator circuit board.



Refer to Pictorial 4-2 (Illustration Booklet, Page 8) for the following steps.

- ( ) Refer to Detail 4-2A (Illustration Booklet, Page 8) and position the large heat sink on the outside of the rear panel, making sure the transistor holes line up with the holes in the panel.
- ( ) Secure the heat sink to the panel at AH and AJ with 6-32  $\times$  1/4" screws and #6 lockwashers and at AF and AG with 6-32  $\times$  3/8" screws and two #6 lockwashers as shown in the Pictorial.
- ( ) Refer to the Pictorial and position the regulator circuit board onto the rear panel so the two transistor sockets fit into the rear panel holes. Secure the circuit board to the rear panel with a 6-32  $\times$  1/4" screw and a #6 lockwasher into spacer AE. Make sure the shoulders on the sockets are seated in their respective panel holes.

Refer to Detail 4-2A for the next three steps.

- ( ) BR1: Spread a thin coating of thermal compound on the back of the bridge rectifier. Mount the rectifier on the inside of the rear panel at BR1 as shown, using a 6-32  $\times$  3/4" screw and a #6 lockwasher. Be sure to position the positive (+) rectifier lug as shown in the Pictorial.
- ( ) Flex the ears on the 6-pin plug. Then, from the inside of the rear panel, push the 6-pin plug into hole P1. Make sure the index notch is toward the right as shown in the Detail.
- ( ) Install the fuseholder in the rear panel at F1 in the manner shown. NOTE: Do not overtighten the fuseholder nut, as you may damage the fuseholder plastic housing. On the top of the fuseholder, use long-nose pliers to bend lug 2 upward about 30 degrees to allow clearance for installing the wires in a later step.
- ( ) Route the free end of the flat 4-wire cable through rear panel hole AN as shown in the Pictorial. The free end of the cable will be connected later.

NOTE: To make a "secure mechanical connection," as in the following step, be sure to wrap the wire end tightly around the indicated lug as shown in the inset drawing on Pictorial 4-2.

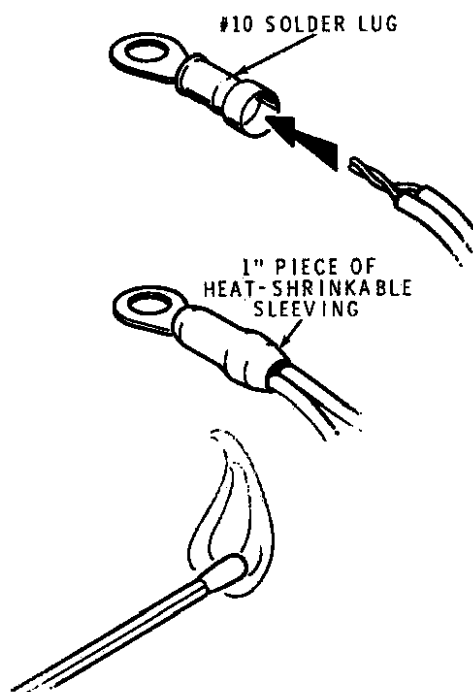
- ( ) On the inner end of the flat 4-wire cable, connect the ends of both red wires to fuseholder lug 2 (S-2). Make a secure mechanical connection and use plenty of heat and solder to assure a good electrical connection.
- ( ) Connect both wires in the red wire pair coming from regulator circuit board holes BH and BJ to fuseholder lug 1 (S-2). Be sure to make a secure mechanical connection. Crimp one red wire through the lug and crimp the other wire around the standing portion of the lug.
- ( ) Push the female pin on the end of the red wire coming from regulator circuit board hole BF into 6-pin plug P1 hole 6. NOTE: Rotate the pin slightly if it seems not to push all the way into the plug at first. Tug on the wire to make sure it is latched in the socket.
- ( ) F1: Refer to Detail 4-2A and place a 20-ampere, 3AG regular (not slow-blow) fuse in the cap of the fuseholder. Then install the cap and fuse into the fuseholder from the outside of the rear panel.
- ( ) Prepare a 6" large green wire and a 3-1/2" large black wire.
- ( ) Connect the 6" large green wire to positive (+) lug 1 of bridge rectifier BR1 (NS).
- ( ) Connect one end of the 3-1/2" large black wire to negative (−) lug 3 of bridge rectifier BR1 (NS).
- ( ) Locate the two green wires coming from regulator circuit board holes BA and BB. Twist these two wires together for about two turns. Then connect the shorter of the two wires to bridge rectifier lug 4 (NS) and the longer to lug 2 (NS).
- ( ) Cut the leads of four .01  $\mu$ F ceramic capacitors to 1/2".

NOTE: In the following steps, as you install the four prepared capacitors on rectifier BR1, position the body of each capacitor toward the center area of the rectifier as shown in the Pictorial.

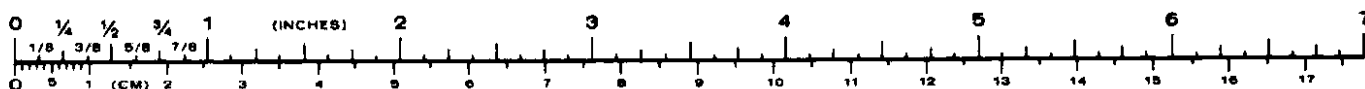
- ( ) C2: Connect a .01  $\mu$ F ceramic capacitor between BR1 lugs 1 (NS) and 4 (NS).
- ( ) C4: Connect a .01  $\mu$ F ceramic capacitor between BR1 lugs 1 (S-3) and 2 (NS).
- ( ) C3: Connect a .01  $\mu$ F ceramic capacitor between BR1 lugs 2 (S-3) and 3 (NS).
- ( ) C1: Connect a .01  $\mu$ F ceramic capacitor between BR1 lugs 3 (S-3) and 4 (S-3).

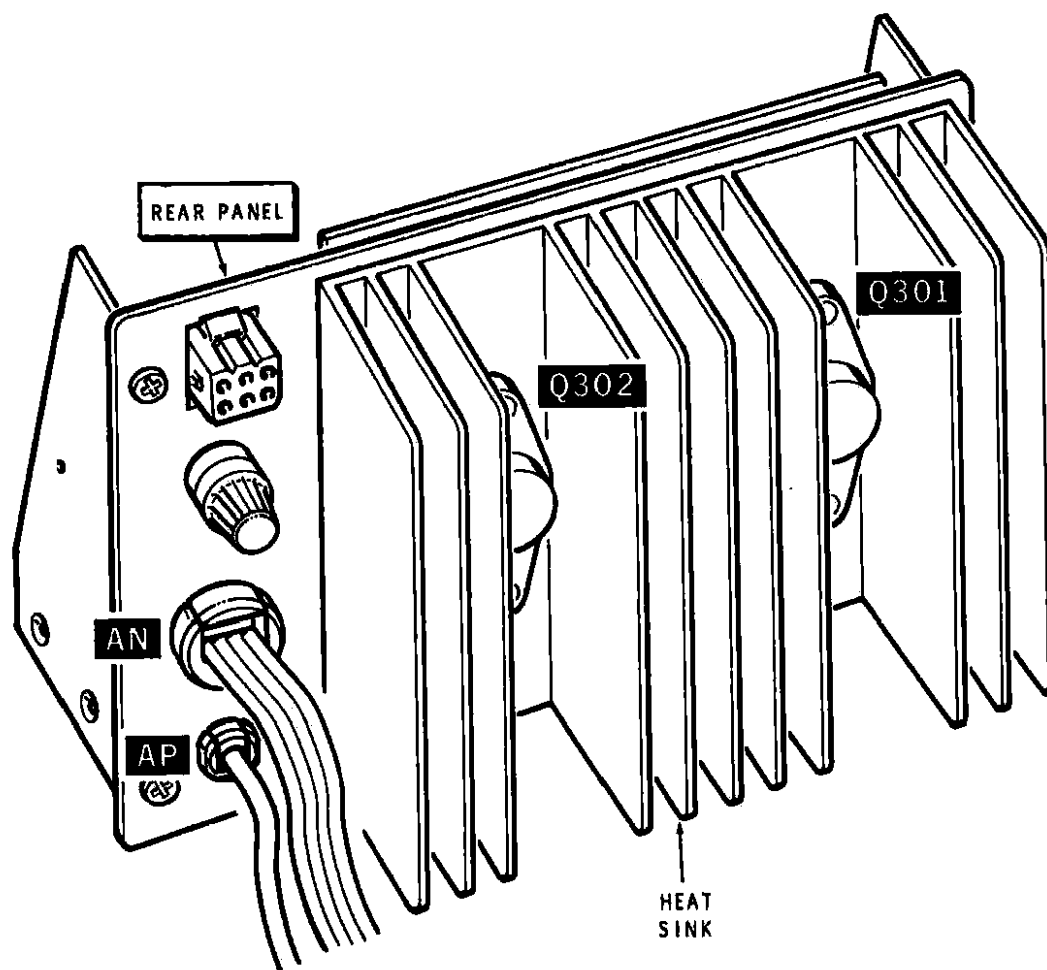
Refer to Detail 4-2B for the next three steps.

- ( ) Twist together the green wire coming from regulator circuit board hole BG and the green wire coming from BR1 lug 1. Push the ends of these wires into a #10 solder lug as shown. Solder the lug onto the two wire ends.
- ( ) Cut a 1" piece of heat-shrinkable sleeving.
- ( ) Make sure the solder lug on the green wire pair has cooled. Then push the 1" sleeve onto the solder lug so the loop in the lug end is just exposed. Heat the sleeve with a match or other suitable heat source until it is shrunk around the lug and the wires. The solder lug will be connected later.
- ( ) Temporarily remove the heat sink mounting hardware from AF and AG. Secure the left support bracket onto the rear panel at AF and AG with the 6-32 hardware you just removed. NOTE: Make sure to position the bracket as far as possible toward the outer edge of the rear panel.
- ( ) Secure the right support bracket to the other end of the rear panel at AK and AL using 6-32  $\times$  1/4" screws and #6 lockwashers.



Detail 4-2B



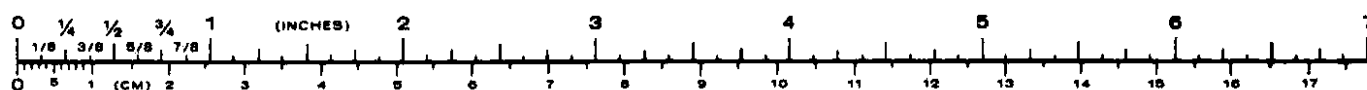


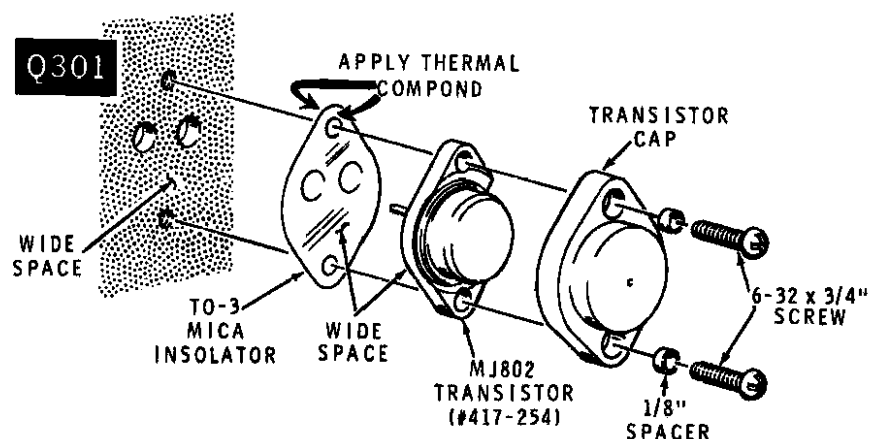
PICTORIAL 4-3

Refer to Pictorial 4-3 for the following steps.

- ( ) Position the rear panel as shown.

**NOTE:** In the following steps, when you install transistors on the rear panel assembly, make sure the shoulders on the transistor sockets are seated in their rear panel holes.





Detail 4-3A

- ( ) Q301: Refer to Detail 4-3A and install an MJ802 transistor (#417-254) transistor at Q301 on the rear panel assembly as follows:

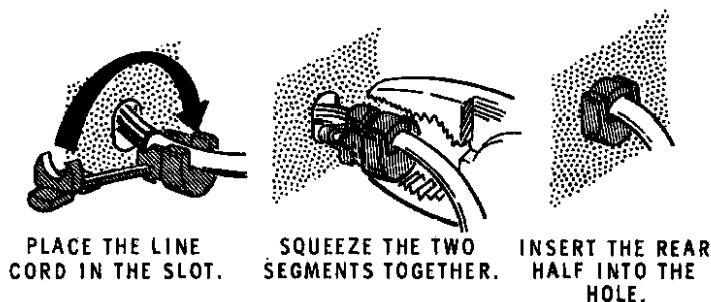
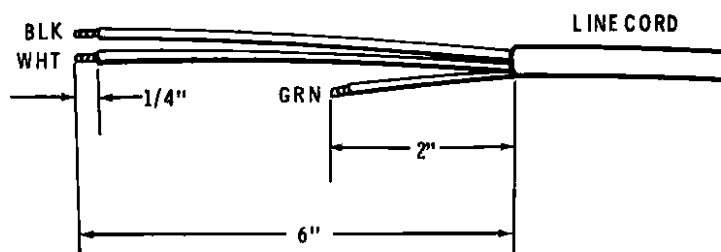
1. Coat both sides of a mica insulator with thermal compound. Then place the insulator on the heat sink at Q301 so the insulator holes match the transistor holes in the heat sink.
2. Making sure you match the wide spacing on the transistor with the hole spacing on the heat sink, push the leads of an MJ802 transistor into the socket holes at Q301.

3. Secure a transistor cap and the transistor to the rear panel assembly with two 6-32 x 3/4" screws and two 1/8" spacers.

- ( ) Q302: In the same manner, install an MJ802 transistor on the rear panel assembly at Q302.

- ( ) Refer to Detail 4-3B and prepare the end of the line cord as shown. Then squeeze the small strain relief onto the line cord just where the outer insulation stops. Push the end of the line cord and the strain relief into rear panel hole AP.

- ( ) Pull the 4-wire flat cable as far as possible out of the rear panel. Then, as in the last step, squeeze the large strain relief onto the cable, as close as possible to the rear panel. Insert the strain relief into rear panel hole AN as shown.



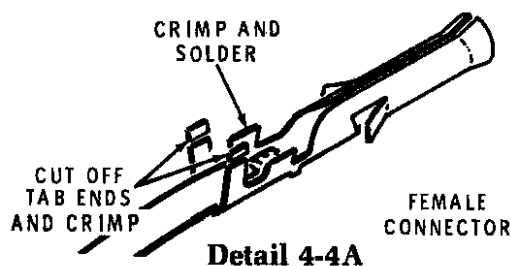
Detail 4-3B

Refer to Pictorial 4-4 (Illustration Booklet, Page 9) for the following steps.

- ( ) Position the rear panel assembly close to the rear edge of the chassis as shown. Then proceed with the following steps.
- ( ) Locate the two heavy red transformer leads and, if necessary, remove additional insulation from the lead ends to bare 1/2" of the wires. Form a loop in the end of each wire.

#### NOTES:

1. In the following steps, as you connect the two red transformer leads to bridge rectifier BR1, be sure to position other wires out of the way so as not to burn the insulation on them.
  2. As the two red leads are very heavy, be sure to make a secure mechanical connection and to use sufficient heat and solder to assure a good electrical connection. The solder note does not include wires and leads previously soldered to the lugs.
- ( ) Securely crimp one red transformer lead around BR1 lug 4 (S-1).
  - ( ) In the same manner, connect the other red transformer lead to BR1 lug 2 (S-1).
  - ( ) Connect the black wire coming from regulator circuit board to solder lug A1 (NS). Make a secure mechanical connection.
  - ( ) Prepare a 5" medium black wire.



- ( ) Refer to Detail 4-4A and crimp and solder a female connector pin onto one end of the 5" medium black wire. Cut off the ends of the long tabs as shown.
- ( ) Connect the other end of the 5" black wire to solder lug A1 (S-2). Make a secure mechanical connection. The connector end of the wire will be installed later.

- ( ) Connect the green line cord lead to solder lug A2 (S-1). Make a secure mechanical connection.
- ( ) Connect the free end of the black wire coming from bridge rectifier lug 3 to chassis solder lug B (NS). Make a secure mechanical connection.
- ( ) Prepare a 5" large black wire.
- ( ) Solder a #10 solder lug onto one end of the 5" large black wire.
- ( ) Connect one end of the 5" large black wire to solder lug B (S-2). Make a secure mechanical connection. The free end of the wire will be connected later.
- ( ) Push the 3-pin plug coming from the regulator circuit board onto the leads of transistor Q1. Be sure the gray wire is toward the right as shown in the Pictorial.

NOTE: In the following step, be sure not to pinch any wires or leads between the chassis and the rear panel.

- ( ) Position the rear panel assembly so the two support brackets are on the outside of the rear chassis flanges. Then secure the right support bracket to the chassis at AR and AS as shown with two 6-32 × 1/4" flat head screws.
- ( ) Similarly, secure the left support bracket to the chassis at AT and AU with 6-32 × 1/4" flat head screws.
- ( ) Secure the solder lug on the two green wires coming from the regulator circuit board to the positive (+) terminal of capacitor C5 with a 10-32 × 1/4" screw.
- ( ) Secure the black wire (coming from solder lug B) to the negative (-) terminal of capacitor C5 with a 10-32 × 1/4" screw.
- ( ) Push the pin on the end of the black wire coming from solder lug A1 into plug P1 hole 1. Tug on the wire to make certain it is latched in the plug. CAUTION: Be sure to install the pin in the correct hole. After it is latched, the pin will be destroyed if you pull it out.

Set the chassis assembly aside temporarily.



# AC CIRCUIT BOARD

## PARTS LIST

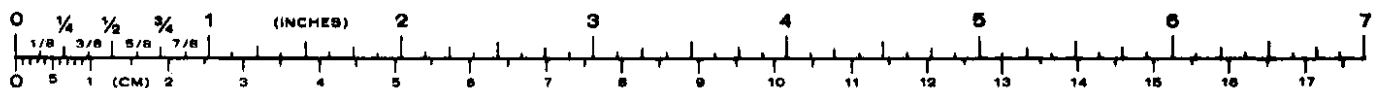
Unpack Pack #3 and check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until all the parts are accounted for.

The key numbers correspond to the numbers on the "Parts Pictorial" in the separate "Illustration Booklet" on Page 10.

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS-DIODES				
A1	6-331	1	330Ω, 1/2-watt (org-org-brn) resistor	R103
A2	9-88	2	Varistor (2504)	R102, R101
A3	56-16	1	1N5231B diode	D105
A4	57-65	4	1N4002 diode	D101 thru D104
CAPACITORS				
B1	21-140	1	.001 μF ceramic	C101
B1	21-72	3	.005 μF ceramic	C102, C103, C104
B1	21-176	1	.01 μF ceramic	C105
B2	25-885	1	100 μF electrolytic	C107
B2	25-891	1	470 μF electrolytic	C106

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
OTHER PARTS				
C1	45-82	1	350 μH choke	L101
C2	54-949	1	6.5-volt transformer	T101
	85-2656-1	1	AC circuit board	
C3	260-65	4	Fuse clip	
	346-60	2	Clear sleeving	
C4	421-5	1	4-ampere, slow-blow fuse (for use with 220 VAC power)	F102
C4	421-9	1	7-ampere, slow-blow fuse (for use with 120 VAC power)	F102
C4	421-20	1	1/2-ampere, slow-blow fuse	F101
C4	421-33	1	1/4-ampere, slow-blow fuse	F101
C5	432-66	4	Push-on connector	



## STEP-BY-STEP ASSEMBLY

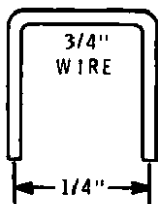
### CIRCUIT BOARD ASSEMBLY

#### START

**IMPORTANT:** If you intend to use 240-VAC, proceed directly to Pictorial 5-2. **DO NOT** perform the steps in this Pictorial.

Position the AC circuit board as shown. Then proceed with the following steps.

- ( ) Cut four 3/4" pieces of heavy bare wire. Form each wire as shown.

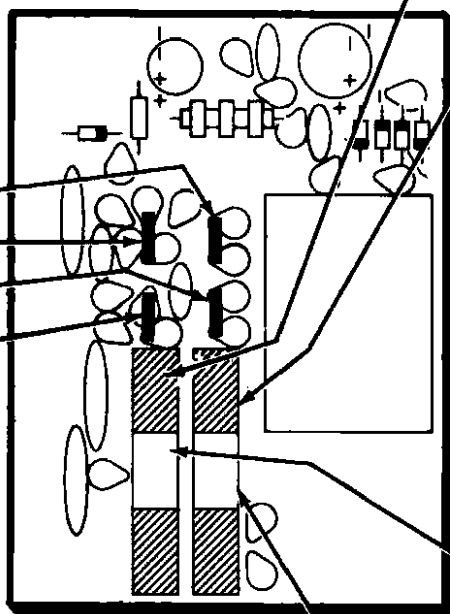


**NOTE:** As you install each of the wire loops in the following steps, solder the wire to both foils and cut off the excess ends.

- ( ) Wire loop to AL-AJ.
- ( ) Wire loop to AW-AS.
- ( ) Wire loop to AK-AH.
- ( ) Wire loop to AU-AQ.

#### 120-VOLT WIRING

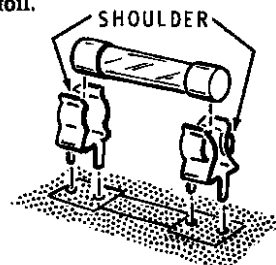
The plug on the power cord for this kit is for standard 120 VAC outlets in most areas. For 240 VAC operation, refer to Pictorial 5-2 on Page 37.



PICTORIAL 5-1

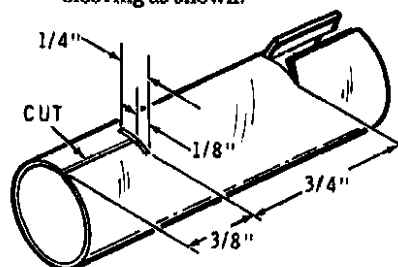
#### CONTINUE

- ( ) Install two fuse clips and a 7-ampere fuse (#421-9) at F102 as shown. Be sure to position the fuse clip shoulders as shown below. Solder the clip lugs to the foil.



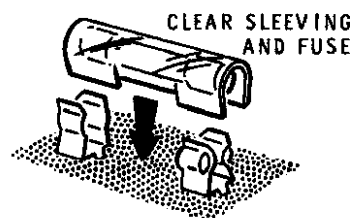
- ( ) In the same manner, install a 1/2 ampere fuse (#421-20) and two clips at F101.

- ( ) Prepare the two pieces of clear sleeving as shown.



- ( ) Remove both fuses from their fuse clips.

- ( ) F102: Place a piece of clear sleeving over the 7-ampere fuse. Then push the fuse and sleeve onto the clips at F102.



- ( ) F101: In the same manner, install a 1/2-ampere fuse and sleeve at F101.

Proceed to Pictorial 5-3.

## 240-VOLT WIRING

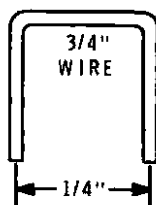
For 240-volt operation, cut off the line cord plug and install the correct plug for your 240-volt receptacle.

### START

**IMPORTANT:** Perform the steps on this Pictorial only if you intend to use 240-VAC.

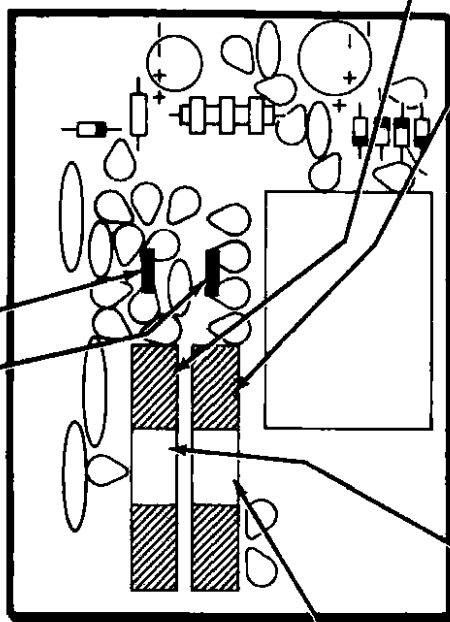
Position the AC circuit board as shown. Then proceed with the following steps.

- ( ) Cut two 3/4" pieces of heavy bare wire. Form each wire as shown.



**NOTE:** As you install each of the wire loops in the following steps, solder the wire to both foils and cut off the excess ends.

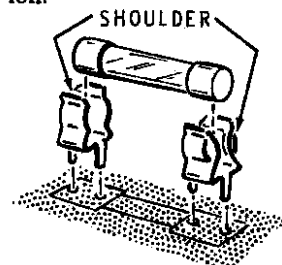
- ( ) Wire loop to AS-AU.
- ( ) Wire loop to AJ-AK.



PICTORIAL 5-2

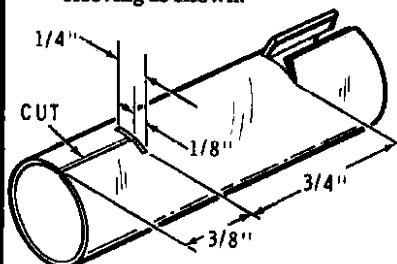
### CONTINUE

- ( ) Install two fuse clips and a 4-ampere fuse (#421-5) at F102 as shown. Be sure to position the fuse clip shoulders as shown below. Solder the clip lugs to the foil.



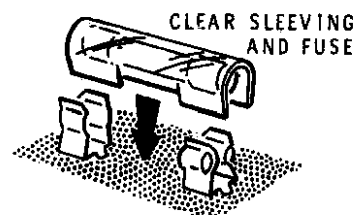
- ( ) In the same manner, install a 1/4-ampere fuse (#421-33) and two clips at F101.

- ( ) Prepare the two pieces of clear sleeving as shown.



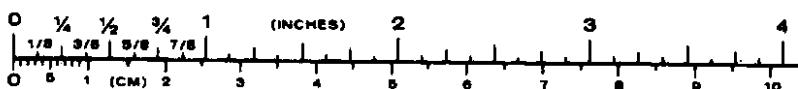
- ( ) Remove both fuses from their fuse clips

- ( ) F102: Place a piece of clear sleeving over the 4-ampere fuse. Then push the fuse and sleeve onto the clips at F102.



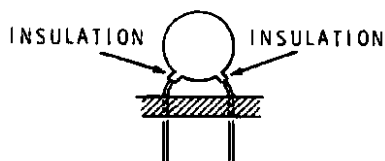
- ( ) F101: In the same manner, install a 1/4-ampere fuse and sleeve at F101.

Proceed to Pictorial 5-3.



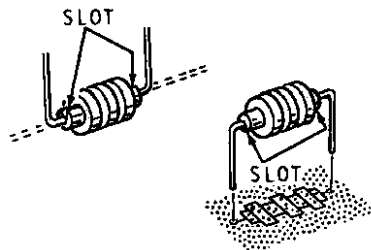
**START** ➡

NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



( ) C101: .001  $\mu$ F ceramic.

When you install a choke, bend the leads toward the slot in the choke body to avoid placing any strain on the leads of the choke winding. Then install the choke as shown.



( ) L101: 350  $\mu$ H choke (#45-82).

( ) R103: 330  $\Omega$ , 1/2-watt (org-org-brn) resistor

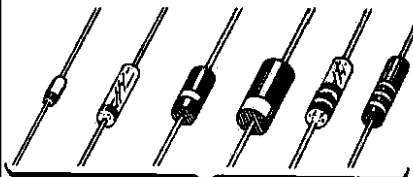
( ) R102: Varistor (#9-88).

( ) R101: Varistor (#9-88).

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

**CONTINUE** ➡

NOTE: When you install a diode, position its banded end as shown in the Pictorial. A circuit will not operate properly if the diode is installed backward.

**BANDED END**

( ) D102: 1N4002 diode (#57-65).

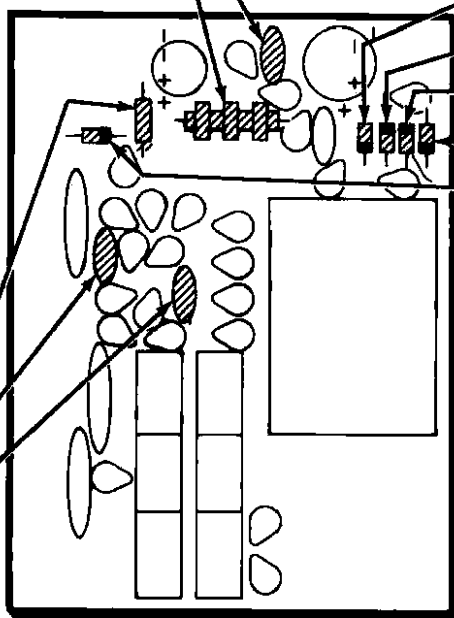
( ) D104: 1N4002 diode (#57-65).

( ) D103: 1N4002 diode (#57-65).

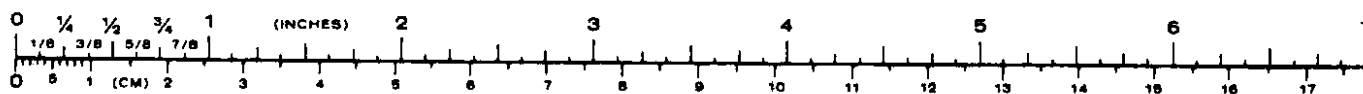
( ) D101: 1N4002 diode (#57-65).

( ) D105: 1N5231B diode (#56-16).

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



**PICTORIAL 5-3**



## START

- ( ) Prepare the following medium wires:

Two 4" violet  
One 10" violet  
One 10" green  
Two 7" red.

NOTE: When you install a wire in this Pictorial, solder it to the foil and cut off the excess wire end.

- ( ) 4" violet wire at AC.

- ( ) 10" violet wire at AG.

- ( ) 4" violet wire at AF.

- ( ) 10" green wire at AZ.

- ( ) C104: .005  $\mu$ F ceramic.

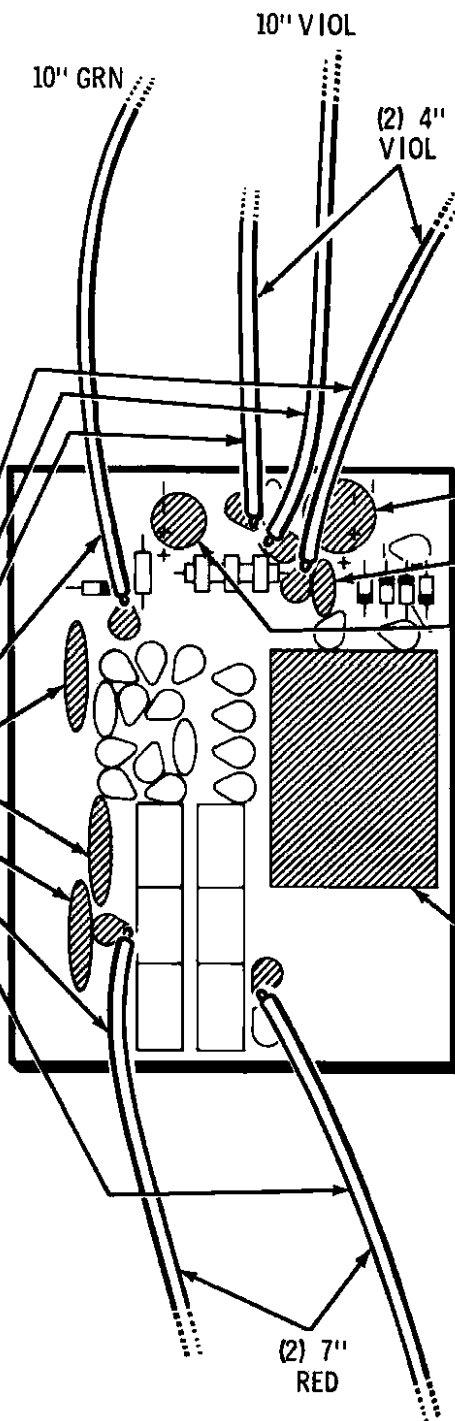
- ( ) C102: .005  $\mu$ F ceramic.

- ( ) C103: .005  $\mu$ F ceramic.

- ( ) 7" red wire at AE.

- ( ) 7" red wire at AD.

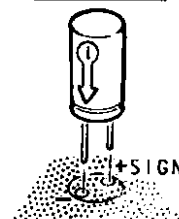
- ( ) Solder the leads and wires to the foil and cut off the excess lengths.



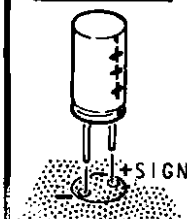
## CONTINUE

NOTE: Before you install an electrolytic capacitor note the position of the identified (+ or -) lead. Be sure you connect the positive (+) lead to the positive (+) marked point on the circuit board.

IDENTIFIED  
LEAD IS  
NEGATIVE (-)



IDENTIFIED  
LEAD IS  
POSITIVE (+)



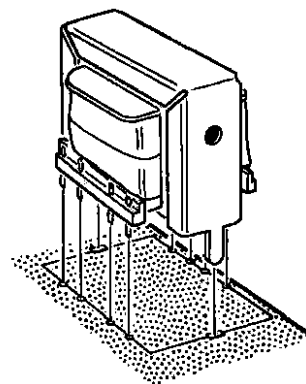
- ( ) C106: 470  $\mu$ F electrolytic (#25-891)

- ( ) C105: .01  $\mu$ F ceramic.

- ( ) C107: 100  $\mu$ F electrolytic (#25-885). Be sure to observe the correct lead positioning.

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

- ( ) T101: 6.5 volt transformer. Push the transformer all the way down onto the surface of the board. Then solder its leads and mounting tabs to the foil. Cut off the excess lead and tab ends.

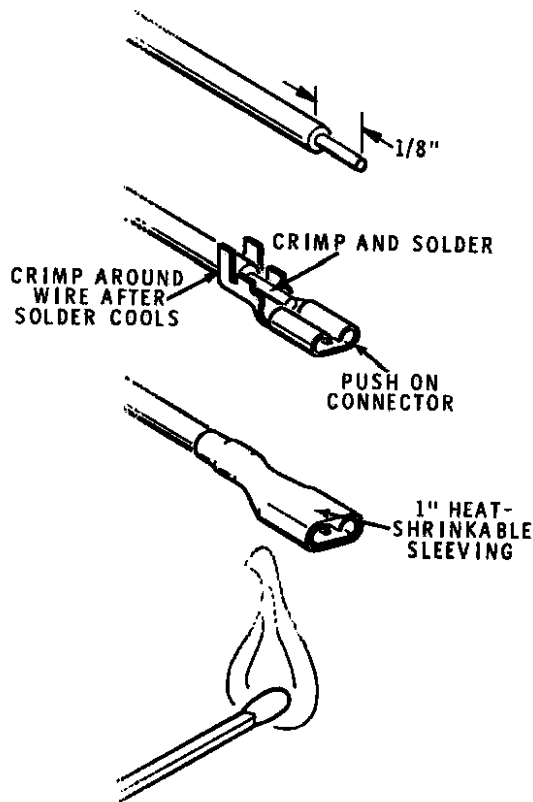


PICTORIAL 5-4

**CIRCUIT BOARD INSTALLATION**

Refer to Pictorial 5-5 (Illustration Booklet, Page 11) for the following steps.

- ( ) Position the AC circuit board on your work area as shown.
- ( ) Cut the bare ends of the six wires on the AC circuit board off to a length of 1/8" (the 10" green and violet wires, the 4" violet wires, and the 7" red wires).

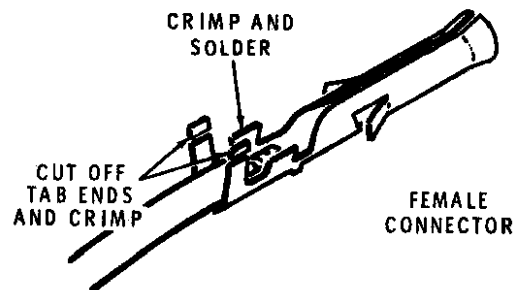
**Detail 5-5A**

Refer to Detail 5-5A for the next four steps.

- ( ) 1. Crimp and solder a push-on connector onto the end of one of the 4" violet wires as shown.
- ( ) 2. Cut four 1" pieces of heat-shrinkable sleeving.
- ( ) 3. Push a 1" piece of heat-shrinkable sleeving onto the end of the connector and violet wire. Then, using a match or other suitable heat source, shrink the sleeving onto the wire and connector. Rotate the sleeving so as to evenly distribute the heat on the sleeving.

- ( ) 4. In the same manner, crimp and solder push-on connectors and shrink 1" sleeving onto the ends of the remaining 4" violet wire and both of the 7" red wires.

NOTE: These four prepared wires will be connected in a later step.

**Detail 5-5B**

- ( ) Refer to Detail 5-5B and crimp and solder a female connector pin onto the end of the 10" violet wire. Be careful that you do not get solder down into the pin.
- ( ) In the same manner, install a female connector pin onto the end of the 10" green wire.
- ( ) Locate the free end of the shielded cable coming from grommet C. As in the previous step, crimp and solder female connector pins onto the ends of the shielded cable inner lead and shield lead.
- ( ) Position the AC circuit board close to the right side of the chassis.

Connect the ends of the three small wires coming from chassis grommet C to the AC circuit board in the next three steps. Solder each wire to the circuit board foil as you install it and cut off the excess wire end.

- ( ) Red wire to hole AY.
- ( ) Brown wire to hole AN.
- ( ) Orange wire to hole AP.

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- ( ) Position the AC circuit board part way into the chassis, just behind the power transformer. Then connect the line cord and power transformer leads to the circuit board in the following steps. Solder each lead as it is installed and cut off the excess lead end.
- ( ) Black line cord lead to hole AA.
- ( ) White line cord lead to hole AB.
- ( ) Black transformer lead to hole AX.
- ( ) Black-green transformer lead to hole AT.
- ( ) Black-yellow transformer lead to hole AV.
- ( ) Black-red transformer lead to hole AR.

## CIRCUIT BOARD CHECKOUT

Carefully check the foil side of the circuit board for the following most commonly made errors:

- ( ) Unsoldered connections.
- ( ) Poor solder connections.
- ( ) Solder bridges between foil patterns.
- ( ) Protruding leads which could touch together.

Refer to the illustrations where the parts were installed as you make the following visual checks:

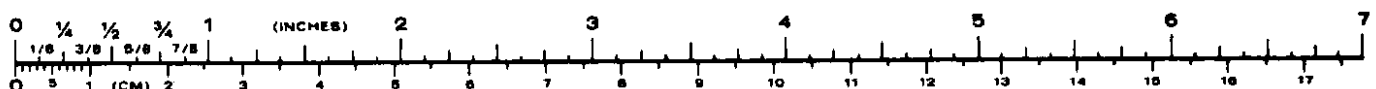
- ( ) Diodes for correct type and position of the banded end.
- ( ) Electrolytic capacitors for the correct position of the identified (+ or -) leads.

Refer to Pictorial 5-6 (Illustration Booklet, Page 12) for the following steps.

- ( ) Position the AC circuit board down into the chassis and onto the top of the four previously installed spacers. Route the three small wires in under the circuit board as shown in the Pictorial.
- ( ) Secure the circuit board to spacers D, E, F, and G with 6-32  $\times$  1/4" screws and #6 lockwashers. Tighten the screws tightly. Then turn the chassis over and tighten the four bottom spacer screws.

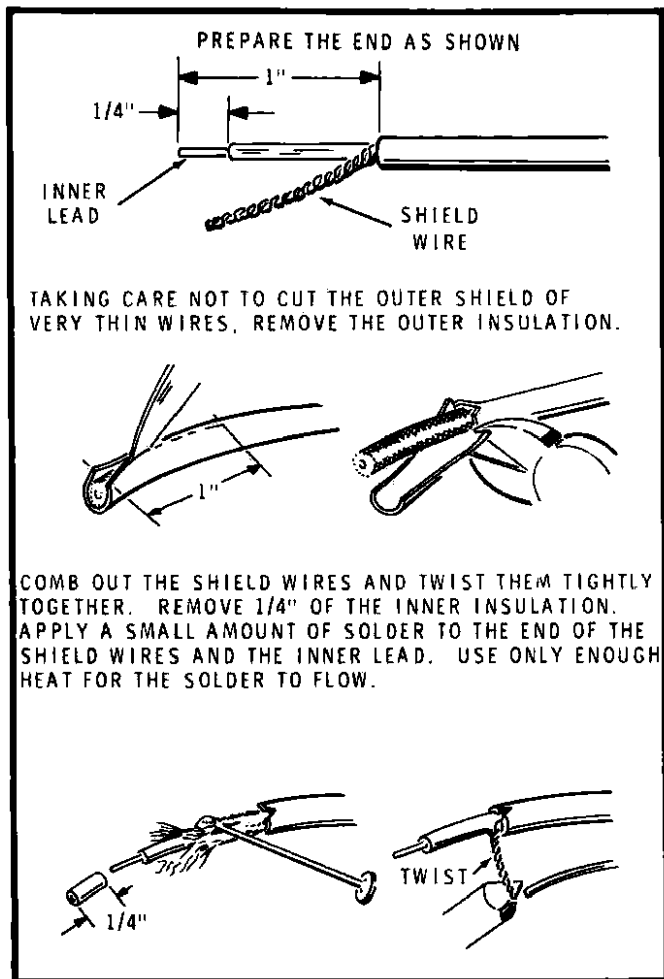
NOTE: In the following steps, disregard any numbers that may be embossed adjacent to the relay lugs. Connect the red and violet wire push-on connectors onto the relay lugs as follows.

- ( ) Twist the two short violet wires together for approximately six turns. Then push the connector on one of the violet wires onto relay K1 lug 2 and push the other connector onto lug 1 as shown.
- ( ) Similarly, twist the two 7" red wires together. Push the connector on one red wire onto relay lug 4 and push the other connector onto lug 3 as shown.
- ( ) Push the pin on the shielded cable shield (coming from grommet C) lead into P1 hole 4 and push the pin on the inner lead into hole 5 as shown.
- ( ) Twist the long green and violet wires together for approximately three turns. Then refer to the inset drawing on the Pictorial and push the violet wire connector into plug P1 hole 2. Push the green wire pin into P1 hole 3. Tug on both wires to make sure they are latched in the socket.
- ( ) Position all wires, cables, and leads neatly down into the chassis assembly. Note that many of these wires, etc., are cut to a length that will permit you to readily lift circuit boards, the rear panel, etc., from the chassis for service and routine checks.



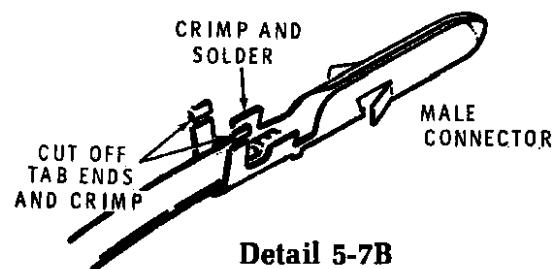
Refer to Pictorial 5-7 (Illustration Booklet, Page 12) for the following steps.

- ( ) Locate the remaining lengths of medium red and medium violet wire (approximately 40"). Remove 1/8" of insulation from one end of each wire. Then tightly twist each wire end and add a small amount of solder to hold the fine strands together.



**Detail 5-7A**

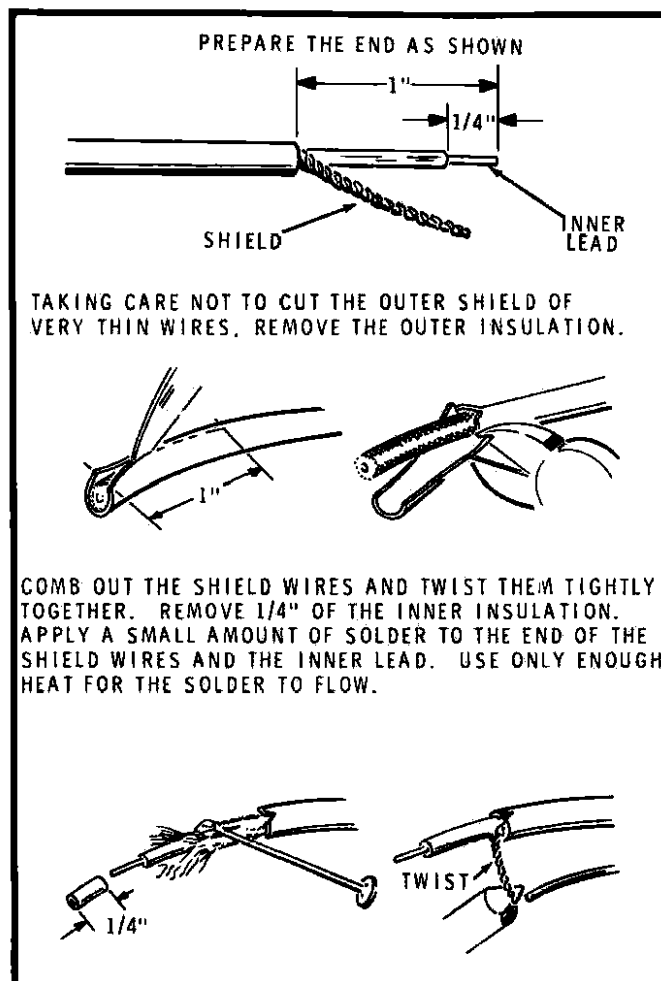
- ( ) Locate the remaining length of shielded cable (approximately 78") and cut the cable into two equal lengths. Refer to Detail 5-7A and prepare one end of each cable as shown.
- ( ) Cut two 1" pieces of double-sided tape.
- ( ) Remove the backing from one side of a piece of tape and wrap the tape around the outer insulation on one of the coaxial cables.
- ( ) In the same manner, wrap a tape around the other end of the same coaxial cable.



**Detail 5-7B**

- ( ) Refer to Detail 5-7B and crimp and solder a male connector pin onto the prepared end of the medium red wire as shown.
- ( ) In the same manner, install male connector pins onto the prepared end of the violet wire, and onto the prepared leads of the shielded cables.
- ( ) Position the 6-pin socket as shown. Then install the connector pins on the indicated wires into the socket holes in the following steps. As you install each wire, tug on it to make sure it is latched in the socket.
- ( ) The tape-marked shielded cable **shield** lead to hole 1.
- ( ) The tape-marked shielded cable **inner** lead to hole 3.
- ( ) Violet lead to hole 2.
- ( ) The remaining shielded cable **shield** lead to hole 4.
- ( ) Shielded cable **inner** lead to hole 5.
- ( ) Red lead to hole 6.
- ( ) Cut the mounting ears from the 6-pin socket.
- ( ) Push the 6-pin socket onto rear panel plug P1. Then stretch all the wires and the cable to their extended lengths. Cut all of these wires and cables to the length of the shortest one. This should form a cable approximately 38" long, all wires and cables of equal length.
- ( ) Cut the remaining heat shrinkable sleeving into 1" pieces.
- ( ) Slide each piece of sleeving onto the wire and cable ends. Push the first piece of sleeving to approximately 3" from socket P1. With a match or other suitable heat source, shrink the sleeving onto the bundled wires.

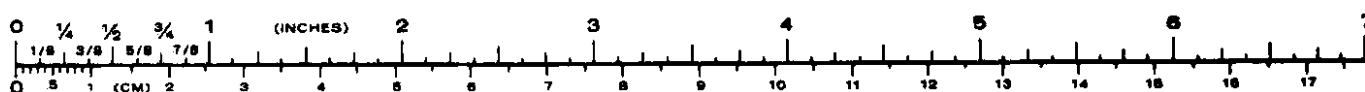




Detail 5-7C

- ( ) Space the remaining pieces of sleeving evenly along the bundled wires. Then, as in the previous step, shrink each piece of sleeving onto the wires and cable.
- ( ) On the free end of the flat 4-wire cable, separate the lead ends for a length of approximately 1". Then prepare each of the four wire ends.
- ( ) Refer to Detail 5-7C and prepare the free ends of the shielded cables in the 6-wire cable assembly coming from the rear panel as shown. Then prepare the remaining two wire ends.

Except for "Final Assembly," this completes the Step-By-Step Assembly of your Power Supply. Check to make sure there are no stray bits of solder or wire ends in the chassis that could cause problems during the kit operation. You will have a resistor and several pieces of hardware left for use in later steps.



## TESTS AND ADJUSTMENTS

During the following tests and adjustments to your kit, if you do not get the desired results, do not proceed with the steps until you have found and corrected any problem. If you are not able to resolve a problem at first, refer to the "In Case of Difficulty" section of this Manual, starting on Page 49.

### NOTES:

1. Do not plug your power supply into a power source until you are directed to do so in a step.
2. You will need a high-impedance input volt-ohmmeter to perform the following tests. It will also be helpful if you have two small test leads with alligator clips.

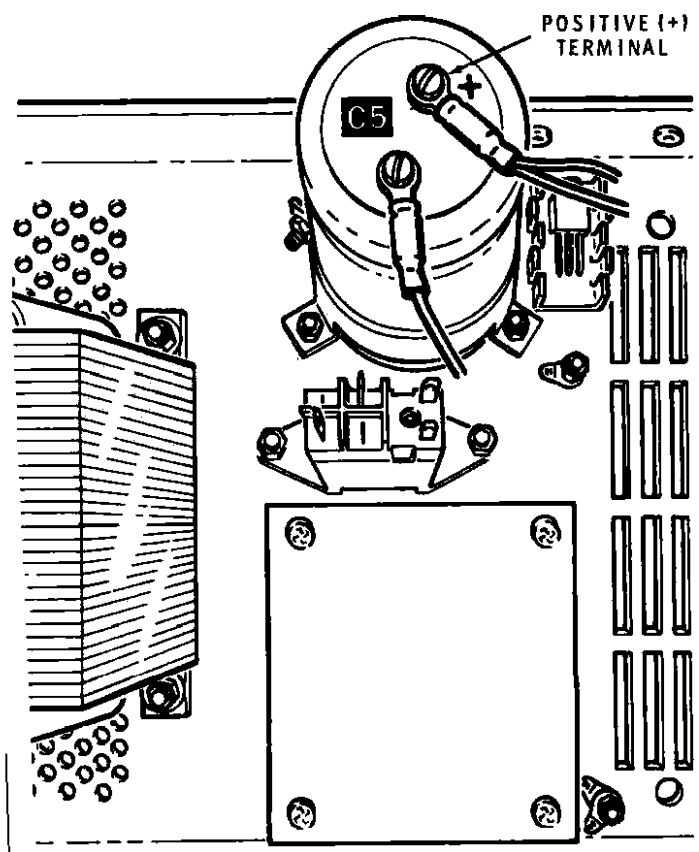
### RESISTANCE CHECKS

- ( ) Connect the ohmmeter ground (common) lead to any convenient point on the bare chassis. Leave this lead connected in this manner until you are directed to remove it in a step.
- ( ) Set the ohmmeter to the  $R \times 10$  range.

Using the positive ohmmeter probe, check the following points for the indicated reading.

- ( ) 1. Line cord plug, large round prong — 0 ohms.
- ( ) 2. Line cord plug, either flat prong (and then the other flat prong) — infinity.

- ( ) 3. On the end of the flat 4-wire cable, either red wire end — 200 ohms (or greater). NOTE: Allow several seconds for the capacitor to charge.
- ( ) Measure the positive (+) terminal of capacitor C5 for 200 ohms (or greater). See Pictorial 6-1.



PICTORIAL 6-1

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Refer to Pictorials 6-2, 6-3 (Illustration Booklet, Page 13), and 6-4 (Illustration Booklet, Page 14) for the following steps.

**CAUTION: Pictorial 6-2 indicates HIGH VOLTAGE AREAS inside the chassis of your power supply. When AC power is applied to your power supply, the voltages in these areas are potentially lethal and could cause severe electrical shock and possible physical damage.**

- ( ) On the display circuit board, set control R204 to the midpoint of its rotation.
- ( ) On the regulator circuit board, set control R310 to the midpoint of its rotation.

**IMPORTANT:** In the following steps, do NOT apply power to your kit unless it is resting on an insulated surface. Make sure all the bare wire ends on the rear panel cables are separated, not touching any part of the chassis or in contact with each other.

- ( ) On the rear panel, remove the 6-wire cable assembly from plug P1.
- ( ) Plug the line cord into an AC outlet.
- ( ) Check the clock on the front panel. You should see some indication of time on each of the four digits. The colon should display both upper and lower dots. The left (hours) digit may be blinking.

## VOLTAGE CHECKS

- ( ) Refer to the following chart and, with the positive voltmeter probe, measure the listed test points for the DC voltage indicated. Voltage readings should be within  $\pm 20\%$ .
- ( ) Set your voltmeter to the +15-volt DC range.

<u>TEST POINT</u>	<u>VOLTAGE</u>
P1, pin 1	0 volts
P1, pin 2	+15 volts
P1, pin 3	+5 volts
P1, pins 4, 5, 6	0 volts
Flat 4-wire cable, either red lead	0 volts

- ( ) Disconnect the line cord from the AC outlet.
- ( ) Reconnect the cable assembly to rear panel plug P1. Make sure the wires on the end of the cable are kept separated.

## REGULATOR ADJUSTMENTS

Refer to Pictorial 6-4 (Illustration Booklet, Page 14) for the following steps.

- ( ) Connect a jumper wire between the tape-marked shielded cable **shield** lead and the violet 4-wire cable leads, or temporarily tack-solder the lead-ends together.
- ( ) Temporarily tack-solder the 75-ohm, 5-watt, wire-wound resistor between either black and either red flat 4-wire cable lead.
- ( ) Temporarily tack-solder the 4-wire cable assembly red lead to either red flat 4-wire cable lead.
- ( ) Plug the line cord into an AC outlet. The relay should click on, and power transformer T1 may hum for a few seconds.
- ( ) Using the positive voltmeter probe, measure for +13.8 volts DC on either red flat 4-wire cable lead. On the regulator circuit board, adjust control R310 for a voltmeter reading of +13.8 volts.

- ( ) Unplug the line cord from the AC outlet.

**NOTE:** In the following step, be careful when you handle the 75-ohm resistor; it may have become very warm during the preceding steps.

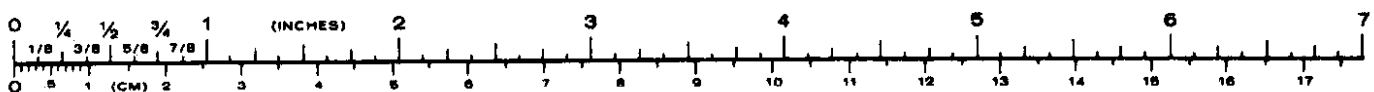
- ( ) Remove the remaining jumper wire or unsolder any temporarily-tacked connection. Remove the 75-ohm wire-wound resistor from the flat-wire cable leads. Be sure to keep all the wire and cable ends separated.
- ( ) Disconnect the voltmeter leads and set the meter aside.

**CLOCK TESTS AND ADJUSTMENTS**

Check and set the clock in the following steps.

- ( ) Plug the line cord into an AC outlet.
- ( ) With a suitable thin tool, depress and hold FAST SET pushbutton switch SW202. Allow the clock to cycle entirely through the 12-hour or the 24-hour format, depending on the way you wired the display circuit board. Check to make sure all numeral segments come on. When you have completed the cycle, stop.
- ( ) Readjust the clock time to approximately 10 minutes prior to your present time.
- ( ) Using the same thin tool, depress SLOW SET pushbutton switch SW201 and adjust the clock to display the present time.
- ( ) Adjust display circuit board control R204 for the desired brightness of the clock digits.
- ( ) Unplug the line cord from the AC outlet.

This completes the "Tests and Adjustments." Proceed to "Final Assembly."



## FINAL ASSEMBLY

Refer to Pictorial 7-1 (Illustration Booklet, Page 15) for the following steps.

- ( ) Refer to Part A of Detail 7-1A (Illustration Booklet, Page 15) and install a foot on the cabinet bottom at AN with 6-32  $\times$  1/2" hardware and a #6 flat washer.
- ( ) In the same manner, install another foot on the cabinet bottom at AP.

**NOTE:** Perform only one of the next two steps. If you wish your Power Supply to rest in a horizontal attitude on your bench, perform the next step. If you wish to have the front of your Power Supply tilted upward slightly, skip the next step and follow the directions in the second step.

- ( ) In the same manner as in the preceding two steps, install feet on the cabinet bottom at AR and AS. **NOTE:** You may discard the two 6-32  $\times$  1-1/4" screws and the tapered spacers.
- ( ) Refer to Part B of Detail 7-1A and place a #6 flat washer on a 6-32  $\times$  1-1/4" screw, followed by a foot and a tapered spacer. Secure the foot and spacer to the cabinet bottom at AR with a #6 lockwasher and a 6-32 nut.
- ( ) In the same manner, install a foot and a tapered spacer on the cabinet bottom at AS.

- ( ) Remove the backing from your "Heathkit" label and carefully position the label into the indicated recess on the front panel escutcheon as shown in the Pictorial.
- ( ) Remove the paper backing from the blue and white label and press the label in place on the inside of the chassis vertical flange as shown in the inset drawing on Pictorial 7-1. **NOTE:** Be sure to refer to the Model and Series numbers on the blue and white label in any correspondence you have with the Heath Company about your kit.

**IMPORTANT:** If you are going to use this Power Supply with other than the Heathkit Model HW-5400 Transceiver, read the information under "Other Transceivers" on the next page before you proceed.

- ( ) Position the chassis assembly of your Power Supply into the cabinet bottom as shown in the Pictorial. Be sure to line up the holes in the side of the cabinet bottom with those in the two rear brackets and those in the front side flanges.
- ( ) Position the cabinet top down onto the flanges of the cabinet bottom. After you align the side holes, secure the two cabinet components to the chassis at AT, AV, AX, and AY with four 6-32  $\times$  3/8" black screws.

This completes the Step-by-Step Assembly of your Power Supply kit.

## **INSTALLATION AND OPERATION**

**NOTE:** If you have purchased the HWA-5400-1 Power Supply for use with the Heathkit HW-5400 Transceiver, refer to the Operation Manual for that kit and prepare the Power Supply cable ends as directed. Use the parts supplied with the Transceiver to perform those steps. After you have completed the cable preparation, return to this point and continue with the following steps.

### **HW-5400 POWER SUPPLY INSTALLATION**

Refer to Pictorial 8-1 (Illustration Booklet, Page 16) for the following steps.

- ( ) Plug the 4-wire flat cable into the rear of the Transceiver.

- ( ) Plug the 4-wire cable assembly into the rear of the Transceiver.
- ( ) Plug the Power Supply into an AC outlet.
- ( ) With a toothpick or other small flat tool, adjust the clock to the time desired.

**NOTE:** Your Power Supply is now completely operational and will be turned on and off appropriately by your Transceiver.

## IN CASE OF DIFFICULTY

The first part of this section of the Manual, titled "Visual Checks," tells you what to do about any difficulties that occur right after your unit is assembled.

If the "Visual Checks" fail to clear up the problems, or if difficulties occur after your unit has been in use for some time, refer to the "Troubleshooting Chart."

NOTE: Refer to the "Circuit Board X-Ray Views" for the physical location of parts.

### VISUAL CHECKS

1. Recheck the wiring. Trace each lead with a colored pencil on the Pictorial as you check it. 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 kit builder.
2. About 90% of the kits that are returned to the Heath Company for service do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all connections to make sure they are soldered as described in the "Soldering" instructions on Pages 6 and 18.
3. Closely examine each circuit board foil in a good light to see that no solder bridges exist between adjacent connections. Remove any solder bridges by holding a clean, hot soldering iron tip between the two points that are bridged until the excess solder flows down onto the tip. Compare your foil pattern with the "Circuit Board X-Ray Views."
4. Check to be sure each transistor is in the proper location (correct part number and/or type number). Make sure each transistor lead is connected to the proper point.
5. Check to be sure the correct diode is installed at each diode location. Make sure each diode band is positioned above the diode band printed on the circuit board.
6. Check each capacitor value. Make sure that a capacitor of the correct value is installed at each capacitor location. Check electrolytic capacitors to be sure their positive (+) and negative (-) leads are at the correct positions.
7. Check each resistor value carefully. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial Diagrams. It would be easy, for example, to install a 2200  $\Omega$  (red-red-red) resistor where a 220  $\Omega$  (red-red-brn) resistor should have been installed.
8. Be sure all the wires and leads connected to the circuit boards have been trimmed as close as possible to the circuit board foils.
9. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

If you still have not located the trouble after the "Visual Checks" are completed, and if a voltmeter is available, check the voltage readings at the locations indicated on the Schematic Diagram. Read the "Precau-

tions for Troubleshooting" before you make any measurements. NOTE: All voltage readings were taken with a high-input impedance voltmeter. Regulated voltages should not vary more than 5% from those indicated on the Schematic. Other voltages may vary as much as  $\pm 20\%$ .

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

## PRECAUTIONS FOR TROUBLESHOOTING

**WARNING:** When power is applied to the kit, the full AC line voltage is present in some areas of your kit (see Pictorial 6-2 on Illustration Booklet, Page 13). Be careful to avoid electrical shock when you perform checks with the power on.

If you have a high-input impedance voltmeter and wish to make voltage measurements, the voltages are shown on the Schematic Diagram. Make sure you observe the following precautions when you make tests with the power on.

1. Be sure you do not short any connections to chassis ground. If the probe should slip, for example, and short out a bias or a voltage supply to ground, it is almost certain to damage one or more transistors and/or diodes.
2. Do not attempt to remove any components from the kit when the power is turned on.



## TROUBLESHOOTING CHART

The following chart lists conditions and possible causes of some troubles you might encounter. If a particular part is mentioned (C106 for example) as a possible cause, check that part and other components connected to it to see that they are installed and/or wired correctly. Also check for solder bridges and poor connections in the surrounding area. It is also possible, on rare occasions, for a part to be faulty and require replacement.

CONDITION	POSSIBLE CAUSE
Less than 200 $\Omega$ reading from line cord flat prong to gnd., or C5 (+) lug to chassis.	<ol style="list-style-type: none"> <li>1. Solder bridge on AC circuit board.</li> <li>2. Transistors Q301, Q302 shorted to heat sink, or no insulators installed.</li> <li>3. Bridge rectifier BR1 incorrectly wired.</li> <li>4. Solder bridge on regulator circuit board.</li> </ol>
Incorrect DC voltages or no indication.	<ol style="list-style-type: none"> <li>1. Fuses F101, F102 open or not installed.</li> <li>2. Transformer T1 primary wiring jumpers not installed.</li> </ol>
No 15-volts DC, or On/Off function.	<ol style="list-style-type: none"> <li>1. Capacitor C106.</li> <li>2. Diodes D101-D104 incorrectly installed.</li> </ol>
Memory circuit 0 or 15-volts DC (should be 5.1-volts).	Zener diode D105.
Cannot adjust 13.8 DC output voltage; remains 17-volts DC.	<ol style="list-style-type: none"> <li>1. 13.8-volt sensor line not connected to DC output.</li> <li>2. Plug P1 incorrectly wired (check both ends, plugs AND sockets).</li> <li>3. Diode D303.</li> <li>4. Transistor Q301.</li> </ol>
DC output reads 25-volts; will not adjust.	<ol style="list-style-type: none"> <li>1. Solder bridge on regulator circuit board.</li> <li>2. Transistors Q1 and Q303.</li> </ol>
DC output at zero.	20-ampere fuse F1.
Clock completely inoperative.	<ol style="list-style-type: none"> <li>1. Display tube V201.</li> <li>2. Control R204.</li> <li>3. Transistor Q201.</li> <li>4. Wiring to display circuit board.</li> <li>5. Solder bridge(s) on display board.</li> </ol>
Clock numeral or colon segments not illuminated.	Check display tube pin connections (see Page 60) and reheat and solder as necessary.
Clock digits illuminated but produce invalid times (e.g. 18:88), or time not advancing.	<ol style="list-style-type: none"> <li>1. IC U201.</li> <li>2. Capacitor C201</li> <li>3. Solder bridge on U201, pin 35.</li> </ol>

## SPECIFICATIONS

Line Voltage .....	120/240 VAC, 50/60 Hz.
Output Voltage .....	13.8 VDC at rated load.
Protection .....	DC Output: 20-ampere fuse. AC Primary: 7-ampere slow-blow fuse for 120 VAC primary, 4-ampere slow-blow fuse for 240 VAC primary.
Output Current .....	As required by the Transceiver up to 18 (20 peak) amperes during transmit.
DC Output Regulation .....	7% from receiver load to transmit load at 120 VAC primary; 4% additional if the AC changes from 110 to 130 VAC or 220 to 260 VAC.
Ripple .....	50 mV or less at rated load.
Duty Cycle .....	18 amperes, 50%, 5 min. ON, 5 min. OFF.
Speaker .....	4 ohms impedance, 300-3000 Hz frequency response, 2 watts peak power.
Clock .....	Display: 4-place vacuum-tube fluorescent, 12/24-hour format.  Accuracy: Line frequency synchronized.
Size (excluding feet) .....	8-1/2" W. × 14" L. × 4-3/8" H. (21.6 × 35.6 × 11.1 cm).
Net Weight .....	26 lbs. (57.3 kg).

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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.

## CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (Illustration Booklet, Page 17) as you read the following Circuit Description.

A different number series has been assigned to the circuit components mounted on each of the circuit boards and on the chassis. These series numbers are referred to in various sections of this Manual to help you identify the components and to determine their locations. These component numbers are grouped as follows:

1- 99	Parts mounted on the chassis.
101-199	Parts mounted on the AC circuit board.
201-299	Parts mounted on the display circuit board.
301-399	Parts mounted on the regulator circuit board.

### PRIMARY CIRCUITS

When the line cord of your Power Supply is connected to an AC power source, the clock transformer primary circuit is energized. This circuit is on at all times, while another primary circuit is controlled by the On-Off switch of the Transceiver. The primary circuits of both transformers include jumper-wiring to accommodate either 120- or 240-VAC and 50/60 Hz power inputs.

### SECONDARY CIRCUITS

AC power to transformer T101 is routed through fuse F101. This circuit is on at all times to provide the necessary power for the On-Off, Memory, and Clock circuits. From the secondary of T101, the voltage is routed across a full-wave bridge rectifier consisting of diodes D101 through D104. From the rectifier, the voltage is filtered by capacitors C105 and C106. The voltage is applied to the clock circuits on the display circuit board, to On-Off relay K1, and to the memory circuits in the Transceiver, when connected. Coil L101, capacitor C107, resistor R103, and zener diode D105 provide additional filtering for the memory circuit 5.1-volt supply.

When the Transceiver is turned on, a grounding path for relay K1 is provided directly from interconnecting cable connector P1 pins 1 and 2. K1 then energizes and closes its contacts to provide an AC path to the primary winding of transformer T1 through fuse F102. Also in the primary circuit of the transformer are varistors R101 and R102, which protect the transformer from transient spikes and bypass capacitors C102, C103, and C104. The output of transformer T1 is rectified by bridge rectifier BR1, filtered by capacitor C5, and then routed to the circuits which regulate the 13.8-volt output.

## OUTPUT CIRCUITS

The bases of transistors Q301 and Q302 are controlled by the action of transistors Q1 and Q303 in the following manner: A 13.8-volt sensor line monitors the output DC voltage and routes the sampled voltage across a voltage divider consisting of resistors R309 and R311 and control R310. Control R310 sets the base bias voltage for Q303, while zener diode D303 sets the emitter reference voltage. When Q303 conducts, it establishes the base bias on transistor Q1 which, in turn, controls the voltage on the bases of transistors Q301 and Q302. Resistors R307 and R308 limit the current through the bases of Q301 and Q302 to inhibit any excess current surges through either transistor. Resistors R303 through R306 in the emitter circuits of these transistors aid in equalizing the current.

At the output of the power supply, capacitors C308 and C309, with resistor R313, provide DC filtering.

The collector voltages for Q1 and Q303 are provided through the circuits of rectifiers D301 and D302, and are filtered by capacitors C301 through C305. Resistor R301 with capacitor C306 help to establish the reference voltage on the base of Q1. This full-wave supply is used to provide more efficient ripple control on the output 13.8-volt DC supply.

## CLOCK CIRCUITS

In the fluorescent display circuit of V201, transistor Q201, resistor R201, and control R204 provide brightness control by regulating the filament-to-grid voltage differential.

The line frequency pulse is routed to the clock portion of integrated circuit U201 through resistor R205. The timekeeping functions of U201 are controlled by jumper wires to produce either 12- or 24-hour operation on either 50 or 60 Hz input, depending on which jumpers you install.

Integrated circuit U201 provides all of the timekeeping and encoding operations to drive display tube V201 directly. Diodes D201 and D202 are used for isolation of the segments in the tens-of-hours digit in V201.

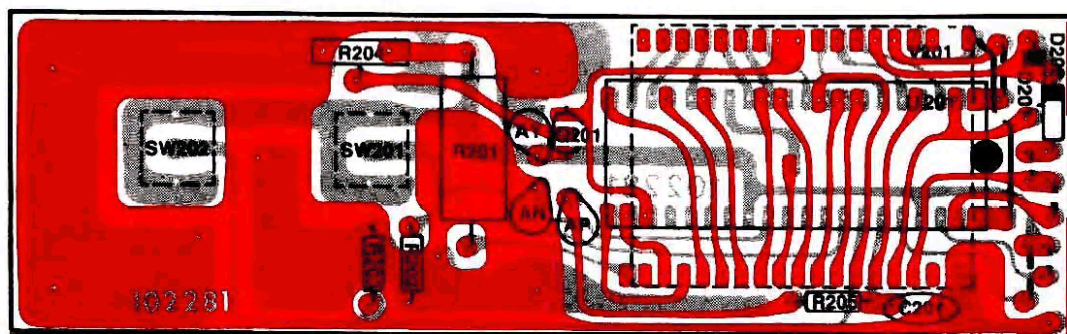
## CIRCUIT BOARD X-RAY VIEWS

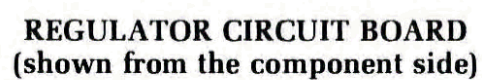
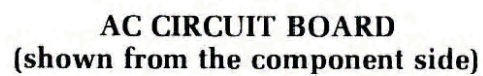
NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

- A. Find the circuit component number (R111, C101, etc.) on the "X-Ray View."
- B. Locate this same number in the "Circuit

Component Number" column of the "Parts List."

- C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



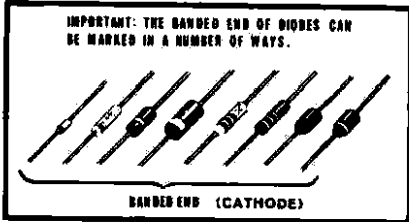
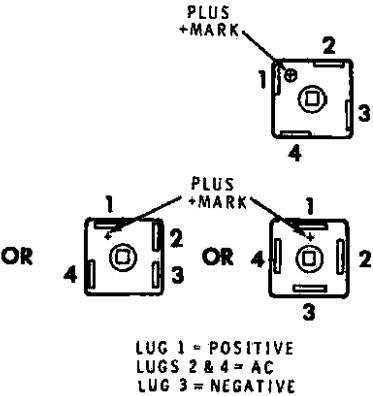


\* Components mounted on the back of circuit board.

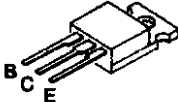
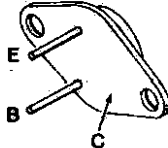



# SEMICONDUCTOR IDENTIFICATION CHART

## DIODES

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
D105, D303	56-16	1N5231B	
D201, D202, D304	56-56	1N4149	
D301, D302	57-42	3A1	
D101 thru D104	57-65	1N4002	
BR1	57-88	MDA990	 <p>LUG 1 = POSITIVE LUGS 2 &amp; 4 = AC LUG 3 = NEGATIVE</p>

TRANSISTORS

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
Q1	417-203	TA7311	
Q301, Q302	417-254	MJ802	
Q201, Q303	417-801	MPSA20	





# CUSTOMER SERVICE

## REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

## ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company  
Benton Harbor  
MI 49022  
Attn: Parts Replacement

**Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.**

## OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

## 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 and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD 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. Do not include the kit Manual.) Place the equipment in a strong carton with at least **THREE INCHES** of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

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

Heath Company  
Service Department  
Benton Harbor, Michigan 49022



**HEATH COMPANY • BENTON HARBOR, MICHIGAN**  
***THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM***

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