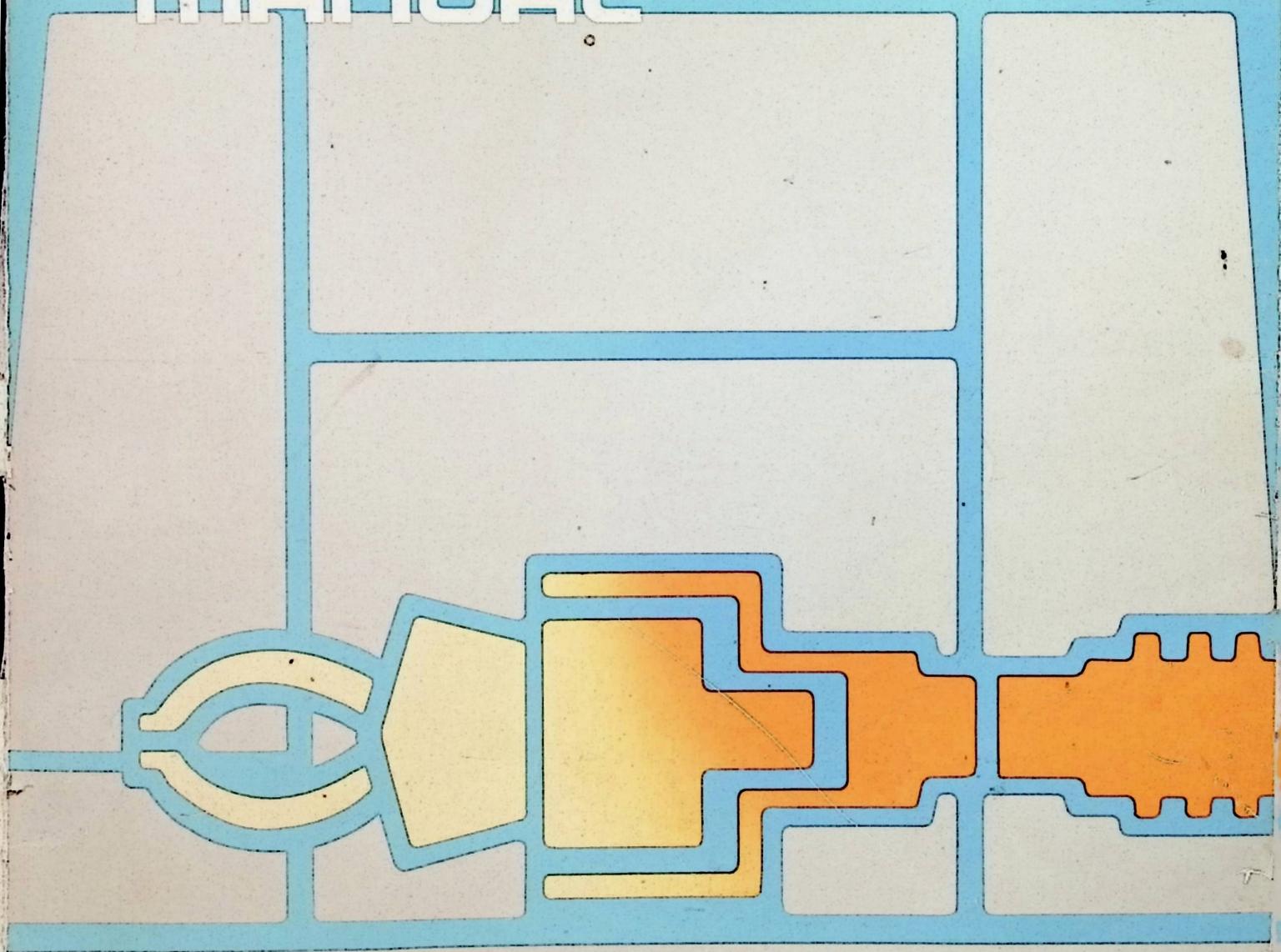
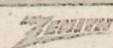


ET-18 ROBOT ASSEMBLY MANUAL



Heathkit



Educational Systems

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 4:30 P.M., EST, Weekdays Only

Audio (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

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 Heath/Zenith Computers and Electronics 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 FORESEEABLE.

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.

HERO ROBOT

Model ET-18A

Assembly Manual

**595-3069-3
HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022**

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INTRODUCTION

The Heathkit Model ET-18 Robot (Hero) is a completely self-contained electromechanical mobile device that is capable of interacting with its environment. It is microprocessor-controlled, with on-board electronic sensors to detect movement, sound, and light; measure the range and bearing of objects; and record the passage of time.

A three-wheeled base with both drive and steering on one wheel permits exceptional maneuverability. Under program control, Hero can traverse a complex path around obstacles, activate its sensors, and modify its behavior in response to sensory inputs.

You can program the on-board microprocessor in three different ways: 1) Through a turret-mounted keyboard; 2) Through a cassette serial port; 3) With a hand-held remote control teaching pendant. With the teaching pendant, you can manually operate the various motors that control the Robot movement. As each movement occurs, the data necessary to duplicate that movement is stored in Hero's memory. Then, you can command Hero to repeat the same series of movements automatically as often as desired.

Because Hero embodies an extremely wide range of applied technology, it is an excellent teaching device in the fields of robotics, industrial electronic controls, microprocessor interfacing, and artificial intelligence.

Housed in an attractive molded plastic case, the housing can be easily removed to access the plug-in circuit boards. An accessible Experimental breadboard allows the user to design circuits that can be interfaced to the Robot's CPU. And, a heavy duty battery pack can be recharged with the accessory Charger that is supplied.

As you use this Assembly Manual to build your Robot, you will gain knowledge and practice identifying electronic parts, circuit board assembly, soldering, and electromechanical assembly techniques. An "Assembly Notes" section tells you how to prepare your work area, the tools you will need, and how to unpack your kit. Instructions for using the Manual, soldering, and parts identification are also included in the Assembly Notes. Since good soldering is one of the most important operations you will perform, the "Step-by-Step Assembly" begins with a circuit board that has few parts but plenty of soldering practice.

After the circuit boards, you will assemble the Remote Control and the Charger as an introduction to electromechanical "nuts and bolts," or hardware, assembly. Finally, you will assemble the base, torso, and head; mount and interconnect the circuit boards; and make initial tests and adjustments. If you follow the instructions and perform each step carefully, you will be rewarded when Hero responds to the tests. And, just in case the tests show that something isn't right, the "In Case of Difficulty" section will help you locate and repair the problem.

Actual operation of the Robot is described in the accompanying User's Manual.

WARNING

Federal Communications Commission requirements prescribe verification of computing devices in Part 15 Subpart J of the rules and regulations. This computing device will meet these requirements when constructed in strict accordance with the instructions in this manual, using only components and materials supplied with the kit or the exact equivalent thereof.

ASSEMBLY NOTES

To simplify the construction of your Robot, each of the printed circuit boards and electromechanical assemblies will be treated as a separate unit. You will unpack only those parts you need, assemble the unit, and then set it aside and begin another unit. After you have completed the circuit boards and assemblies,

you will mount and interconnect them to complete your Robot.

Read completely through these "Assembly Notes." The information they contain will be a big help to you when you begin to unpack and assemble your kit.

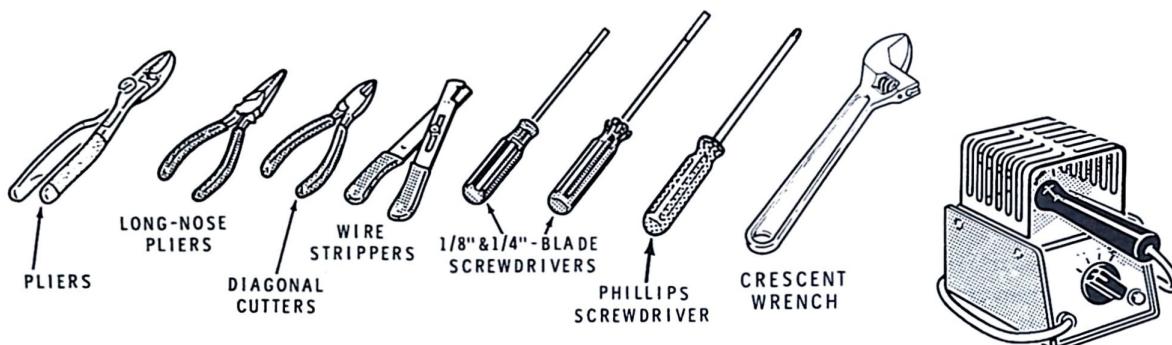
YOUR WORK AREA

You will need a work area where you will not be in anyone's way, and where you and your kit parts will not be disturbed during the assembly. You will also need a work bench (desk or table at least 2-1/2 feet by 4 feet) with a firm top surface to work on. Be sure your work area is well lighted, or use a desk lamp or table lamp.

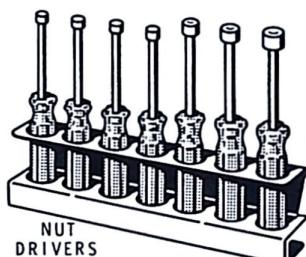
Keep your work bench orderly and clear of all items, parts, or tools except those you are working with. As you complete a circuit board or sub-assembly, you will be told to lay it aside. Unless you have a very large work bench, you would be wise to lay the assembled units on another bench, table, or shelf, or in a large box until you are told to locate them again.

TOOLS

You will need these tools to assemble your kit.



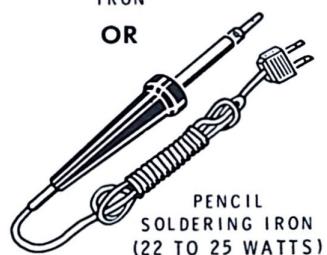
OTHER HELPFUL TOOLS



*TO REMOVE SOLDER FROM CIRCUIT CONNECTIONS.

SOLDERING IRON

OR



PENCIL
SOLDERING IRON
(22 TO 25 WATTS)

UNPACKING

When you opened the shipping container to remove this Manual, you probably noticed a "Pack Index Sheet" that shows the location of "Pack #1", "Pack #2", etc., and a "Final Pack". For the most part, each pack will contain all of the parts you need to assemble one unit (a circuit board or sub-assembly). Sometimes, larger parts for a given unit will be found in the Final Pack, and will be so indicated in the Parts List for that unit.

As you begin to assemble each part of your kit, unpack only the parts listed in the Parts List for that unit.

Check the parts against the list and compare them with the illustrations in the Parts Pictorial. Some parts may be packed in a small envelope stamped with a number. You may open the envelope to identify the part, but return the part to the envelope until you are ready to install it in an assembly step.

Save all packing material for each unit until you have checked and identified all the parts for that unit. Report any incorrect or missing parts to the Heath Company on the Parts Order Form that is included in this kit. Evidence of rough handling or shipping damage must be reported to the carrier who delivered your kit.

USING THIS MANUAL

1. Each step tells you to do something such as mount a part or solder a connection. Read the entire step and then perform the operation exactly as told.
2. As you complete a step, make a check mark (/) in the space provided. This will keep you from missing any steps.
3. The illustrations in this 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 told to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another.
4. The separate "Illustration Booklet" contains illustrations (Pictorials and Details) that are too large for the Assembly Manual. Keep the Illustration Booklet with the Assembly Manual. Its illustrations are arranged in Pictorial number sequence.
5. Position each part as shown in the Pictorial, and do not solder until you are told to do so.
6. Each electronic part in this kit has its own component number (R102, C614, D401, etc.). Use these component numbers when you want to identify the same part in the various sections of this 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 sections at the rear of this Manual.
 - In the Technical Manual.

STEP-BY-STEP ASSEMBLY

In the assembly sections of this Manual, you will unpack and assemble one circuit board at a time, and then one sub-assembly at a time. Finally, you will

mount and interconnect the circuit boards and sub-assemblies to complete your Robot. Unpack ONLY the parts that are called for in each Parts List.

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:

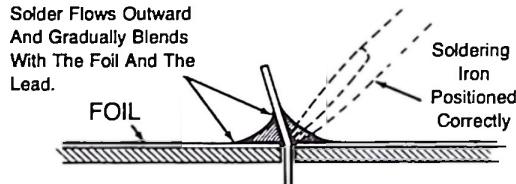
1. Use the right type of soldering iron. A 25 to 40-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.

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 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.

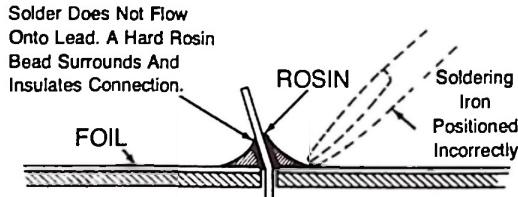
SAFETY WARNING: Avoid eye injury when you cut off excessive lead lengths. Hold the leads so they cannot fly toward your eyes.

A GOOD SOLDER CONNECTION

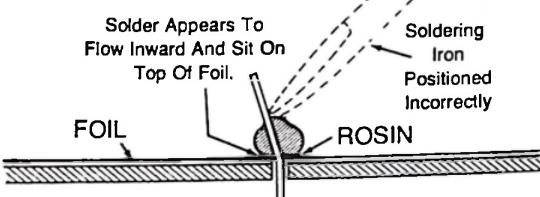


When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS



When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



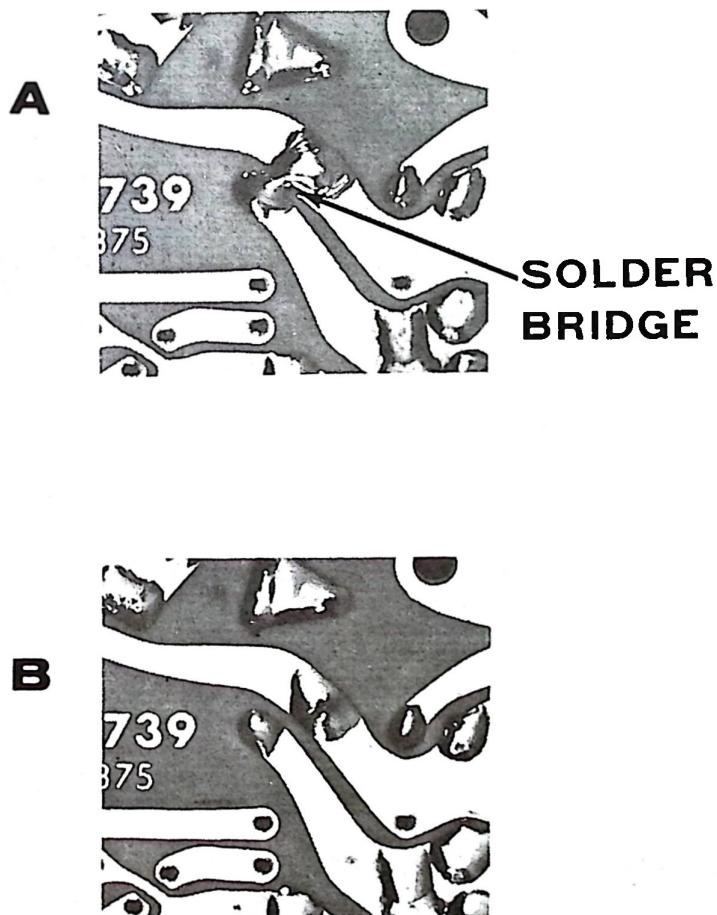
When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

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.

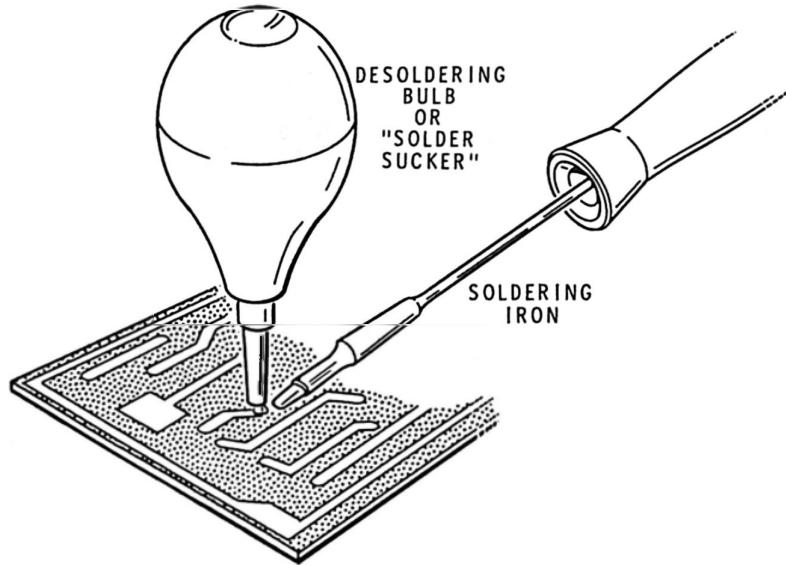
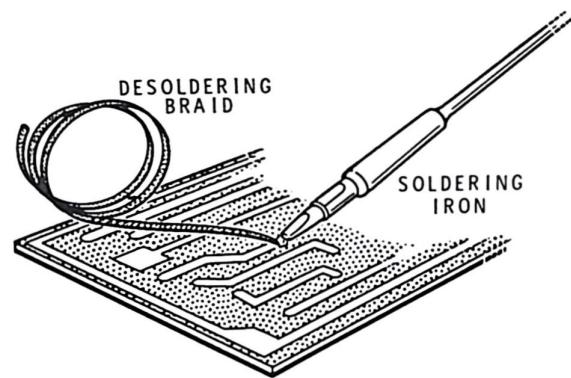
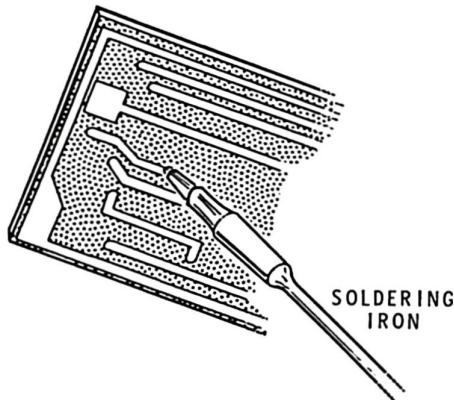


SOLDER REMOVAL

You can clear a solder bridge, or remove solder from a connection (to remove and replace a part, for instance), in the following manner:

1. Clean and "tin" (apply solder to) the tip of your hot soldering iron on a damp sponge or cloth.
2. Hold the circuit board above the soldering iron and touch the tip of the iron UNDER the solder you wish to remove. Let the melted solder flow downward onto the tip.

3. When the melted solder runs onto the tip of the iron, remove the iron from the connection and clean the excess solder from the tip.
4. Repeat the above steps until most of the unwanted solder is removed.
5. Use the desoldering braid (supplied), or a desoldering bulb or "solder sucker," if necessary to clear the rest of the solder from a connection.



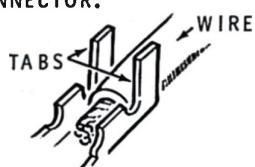
ATTACHING CONNECTORS

You will be required to attach various connectors to the ends of wires as you assemble this kit. Since many of the connectors will be inserted into connector blocks, their tabs must be carefully rounded. Unless you have a crimping tool for installing connectors, use the following procedure.

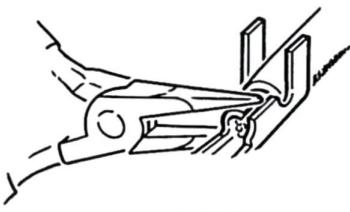
- CUT WIRE TO SPECIFIED LENGTH.
REMOVE 1/8" OF INSULATION
FROM END.



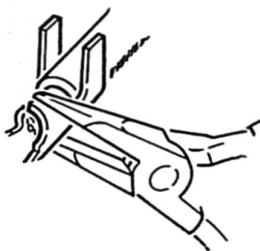
- INSERT WIRE BETWEEN TABS
IN CONNECTOR.



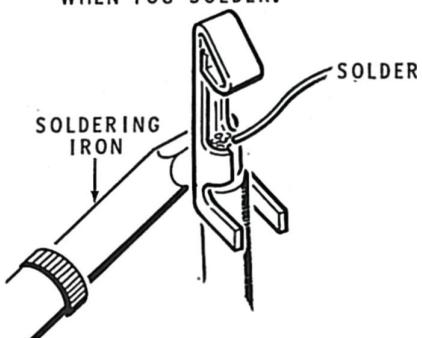
- BEND TAB TIGHTLY AROUND
BARE WIRE END.



- BEND OPPOSITE TAB
AROUND FIRST TAB.



- APPLY SOLDER. DO NOT ALLOW SOLDER
TO FLOW INTO THE CONNECTOR END.
HOLD THE CONNECTOR END UPWARD
WHEN YOU SOLDER.



- WHEN SOLDER COOLS,
CAREFULLY SHAPE END TABS
AROUND THE INSULATION
ON THE WIRE.

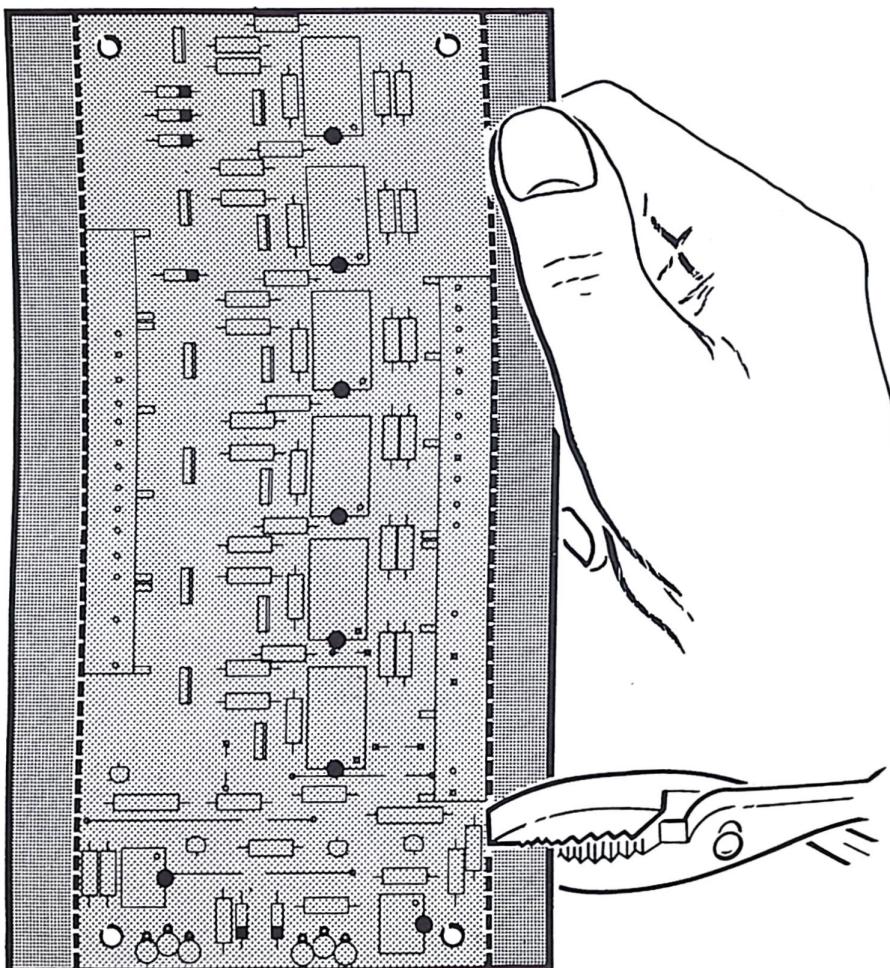


NOTE: FOR SMALLER WIRES,
YOU MAY HAVE TO CLIP OFF
ABOUT 1/32" OF THE END TABS
BEFORE YOU SHAPE THE TABS
AROUND THE INSULATION.

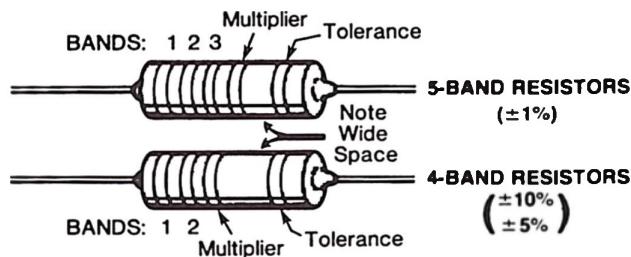
BREAK AWAY EDGES

Some of the circuit boards in this kit have an extra 3/8" blank area along one or more edges. This extra area was necessary during the manufacture of the board, but must be removed before you mount and solder parts on the board.

You can break away the extra area at the scored line with your fingers or a pair of pliers as shown.



PARTS



Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), $k\Omega$ (kilohms), or $M\Omega$ (megohms). They are usually identified by a color code of four or five color bands, where each color represents a number. See the "Resistor Color Code" chart. These colors are given in the steps in their proper order (except for the last band, which indicates a resistor's "tolerance"; see the "Resistor Tolerance" chart). You do not need to know the color code.

Occasionally, a "precision" or "power" resistor may have the value stamped on it. The letter R, K, or M may also be used at times to signify a decimal point, as in:

- 2R2 = 2.2 Ω
- 2K2 = 2.2 $k\Omega$, or 2200 Ω
- 2M2 = 2.2 $M\Omega$

Precision resistors may also be marked as shown in the following examples. The values of the multipliers are shown in the "Multiplier Chart," and the tolerance values are shown in the "Resistor Tolerance" chart.

EXAMPLES: 1009C = $100 \times 0.1 = 10 \Omega$, $\pm 0.25\%$
1001D = $100 \times 10 = 1000 \Omega$, $\pm 0.5\%$

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

First and second digits of capacitor's value: 15

Multiplier: Multiply the first & second digits by the proper value from the "Multiplier Chart."

To find the tolerance of the capacitor, look up this letter in the capacitor Tolerance chart.

RESISTOR COLOR CODE				
	Band 1	Band 2	Band 3 (if used)	Multiplier
Color	1st Digit	2nd Digit	3rd Digit	
Black	0	0	0	1
Brown	1	1	1	10
Red	2	2	2	100
Orange	3	3	3	1,000
Yellow	4	4	4	10,000
Green	5	5	5	100,000
Blue	6	6	6	1,000,000
Violet	7	7	7	0.01
Gray	8	8	8	0.1
White	9	9	9	

RESISTOR TOLERANCE		
	COLOR OR LETTER	
$\pm 10\%$	SILVER	
$\pm 5\%$	GOLD	J
$\pm 2\%$	RED	G
$\pm 1\%$	BROWN	F
$\pm 0.5\%$	GREEN	D
$\pm 0.25\%$	BLUE	C
$\pm 0.1\%$	VIOLET	B
$\pm 0.05\%$	GRAY	

MULTIPLIER CHART			
FOR THE NUMBER:	MULTIPLY BY:	FOR THE NUMBER:	MULTIPLY BY:
0	1	4	10,000
1	10	5	100,000
2	100	8	0.01
3	1000	9	0.1

LETTER	10 pF OR LESS	OVER 10 pF
B	$\pm 0.1 \text{ pF}$	
C	$\pm 0.25 \text{ pF}$	
D	$\pm 0.5 \text{ pF}$	
F	$\pm 1.0 \text{ pF}$	$\pm 1\%$
G	$\pm 2.0 \text{ pF}$	$\pm 2\%$
H		$\pm 3\%$
J		$\pm 5\%$
K		$\pm 10\%$
M		$\pm 20\%$

EXAMPLES: 151K = $15 \times 10 = 150 \text{ pF}$
759 = $75 \times 0.1 = 7.5 \text{ pF}$

NOTE: The letter "R" may be used at times to signify a decimal point, as in: 2R2 = 2.2 (pF or μF).

EXPERIMENTAL CIRCUIT BOARD

PARTS LIST

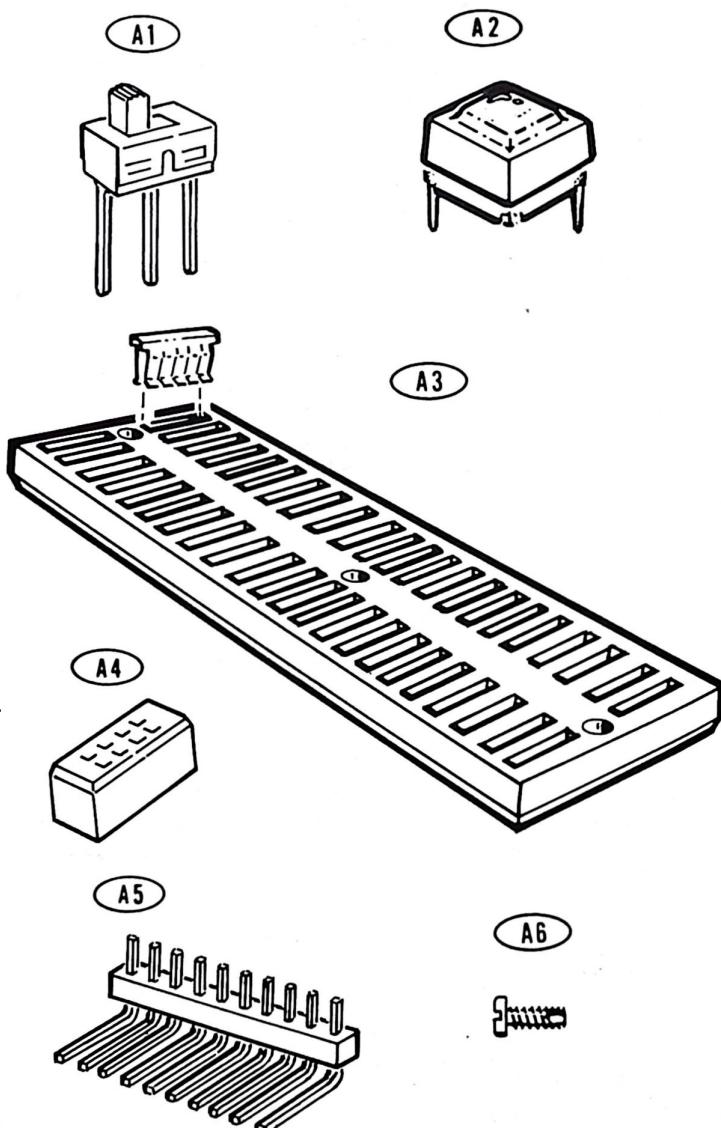
Refer to the "Pack Index Sheet" and remove the parts from pack #1. Check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial. Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

Some parts are marked with a "171-" or "172-" packaging number. These numbers are used for packaging purposes only and do not appear in the "Parts List."

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. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	60-623	1	Slide switch	SW1302
A2	64-901	1	Pushbutton switch	SW1301
A3	432-880	1	Large connector block with 128 metal inserts	
A4	432-973	8	4-pin connector block	
A5	432-984	4	10-pin angled pin connector	
A6	250-163	3	#4 x 5/16" self-tapping screw	
	85-2895-1	1	Experimental printed circuit board Solder De-soldering braid Manual (See Page 1 for part number) *Parts Order Form	

*NOTE: A set of labels and the Parts Order Form are packed with this Manual. Set the labels aside until they are called for later.



STEP-BY-STEP ASSEMBLY

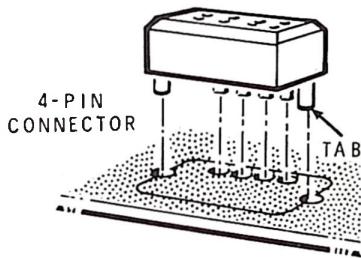
START

In the following steps, you will be told how to install and solder the first part on the circuit board. Read and perform each step separately. Then use the same procedure when you install and solder other parts on the circuit board.

NOTE: If this circuit board (or a future circuit board) has an extra blank area along one or more edges, refer to Page 12 and break away the edge at the perforation.

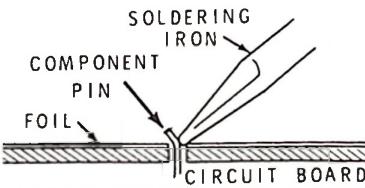
- () Position the circuit board as shown with the printed side up. This is the side with the name "Experimental Board" and 85-2565-1 printed on it. The opposite side will be referred to as the foil side.

- () Refer to the Detail below and mount a 4-pin connector block at the indicated location. Be sure the pins and tabs enter the circuit board holes and the block sets flush against the circuit board.

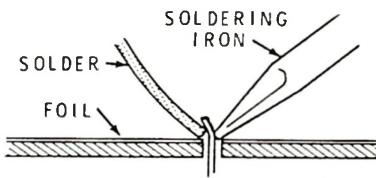


- () Turn the circuit board over and solder each of the four pins to the foil as follows:

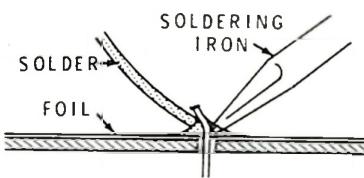
1. Push the soldering iron tip against both the pin and the circuit board foil. Heat both for two or three seconds.

**CONTINUE**

2. Then apply solder to the other side of the connection. **IMPORTANT:** Let the heated pin 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.



- () When you have soldered all four pins, check carefully to be sure there are no solder bridges between foils. Examine each pin for a good solder connection. Compare your soldering with the illustrations on Page 9.

NOTE: If you find a solder bridge, remove it as described on Page 10.

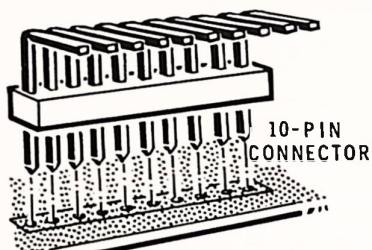
- () As before, install the remaining seven 4-pin connector blocks and solder their pins to the foil. Then inspect the foil side of the board for solder bridges.

- () Touch the tip of your soldering iron to each plastic tab on the foil side of the circuit board. This will melt the tabs to the holes for secure mounting of the connector block.

PICTORIAL 1-1

START ▶

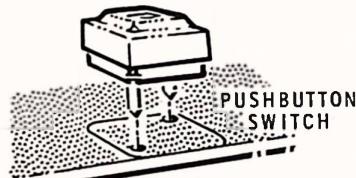
- () P1301: Install a 10-pin angled connector at P1301 as shown below. Insert all ten pins into their holes and solder them to the foils.



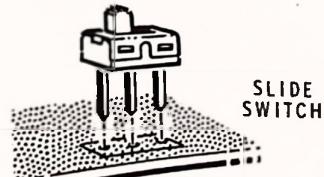
- () Carefully inspect the foils for good solder connections, and to be sure there are no solder bridges between foils.

- () P1302, P1303, P1304: In the same manner, install the other 10-pin angled connectors. Solder the pins to the foil and inspect for solder bridges.

- () SW1301: Mount the pushbutton switch at SW1301 as shown and solder both pins to the foil.



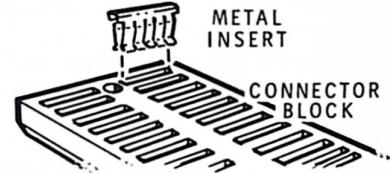
- () SW1302: Mount the slide switch at SW1302 as shown, flush against the circuit board, and solder the pins to the foil. This switch may be installed either way in the circuit board. Cut off any excess pin lengths.



- () Reinspect all solder connections on the foils. Remove any solder bridges, and resolder any poor connections. Then lay the circuit board aside.

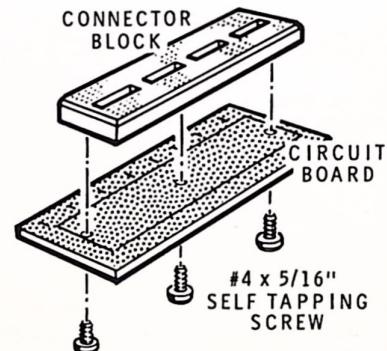
CONTINUE ▶

- () Position the large connector block face down on your work bench. Press a metal insert into the connector block as shown.



- () In the same manner, press metal inserts into the remaining slots in the connector block. You can discard any inserts that are left over.

- () Install the connector block on the circuit board with three #4 × 5/16" self-tapping screws. You may discard the vinyl insulator that was packed with the connector block.



This completes the assembly of the Experimental Circuit Board. Set the circuit board aside.

PICTORIAL 1-2

SENSE CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #2. Check each part against the following list. The key numbers correspond to the numbers on the "Sense Circuit Board Parts Pictorial" (Illustration Booklet, Page 1). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

Some parts are marked with a "171-" or "172-" packaging number. These numbers are used for packaging purposes only and do not appear in the "Parts List."

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. For prices, refer to the separate "Heath Parts Price List."

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

CIRCUIT Comp. No.

RESISTORS — CONTROLS

All resistors are 1/4-watt, 5% (fourth band gold).

NOTE: The resistors may be packaged in more than one envelope. Open all resistor envelopes before you check the resistors against the Parts List.

A1	6-100-12	1	10 Ω (brn-blk-blk)	R618
A1	6-470-12	4	47 Ω (yel-viol-blk)	R625, R634, R635, R648
A1	6-471-12	1	470 Ω (yel-viol-brn)	R629
A1	6-681-12	9	680 Ω (blu-gry-brn)	R607, R608, R609, R611, R612, R613, R614, R615, R616
A1	6-102-12	4	1000 Ω (brn-blk-red)	R637, R641, R642, R649
A1	6-472-12	15	4700 Ω (yel-viol-red)	R604, R605, R606, R617, R619, R623, R624, R626, R627, R628, R632, R638, R639, R643, R644

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

CIRCUIT Comp. No.

Resistors (Cont'd.)

A1	6-103-12	2	10 kΩ (brn-blk-org)	R636, R647
A1	6-104-12	1	100 kΩ (brn-blk-yel)	R645
A1	6-564-12	1	560 kΩ (grn-blu-yel)	R621
A1	6-225-12	1	2.2 MΩ (red-red-grn)	R631
A2	10-1049	1	2 MΩ control	R646
A2	10-928	1	1 MΩ control	R633

CAPACITORS

B1	21-722	2	330 pF ceramic	C608, C613
B1	21-140	1	.001 μF ceramic	C609
B2	27-138	2	.033 μF Mylar	C607, C611
B3	21-762	5	.1 μF (104) glass	C601, C602, C604, C605, C614
B4	25-212	1	22 μF tantalum	C603
B5	25-918	4	100 μF electrolytic	C606, C612, C615, C617
B6	25-864	1	10 μF electrolytic	C616

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

KEY No.	HEATH Part No.	QTY. _____	DESCRIPTION _____	CIRCUIT Comp. No.
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TRANSISTORS — INTEGRATED CIRCUITS (IC's)

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

D1	417-233	2	2N3643 transistor	Q608, Q612
D1	417-235	3	2N4121 transistor	Q604, Q607, Q609
D1	417-801	5	MPSA20 transistor	Q602, Q603, Q605, Q606, Q611
D1	417-865	1	MPSA55 transistor	Q601

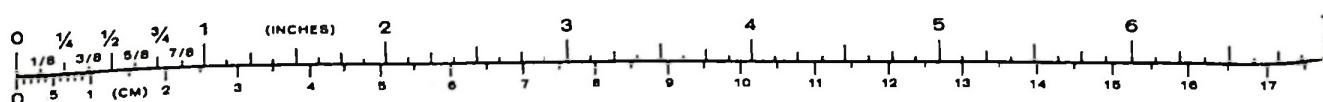
NOTE: Some IC's are protected by a foam pad against static electricity. DO NOT remove them from their foam pad until you are instructed to install the IC in a step.

D2	443-754	1	74LS240 IC	U601
D2	443-949	1	ADC0804 IC	U602

MISCELLANEOUS

85-2874-1	1	Sense circuit board
344-50	20"	Black wire
E1	412-640	8 Red light-emitting diode (LED) V601-V608
E2	432-134	2 Wire socket
E3	432-779	2 12-pin connector
E4	434-311	2 20-pin IC socket
E5	490-111	1 IC puller
E6	56-602	2 Germanium

NOTE: Break away any perforated or scored blank edges of the circuit board as described on Page 12.



START →**STEP-BY-STEP ASSEMBLY**

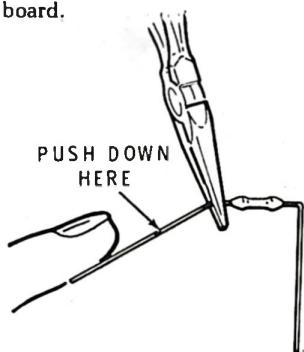
In the following steps, you will be given detailed instructions on how to install and solder the first resistor on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

NOTE: Only a portion of the circuit board is shown in some of the following Pictorials. The small "Identification Drawing" at the top of the page shows the area of the circuit board to be assembled.

- () Position the circuit board as shown with the printed side (not the foil side) up.

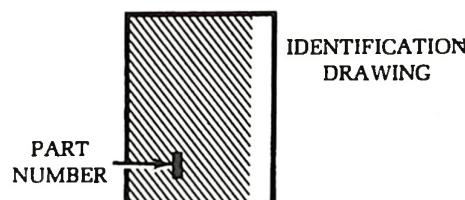
NOTE: When you install a component that has its value printed on it, position the value marking up, so it can be easily read. Diodes should be mounted with their type or part number up, if possible.

- () Hold a $680\ \Omega$ (blu-gry-brn) resistor with long-nose pliers and bend the leads straight down to fit the hole spacing on the circuit board.

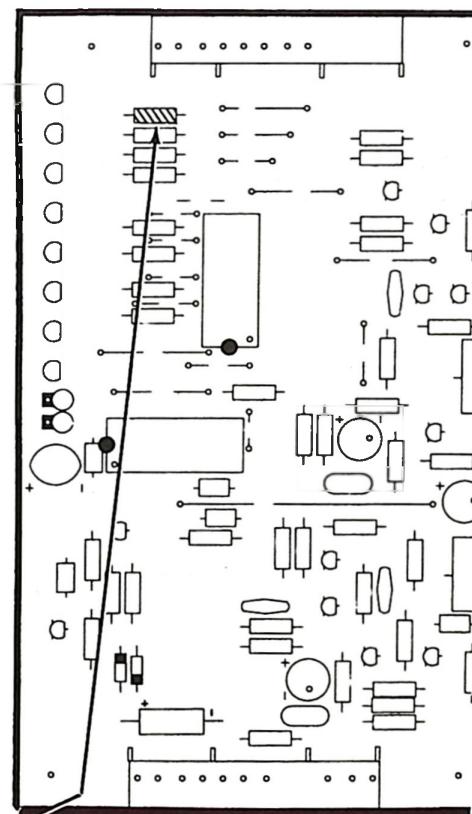


- () R616: Push the leads through the holes at the indicated location on the circuit board. The end with color bands may be positioned either way.

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



The steps performed in this Pictorial are in this area of the circuit board.

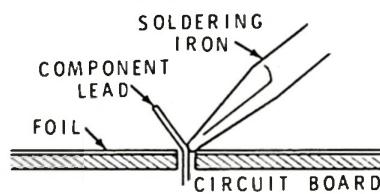


PICTORIAL 2-1

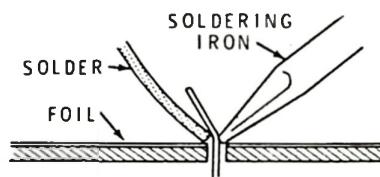
CONTINUE →

- () Turn the circuit board over and solder the resistor leads to the foil as follows:

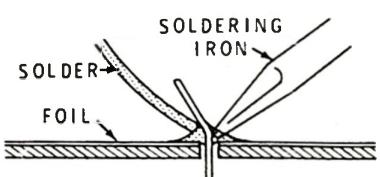
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat both for two or three seconds.



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

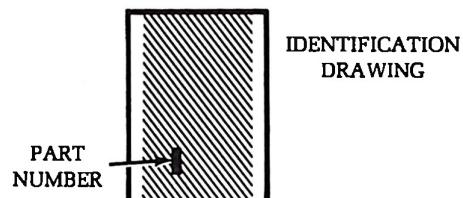


3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.



- () 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 8. After you have checked the solder connections, proceed with the assembly on Page 20. Use the same soldering procedure for each connection.

**START**

NOTE: When a black wire is called for in a step, remove 1/4" of insulation from each end of the specified length of black wire. When a bare wire is called for, remove all the insulation from the proper length of black wire.

Be sure you installed resistor R616 in Pictorial 2-1

(1" bare wire.) ✓

(1-3/8" black wire.) ✓

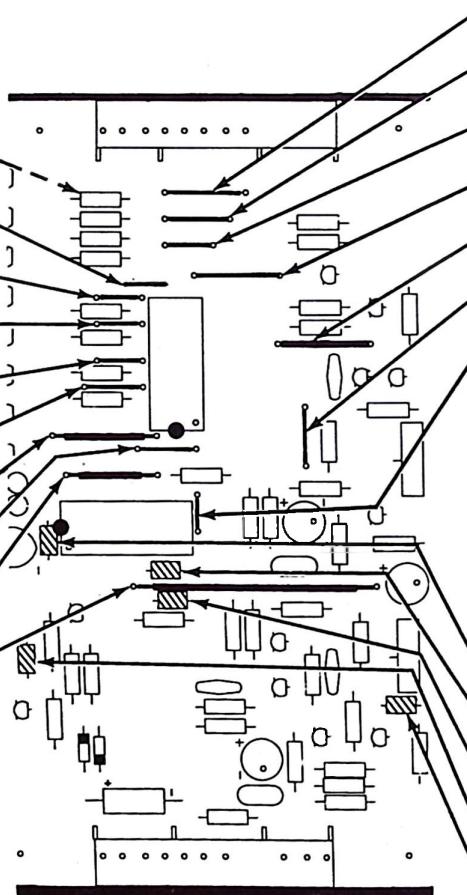
(1" bare wire.) ✓

(1-1/4" black wire.) ✓

(2-3/8" black wire.) ✓

(Solder the wires to the foil and cut off the excess wire lengths.

The steps performed in this Pictorial are in this area of the circuit board.

**CONTINUE**

(1-1/8" bare wire.) ✓

(1" bare wire.) ✓

(1" bare wire.) ✓

(1-1/8" bare wire.) ✓

(1-1/4" black wire.) ✓

(1" bare wire.) ✓

(1" bare wire.) ✓

(Solder the wires to the foil and cut off the excess wire lengths.

NOTE: When you install the following capacitors, be sure to hold the leads with long-nose pliers when you bend the leads so you do not break the glass body. The capacitors can be installed either way.

(C602: .1 μ F glass.) ✓

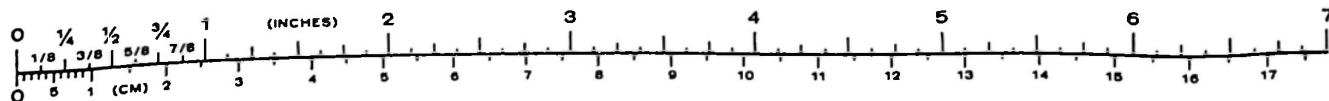
(C605: .1 μ F glass.) ✓

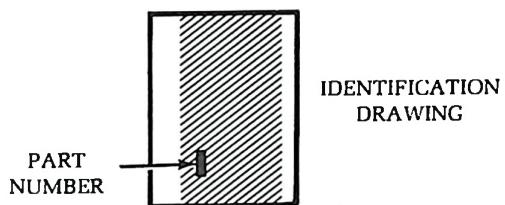
(C604: .1 μ F glass.) ✓

(C601: .1 μ F glass.) ✓

(C614: .1 μ F glass.) ✓

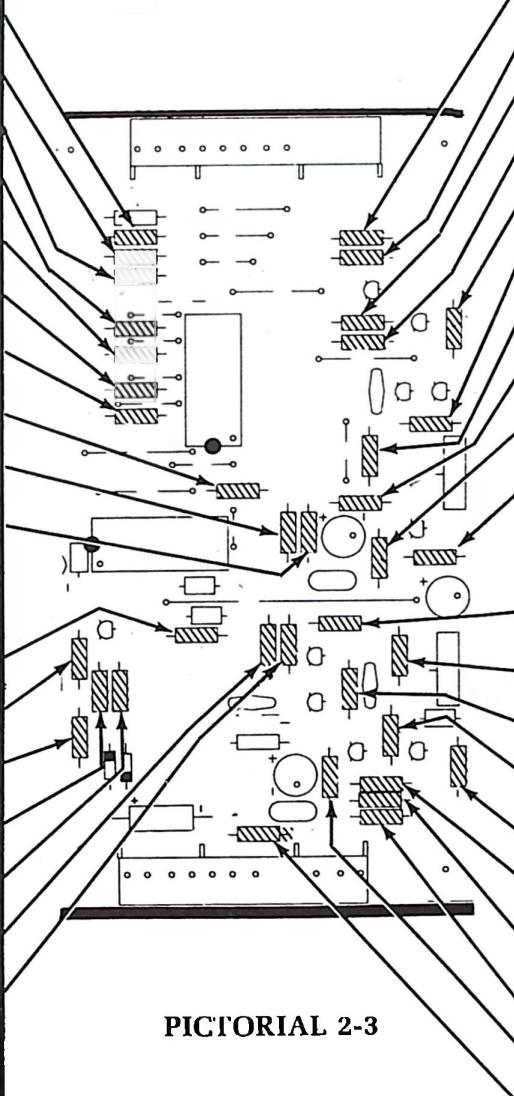
(Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-2

**START**

- R615: 680 Ω (blu-gry-brn). ✓
- R614: 680 Ω (blu-gry-brn). ✓
- R618: 680 Ω (blu-gry-brn). ✓
- R612: 680 Ω (blu-gry-brn). ✓
- R611: 680 Ω (blu-gry-brn). ✓
- R609: 680 Ω (blu-gry-brn). ✓
- R608: 680 Ω (blu-gry-brn). ✓
- R618: 10 Ω (brn-blk-blk). ✓
- R629: 470 Ω (yel-viol-brn). ✓
- R627: 4700 Ω (yel-viol-red). ✓
- Solder the leads to the foil and cut off the excess lead lengths.
- R617: 4700 Ω (yel-viol-red). ✓
- R607: 680 Ω (blu-gry-brn). ✓
- R605: 4700 Ω (yel-viol-red). ✓
- R604: 4700 Ω (yel-viol-red). ✓
- R606: 4700 Ω (yel-viol-red). ✓
- R623: 4700 Ω (yel-viol-red). ✓
- R625: 47 Ω (yel-viol-blk). ✓
- Solder the leads to the foil and cut off the excess lead lengths.

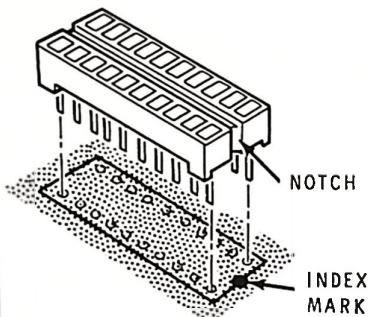
The steps performed in this Pictorial are in this area of the circuit board.

**CONTINUE**

- R637: 1000 Ω (brn-blk-red). ✓
- R636: 10 k Ω (brn-blk-org). ✓
- R632: 4700 Ω (yel-viol-red). ✓
- R635: 47 Ω (yel-viol-blk). ✓
- R628: 4700 Ω (yel-viol-red). ✓
- R634: 47 Ω (yel-viol-blk). ✓
- R631: 2.2 M Ω (red-red-grn). ✓
- R648: 47 Ω (yel-viol-blk). ✓
- R647: 10 k Ω (brn-blk-org). ✓
- R649: 1000 Ω (brn-blk-red). ✓
- Solder the leads to the foil and cut off the excess lead lengths.
- R626: 4700 Ω (yel-viol-red). ✓
- R645: 100 k Ω (brn-blk-yel). ✓
- R621: 560 k Ω (grn-blu-yel). ✓
- R643: 4700 Ω (yel-viol-red). ✓
- R642: 1000 Ω (brn-blk-red). ✓
- R641: 1000 Ω (brn-blk-red). ✓
- R644: 4700 Ω (yel-viol-red). ✓
- R639: 4700 Ω (yel-viol-red). ✓
- R619: 4700 Ω (yel-viol-red). ✓
- R638: 4700 Ω (yel-viol-red). ✓
- Solder the leads to the foil and cut off the excess lead lengths.

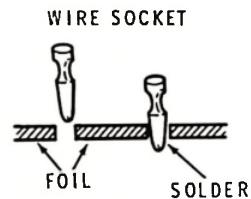
START

When you install an IC socket, align the notch of the socket with the index mark on the circuit board and insert the pins into their holes. Then solder the pins to the foil.



- () 20-pin IC sockets at locations U601 and U602.

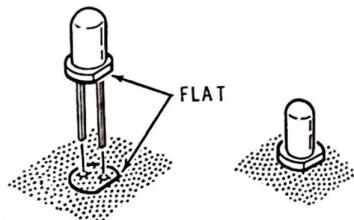
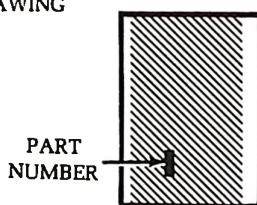
When you install a wire socket, insert its pointed end tightly into the circuit board hole from the lettered side. Then solder the pin to the foil. DO NOT get solder inside the pin.



- () Wire socket at TP2.

- () Wire socket at TP1.

When you install an LED, align its flat with the flat outline on the board. Insert the leads all the way into their holes, then solder the leads to the foil and cut off the excess lead lengths.

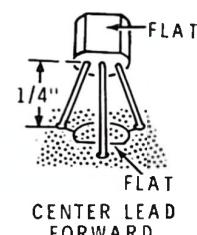
**IDENTIFICATION DRAWING**

The steps performed in this Pictorial are in this area of the circuit board.

CONTINUE

- () Eight LEDs at location V601 through V608.

NOTE: When you install a transistor, align its flat with the flat on the board. Insert the leads into the correct holes. Position the transistor 1/4" above the board. Then solder the leads to the foil and cut off the excess lead lengths.



CENTER LEAD FORWARD

- (✓) Q608: 2N3643 transistor (#417-233). ✓

- (✓) Q607: 2N4121 transistor (#417-235). ✓

- (✓) Q606: MPSA20 transistor (#417-801). ✓

- (✓) Q605: MPSA20 transistor (#417-801). ✓

- (✓) Q602: MPSA20 transistor (#417-801). ✓

- (✓) Q612: 2N3643 transistor (#417-233). ✓

- (✓) Q601: MPSA55 transistor (#417-865). ✓

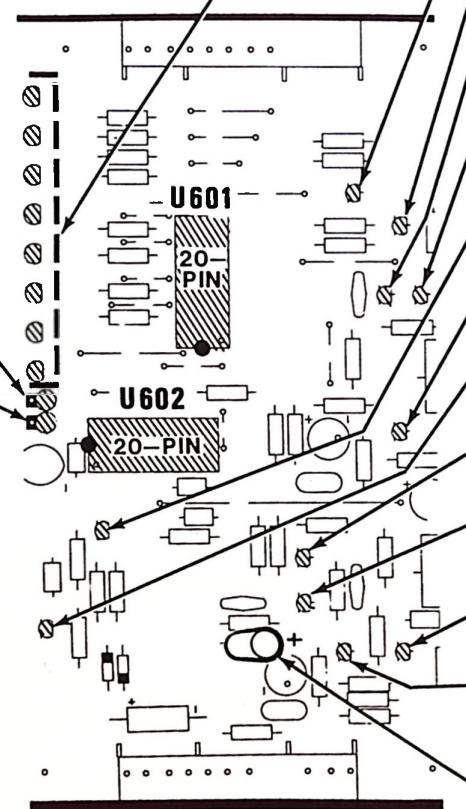
- (✓) Q604: 2N4121 transistor (#417-235). ✓

- (✓) Q603: MPSA20 transistor (#417-801). ✓

- (✓) Q611: MPSA20 transistor (#417-801). ✓

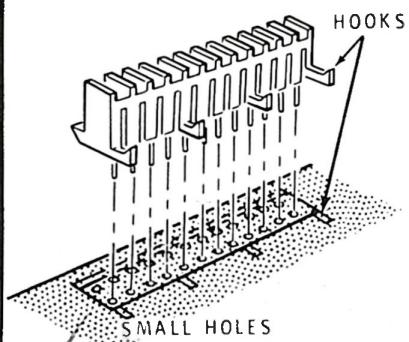
- (✓) Q609: 2N4121 transistor (#417-235). ✓

- (✓) C617: 100 μ F electrolytic. Bend the leads outward and install the capacitor at "47". Be sure to position the positive (+) lead as shown. See Detail 2-5B.

**PICTORIAL 2-4**

START ▶

When you install a 12-pin connector, align its hooks with their outline on the board and insert the pins all the way into the row of small holes. Then solder the pins to their foils.



12-pin connectors at locations P601 and P602. ✓

C613: 330 pF ceramic. See Detail 2-5A. ✓

C615: 100 μ F electrolytic. See Detail 2-5B. ✓

C612: 100 μ F electrolytic. ✓

C611: .033 μ F Mylar. ✓

C603: 22 μ F tantalum. See Detail 2-5C. ✓

NOTE: When you install a diode in the next two steps, position the banded end over the band mark on the circuit board.



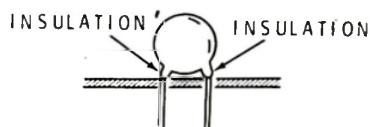
D602: 1N4149 diode (#56-602). ✓

D601: 1N4149 diode (#56-602). ✓

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

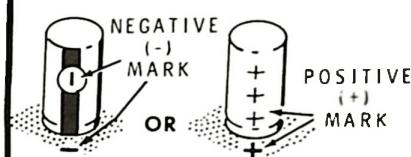
C616: 10 μ F electrolytic. Match the + or - marks of the capacitor with the same mark on the circuit board. ✓

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



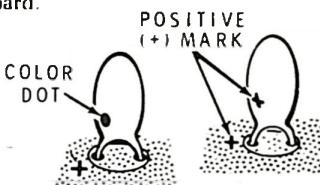
Detail 2-5A

NOTE: When you install electrolytics, be sure to match the plus (+) mark on the capacitor with the plus (+) mark on the circuit board, or match the minus (-) mark on the capacitor with the minus mark on the circuit board.



Detail 2-5B

NOTE: When you install a tantalum capacitor, match the positive (+) mark, or color dot on the capacitor with the positive (+) mark on the board.



Detail 2-5C

CONTINUE ▶

C608: 330 pF ceramic. ✓

C609: .001 μ F ceramic. ✓

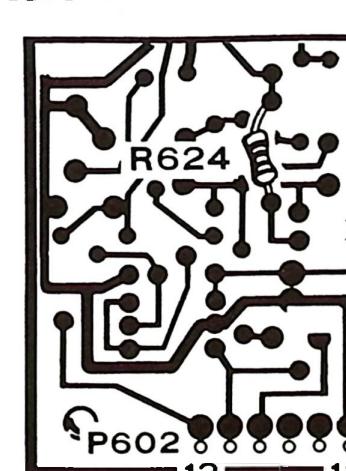
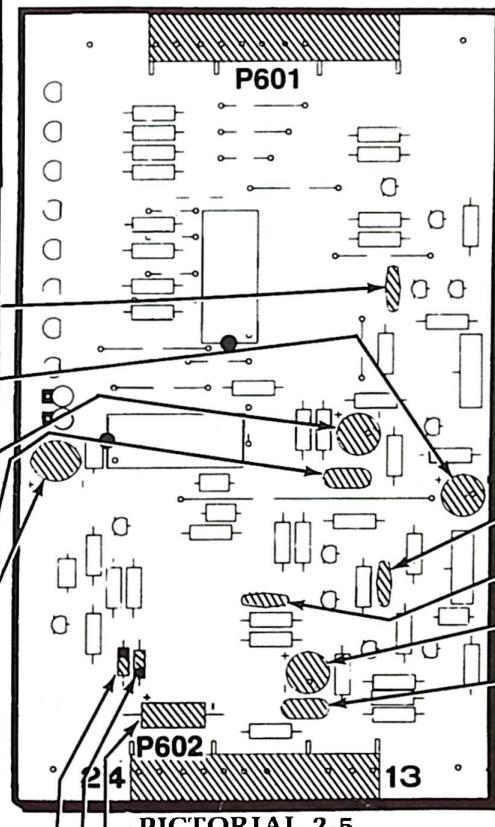
C606: 100 μ F electrolytic. ✓

C607: .033 μ F Mylar. ✓

Refer to Detail 2-5D and position the circuit board foil side up, with plug P602 at the bottom.

R624: Cut the leads of a 4700 Ω resistor (yel-viol-red) to 1/2". Then tack solder the resistor leads to the indicated foil pads.

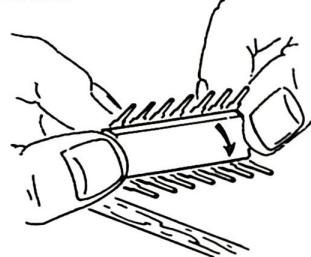
Solder the leads to the foil and cut off the excess lead lengths.



Detail 2-5D

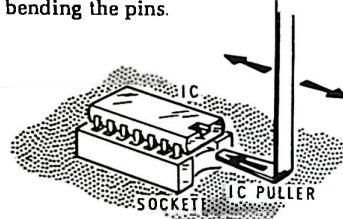
START ▶

When you install an integrated circuit (IC), straighten its pins on a flat surface as shown. Then refer to Detail 2-6A to identify the pin 1 end of the IC end of the socket.



Carefully insert the pins in the socket and press firmly. Be sure that all pins enter the socket and that none are bent under the IC.

If you must remove an IC from its socket, use the IC puller as shown. Pry each end a little at a time to avoid bending the pins.

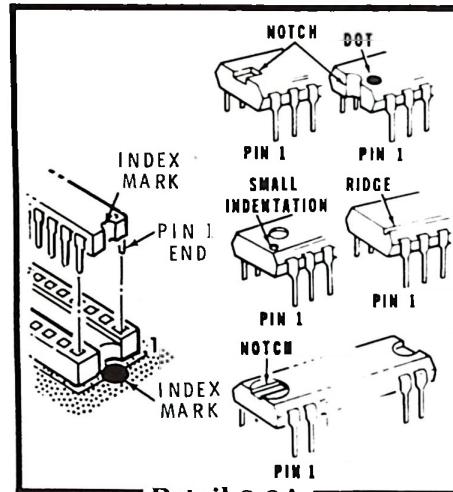


() U601: 74LS240 IC (#443-754).

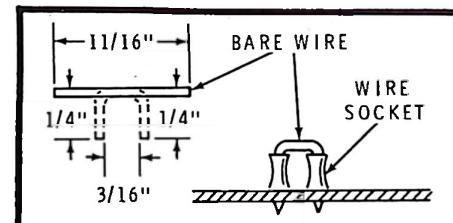
CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad from the IC, DO NOT let go of the IC. Install the IC as follows. Read the entire step before you pick up the IC.

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 the other hand.
5. Align the pin 1 end of the IC with the index mark on the circuit board. See Detail 2-6A.
6. Then push the IC pins into the IC socket. Once in the socket, the IC is protected.

() U602: ADC0804 IC (#443-949).



Detail 2-6A



Detail 2-6B

CONTINUE ▶

- () Bend an 11/16" bare wire and insert it into wire sockets TP1 and TP2 as shown in Detail 2-6B.

NOTE: Solder the pins to the foil as you install a control. Be sure it is tight against and perpendicular to the circuit board. Do not cut off the pins.

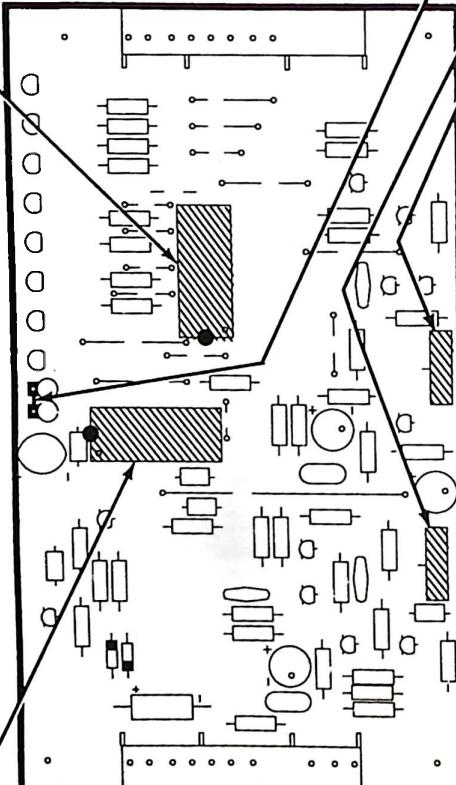


() R646: 2MΩ control.

() R633: 1 MΩ control.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.



- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.
- () Transistor for the proper type and installation.
- () Electrolytic and tantalum capacitors for the correct position of the positive (+) end.
- () IC's for the proper type and installation.

Set the circuit board aside temporarily.

PICTORIAL 2-6

MOTION CIRCUIT BOARD

PARTS LIST

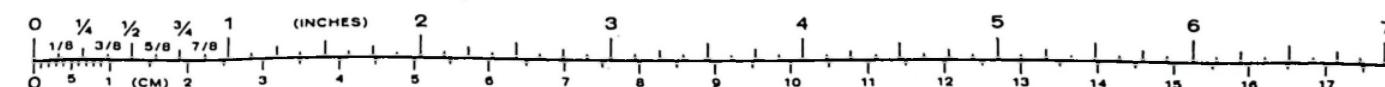
Refer to the "Pack Index Sheet" and remove the parts from pack #3. Check each part against the following list. The key numbers correspond to the numbers on the "Motion Circuit Board Parts Pictorial" (Illustration Booklet, Page 1). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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

RESISTORS — CONTROL

All resistors are 1/4-watt, 5% (fourth band gold).

A1	6-100-12	1	10Ω (brn-blk-blk)	R1420
A1	6-471-12	1	470Ω (yel-viol-brn)	R1404
A1	6-102-12	2	1000Ω (brn-blk-red)	R1419, R1422
A1	6-272-12	1	2700Ω (red-viol-red)	R1423
A1	6-682-12	1	6800Ω (blu-gry-red)	R1410
A1	6-103-12	3	10kΩ (brn-blk-org)	R1406, R1412, R1421
A1	6-223-12	1	22kΩ (red-red-org)	R1408
A1	6-333-12	1	33kΩ (org-org-org)	R1401
A1	6-473-12	1	47kΩ (yel-viol-org)	R1414
A1	6-563-12	1	56kΩ (grn-blu-org)	R1417
A1	6-683-12	1	68kΩ (blu-gry-org)	R1402
A1	6-104-12	5	100kΩ (brn-blk-yel)	R1403, R1405, R1407, R1416, R1418



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. For prices, refer to the separate "Heath Parts Price List."

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

KEY	HEATH	QTY.	DESCRIPTION	CIRCUIT
No.	Part No.			Comp. No.
A1	6-474-12	1	470 kΩ (yel-viol-yel)	R1424
A1	6-224-12	1	220 kΩ (red-red-yel)	R1415
A1	6-105-12	1	1MΩ (brn-blk-grn)	R1413
A1	6-275-12	1	2.7 MΩ (red-viol-grn)	R1411
A2	10-326	1	500 kΩ control	R1409
CAPACITORS				
B1	21-722	1	330 pF ceramic	C1403
B1	21-163	.1	.001 μF ceramic	C1401
B1	21-176	2	.01 μF ceramic	C1402, C1413
B2	27-42	1	.0068 μF Mylar	C1408
B2	27-77	4	.1 μF Mylar	C1405, C1407, C1409, C1411
B3	25-859	1	.47 μF electrolytic	C1404
B3	25-900	1	1 μF electrolytic	C1410
B3	25-880	2	10 μF electrolytic	C1406, C1412

<u>KEY HEATH No.</u>	<u>QTY. DESCRIPTION Part No.</u>	<u>CIRCUIT Comp. No.</u>	<u>KEY HEATH No.</u>	<u>QTY. DESCRIPTION Part No.</u>	<u>CIRCUIT Comp. No.</u>
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TRANSISTORS — INTEGRATED CIRCUITS (IC's)

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

C1	417-801	3	MPSA20 transistor	Q1401, Q1402, Q1404
C1	417-865	1	MPSA55 transistor	Q1403

NOTE: Some IC are protected by a foam pad from static electricity. DO NOT remove them from their foam pad until you are instructed to do so in a step.

C1	442-681	1	78L08 IC	U1401
C2	442-602	1	LM324 IC	U1403
C2	443-701	1	4049 IC	U1402

OTHER CIRCUIT COMPONENTS

D1	56-56	1	1N4149 diode	D1401
D2	412-640	1	Light emitting diode (LED)	V1401

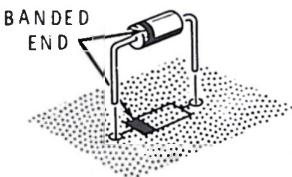
MISCELLANEOUS

85-2995-1	1	Motion circuit board
344-50	2-1/2"	Black wire
347-55	6"	8-conductor flat cable
E1	432-66	4 Push-on connector
E2	432-827	1 4-pin connector
E3	434-298	1 14-pin IC socket
E3	434-299	1 16-pin IC socket

STEP-BY-STEP ASSEMBLY**START** ▶

- () If this circuit board, or a future circuit board, has a perforated blank edge, break it away as described on Page 12.

NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board. A DIODE WILL NOT WORK PROPERLY IF IT IS INSTALLED BACKWARDS. See Detail 3-1A.



If your diode has a solid body, the band is clearly defined. If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass.

(✓) D1401: 1N4149 diode (#56-56).

(✓) R1403: 100 kΩ (brn-blk-yel).

(✓) R1402: 68 kΩ (blu-gry-org).

(✓) R1401: 33 kΩ (org-org-org).

(✓) R1404: 470 Ω (yel-viol-brn).

(✓) R1407: 100 kΩ (brn-blk-yel).

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

(✓) R1412: 10 kΩ (brn-blk-org).

(✓) R1416: 100 kΩ (brn-blk-yel).

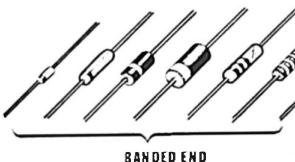
(✓) R1414: 47 kΩ (yel-viol-org).

(✓) R1415: 220 kΩ (red-red-yel).

(✓) R1413: 1 MΩ (brn-blk-grn).

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

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

**Detail 3-1A****CONTINUE** ▶

(✓) R1405: 100 kΩ (brn-blk-yel).

(✓) R1406: 10 kΩ (brn-blk-org).

() R1408: 22 kΩ (red-red-org).

() R1410: 6800 Ω (blu-gry-red).

() Remove the insulation from two 1" black wires for use in the next two steps.

() 1" bare-wire.

() 1" bare-wire.

(✓) R1419: 1000 Ω (brn-blk-red).

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

() R1411: 2.7 MΩ (red-viol-grn).

() R1423: 2700 Ω (red-viol-red).

() R1421: 10 kΩ (brn-blk-org).

() R1422: 1000 Ω (brn-blk-red).

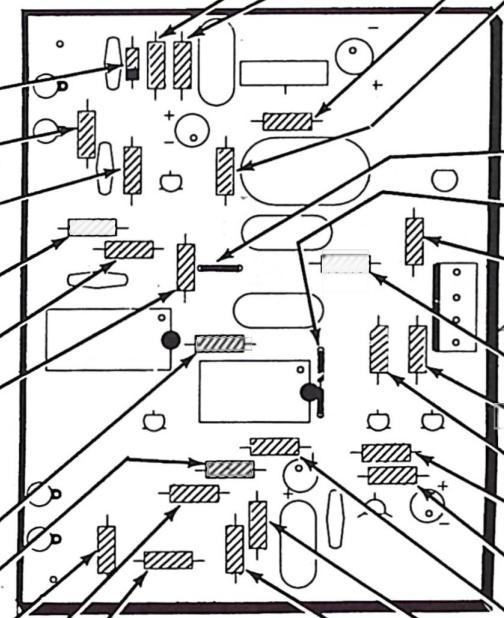
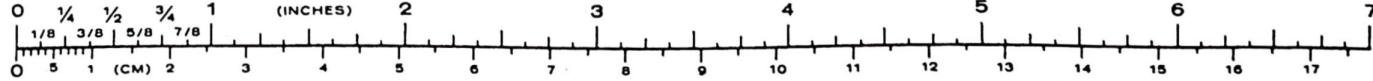
() R1420: 10 Ω (brn-blk-blk).

() R1424: 470 kΩ (yel-viol-yel).

() R1417: 56 kΩ (grn-blu-org).

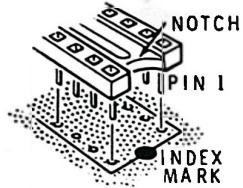
() R1418: 100 kΩ (brn-blk-yel).

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

**PICTORIAL 3-1**

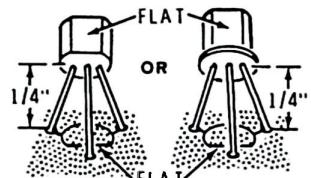
START ▶

NOTE: When you install an IC socket, be sure the index mark is still visible after the socket is installed. Then solder the pins to the foil.



- () 16-pin IC socket at location U1402.

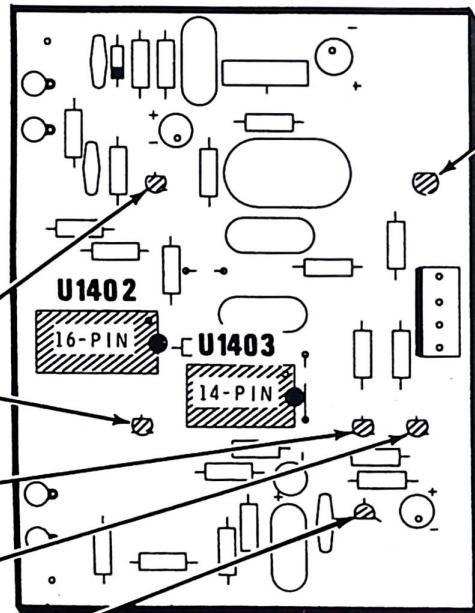
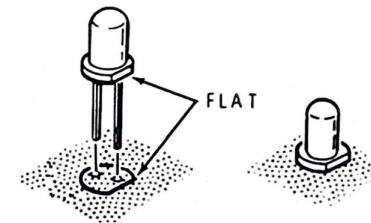
NOTE: When you install the transistors in this Pictorial, align the flat with the flat on the board. Insert the leads into their correct holes. Position the transistors $\frac{1}{4}$ " above the board. Then solder the leads to the foil and cut off the excess lead lengths.



- () Q1401: MPSA20 transistor (#417-801).
- () Q1402: MPSA20 transistor (#417-801).
- () Q1403: MPSA55 transistor (#417-865).
- () Q1404: MPSA20 transistor (#417-801).
- () U1401: 78L08 IC (#442-681). Bend the center lead away from the flat.

CONTINUE ▶

- () V1401: Light-emitting diode. Align the flat of the LED with the flat on the board and insert the leads into their holes. Press the LED tight against the board and solder the leads to the foil. Then cut off the excess lead lengths.

**PICTORIAL 3-2**

START

When you install an electrolytic capacitor, align the positive (+) mark on the capacitor with the positive (+) mark on the board, or align the negative (-) mark on the capacitor with the negative mark (-) on the board.

(C1406: 10 μF electrolytic.

(C1405: .1 μF Mylar.

(C1403: 330 pF ceramic.

(C1401: .001 μF ceramic.

(C1404: .47 μF electrolytic.

(C1407: .1 μF Mylar.

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

(C1402: .01 μF ceramic.

(C1409: .1 μF Mylar.

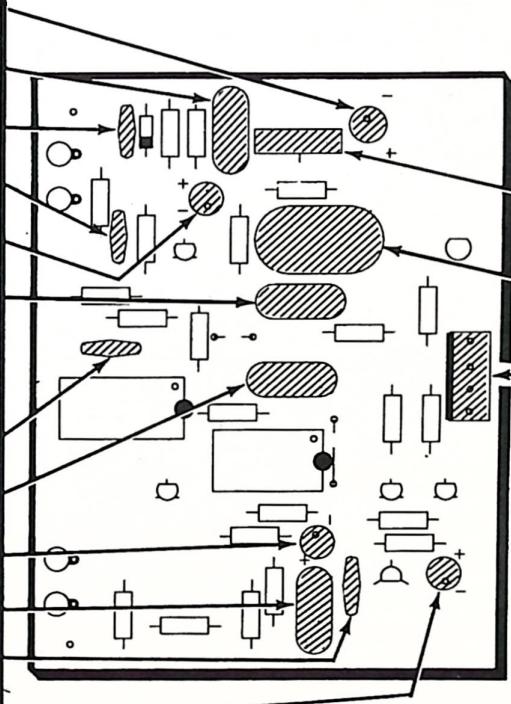
(C1410: 1 μF electrolytic.

(C1411: .1 μF Mylar.

(C1413: .01 μF ceramic.

(C1412: 10 μF electrolytic.

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

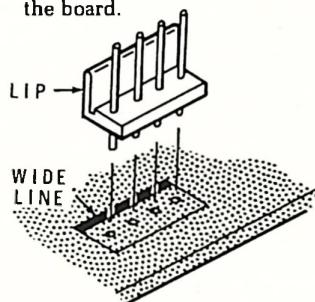
**CONTINUE**

Solder the pins or leads to the foil as you install each part.

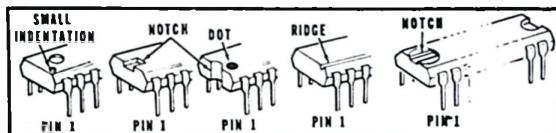
(R1409: 500 k Ω control. Push the control tight against the board.

(C1408: .0068 μF Mylar. Cut off the excess lead lengths after you solder them.

(4-pin connector. Align its lip with the wide line on the board and push the connector tight against the board.

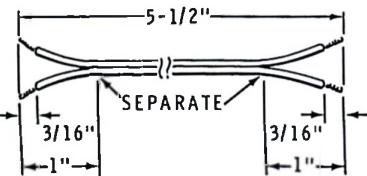


PICTORIAL 3-3

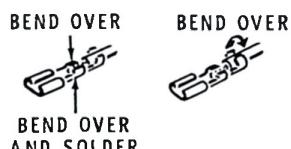
**START**

- () Prepare two 5-1/2" 2-conductor cables as follows:

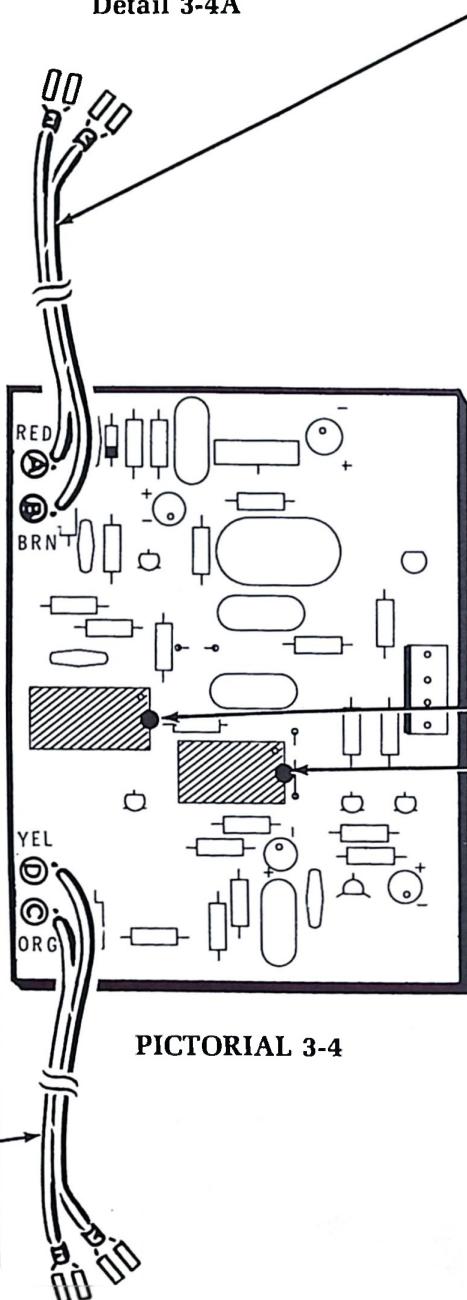
1. Carefully remove the red and brown conductor pair and the orange and yellow conductor pair from the 8-conductor flat cable. Then cut these two pairs to a length of 5-1/2".
2. Separate each conductor pair 1" at both ends and remove 3/16" of insulation from each conductor.
3. Tightly twist the fine strands of each exposed wire end.
4. Melt a small amount of solder on each exposed wire end to hold the fine strands together.



5. Install a push-on connector on both conductors at one end of each prepared cable as shown. See Page 11.

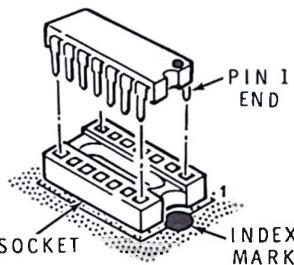


- () Connect the orange and yellow cable to the board with the yellow conductor to hole D and the orange conductor to hole C. Solder the conductors to the foil.

Detail 3-4A**PICTORIAL 3-4****CONTINUE**

- () Connect the other cable to the board with its red conductor to hole A and the brown conductor to hole B. Solder the conductor ends to the foil.

NOTE: When you install an integrated circuit, position the pin 1 end of the integrated circuit at the index mark end of the outline printed on the circuit board. Then insert the integrated circuit pins into their corresponding socket holes and press the integrated circuit down into the socket. Be sure to handle any protected IC's as described earlier. Refer to Detail 3-4A to identify the pin 1 end of an integrated circuit.



- () U1402: MC14049 IC (#443-701).

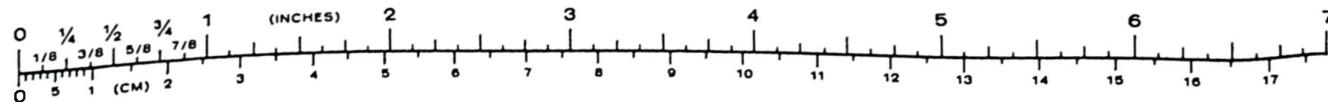
- () U1403: LM324 IC (#442-602).

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

- () Unsoldered conditions.
- () Poor solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.
- () Transistors and IC's for the proper type and installation.
- () Electrolytic capacitors for the correct position of the positive (+) lead.
- () Diode for proper position of the banded end.

- () Set the motion circuit board aside.



POWER SUPPLY CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #4. Check each part against the following list. The key numbers correspond to the numbers on the "Power Supply Circuit Board Parts Pictorial" (Illustration Booklet, Page 2). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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RESISTORS — CONTROLS

All resistors are 1/4-watt, 5% (fourth band gold) unless they are designated 1% (fifth band brown).

A1	6-1500-12	2	150 Ω, 1% (brn-grn-blk-blk)	R202, R225
A1	6-511-12	1	510 Ω (grn-brn-brn)	R214
A1	6-6500-12	2	650 Ω, 1% (blu-grn-blk-blk)	R205, R228
A2	6-681	2	680 Ω, 1/2-watt (blu-gry-brn)	R236, R237
A1	6-102-12	1	1000 Ω (brn-blk-red)	R215
A1	6-152-12	3	1500 Ω (brn-grn-red)	R201, R216, R224
A1	6-472-12	3	4700 Ω (yel-viol-red)	R212, R219, R235
A1	6-4751-12	3	4750 Ω, 1% (yel-viol-grn-brn)	R217, R221, R222
A1	6-5491-12	1	5490 Ω, 1% (grn-yel-wht-brn)	R218
A1	6-303-12	1	30 kΩ (org-blk-org)	R223
A1	6-473-12	2	47 kΩ (yel-viol-org)	R206, R229
A1	6-8873-12	2	887 kΩ, 1% (gry-gry-viol-org)	R207, R233
A1	6-9093-12	2	909 kΩ, 1% (wht-blk-wht-org)	R208, R234

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. For prices, refer to the separate "Heath Parts Price List."

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

B1	27-74	3	.01 μF Mylar	C208, C212, C213
B2	21-752	5	.1 μF(104) ceramic	C202, C203, C206, C215, C216
B3	25-922	2	.68 μF electrolytic	C201, C214
B3	25-900	2	1 μF electrolytic	C204, C218
B3	25-880	2	10 μF vertical electrolytic	C205, C217
B4	25-864	1	10 μF axial lead electrolytic	C211
B5	25-893	1	1000 μF electrolytic	C207

DIODES — CHOKE

C1	57-42	2	3A1 diode	D201, D205
C1	57-65	2	1N4002 diode	D203, D207
C1	56-669	2	1N5524D diode	D202, D206
C1	57-607	1	1N5817 diode	D204
C2	46-71	1	650 μH choke	L201

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

TRANSISTORS — INTEGRATED CIRCUITS (IC's)

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

D1	417-295	1	MPSL51 transistor	Q203
D1	417-235	4	2N4121 transistor	Q201, Q202, Q205, Q206
D2	417-289	1	2N6109 transistor	Q204
E1	442-75	2	311 IC	U202, U205
E1	442-700	1	3524 IC	U203

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

HARDWARE

F1	250-1415	1	4-40 × 3/8" screw
F2	252-2	1	4-40 nut
F3	254-9	1	#4 lockwasher

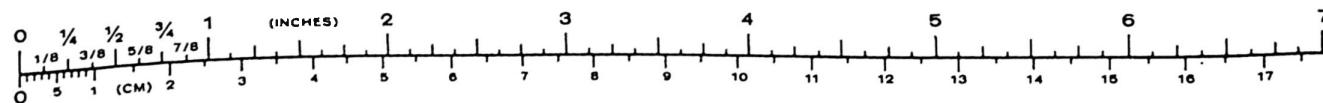
CONNECTORS — SOCKETS

G1	432-779	2	12-pin connector
G2	432-866	6	Spring connector
G3	432-1080	2	3-slot connector housing
G4	434-230	2	8-pin IC socket
G4	434-299	1	16-pin IC socket

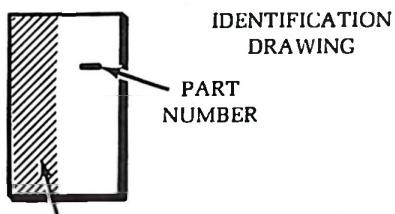
MISCELLANEOUS

85-2887-1	1	Power supply circuit board	
H1	215-89	1	Heat sink
H2	260-65	4	Fuse clip
H3	421-3	1	2 ampere 3AG fuse
H3	421-5	1	4 ampere 3AG fuse
H4	432-134	12	Wire socket (2 extra)
	344-15	6"	Black wire
	344-16	6"	Red wire
	344-80	6"	Orange wire
	490-5	1	Nut starter

F201
F202



STEP-BY-STEP ASSEMBLY

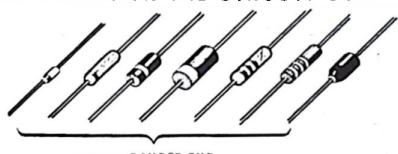


The steps performed in this Pictorial are
in this area of the circuit board.

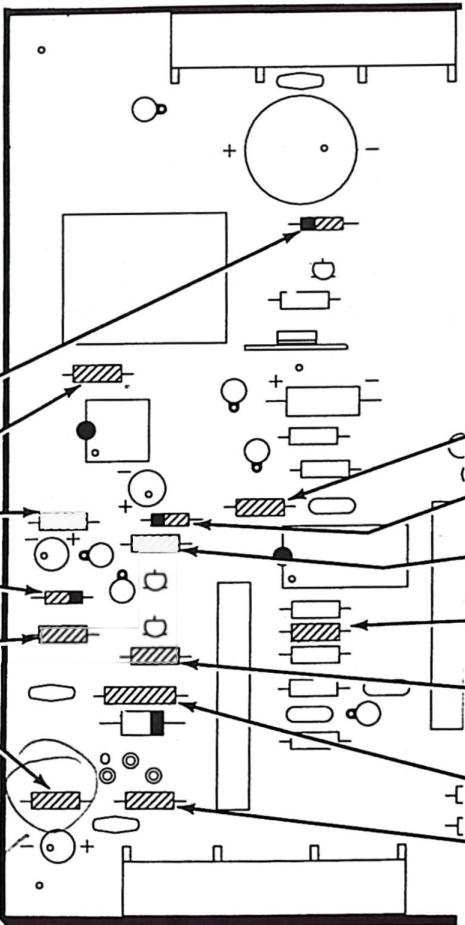
START

Position the power supply circuit
board printed side up as shown.

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

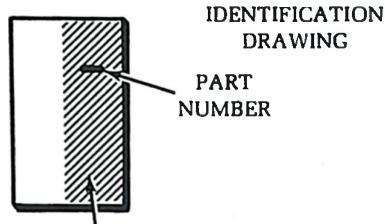


- D204: 1N5817 diode (#57-607). ✓
- R212: 4700 Ω (yel-viol-red). ✓
- R208: 909 k Ω , 1% (wht-blk-wht-org). ✓
- D202: 1N5524D diode (#56-669). ✓
- R206: 47 k Ω (yel-viol-org). ✓
- R202: 150 Ω , 1% (brn-grn-blk-blk).
- Solder the leads to the foil and cut off the excess lead lengths.

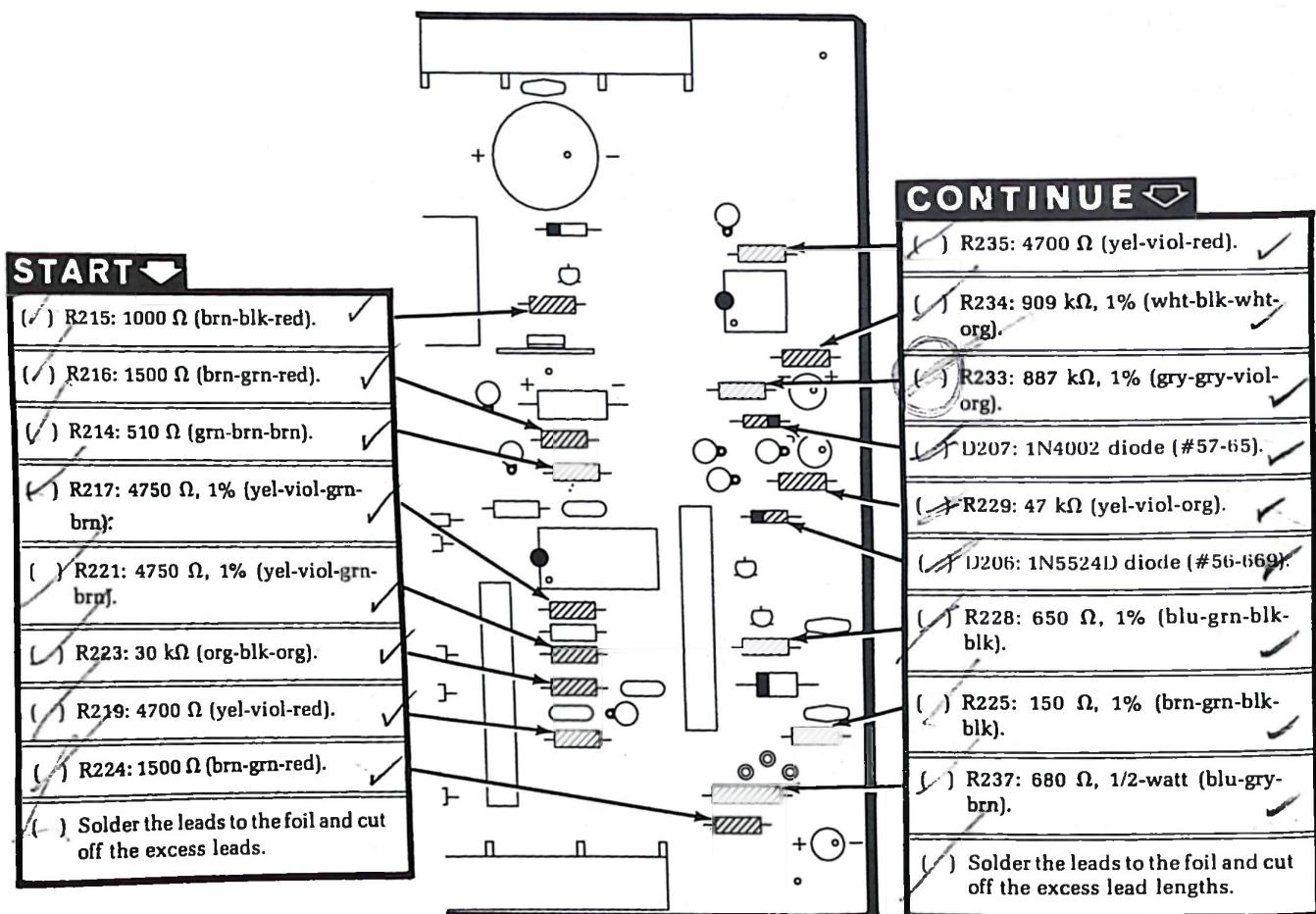
**CONTINUE**

- R218: 5490 Ω , 1% (grn-yel-wht-brn). ✓
- D203: 1N4002 diode (#57-65). ✓
- R207: 887 k Ω , 1% (gry-gry-viol-org). ✓
- R222: 4750 Ω , 1% (yel-viol-grn-brn). ✓
- R205: 650 Ω , 1% (blu-grn-blk-blk). ✓
- R236: 680 Ω , 1/2-watt (blu-gry-brn). ✓
- R201: 1500 Ω (brn-grn-red). ✓
- Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 4-1



The steps performed in this Pictorial are
in this area of the circuit board.

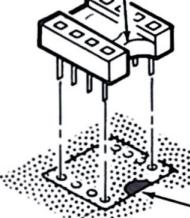


PICTORIAL 4-2

START

NOTE: When you install an IC socket, be sure the index mark is still visible after the socket is installed. Then solder the pins to the foil.

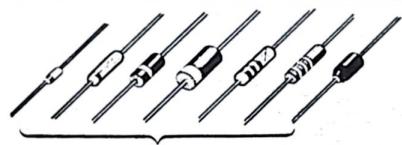
INDEX
MARK



INDEX
MARK

- () 8-pin IC socket at location U205.
- () 8-pin IC socket at location U202.
- () 16-pin IC socket at location U203.

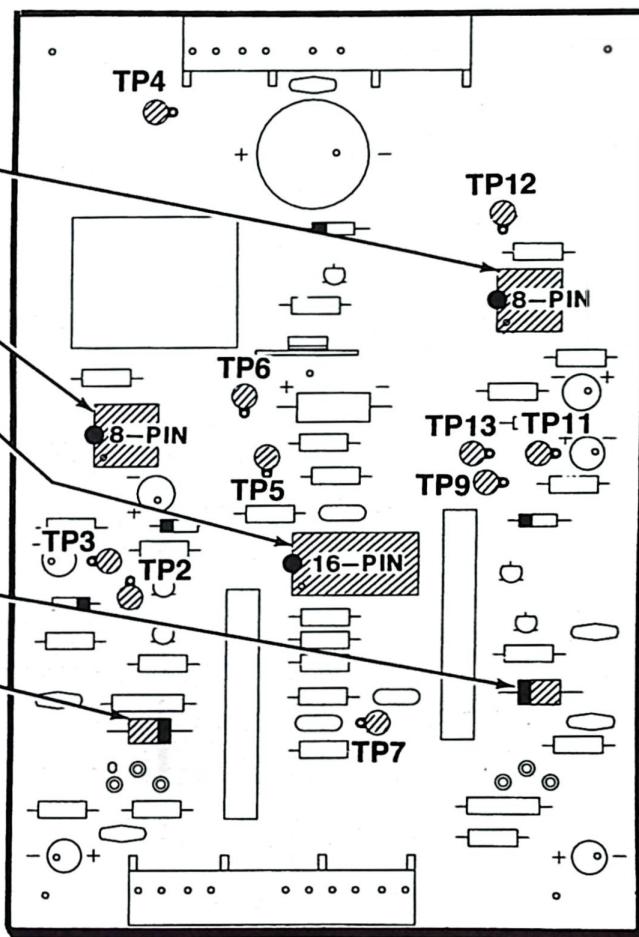
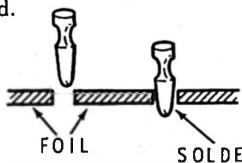
NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



BANDED END

- () D205: 3A1 diode (#57-42).
- () D201: 3A1 diode (#57-42).
- () Solder the leads to the foil and cut off the excess lead lengths.

- () Ten wire sockets at locations TP2 through TP13. There is no TP1, TP8, or TP10. Solder each socket to the foil as it is installed.

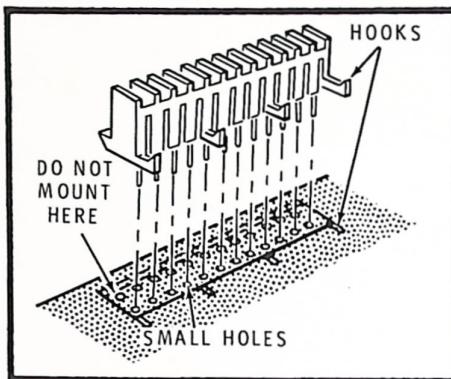
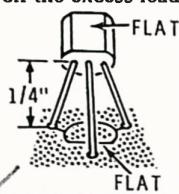


PICTORIAL 4-3

AB # 1, 8 or 10 1

START

NOTE: When you install a transistor in each of the following steps, align its flat with the flat on the board. Insert the leads into their correct holes. Position the transistor $1/4"$ above the board. Then solder the leads to the foil and cut off the excess lead lengths.

**Detail 4-4A**

() Q203: MPSL51 transistor (#417-295).

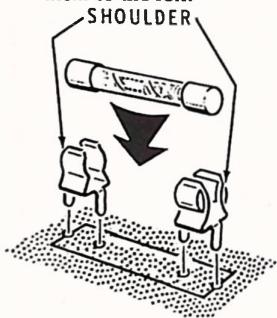
(✓) Q205: 2N4121 transistor (#417-235).

(✓) Q206: 2N4121 transistor (#417-235).

(✓) Q202: 2N4121 transistor (#417-235).

(✓) Q201: 2N4121 transistor (#417-235).

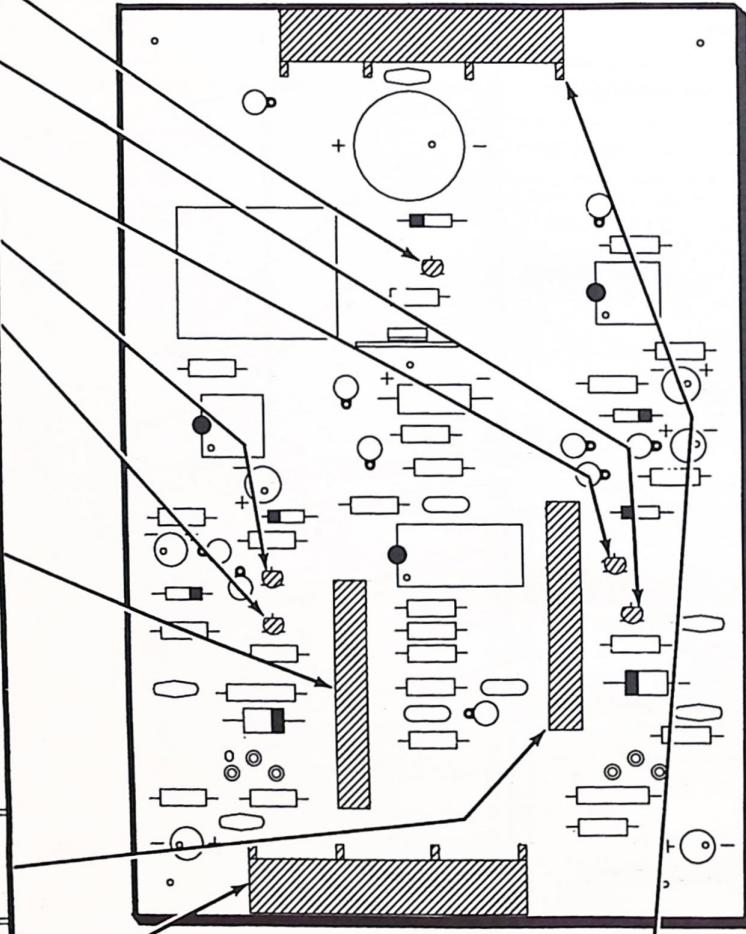
(✓) F201: Install a fuse clip on each end of a 2-ampere fuse. Insert the clips in the circuit board and solder them to the foil.

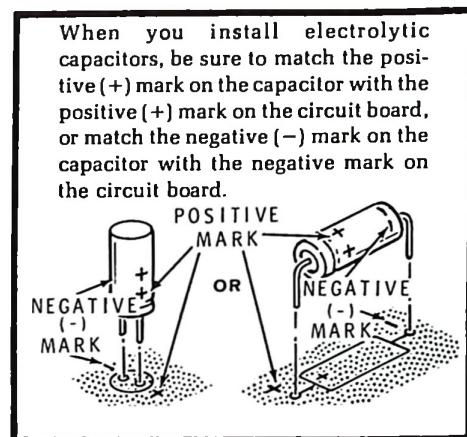


() F202: In the same manner, install a 4-ampere fuse and fuse clips at F202.

() 12-pin connector at location P202. Solder the pins to the foil as you install the connector. See Detail 4-4A.

(✓) 12-pin connector at P201. Solder the pins to the foil.

**PICTORIAL 4-4**



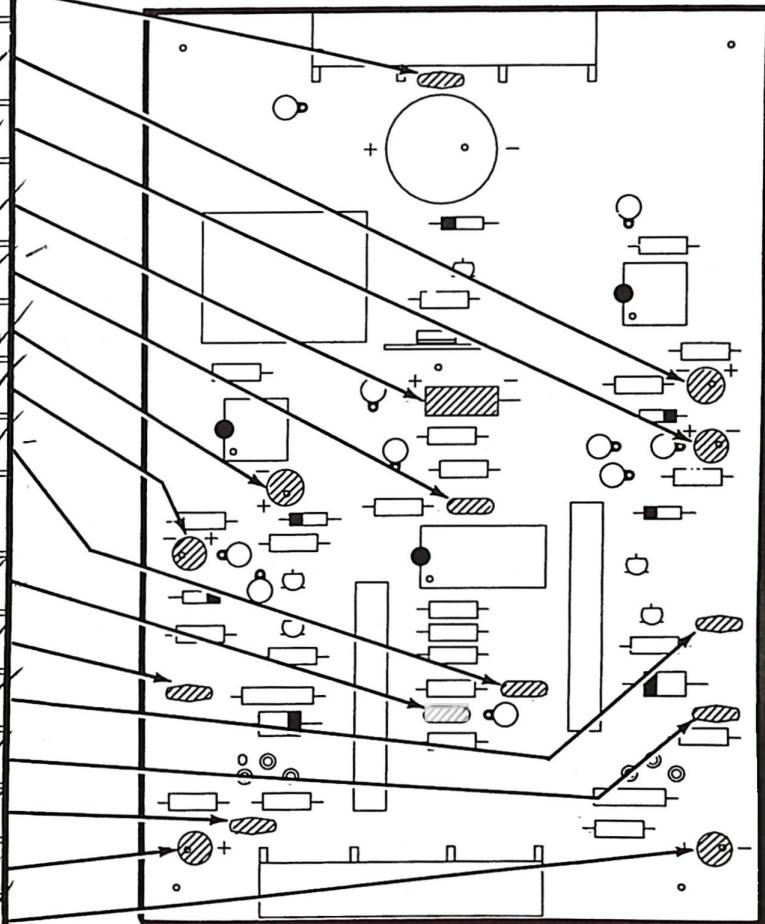
Detail 4-5A

START() C206: .1 μ F (104) ceramic.() C217: 10 μ F vertical electrolytic.
See Detail 4-5A.() C218: 1 μ F electrolytic.() C211: 10 μ F axial lead electrolytic.
See Detail 4-5A.() C208: .01 μ F Mylar.() C205: 10 μ F vertical electrolytic.() C204: 1 μ F electrolytic.() C213: .01 μ F Mylar.

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

() C212: .01 μ F Mylar.() C203: .1 μ F (104) ceramic.() C216: .1 μ F (104) ceramic.() C215: .1 μ F (104) ceramic.() C202: .1 μ F (104) ceramic() C201: .68 μ F electrolytic.() C214: .68 μ F electrolytic.

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

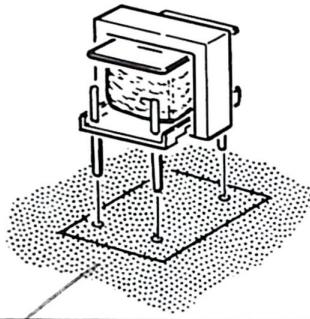


PICTORIAL 4-5

START ▶

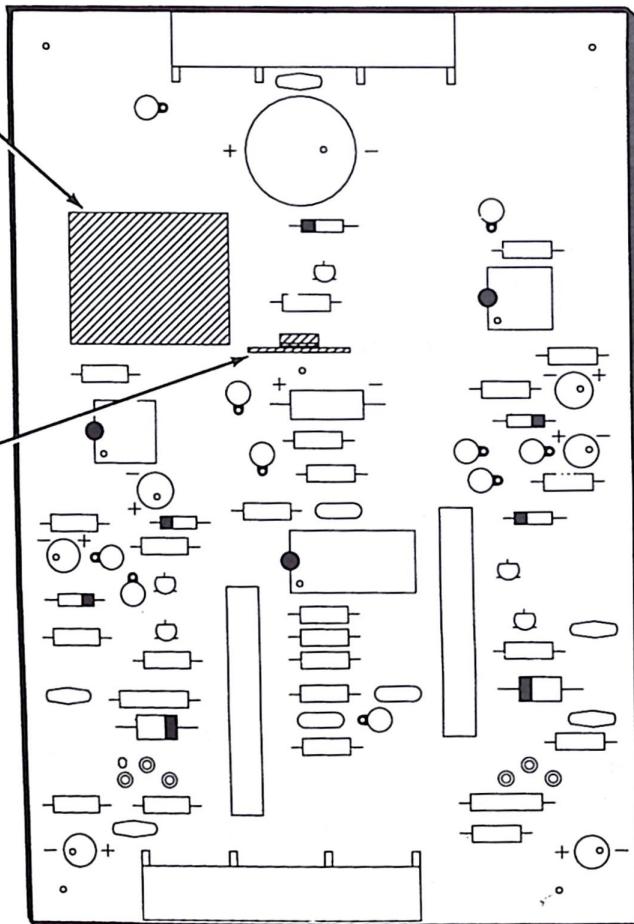
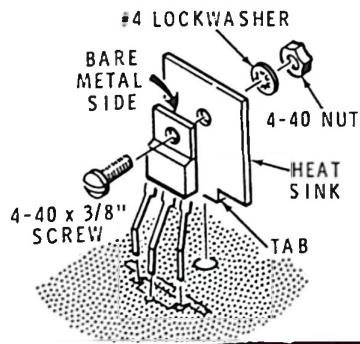
Solder the pins to the foil and cut off any excess as you install each part.

- () L201: 650 μ H choke. This choke may be installed either way.



- () Q204: 2N6109 transistor (#417-289) and heat sink.

1. Secure metal side of transistor to heat sink with a 4-40 \times 3/8" screw, #4 lockwasher, and a 4-40 nut. Use the nut starter (supplied) to hold and start nuts on screws.
2. Carefully bend the transistor leads to align with the board holes.
3. Insert the transistor leads and the heat sink tab into their holes in the board and then solder them to their foil pads.

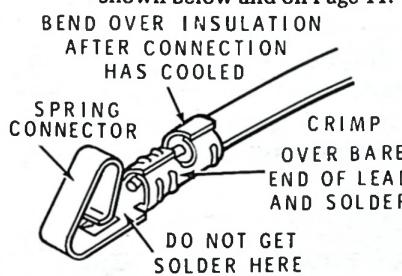


PICTORIAL 4-6

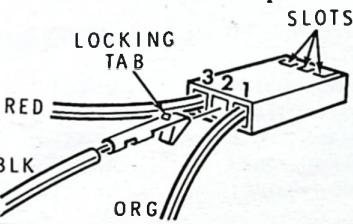
START

- () Prepare six (two black, two red, and two orange) wires as follows:

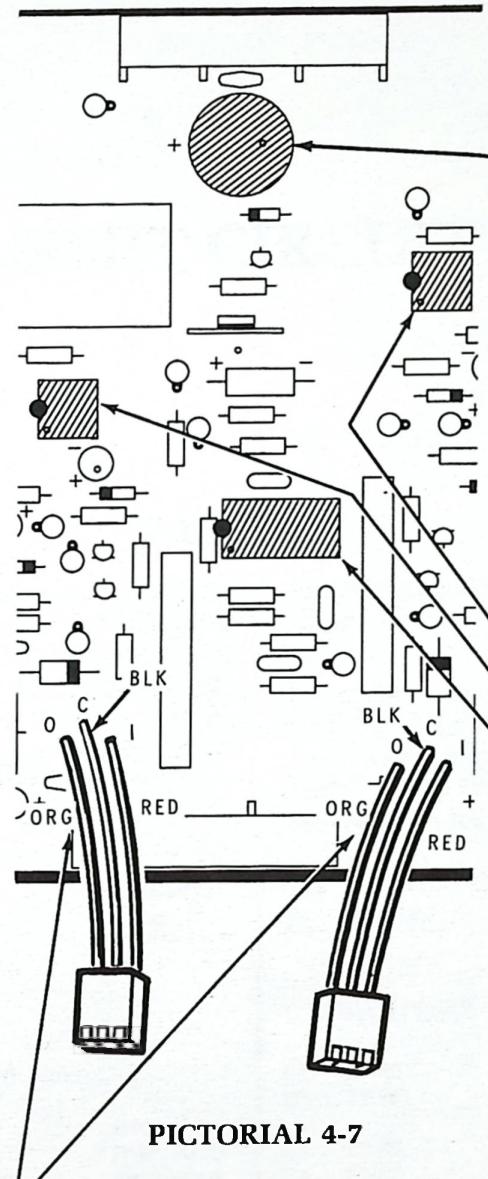
1. Cut each wire to 3".
2. Remove 3/16" of insulation from both ends of each wire.
3. Tightly twist the fine wire strands and then melt a small amount of solder on all exposed wire ends.
4. Cut one end of each wire so the exposed portion is 1/8" long.
5. At this end of each wire, install a spring connector as shown below and on Page 11.



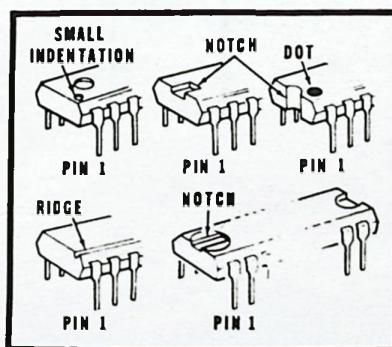
6. Insert the spring connectors into their indicated holes in the two 3-slot connector housings. Push the connector in until it locks into place.



- () Solder the wires of these assemblies into their correct board holes (orange to 0, black to C, and red to I) at locations U201 and U204.



PICTORIAL 4-7

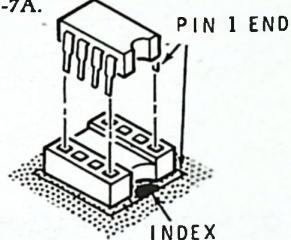


Detail 4-7A

CONTINUE

- () C207: 1000 μ F electrolytic. Be sure to match the (+) or (-) marks on the capacitor and on the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

Align the pin 1 end of the IC with the index mark on the circuit board as you install each integrated circuit. See Detail 4-7A.



- () U205: 311 IC (#442-75).

- () U202: 311 IC (#442-75).

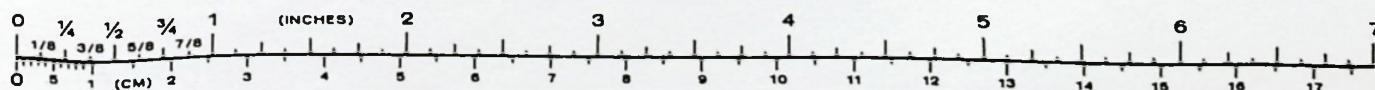
- () Ü203: 3524 IC (#442-700).

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.
- () Transistors and IC's for the proper type and installation.
- () Electrolytic capacitors for the correct position of the positive (+) lead.
- () Diodes for proper type and position of the banded end.

Set the circuit board aside temporarily. Discard remaining wire scraps.



SONAR TRANSMIT CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #5. Check each part against the following list. The key numbers correspond to the numbers on the "Sonar Transmit Circuit Board Parts Pictorial" (Illustration Booklet, Page 2). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it

until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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. 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 - CONTROL

NOTE: All resistors are 1/4 watt, 5% (fourth band gold).

A1	6-100-12	1	10 Ω (brn-blk-blk)	R106
A1	6-681-12	2	680 Ω (blu-gry-brn)	R101, R105
A1	6-472-12	2	4700 Ω (yel-viol-red)	R102, R103
A1	6-562-12	1	5600 Ω (grn-blk-red)	R107
A1	6-103-12	3	10 k Ω (brn-blk-org)	R104, R109, R111
A1	6-684-12	1	680 k Ω (blu-gry-yel)	R112
A2	10-312	1	10 k Ω control	R108

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

CAPACITORS

B1	21-22	2	220 pF ceramic	C107, C108
B2	21-761	3	.01 μ F glass (103)*	C103, C106, C111
B3	27-70	1	.0022 μ F Mylar	C112
C4	27-63	1	.022 μ F Mylar	C104
C5	25-859	2	.47 μ F electrolytic	C101, C102

*NOTE: Do not confuse the glass capacitors with the diode listed on the next page. Identify the diode by its banded end.

KEY	HEATH No.	QTY.	DESCRIPTION
	Part No.		

CIRCUIT
Comp. No.

DIODE - TRANSISTORS - INTEGRATED CIRCUITS (IC's)

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

D1	56-56	1	1N4149 diode	D101
D2	417-801	1	MPSA20 transistor	Q102
D2	417-865	1	MPSA55 transistor	Q101
D2	442-681	1	78L08 regulator IC	U102

KEY	HEATH No.	QTY.	DESCRIPTION
	Part No.		

CIRCUIT
Comp. No.

NOTE: Some IC's are protected by a foam pad against static electricity. DO NOT remove them from their foam pad until you are instructed to install the IC in a step.

D3	443-607	1	4013 IC	U104
D3	443-695	1	4001 IC	U105
D3	443-760	1	4040 IC	U103
D3	443-778	1	4093 IC	U106
D3	443-808	1	4N26 opto-isolator IC	U101

MISCELLANEOUS

E1	432-134	6	Wire socket
E2	432-923	3	4-pin connector
E3	432-950	1	6-pin connector
E4	434-298	3	14-pin IC socket
E4	434-299	1	16-pin IC socket
	344-50	10"	Black wire
	85-2592-1	1	Sonar Transmit circuit board

STEP-BY-STEP ASSEMBLY

START ↓

Position the circuit board as shown and install the following wires and parts. Do not solder to the foil until a step tells you to solder.

() Remove all of the insulation from a 7" length of black wire. Cut this wire into four 1" and two 1-1/2" lengths for use as jumper wires in the following steps.

() Install a 1-1/2" jumper wire at J.

() Install a 1-1/2" jumper at J.

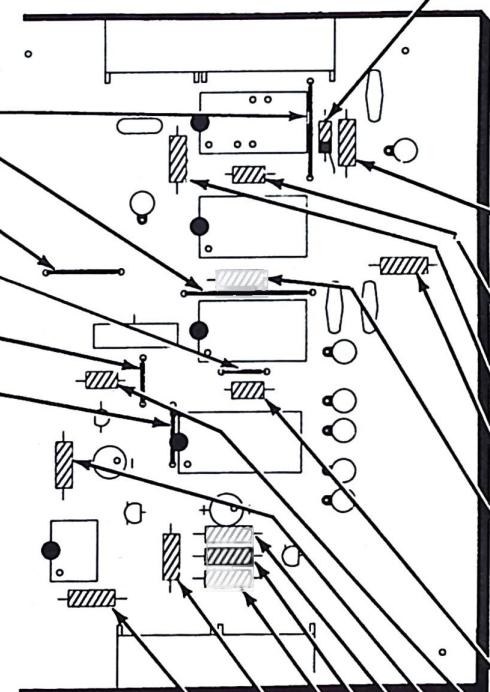
() Install a 1" jumper at J.

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



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

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



PICTORIAL 5-1

CONTINUE ↓

NOTE: The diode you will install in the next step has a glass body. Be careful not to break the glass when you install the diode.

() D101: 1N4149 diode (#56-56). Be sure to position the banded end over the band mark on the circuit board.



() R112: 680 kΩ (blu-gry-yel). Do not confuse this with the 680 Ω (blu-gry-brn).

() C111: .01 μF (103) glass capacitor. Be careful not to break the glass body.

() R107: 5600 Ω (grn-blu-red).

() R111: 10 kΩ (brn-blk-org).

() R109: 10 kΩ (brn-blk-org).

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

() C106: .01 μF (103) glass capacitor.

() C103: .01 μF (103) glass capacitor.

() R106: 10 Ω (brn-blk-blk).

() R105: 680 Ω (blu-gry-brn).

() R103: 4700 Ω (yel-viol-red).

() R104: 10 kΩ (brn-blk-org).

() R102: 4700 Ω (yel-viol-red).

() R101: 680 Ω (blu-gry-brn).

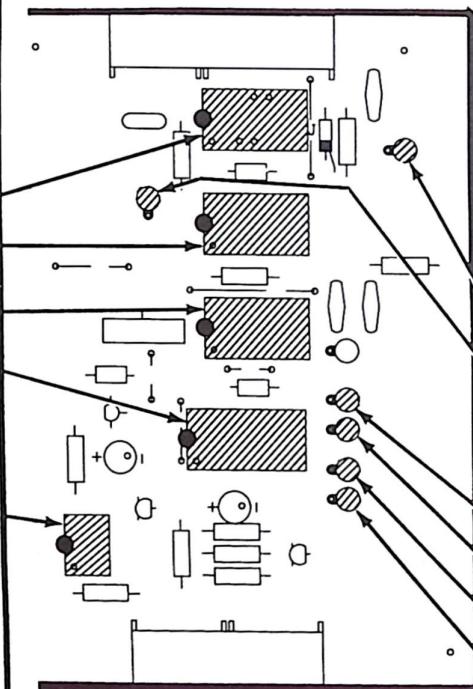
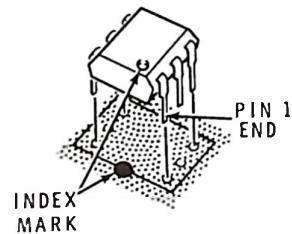
() Solder the leads to the foil and cut off the excess lead lengths.

START ▶

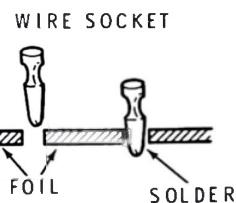
NOTE: As you install an IC socket in the following steps, position the socket so its notched (indexed) end is over the index mark on the circuit board. Carefully insert all of the socket pins into their holes, then solder each pin to its foil pad.



- () 14-pin IC socket at U106.
- () 14-pin IC socket at U105.
- () 14-pin IC socket at U104.
- () 16-pin IC socket at U103.
- () U101: 4N26 opto-isolator IC (#443-808). Refer to Detail 5-2A to identify the indexed end of the IC, then position that end over the index mark on the circuit board. Be sure all six pins enter their respective holes, then solder the pins to the foil pads.

**PICTORIAL 5-2****CONTINUE** ▶

NOTE: In the following steps, you will install wire sockets. Press the pointed end of the wire socket fully into the hole in the circuit board and solder to the foil pad. Do not allow solder to flow into the socket.

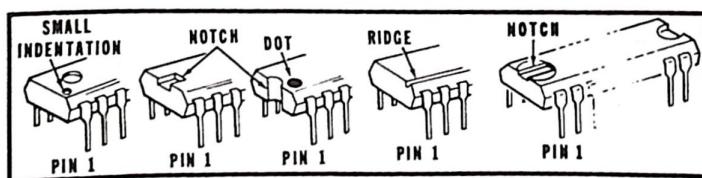


- () Install a wire socket at TP2.
- () Install a wire socket at TP1.

Install wire sockets at these locations:

- C.
- E.
- B.
- A.

() Carefully examine the foil side of the circuit board for possible solder bridges or poorly soldered connections, especially at IC socket pins where the foil pads are close together. To clear a solder bridge, hold the tip of your soldering iron under the bridged point and let the melted solder run down onto the tip of the iron.

**Detail 5-2A**

CONTINUE **START** 

(✓) C112: .0022 μF Mylar capacitor.

(✓) C104: .022 μF Mylar capacitor.

(✓) C108: 220 pF ceramic capacitor.

(✓) C107: 220 pF ceramic capacitor.

NOTE: When you install electrolytic capacitors, match the positive (+) or negative (-) marked lead of the capacitor with the same mark on the circuit board.

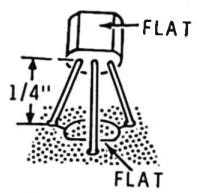


(✓) C101: .47 μF electrolytic capacitor.

(✓) C102: .47 μF electrolytic capacitor.

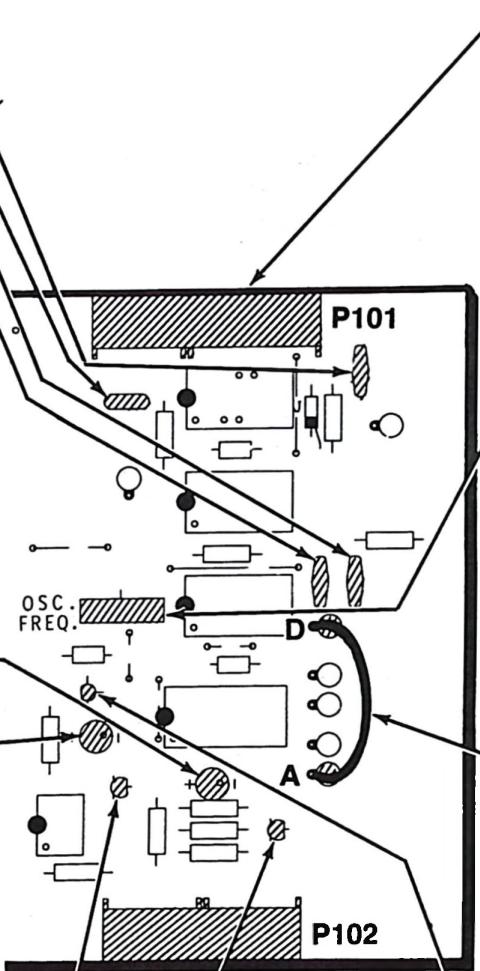
(✓) Solder the leads to the foil and cut off the excess lead lengths.

IMPORTANT: Install transistors in the manner shown. First line up the flat side of the transistor with the outline of the flat on the circuit board. Then insert the transistor leads into their correct holes. Push the transistor down to about 1/4" above the circuit board. Solder the leads to the foil and cut off the excess lead lengths.



(✓) Q101: MPSA55 transistor (417-865).

(✓) Q102: MPSA20 transistor (#417-801).



(✓) Install a 4-pin and a 6-pin connector at P101. Position the connectors so their hooks are over their outlines on the circuit board. Be sure all of the connector pins enter their holes and the body of each connector is flush against the circuit board. Solder the pins to the foils.

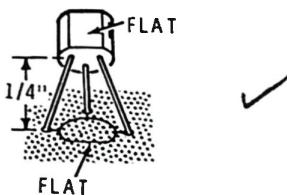
(✓) In the same manner, install two 4-pin connectors at P102 and solder the pins to the foil.

(✓) R108: Install a 10 k Ω control at OSC. FREQ. Position the control as shown and insert its pins fully into the holes. Then solder the pins to the foils.

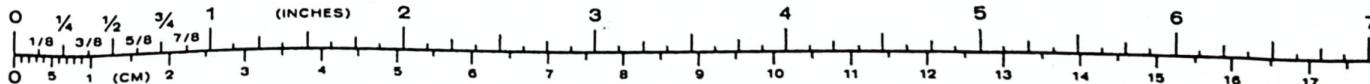


(✓) Cut a 2-1/2" length of black wire and remove 1/4" of insulation from each end. Insert one end of this wire into the hole at D and solder to the foil side. Insert the free end of this wire into the wire socket at A. Do not solder.

(✓) U102: 78L08 voltage regulator IC (#442-681). Align the flat side of the IC with the flat outline on the circuit board, and insert the leads into their holes. Position the IC approximately 1/4" above the circuit board. Then solder the leads to the foil.



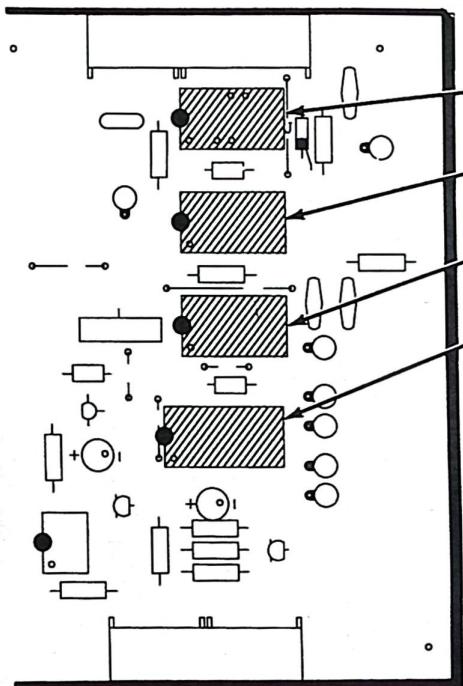
PICTORIAL 5-3



START ▶

CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad from the IC, DO NOT let go of the IC. Install the IC 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 the other hand.
5. Align the pin 1 end of the IC with the index mark on the circuit board. See Detail 5-4A.
6. Then push the IC pins into the IC socket. Once in the socket, the IC is protected.

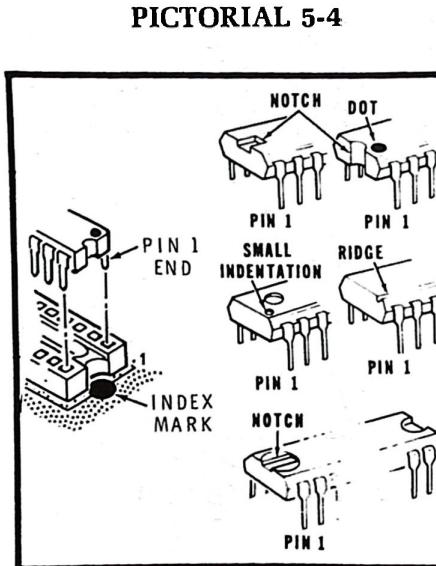
**CONTINUE** ▶

- () U106: 14093 integrated circuit (#443-778).
- () U105: 4001 integrated circuit (#443-695).
- () U104: 14013 integrated circuit (#443-607).
- () U103: 14040 integrated circuit (#443-760).

CIRCUIT BOARD CHECKOUT

Carefully examine both sides of the circuit board for any of the following most commonly made errors.

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foils.
- () Component leads in the wrong holes.
- () Diodes installed backward (banded end the wrong way).
- () Integrated circuit (or its socket) incorrectly installed.

**Detail 5-4A**

SONAR RECEIVE CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #6. Check each part against the following list. The key numbers correspond to the numbers on the "Sonar Receive Circuit Board Parts Pictorial" (Illustration Booklet, Page 3). Any part that is in an

individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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

RESISTORS

NOTE: All resistors are 1/4 watt, 5% (fourth band gold).

A1	6-470-12	1	47 Ω (yel-viol-blk)	R1111
A1	6-102-12	2	1000 Ω (brn-blk-red)	R1102, R1105
A1	6-103-12	4	10 kΩ (brn-blk-org)	R1101, R1104, R1106, R1108
A1	6-333-12	1	33 kΩ (org-org-org)	R1112
A1	6-473-12	1	47 kΩ (yel-viol-org)	R1113
A1	6-104-12	3	100 kΩ (brn-blk-yel)	R1103, R1107, R1109

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

CIRCUIT Comp. No.

CAPACITORS

B1	20-106	1	390 pF mica	C1111
B2	21-176	3	.01 μF ceramic	C1101, C1104, C1108
B3	21-75	2	100 pF ceramic	C1102, C1107
B4	27-73	1	.047 μF Mylar	C1106
B5	25-912	1	3.3 μF electrolytic	C1112
B5	25-880	2	10 μF electrolytic	C1103, C1105
B6	25-883	2	47 μF electrolytic	C1109, C1113

KEY	HEATH No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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KEY	HEATH No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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RF CHOKE — INTEGRATED CIRCUITS — DIODE

NOTE: Integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. This refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.
3. Part number and type number.
4. Part number with a type number other than the one listed.

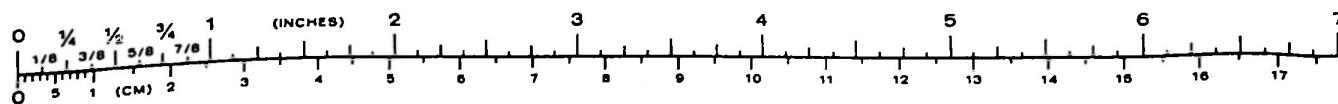
CAUTION: An integrated circuit that is packaged in a conductive foam is called a "protected IC" and can be easily damaged by static electricity. Do not remove a protected IC from its foam pad until you are ready to install it, and then follow the instructions very carefully.

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

C1	45-47	1	2 mH RF choke	L1101
C2	442-715	2	CA3130 integrated circuit	U1101, U1102
C2	443-785	1	74C221 integrated circuit	U1103
C3	56-26	1	1N191 diode	D1101

MISCELLANEOUS

85-2857-1	1	Sonar Receive printed circuit board	
D1	432-121	3	Circuit board pin
D2	432-183	1	Connector shell
D3	432-854	5	Male connector pin
D4	434-299	1	16-pin IC socket
D4	434-230	2	8-pin IC socket
	347-55	3"	Flat cable



STEP-BY-STEP ASSEMBLY

START ▶

() Position the circuit board as shown and install the following resistors.

() R1102: 1000 Ω (brn-blk-red).

() R1103: 100 k Ω (brn-blk-yel).

() R1101: 10 k Ω (brn-blk-org).

() R1104: 10 k Ω (brn-blk-org).

() R1105: 1000 Ω (brn-blk-red).

() R1106: 10 k Ω (brn-blk-org).

() R1107: 100 k Ω (brn-blk-yel).

() R1108: 10 k Ω (brn-blk-org).

() R1109: 100 k Ω (brn-blk-yel).

() R1111: 47 Ω (yel-viol-blk).

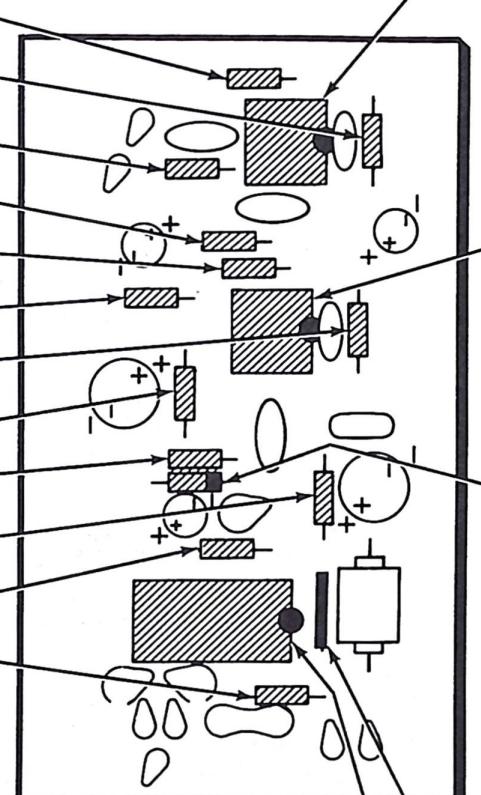
() R1113: 47 k Ω (yel-viol-org).

(✓) R1112: 33 k Ω (org-org-org).

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



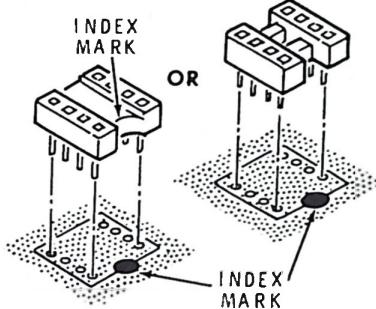
() Solder the leads to the foil and cut off the excess lead lengths. Save one of the cut-off resistor leads.



PICTORIAL 6-1

CONTINUE ▶

() Install an 8-pin IC socket at U1101. Position the indexed end of the socket over the index mark on the circuit board. Then insert all 16 pins in their holes and solder the pins to the foil pads.

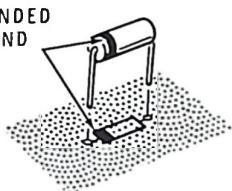


() In the same manner, install an 8-pin IC socket at U1102.

NOTE: The diode you will install in the next step has a glass body. Be careful not to break the glass when you install the diode.

() D1101: 1N191 diode (56-26). Be sure to position the banded end over the band mark on the circuit board.

BANDED
END



If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass.

() Use a cut-off resistor lead to form a jumper wire as shown. Then install this jumper at J.



() Install a 16-pin IC socket at U1103.

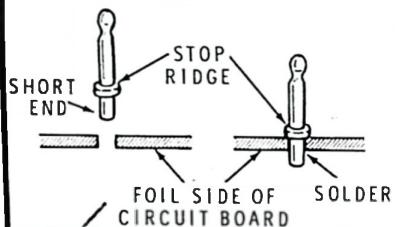
() Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

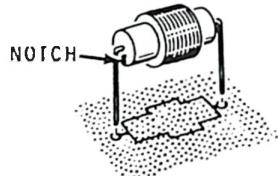
NOTE: When you install an electrolytic capacitor, match the positive (+) or negative (-) lead of the capacitor with the (+) or (-) mark on the circuit board.

START

NOTE: When you install circuit board pins in a following step, press the short end fully into the hole from the component side of the circuit board. Then solder the pin to the foil side.

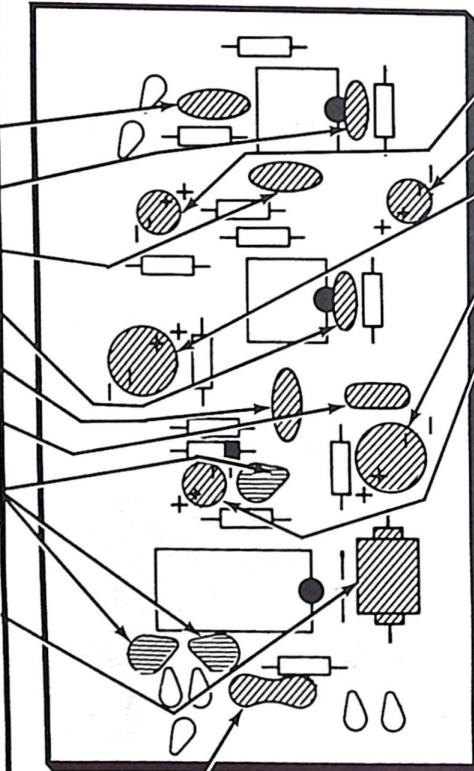


- () C1101: .01 μF ceramic.
- () C1102: 100 pF ceramic.
- () C1104: .01 μF ceramic.
- (✓) C1107: 100 pF ceramic.
- () C1108: .01 μF ceramic.
- () C1106: .047 μF mylar.
- () Install circuit board pins at TP1, TP2, and TP3.
- () L1101: 2 mH choke (#45-47). Bend the leads toward the notches in the body.

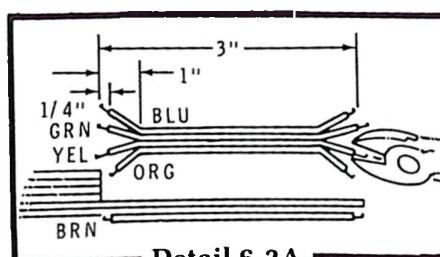


- () C1111: 390 pF mica.

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



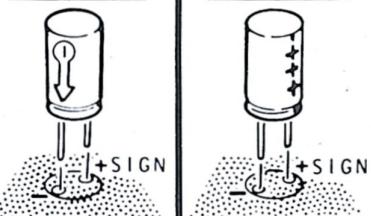
PICTORIAL 6-2



Detail 6-2A

IDENTIFIED
LEAD IS
NEGATIVE (-)

IDENTIFIED
LEAD IS
POSITIVE (+)



- () C1105: 10 μF electrolytic.
- () C1103: 10 μF electrolytic.
- () C1109: 47 μF electrolytic.
- (✓) C1113: 47 μF electrolytic.
- (✓) C1112: 3.3 μF electrolytic.
- () Solder the leads to the foil and cut off the excess lead lengths.
- () Prepare a 3" blue-green-yellow-orange cable and a 3" brown wire as shown in Detail 6-2A.

- () Separate the cable wires at each end and remove 1/4" of insulation from each wire.

- () Install a male connector pin on the end of the brown wire as shown. Be sure to solder the wire and crimp the tabs as was described on Page 11.

LARGE MALE
CONNECTOR PIN

TRIM AND CRIMP
AROUND INSULATION
AFTER SOLDER COOLS



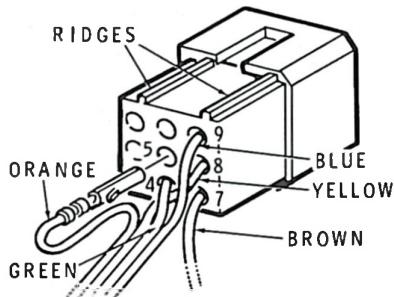
- () In the same manner, install connector pins on the ends of the blue, green, yellow, and orange wires.

START

Refer to the drawing below and position the connector shell as shown, then insert the connector pins in the connector shell as follows:

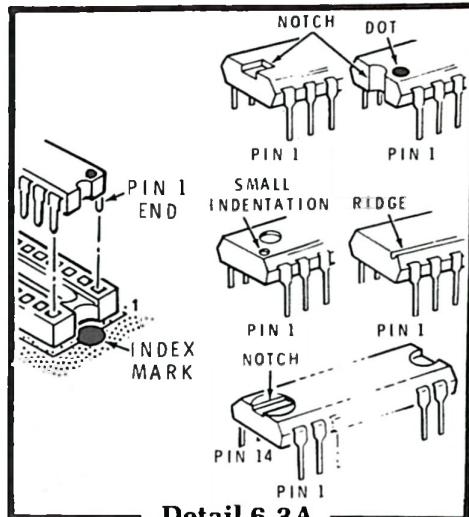
NOTE: Be sure to use the correct hole in the connector. Pins cannot be removed easily once they snap into place in the shell.

- () Brown to hole 7.
- () Yellow to hole 8.
- () Blue to hole 9.
- () Green to hole 4.
- () Orange to hole 5.

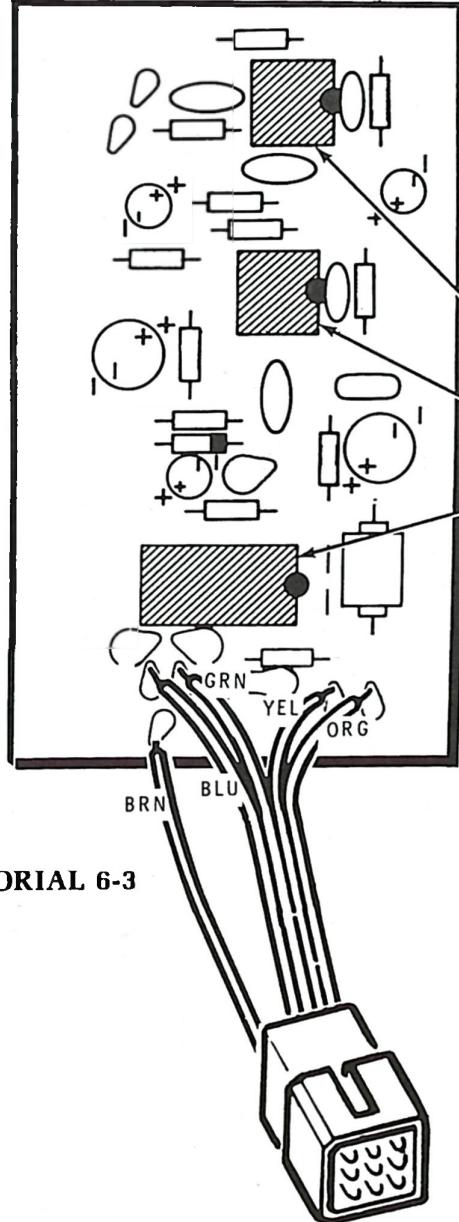


Connect and solder the wires to the circuit board as follows:

- () Brown to hole G.
- () Orange to hole D.
- () Yellow to hole F.
- () Green to hole E.
- () Blue to hole C.



Detail 6-3A



PICTORIAL 6-3

CONTINUE

CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad from the IC, DO NOT let go of the IC. Install the IC 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 the other hand.
5. Align the pin 1 end of the IC with the index mark on the circuit board. See Detail 6-3A.
6. Then push the IC pins into the IC socket. Once in the socket, the IC is protected.

() U1101: CA3130 integrated circuit (#442-715).

() U1102: CA3130 integrated circuit (#442-715).

() U1103: 74C221 integrated circuit (#443-785).

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil pads.
- () Protruding leads which could touch together.
- () Electrolytics installed with their positive (+) or negative (-) leads reversed.
- () Integrated circuits improperly installed.

This completes the assembly of the Sonar Receive circuit board. Set the circuit board aside until it is called for later.

MAIN DRIVE CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #7. Check each part against the following list. The key numbers correspond to the numbers on the "Main Drive Circuit Board Parts Pictorial" (Illustration Booklet, Page 3). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it

until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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. For prices, refer to the separate "Heath Parts Price List."

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

RESISTORS

1/4-Watt, 1%, (last band brown)

NOTE: The resistors may be packed in more than one envelope. Open all resistor envelopes in this pack before you check them against the Parts List.

A1	6-2001-12	1	2000 Ω (red-blk-blk-brn)	R801
A1	6-4001-12	1	4000 Ω (yel-blk-blk-brn)	R802
A1	6-8001-12	1	8000 Ω (gry-blk-blk-brn)	R803
A1	6-1602-12	1	16 k Ω (brn-blu-blk-red)	R804
A1	6-3202-12	1	32 k Ω (org-red-blk-red)	R805
A1	6-5002-12	1	50 k Ω (grn-blk-blk-red)	R811
A1	6-6402-12	1	64 k Ω (blu-yel-blk-red)	R806
A1	6-1503-12	1	150 k Ω (brn-gm-blk-org)	R807

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

1/4-Watt, 5%, (last band gold)

A1	6-221-12	1	220 Ω (red-red-brn)	R813
A1	6-471-12	5	470 Ω (yel-viol-brn)	R815, R831, R833, R835, R837
A1	6-102-12	6	1000 Ω (brn-blk-red)	R808, R814, R839, R841, R842, R843
A1	6-222-12	3	2200 Ω (red-red-red)	R817, R821, R829
A1	6-682-12	1	6800 Ω (blu-gry-red)	R828

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.	KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
1/4-Watt, 5% Resistors (Cont'd.)									
A1	6-103-12	3	10 kΩ (bm-blk-org)	R809, R812, R822	D1	417-235	2	2N4121 transistor	Q803, Q806
A1	6-223-12	6	22 kΩ (red-red-org)	R816, R818, R832, R834, R836, R838	D1	417-864	2	MPSA05 transistor	Q801, Q805
A1	6-104-12	3	100 kΩ (bm-blk-yel)	R824, R826, R827	D1	417-881	1	MPSA13 transistor	Q802
A1	6-124-12	1	120 kΩ (bm-red-yel)	R823	D2	417-857	1	MJE5976 transistor	Q804
OTHER									
A2	6-101-2	1	100 Ω, 2-watt, 5% (bm-blk-brn-gld)	R819	D3	443-808	6	4N26 IC	U804, U805, U807, U808, U809, U811
CAPACITORS									
B1	21-43	1	.001 μF ceramic	C805	D3	442-71	1	LM3900 IC	U806
B1	21-176	2	.01 μF ceramic	C802, C804	D3	442-740	1	LM556 (or MC 1456) IC	U803
B2	27-77	2	.1 μF Mylar	C801, C803	CAUTION: Do not remove the following IC from its protective foam pad until you are directed to do so in a step.				
B3	25-880	1	10 μF electrolytic	C806	D3	442-99	2	CD4016 integrated circuit	U801, U802
DIODES									
C1	56-56	1	1N4149	D801	CONNECTOR — SOCKETS — RELAY				
C1	57-65	3	1N4002	D802, D803, D804	E1	432-134	4	Connector (includes 1 extra)	K801
TRANSISTORS — INTEGRATED CIRCUITS (ICs)									
MISCELLANEOUS									
NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:									
<ol style="list-style-type: none"> 1. Part number. 2. Type number. (For integrated circuits, this refers 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. 									



STEP-BY-STEP ASSEMBLY

START

Position the circuit board as shown and install the following resistors.

() R837: 470 Ω (yel-viol-brn). ✓

() R838: 22 k Ω (red-red-org). ✓

() R836: 22 k Ω (red-red-org). ✓

() R835: 470 Ω (yel-viol-brn). ✓

() R833: 470 Ω (yel-viol-brn). ✓

() R834: 22 k Ω (red-red-org). ✓

() R832: 22 k Ω (red-red-org). ✓

() R831: 470 Ω (yel-viol-brn). ✓

() R721: 2200 Ω (red-red-red). ✓

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

() R822: 10 k Ω (brn-blk-org). ✓

() R817: 2200 Ω (red-red-red). ✓

() R818: 22 k Ω (red-red-org). ✓

() R816: 22 k Ω (red-red-org). ✓

() R815: 470 Ω (yel-viol-brn). ✓

() R828: 6800 Ω (blu-gry-red). ✓

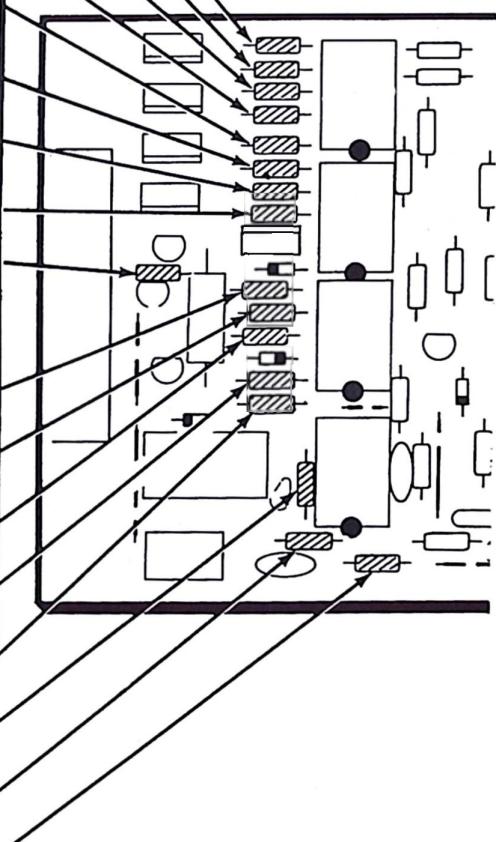
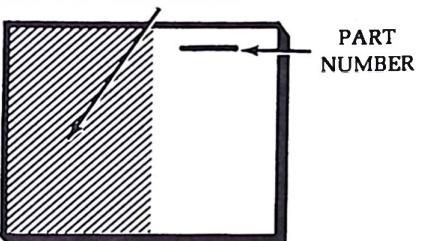
() R824: 100 k Ω (brn-blk-yel). ✓

() R823: 120 k Ω (brn-red-yel). ✓

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

IDENTIFICATION
DRAWING

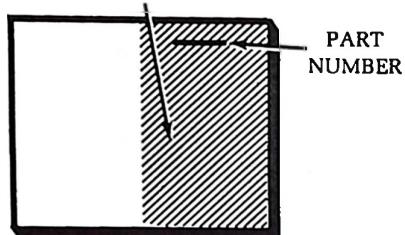
The steps performed in this Pictorial are in this area of the circuit board.



PICTORIAL 7-1

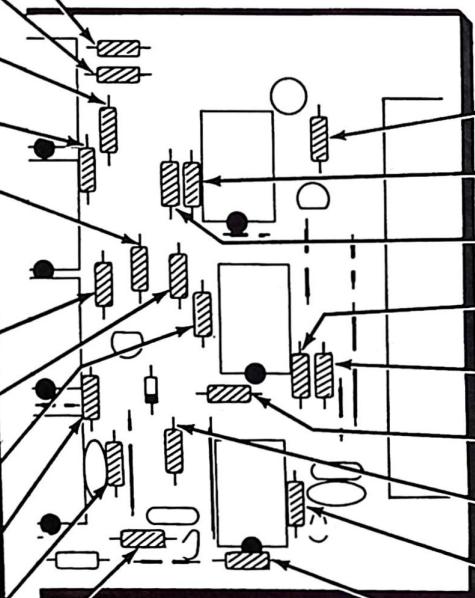
**IDENTIFICATION
DRAWING**

The steps performed in this Pictorial are
in this area of the circuit board.



START

- () R839: 1000 Ω (brn-blk-red). ✓
- () R841: 1000 Ω (brn-blk-red). ✓
- () R842: 1000 Ω (brn-blk-red). ✓
- () R843: 1000 Ω (brn-blk-red). ✓
- () R827: 100 k Ω (brn-blk-yel). ✓
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R813: 220 Ω (red-red-brn). ✓
- () R803: 8000 Ω (gry-blk-blk-brn). ✓
- () R804: 16 k Ω (brn-blk-blk-red). ✓
- () R814: 1000 Ω (brn-blk-red) ✓
- () R286: 100 k Ω (brn-blk-yel). ✓
- () R811: 50 k Ω (grn-blk-blk-red). ✓
- () Solder the leads to the foil and cut off the excess lengths.



PICTORIAL 7-2

CONTINUE

- () R829: 2200 Ω (red-red-red). ✓
- () R802: 4000 Ω (yel-blk-blk-brn). ✓
- () R801: 2000 Ω (red-blk-blk-brn). ✓
- () R806: 64 k Ω (blu-yel-blk-red). ✓
- () R805: 32 k Ω (org-red-blk-red). ✓
- () R812: 10 k Ω (brn-blk-org). ✓
- () R809: 10 k Ω (brn-blk-org). ✓
- () R808: 1000 Ω (brn-blk-red). ✓
- () R807: 150 k Ω (brn-grn-blk-org). ✓
- () Solder the leads to the foil and cut off the excess lengths.

START

NOTE: You will be instructed to prepare wires ahead of time. To prepare the wire, cut it to the indicated length and remove $\frac{1}{4}$ " of insulation from the ends. The wires are listed in the order in which they will be used.

- () Prepare the following lengths of wire:

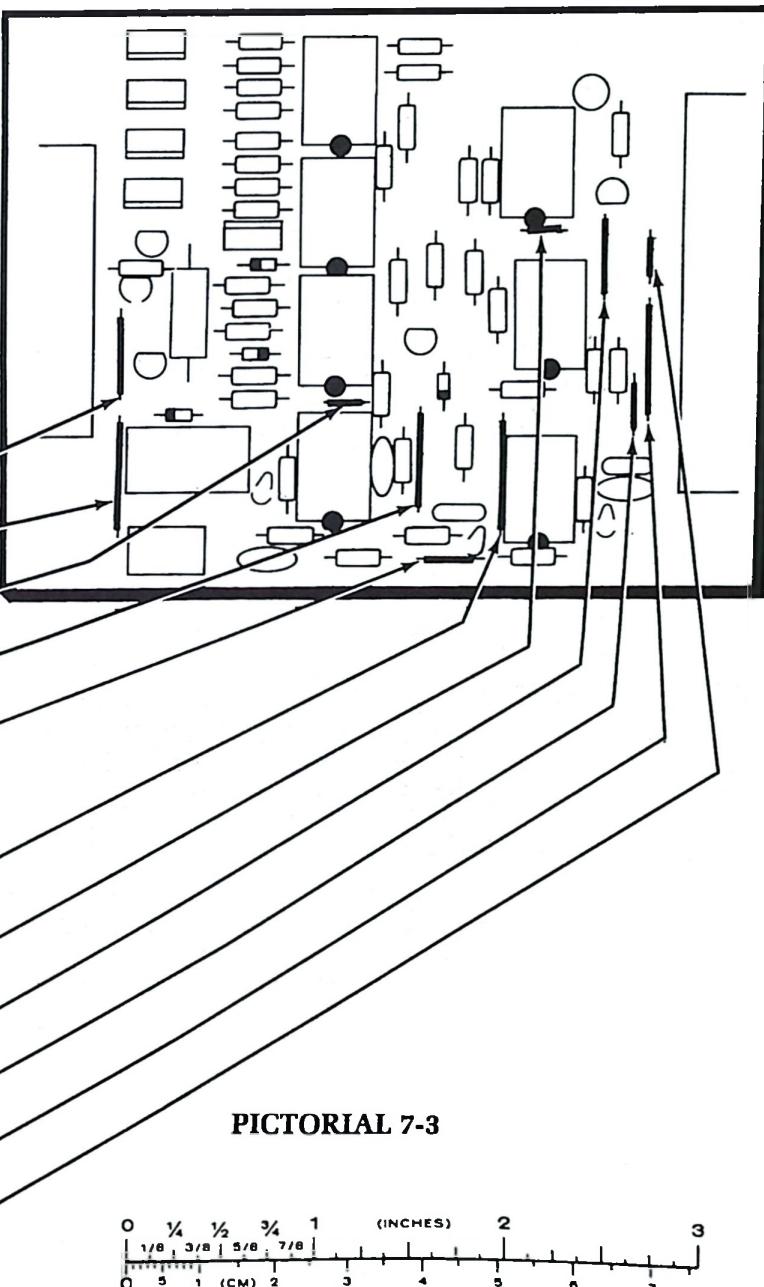
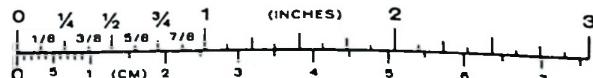
1-1/8"	1-1/4"
1-1/4"	3/4"
3/4"	1"
1-1/4"	7/8"
7/8"	1-1/4"
	3/4"

- | | |
|-------------|-----|
| () 1-1/8". | ✓ 1 |
| () 1-1/4". | ✓ 2 |
| (✓) 3/4". | ✓ 3 |
| () 1-1/4". | ✓ 4 |
| (✓) 7/8". | ✓ 5 |

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

- | | |
|-------------|------|
| () 1-1/4". | ✓ 6 |
| (✓) 3/4". | ✓ 7 |
| (✓) 1". | ✓ 8 |
| () 7/8". | ✓ 9 |
| () 1-1/4". | ✓ 10 |
| (✓) 3/4". | ✓ 11 |

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

**PICTORIAL 7-3**

START ▶

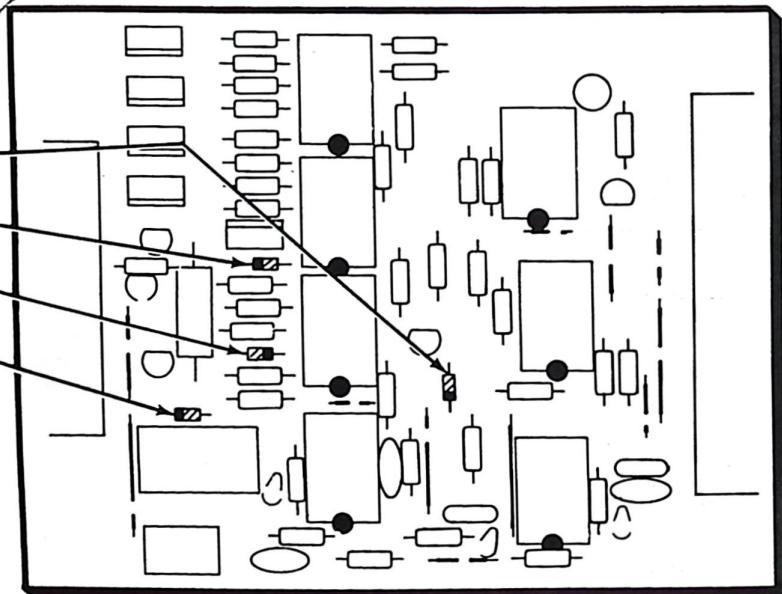
NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



BANDED END (CATHODE)

- () D801: 1N4149 (#56-56).
- () D804: 1N4002 (#57-65).
- () D803: 1N4002 (#57-65).
- () D802: 1N4002 (#57-65).
- () Solder the leads to the foil and cut off the excess lengths.

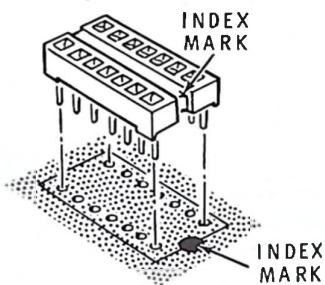
Missing



PICTORIAL 7-4

START ▶

NOTE: You will install IC sockets in the following steps. 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 each socket.

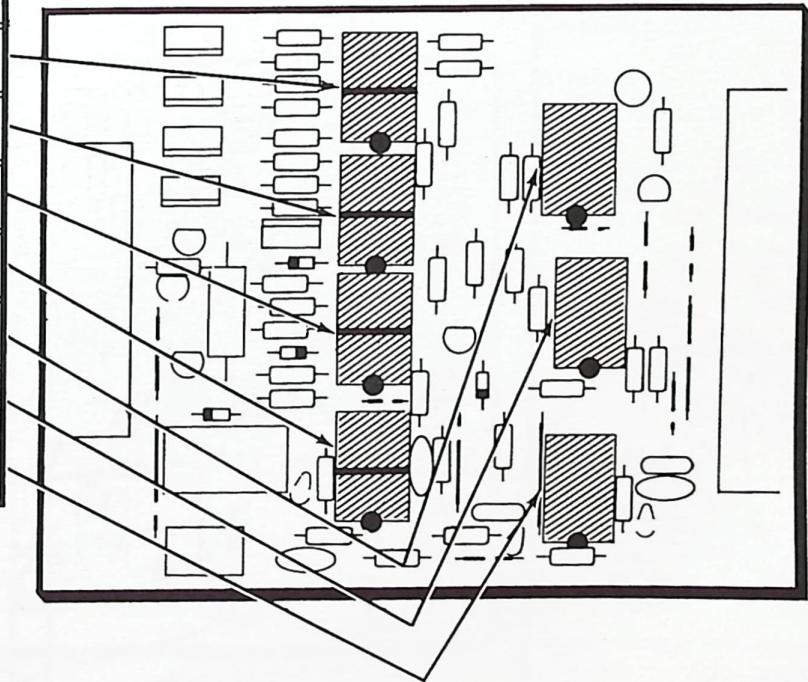
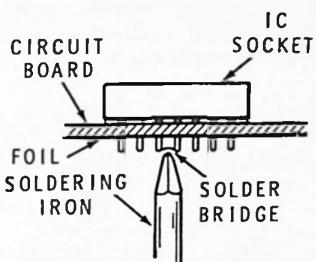


Install seven 14-pin IC sockets in the following locations. NOTE: Some locations have two designations. This is because two IC's will be installed in the socket.

- () U809, U811.
- () U807, U808.
- () U804, U805.
- () U806.
- () U801.
- () U802.
- () U803.

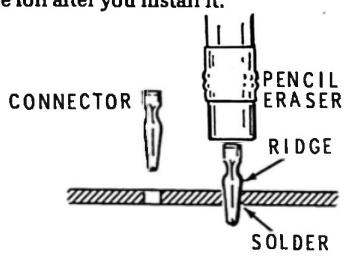
CONTINUE ▶

() Carefully check each 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.

**PICTORIAL 7-5**

START ▶

NOTE: Install the following connectors as shown and solder them to the foil. Do not use excessive pressure when you install them or they could bend. One extra connector has been supplied. Solder each connector to the foil after you install it.

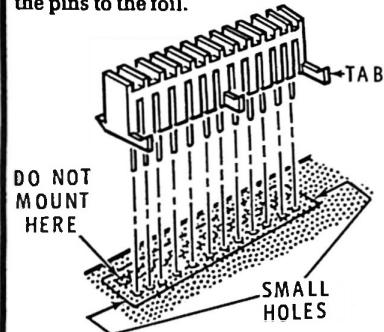


(✓) TP1.

(✓) TP2.

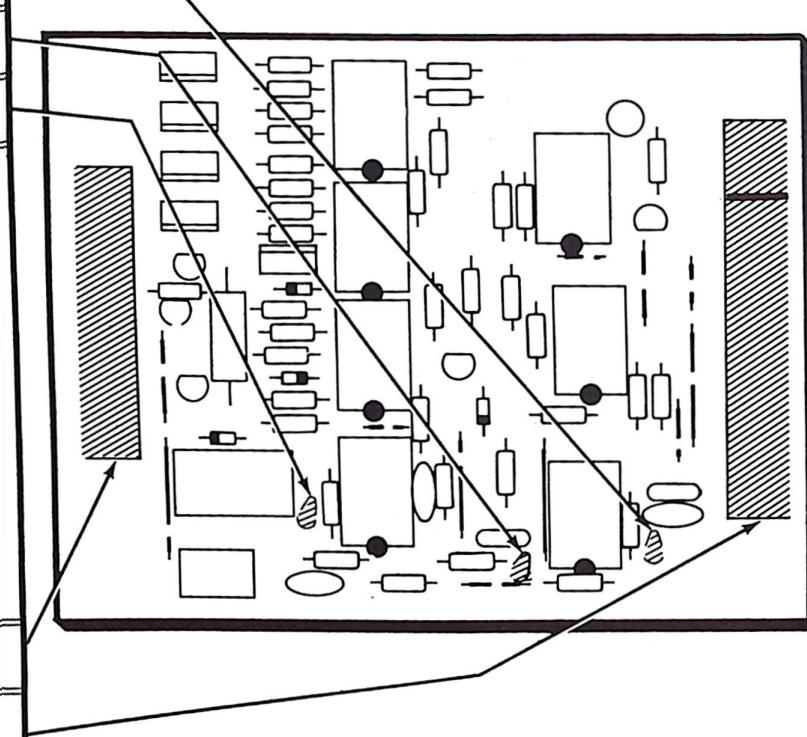
(✓) TP3.

NOTE: When you install the following sockets, position them with the tabs as shown. Insert the pins in the small holes in the board and solder the pins to the foil.



(✓) P801: 12-pin socket.

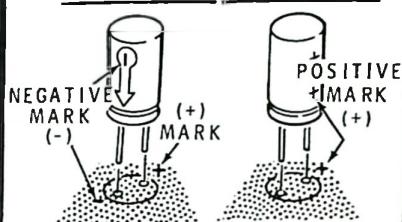
(✓) P802: 12-pin socket and 4-pin socket.

**PICTORIAL 7-6**

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 (-) LEAD IS POSITIVE (+)

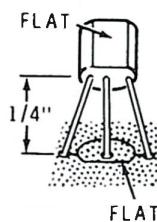


(✓) C806: 10 μ F electrolytic.

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

START

To mount transistors in the following steps, 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 lengths.



() Q806: 2N4121 (#417-235). ✓

() Q801: MPS-A05 (#417-864). ✓

() Q803: 2N4121 (#417-235). ✓

() Q805: MPS-A05 (#417-864). ✓

() Q802: MPS-A13 (#417-881). ✓

() C801: .1 μ F Mylar. ✓

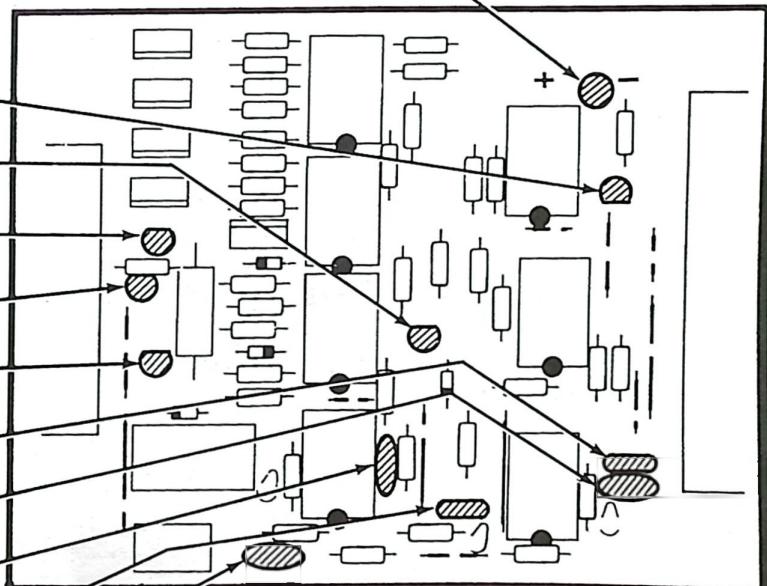
() C802: .01 μ F ceramic. ✓

() C805: .001 μ F ceramic. ✓

() C803: .1 μ F Mylar. ✓

() C804: .01 μ F ceramic. ✓

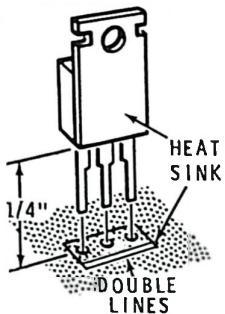
() Solder the leads to the foil and cut off the excess lengths.



PICTORIAL 7-7

START ▶

NOTE: When you install the following transistors, match up the heat sink with the wide outline on the board as shown. Insert the leads in their corresponding holes. Solder the leads to the foil and cut off the excess lengths.



(✓) Q811: 2N6387 (#417-918).

(✓) Q809: 2N6387 (#417-918).

(✓) Q808: 2N6387 (#417-918).

(✓) Q807: 2N6387 (#417-918).

() Q804: MJE5976 (#417-857). ✓

(✓) R819: 100 Ω, 2-watt, 5% (brn-blk-brn-gld). Position the resistor 1/4" from the board, solder the leads to the foil and cut off the excess lead lengths.

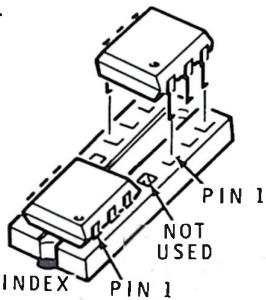


(✓) K801: Install the relay and solder the leads to the foil. Disregard any numbers printed on the relay.

(✓) R825: 20 kΩ control. Install the control and solder the lugs to the foil.

**CONTINUE** ▶

The following six IC's will be installed in three sockets (two in each socket). Install one at one end of the socket and one at the other end. This will leave the center pins of the IC socket unused. The index mark of both IC's should point in the direction of the index mark on the board as shown below and in Detail 7-8A.



() U811: 4N26 (#443-808).

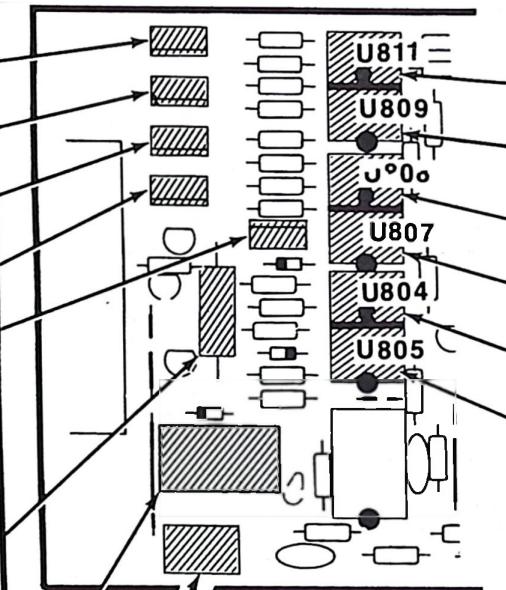
() U809: 4N26 (#443-808).

() U808: 4N26 (#443-808).

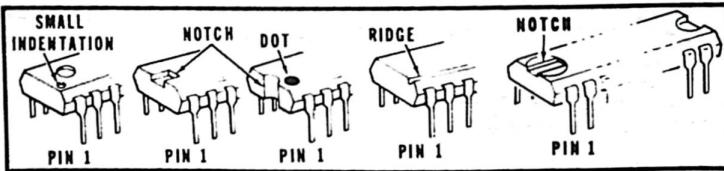
() U807: 4N26 (#443-808).

() U804: 4N26 (#443-808).

() U805: 4N26 (#443-808).



PICTORIAL 7-8



Detail 7-8A

START

CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad from the IC, DO NOT let go of the IC. Install the IC 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 the other hand.
5. 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.

U801: CD4016 (#442-99).

U802: CD4016 (#442-99).

U803: LM556 or MC1456 (#442-740).

U806: LM3900 (#442-71).

CONTINUE**CIRCUIT BOARD CHECKOUT**

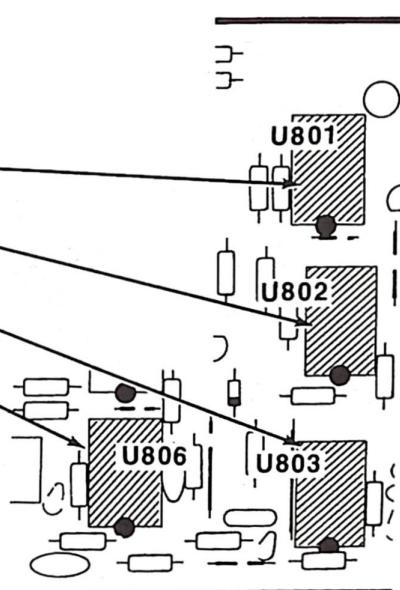
Carefully inspect the foil side of the circuit board for the following most commonly made errors.

- 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.

- Transistors and diodes for proper type and installation.
- Integrated circuits for the proper type and installation.
- Electrolytic capacitors for the correct position of the identified (+ or -) lead.

This completes the assembly of the Main Drive Circuit Board. Set the board aside and proceed to the next page.

FINISH

PICTORIAL 7-9

ARM DRIVE CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #8. Check each part against the following list. The key numbers correspond to the numbers on the "Arm Drive Circuit Board Parts Pictorial" (Illustration Booklet, Page 4. Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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. For prices, refer to the separate "Heath Parts Price List."

KEY	HEATH No.	QTY.	DESCRIPTION
	Part No.		

CIRCUIT Comp. No.

RESISTORS

All resistors are 5% (fourth band gold).

1/4-Watt

A1	6-271-12	26	270 Ω (red-viol-brn)
----	----------	----	-----------------------------

R701, R707, R714, R715, R717, R718, R721, R722, R724, R725, R727, R728, R731, R732, R734, R735, R737, R738, R741, R742, R744, R745, R747, R748, R751, R752
--

A1	6-222-12	2	2200 Ω (red-red-red)
----	----------	---	-----------------------------

R702, R708

KEY	HEATH No.	QTY.	DESCRIPTION
	Part No.		

CIRCUIT Comp. No.

A1	6-472-12	16	4700 Ω (yel-viol-red)
----	----------	----	------------------------------

R705, R706, R712, R713, R716, R719, R723, R726, R729, R733, R736, R739, R743, R746, R749, R753 R703, R709

A1	6-103-12	2	10 k Ω (bm-blk-org)
----	----------	---	----------------------------

CIRCUIT Comp. No.

A1	6-103-12	2	10 k Ω (bm-blk-org)
----	----------	---	----------------------------

1/2 Watt

A2	6-471	2	470 Ω (yel-viol-brn)
----	-------	---	-----------------------------

R704, R711

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

TRANSISTORS — INTEGRATED CIRCUITS (ICs)

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

B1	417-801	2	MPSA20 transistor	Q701, Q704
B1	417-865	2	MPSA55 transistor	Q702, Q705
B2	417-918	12	2N6387 transistor	Q707, Q708, Q709, Q711, Q712, Q713, Q714, Q715, Q716, Q717, Q718, Q719
B3	443-808	14	4N26 IC	U701, U702, U703, U704, U705, U706, U707, U708, U709, U711, U712, U713, U714, U715

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

DIODES

C1	57-65	6	1N4002 diode	D701-D706,
C1	56-605	8	1N4746A zener diode	D707-D711, D716-D719

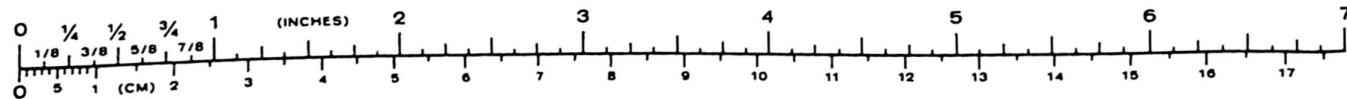
CONNECTORS — SOCKET — SHELL

D1	432-866	6	Spring connector
D2	432-923	2	4-pin connector
D3	432-779	3	12-pin connector
D4	434-298	6	14-pin IC socket
D5	432-1080	2	3-slot connector housing

MISCELLANEOUS

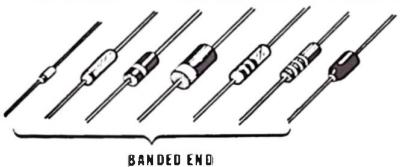
344-50	9"	Black wire
344-91	6"	Brown wire
344-92	6"	Red wire
344-93	6"	Orange wire
85-2815-1	1	Arm drive circuit board

]



STEP-BY-STEP ASSEMBLY**START** ▾

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



BANDED END

In the following steps you will install eight 1N4746A diodes (#56-605). Position the banded ends as shown.

- () D718
- () D716
- () D719
- () D717
- () D711
- () D709
- () D708
- () D707

When a black wire is called for in a step, remove $1/4"$ of insulation from both ends of the specified length of solid black wire.

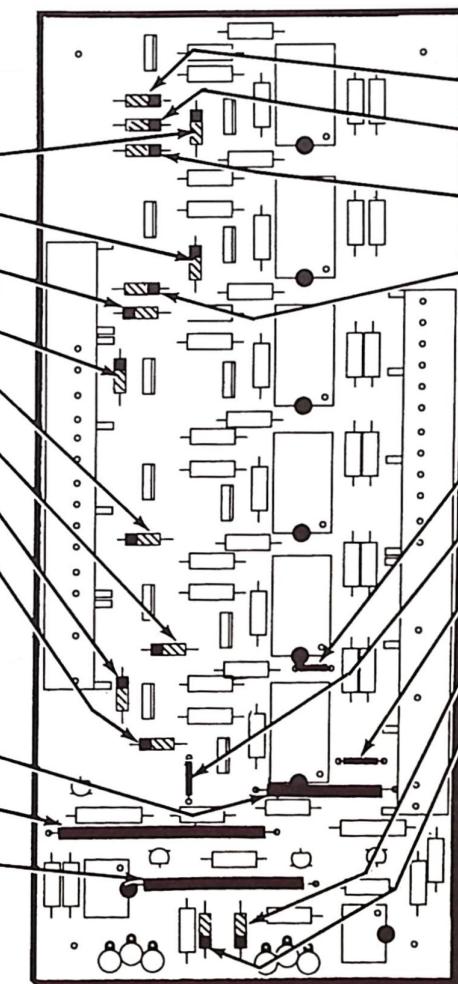
- () 1-1/2" black wire.
- () 2-1/8" black wire.
- () 1-3/4" black wire.
- () Solder the wires to the foil and cut off the excess lead lengths.

CONTINUE ▾

- () D706: 1N4002 diode (#57-65).
- () D705: 1N4002 diode (#57-65).
- () D704: 1N4002 diode (#57-65).
- () D703: 1N4002 diode (#57-65).

When a bare wire is called for, remove all of the insulation from the indicated lengths of solid black wire.

- () 1" bare wire.
- () 1" bare wire.
- () 1" bare wire.
- () D701: 1N4002 diode (#57-65).
- () D702: 1N4002 diode (#57-65).
- () Solder the leads to the foil and cut off the excess lead lengths.

**PICTORIAL 8-1**

START

Locate thirteen 4700 Ω (yel-viol-red) resistors and install them in the following steps.

R753: 4700 Ω .

R749: 4700 Ω .

R746: 4700 Ω .

R743: 4700 Ω .

R739: 4700 Ω .

R736: 4700 Ω .

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

R733: 4700 Ω .

R729: 4700 Ω .

R726: 4700 Ω .

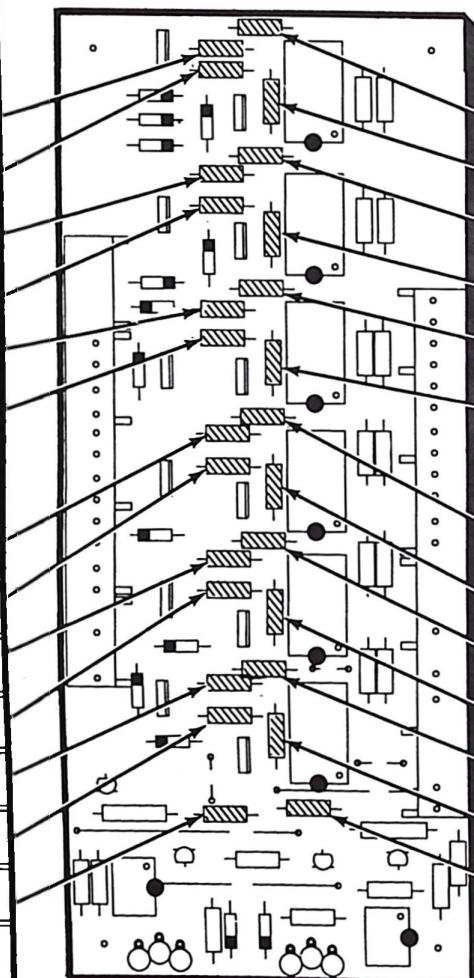
R723: 4700 Ω .

R719: 4700 Ω .

R716: 4700 Ω .

R712: 4700 Ω .

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

**CONTINUE**

Locate thirteen 270 Ω (red-viol-brn) resistors and install them in the following steps.

R752: 270 Ω .

R748: 270 Ω .

R745: 270 Ω .

R742: 270 Ω .

R738: 270 Ω .

R735: 270 Ω .

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

R732: 270 Ω .

R728: 270 Ω .

R725: 270 Ω .

R722: 270 Ω .

R718: 270 Ω .

R715: 270 Ω .

R707: 270 Ω .

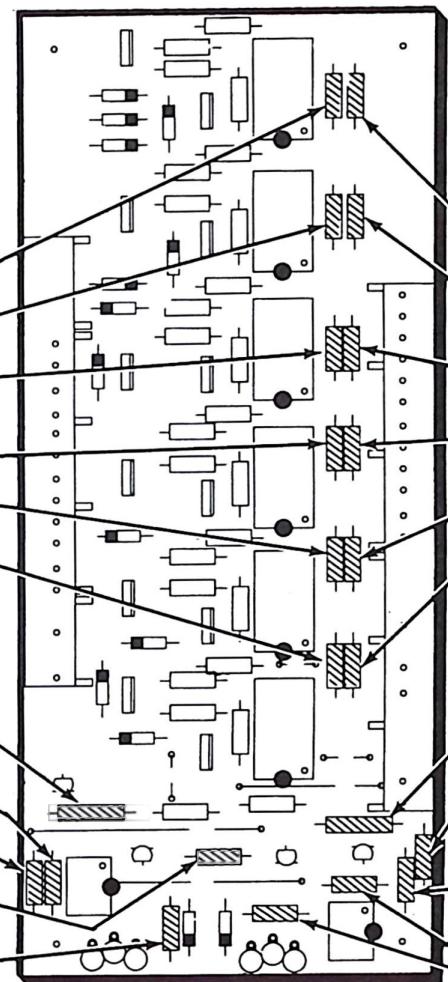
Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 8-2

START

Install six 270 Ω (red-viol-brn) resistors in the following steps.

- () R747: 270 Ω .
- () R741: 270 Ω .
- () R734: 270 Ω .
- () R731: 270 Ω .
- () R724: 270 Ω .
- () R717: 270 Ω .
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R711: 470 Ω , 1/2-watt (yel-viol-brn).
- () R709: 10 k Ω (brn-blk-org).
- () R708: 2200 Ω (red-red-red).
- () R705: 4700 Ω (yel-viol-red).
- () R713: 4700 Ω (yel-viol-red).
- () Solder the leads to the foil and cut off the excess lead lengths.

**CONTINUE**

Install six 270 Ω (red-viol-brn) resistors in the following steps:

- () R751: 270 Ω .
- () R744: 270 Ω .
- () R737: 270 Ω .
- () R727: 270 Ω .
- () R721: 270 Ω .
- () R714: 270 Ω .
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R704: 470 Ω , 1/2-watt (yel-viol-brn).
- () R701: 270 Ω (red-viol-brn).
- () R702: 2200 Ω (red-red-red).
- () R703: 10 k Ω (brn-blk-org).
- () R706: 4700 Ω (yel-viol-red).
- () Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 8-3

START ▶

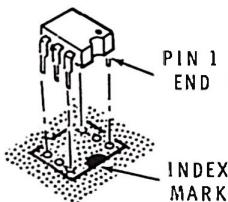
NOTE: When you install an IC socket, be sure the index mark is still visible after the socket is installed. Then solder the pins to the foil.



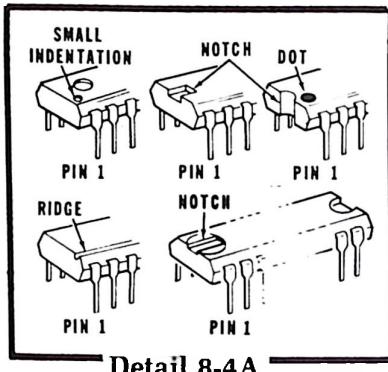
- 14-pin IC sockets at the six indicated locations.

When you install an integrated circuit, be sure the pin 1 end of the IC is toward the index mark on the circuit board. See Detail 8-4A to identify the pin 1 end of an IC.

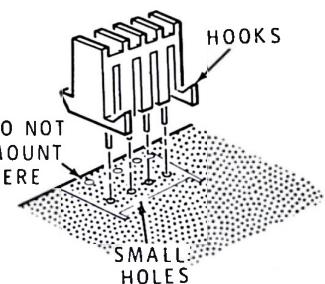
Solder the pins to the foil as you install the next two ICs.



- U702: 4N26 integrated circuit (#443-808).
- U701: 4N26 integrated circuit (#443-808).

**CONTINUE** ▶

Solder the pins of each connector to the foil as it is installed.



- 4-pin connector.

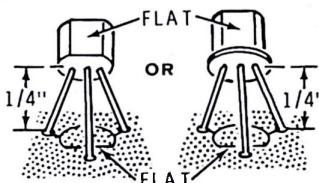
- 12-pin connector.

- 4-pin connector.

- 12-pin connector.

- 12-pin connector.

NOTE: When you install a transistor in each of the following steps, align its flat with the flat on the board. Insert the leads into their correct holes. Position the transistor $\frac{1}{4}$ " above the board. Then solder the leads to the foil and cut off the excess lead lengths.

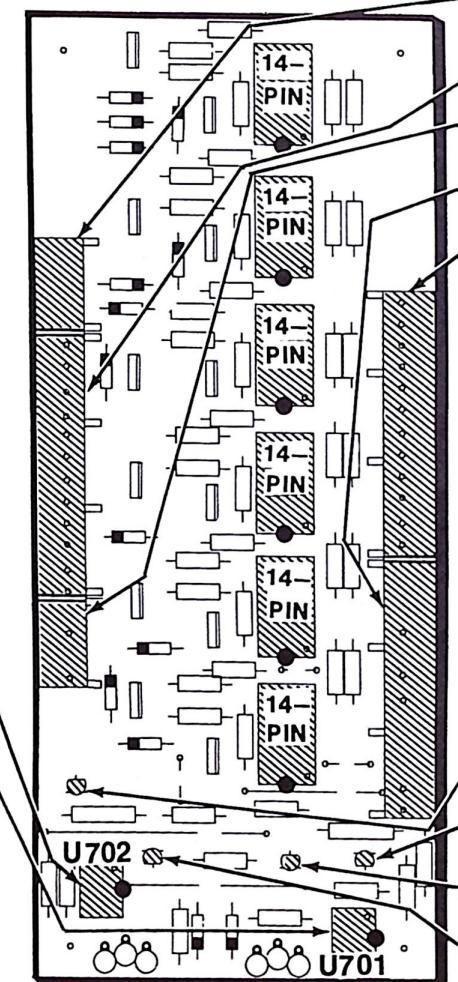


- Q704: MPSA20 transistor (#417-801).

- Q701: MPSA20 transistor (#417-801).

- Q702: MPSA55 transistor (#417-865).

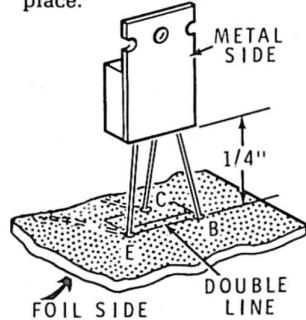
- Q705: MPSA55 transistor (#417-865).

**PICTORIAL 8-4**

START

In each of the next twelve steps, you will install a transistor in the following manner:

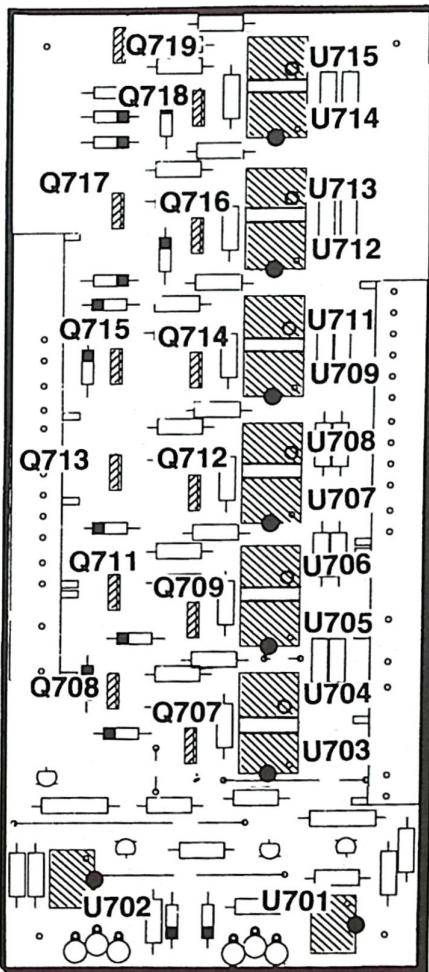
1. Align the metal side of the transistor with the double lines on the circuit board and insert the leads in their holes.
2. Position the transistor $1/4"$ above the circuit board and bend the leads on the foil side to hold the transistor in place.



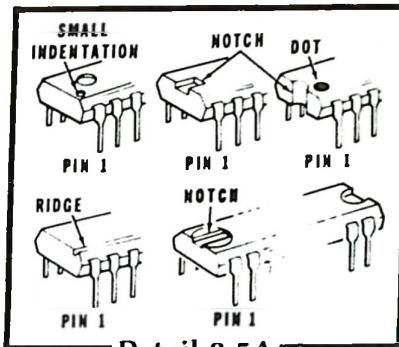
3. Turn the circuit board over and solder all three leads to the foil.
4. Cut off the excess transistor leads.

Install twelve 2N6387 transistors (#417-918) in the following steps.

- () Q719
- () Q718
- () Q717
- () Q716
- () Q715
- () Q714
- () Q713
- () Q712
- () Q711
- () Q709
- () Q708
- () Q707



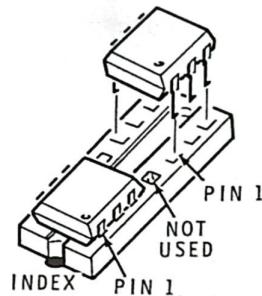
PICTORIAL 8-5



Detail 8-5A

CONTINUE

When you install 2 ICs in a single 14-pin socket, be sure the pin 1 ends of both ICs are towards the index mark on the circuit board. See Detail 8-5A to identify the pin 1 end of an IC.

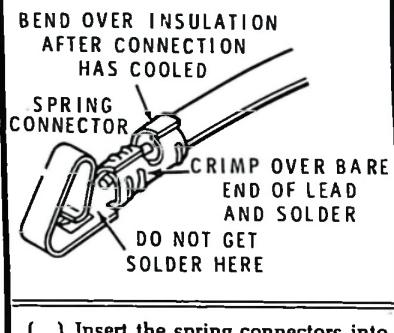


Install a 4N26 integrated circuit (#443-808) at each of the next twelve locations.

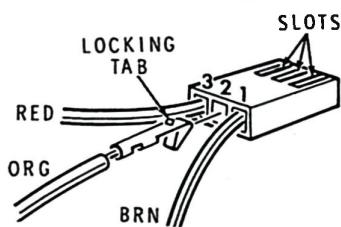
- () U715.
- () U714.
- () U713.
- () U712.
- () U711.
- () U709.
- () U708.
- () U707.
- () U706.
- () U705.
- () U704.
- () U703.

START ▶

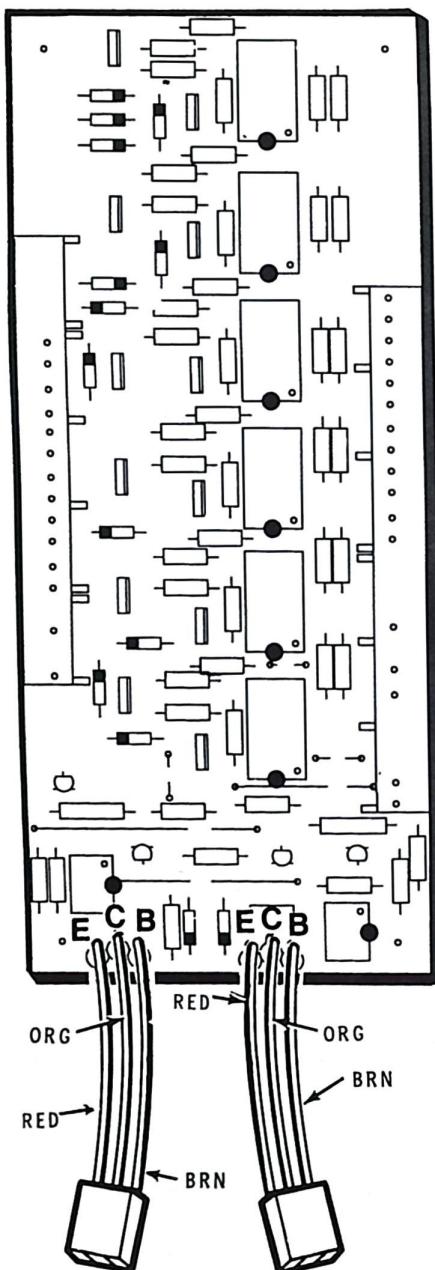
- () Prepare two 3" lengths of brown, red, and orange wire.
- () On one end of each wire, install a spring connector as shown below and on Page 11.
- () Remove 1/4" of insulation from the other end of each wire.



- () Insert the spring connectors into their indicated holes in the two 3-slot connector housings.



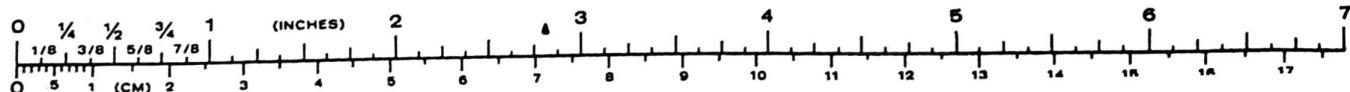
- () Solder the wires of these assemblies into their correct holes (red to E, org to C, and brn to B) at locations Q706 and Q703.

**CONTINUE** ▶**CIRCUIT BOARD CHECKOUT**

Carefully inspect the circuit board for the following conditions.

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.
- () Transistors and ICs for the proper type and installation.
- () Diodes for proper position of the banded end.

Set the circuit board aside temporarily.

PICTORIAL 8-6

DISPLAY CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #9. Check each part against the following list. The key numbers correspond to the numbers on the "Display Circuit Board Parts Pictorial" (Illustration Booklet, Page 4). Any part that is in an individual

envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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

RESISTORS

NOTE: All resistors are 1/4-watt, 5%, unless otherwise noted.

A1	6-470	1	47 Ω, 1/2-watt (yel-viol-blk)	R1205 ✓
A2	6-471-12	48	470 Ω (yel-viol-brn)	R1206 thru ✓ R1258
A2	6-222-12	1	2200 Ω (red-red-red)	R1204 ✓
A2	6-472-12	1	4700 Ω (yel-viol-red)	R1259 ✓
A2	6-682-12	1	6800 Ω (blu-gry-red)	R1201 ✓
A2	6-822-12	6	8200 Ω (gry-red-red)	R1261 thru ✓ R1266
A2	6-103-12	1	10 kΩ (brn-blk-org)	R1203 ✓

CAPACITORS

B1	21-761	9	.01 μF (103) glass capacitor	C1204 - C1213 ✓
B2	25-880	1	10 μF electrolytic capacitor	C1203 ✓
B3	25-920	1	68 μF electrolytic capacitor	C1201 ✓

TRANSISTORS — INTEGRATED CIRCUITS — LEDs

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

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

CAUTION: Some integrated circuits are packaged in a conductive foam and are called "protected ICs". DO NOT remove a protected IC from the foam pad until you are ready to install it, or it could easily be damaged by static electricity.

C1	417-263	1	SJE607 transistor	Q1201 ✓
C2	417-881	1	MPSA13 transistor	Q1202 ✓
C3	443-720	2	80C97 integrated circuit	U1207, U1209 ✓
C3	443-804	6	74LS259 integrated circuit	U1201 - U1206 ✓
C3	443-807	1	74LS42 integrated circuit	U1208 ✓
C4	411-875	6	7-segment LED	V1201 - V1206 ✓

MISCELLANEOUS

D1	64-839	17	Pushbutton switch ✓	
D2	434-298	6	14-pin IC socket ✓	
D3	434-299	9	16-pin IC socket ✓	
D4	432-946	1	25-pin connector ✓	
D5	462-1023	17	Pushbutton key top ✓	
D6	390-1395	1	Key top label set ✓	
D7	390-1404	1	LED label set ✓	
	85-2599-2	1	Display circuit board ✓	

STEP-BY-STEP ASSEMBLY**START** ▶

Position the circuit board as shown.

(✓) C1204 through C1209: Six .01 μ F (103) glass capacitors. Be careful not to break the glass body when you bend the leads.

(✓) R1259: 4700 Ω (yel-viol-red). DON'T use a 470 Ω (yel-viol-brn).

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

NOTE: You will find it easier to solder the leads of the following resistors if you install a few, solder, cut off the excess lead lengths, then install some more.

(✓) R1206 through R1258: Forty-eight 470 Ω resistors (yel-viol-brn).

(✓) C1212: .01 μ F (103) glass capacitor.

(✓) R1204: 2200 Ω (red-red-red).

(✓) R1205: 47 Ω , 1/2-watt (yel-viol-blk).

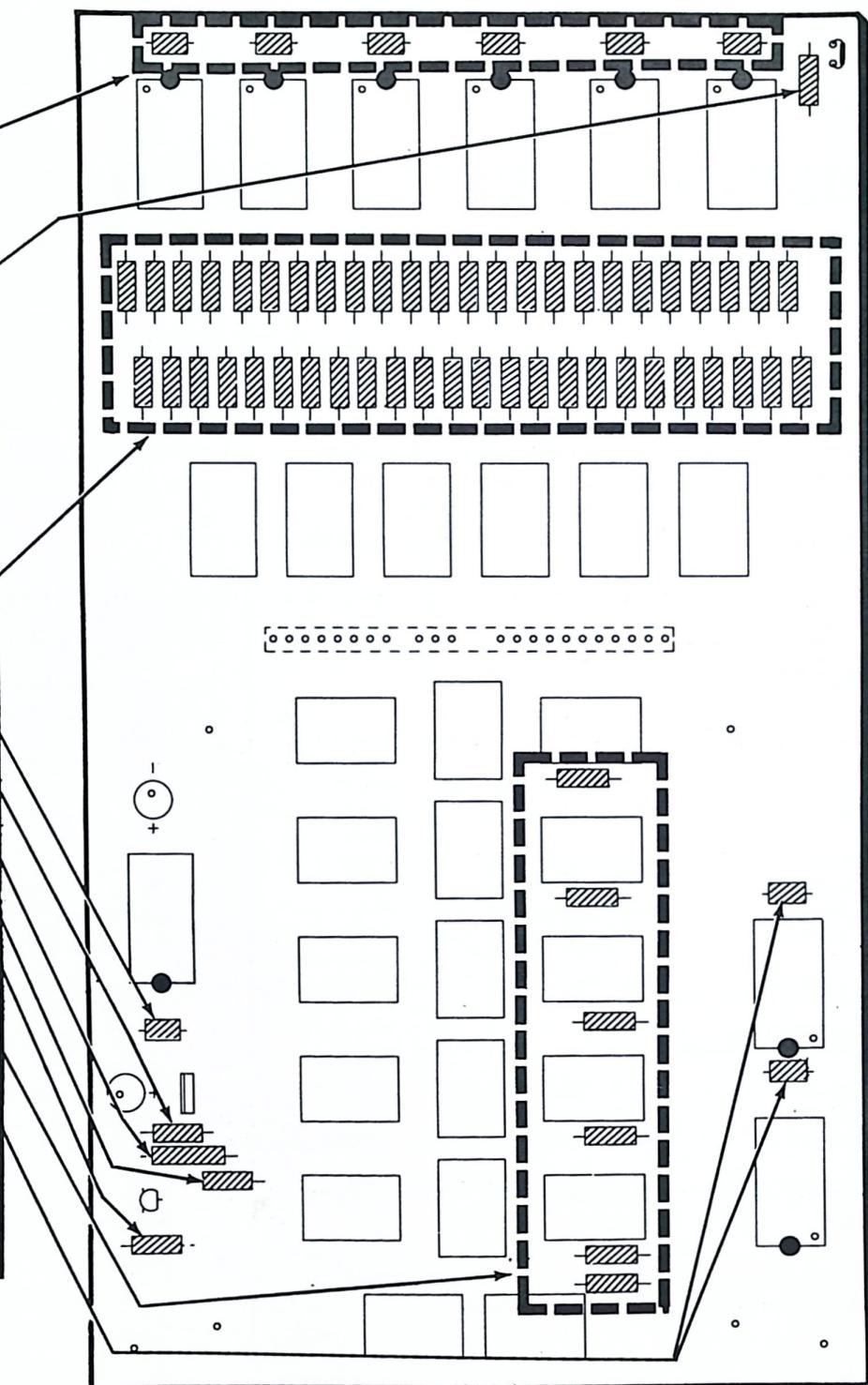
(✓) R1201: 6800 Ω (blu-gry-red).

(✓) R1203: 10 k Ω (brn-blk-org).

(✓) R1261 through R1266: Six 8200 Ω (gry-red-red) resistors.

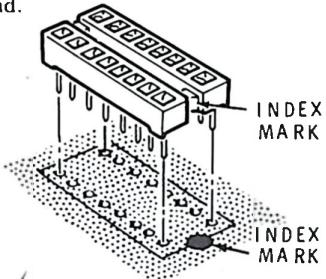
(✓) C1211, C1213: .01 μ F (103) glass capacitor.

(✓) Solder the leads to the foil and cut off the excess lead lengths. Save two of the cut off resistor leads.

**PICTORIAL 9-1**

START

NOTE: When you install IC sockets, place the notched end of the socket over the index mark on the circuit board and insert the pins into the holes. Then solder each pin to its foil pad.



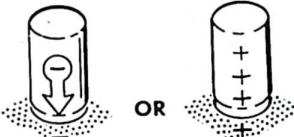
(✓) Install 16-pin IC sockets at the nine locations indicated.

(✓) Install 14-pin IC sockets at the six locations indicated. The notched end may be in either direction.

(✓) Install two cut-off resistor leads at J. Insert the wires through the holes and solder the end of each lead to the foil pads. Then twist the free ends together loosely.



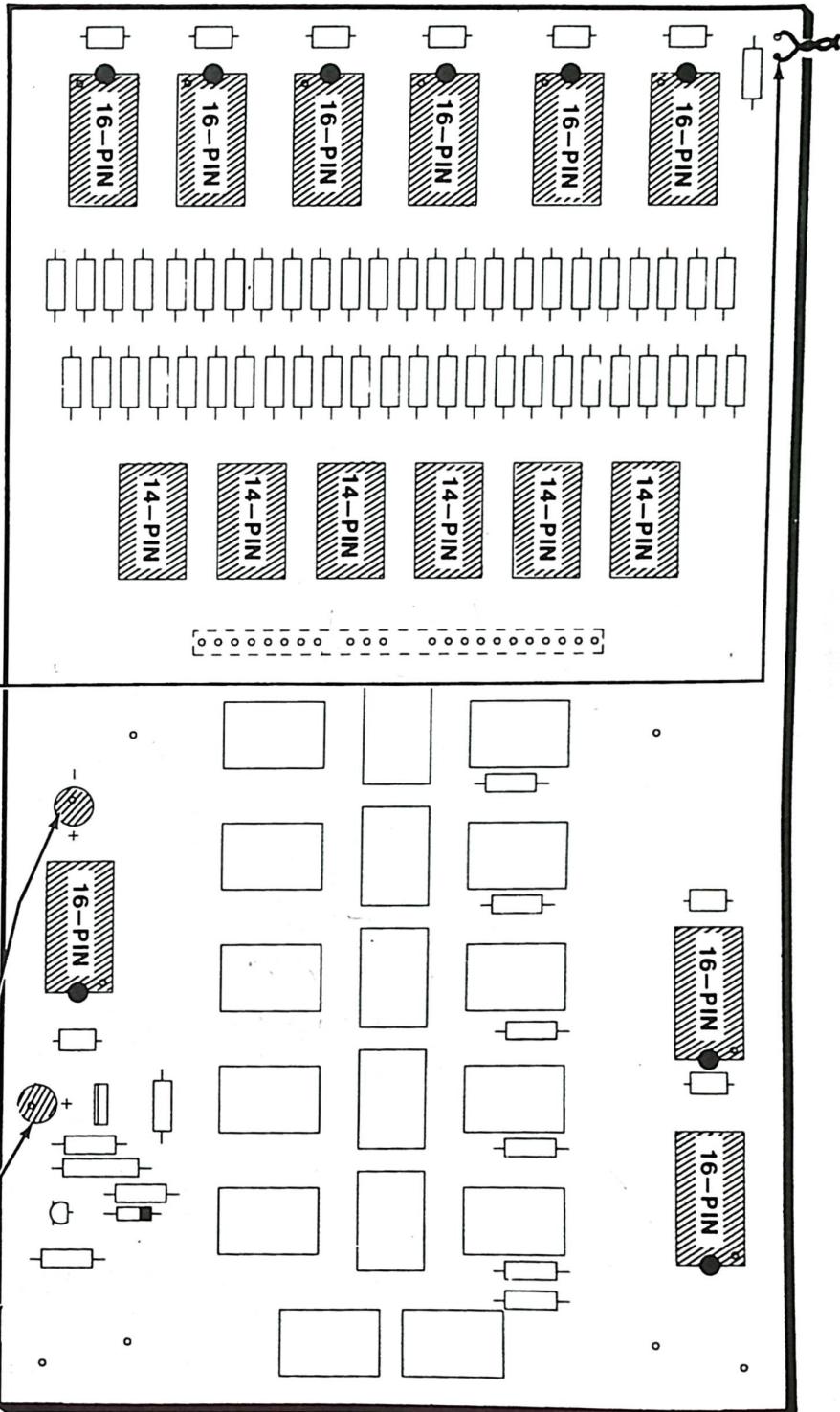
NOTE: When you install an electrolytic capacitor, be sure to insert the positive (+) or negative (-) lead of the capacitor into the corresponding (+) or (-) marked hole of the circuit board.



(✓) C1201: 68 μ F electrolytic.

(✓) C1203: 10 μ F electrolytic.

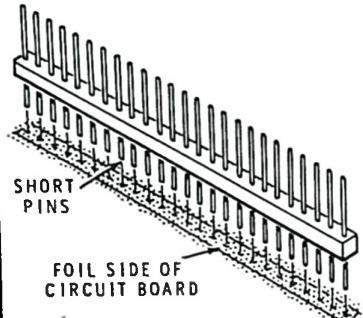
(✓) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 9-2

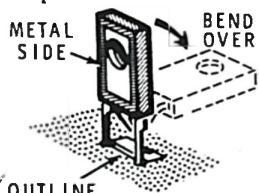
START

In this step you will install the 25-pin connector on the foil side of the circuit board as shown. Insert the shorter pins into their holes and press the body of the connector flush against the circuit board. Then solder each pin to its foil pad on the component side of the board.



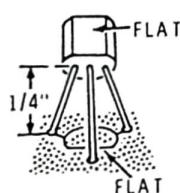
(✓) P1201: 25-pin connector.

NOTE: When you install the following transistor, bend its leads as shown and position the metal side over the dark outline on the circuit board. Then insert the E, C, and B leads into their holes on the board and solder them to their foil pads.



(✓) Q1201: SJE607 transistor (#417-263). Bend the transistor over so it is parallel with the circuit board.

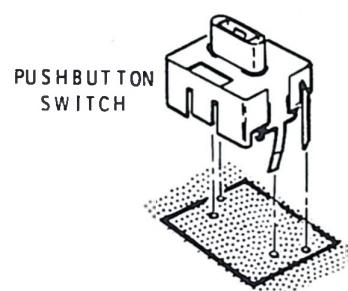
(✓) Q1202: MPSA13 transistor (#417-881). Align the flat of the transistor with the flat of the outline on the circuit board and insert the leads into their holes. Position the transistor $1/4"$ above the circuit board and solder the leads to the foil. Cut off the excess lead lengths on the foil side of the circuit board.



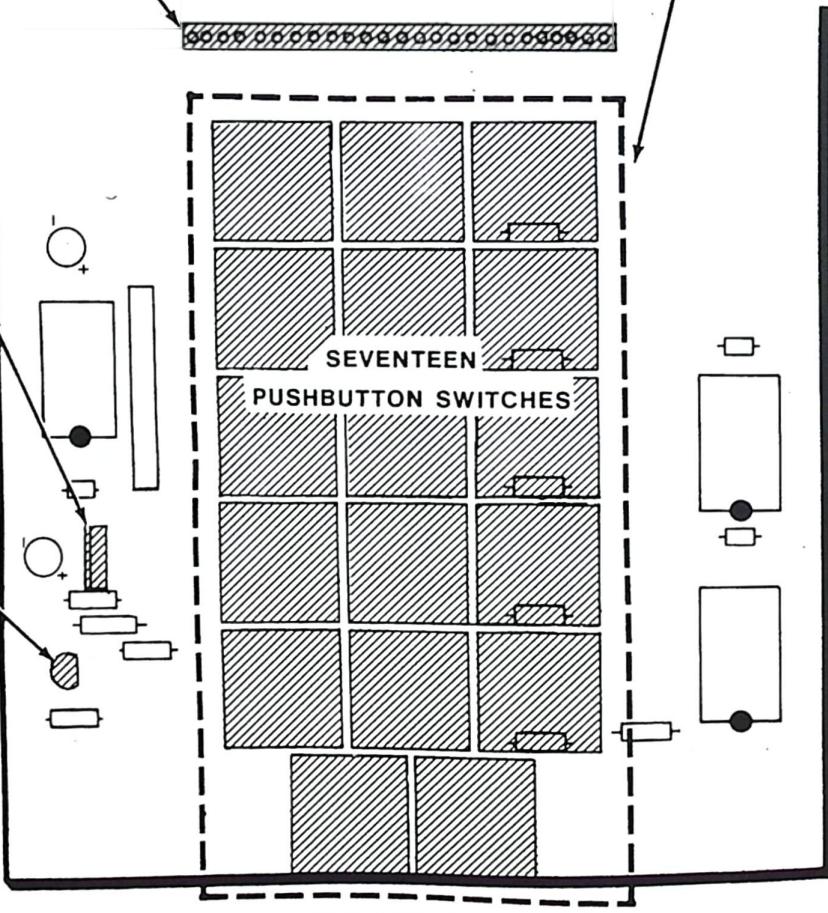
**FOR GOOD SOLDER CONNECTIONS YOU MUST
KEEP THE SOLDERING IRON TIP CLEAN.
WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH**

**CONTINUE**

As you install pushbutton switches in the following step, be sure each key is down against the top of the keyboard before you solder its two lugs. Also be sure the closer-spaced center lugs are installed in the indicated holes.



(✓) Seventeen pushbutton switches.



PICTORIAL 9-3

START

When you install an integrated circuit (IC), as in the following steps, refer to Detail 9-4A to identify the pin 1 end of the IC. Position this end of the IC toward the index mark on the circuit board and insert the pins into the IC socket. Be sure all of the IC pins enter the socket, and that none are bent under the IC.

(✓) U1201 through U1206: Six 74LS259 integrated circuits (#443-804).

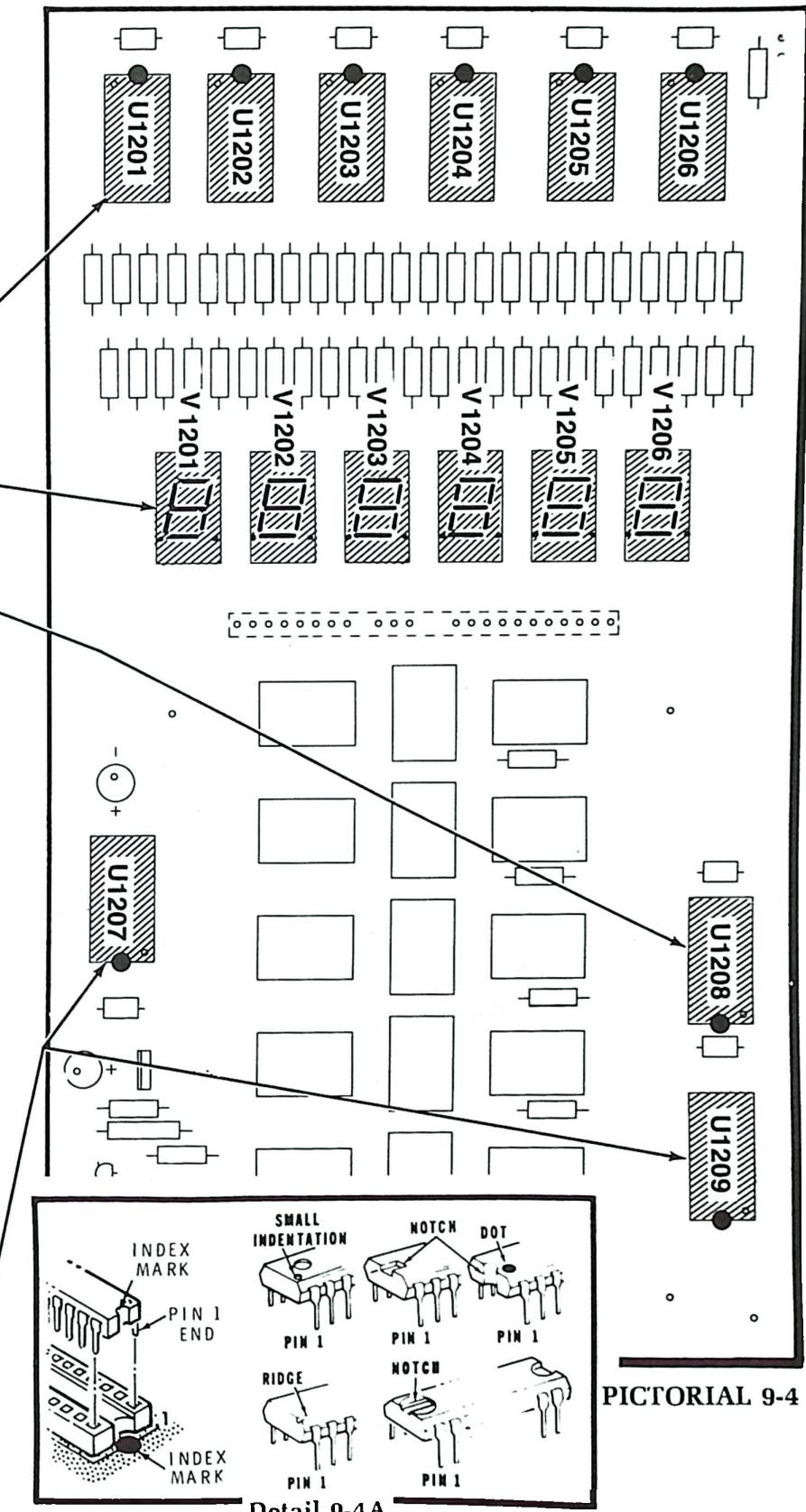
() V1201 through V1206: Six 7-segment LEDs (#411-875). Position the LED with its decimal points toward the bottom of the circuit board, then insert the pins into the IC socket.

() U1208: 74LS42 integrated circuit (#443-887).

CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the IC from its foam pad, DO NOT let go of the IC until you have installed it in its socket. Read the following steps before you pick up the IC.

1. Pick up the IC and its foam pad with BOTH hands.
2. Hold the IC with one hand and remove the foam pad with the other.
3. Continue to hold the IC with one hand and straighten any bent pins with the other hand.
4. Pick up the circuit board with your free hand.
5. Align the pin 1 end of the IC with the index mark on the circuit board.
6. Press the IC pins into the IC socket. Once installed, it is protected.

() U1207, U1209: 80C97 integrated circuit (#443-720).

**PICTORIAL 9-4****Detail 9-4A**

START

- Affix a red LED label on the face of each LED. First, peel a label from the paper backing and center the label on the LED. Then press the label in place. Discard any leftover red labels.

- Affix pushbutton key top labels to the seventeen key tops. Peel a label from the paper backing and carefully center the label in the recess of the key top. Then press the label in place. CAUTION: Center the label very carefully; once it is pressed onto a key top, you cannot remove it without destroying the label.

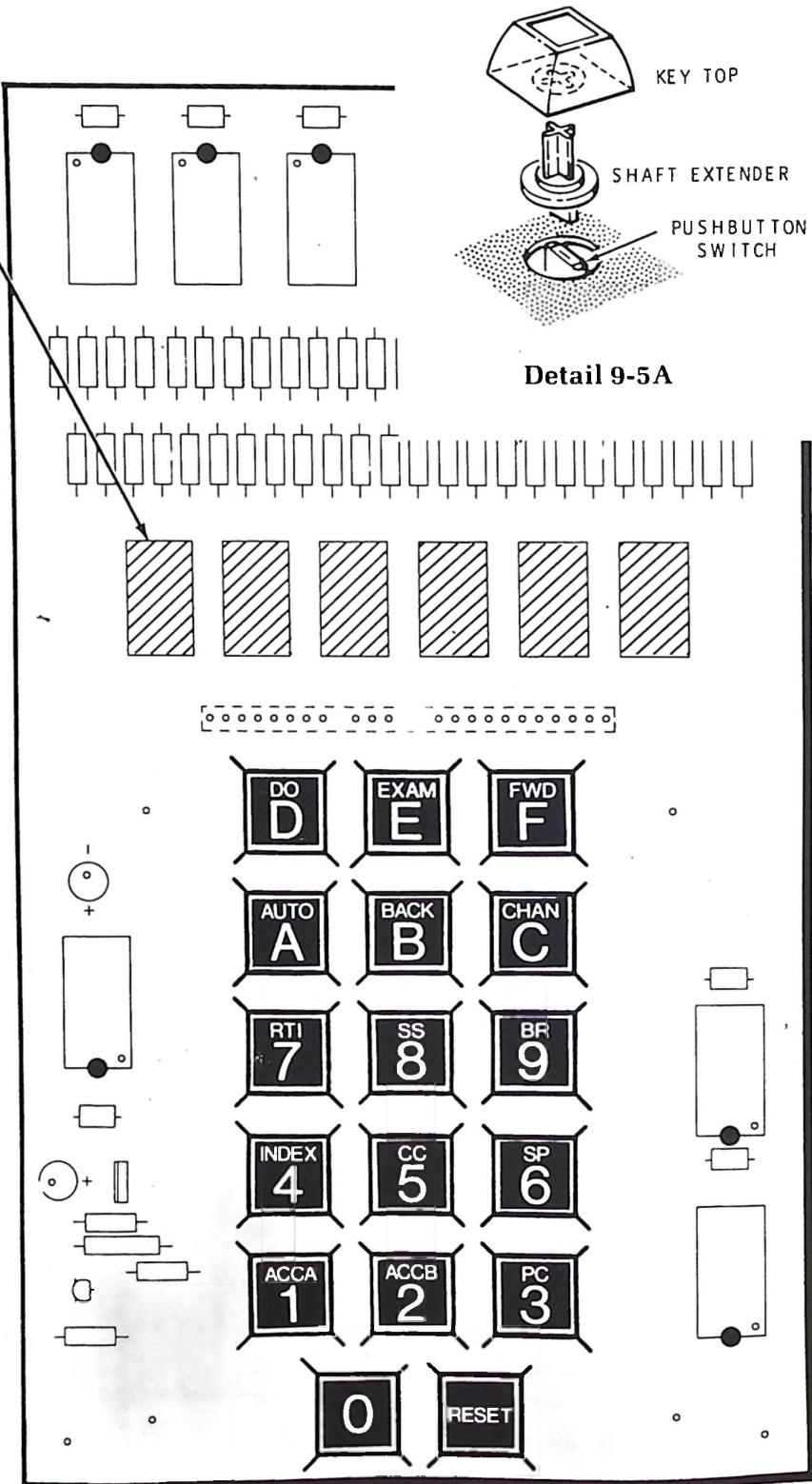
- Refer to Detail 9-5A and push a shaft extender and the appropriate labeled key top onto each of the 17 pushbutton switches. Push firmly on the key top to seal both the shaft extender and key top fully onto the switch.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

- Unsoldered connections.
- Poor solder connections.
- Solder bridges between foils.
- Protruding leads that could touch together.
- Transistors for their proper type and installation.
- Electrolytic capacitors for the correct position of the positive (+) or negative (-) leads.
- Diode for the correct position of the banded end.
- Integrated circuits for the correct type and installation.

Set aside the display board.

**PICTORIAL 9-5**

IN/OUT CIRCUIT BOARD

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #10. Check each part against the following list. The key numbers correspond to the numbers on the "In/Out Circuit Board Parts Pictorial" (Illustration Booklet, Page 5). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is

called for in a step. Do not discard any packing materials until all parts are accounted for.

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. For prices, refer to the separate "Heath Parts Price List."

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

RESISTORS

All resistors are 1/4 watt, 5% (fourth band gold).

A1	6-271-12	1	270 Ω (red-viol-brn)	R305
A1	6-471-12	4	470 Ω (yel-viol-brn)	R309, R310, R312, R320
A1	6-102-12	2	1000 Ω (brn-blk-red)	R319, R325
A1	6-222-12	1	2200 Ω (red-red-red)	R322
A1	6-272-12	4	2700 Ω (red-viol-red)	R308, R311, R313, R321
A1	6-472-12	3	4700 Ω (yel-viol-red)	R337, R338, R339
A1	6-103-12	3	10 k Ω (brn-blk-org)	R314, R316, R324
A1	6-223-12	2	22 k Ω (red-red-org)	R326, R332
A1	6-473-12	4	47 k Ω (yel-viol-org)	R302, R303, R304, R315
A1	6-683-12	2	68 k Ω (blu-gry-org)	R331, R335
A1	6-104-12	10	100 k Ω (brn-blk-yel)	R306, R307, R317, R323, R334, R327, R328, R329, R333, R336
A1	6-225-12	1	2.2 M Ω (red-red-grn)	R318
A2	9-119	3	Resistor pack (8 \times 10k)	RP301, RP302, RP303

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

CAPACITORS

B1	21-3	1	10 pF (10 k) ceramic	C315 ✓
B2	21-22	3	220 pF (220 k) ceramic	C306, C308, ✓ C309
B2	21-27	1	5000 pF ceramic (.005 μ F)	C331 ✓
B2	21-99	3	.2 μ F ceramic	C313, C332, ✓ C333
B3	21-769	13	.01 μ F (103) glass	C301-C305, C307, C311, C314, C317, C326-C329
B4	27-77	1	.1 μ F Mylar	C312 ✓
B5	27-85	1	.22 μ F Mylar	C325 ✓
B6	25-858	5	.33 μ F electrolytic	C318-C323 ✓
B6	25-925	1	4.7 μ F electrolytic	C324 ✓
B6	25-948	1	100 μ F electrolytic	C334 ✓
B7	31-57	1	2.7-20 pF trimmer	C316 ✓

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

CIRCUIT Comp. No.

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

CIRCUIT Comp. No.

DIODES — TRANSISTORS — ICs

NOTE: Transistors and integrated circuits are marked for identification in one of the following ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any other letters or numbers on the IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

CAUTION: Some integrated circuits are packaged in a foam pad to protect them from static electricity. DO NOT remove any IC from its foam pad until you are instructed to install it in a step.

C1	56-56	7	1N4149 diode	D301-D307 ✓
C1	56-97	1	1N3017B diode	D308 ✓
C2	417-801	6	MPSA20 transistor	Q301-Q304, Q305, Q307 ✓
C2	417-235	2	2N4121 transistor	Q306, Q308 ✓
C2	442-627	2	78L05 integrated circuit	U326, U327 ✓
C3	443-603	1	4011 integrated circuit	U319 ✓
C3	443-607	1	4013 integrated circuit	U318 ✓
C3	443-701	1	4049 integrated circuit	U317 ✓
C3	443-706	1	4071 integrated circuit	U323 ✓

DIODES — TRANSISTORS — ICs (Cont'd.)

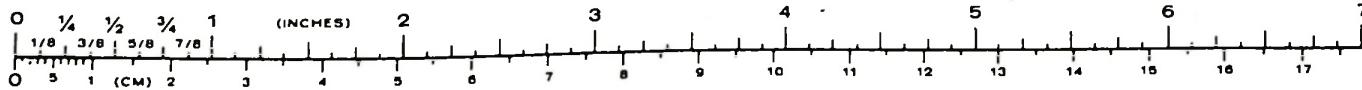
C3	443-720	1	80C97 integrated circuit	U314 ✓
C3	443-736	1	14508 integrated circuit	U316 ✓
C3	443-760	1	14040 integrated circuit	U313 ✓
C3	443-778	1	14093 integrated circuit	U324 ✓
C3	443-779	1	74LS02 integrated circuit	U320 ✓
C3	443-785	1	74C221 integrated circuit	U325 ✓
C3	443-791	5	74LS244 integrated circuit	U301 - U304, U312 ✓
C3	443-863	7	74LS374 integrated circuit	U305, U306, U307, U308, U309, U310, U311 ✓
C3	443-875	1	74LS32 integrated circuit	U322 ✓
C3	443-916	1	4538 integrated circuit	U321 ✓
C3	443-1055	1	5832 integrated circuit	U315 ✓

MISCELLANEOUS

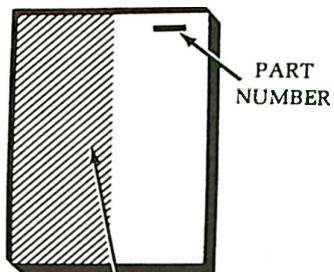
D1	434-298	6	14-pin IC socket	✓
D1	434-299	5	16-pin IC socket	✓
D1	434-310	1	18-pin IC socket	✓
D1	434-311	12	20-pin IC socket	✓
D1	434-307	1	24-pin IC socket	✓
D2	432-779	4	12-pin connector	✓
D3	432-903	12	10-pin connector	✓
D4	432-1265	1	3-pin connector	✓
D5	432-1041	1	Jumper plug	✓
D6	404-624 85-2865-1	1	32.768 kHz crystal	✓
		1	In/Out circuit board	✓

Y301

*Leave these integrated circuits in the envelope until you are instructed to install them. Although they may bear the same type number as the #443-863 integrated circuits, they must not be interchanged.



STEP-BY-STEP ASSEMBLY

IDENTIFICATION
DRAWING

The steps performed in this Pictorial are in this area of the circuit board.

START ↓

Position the I/O circuit board as shown and install the following components.

(✓) R332: 22 kΩ (red-red-org).

(✓) R334: 100 kΩ (brn-blk-yel).

(✓) R333: 100 kΩ (brn-blk-yel).

(✓) R335: 68 kΩ (blu-gry-org).

(✓) R336: 100 kΩ (brn-blk-yel).

(✓) R331: 68 kΩ (blu-gry-org).

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

(✓) R329: 100 kΩ (brn-blk-yel).

(✓) R327: 100 kΩ (brn-blk-yel).

(✓) R328: 100 kΩ (brn-blk-yel).

(✓) R338: 4700 Ω (yel-viol-red).

(✓) R337: 4700 Ω (yel-viol-red).

(✓) R326: 22 kΩ (red-red-org).

(✓) R324: 10 kΩ (brn-blk-org).

(✓) R325: 1000 Ω (brn-blk-red).

(✓) R323: 100 kΩ (brn-blk-yel).

(✓) R320: 470 Ω (yel-viol-brn).

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

CONTINUE ↓

NOTE: In the following steps when you install a glass capacitor, bend its leads carefully to avoid breaking its envelope.

(✓) C301: .01 μF (103) glass capacitor.

(✓) C302: .01 μF (103) glass capacitor.

(✓) C303: .01 μF (103) glass capacitor.

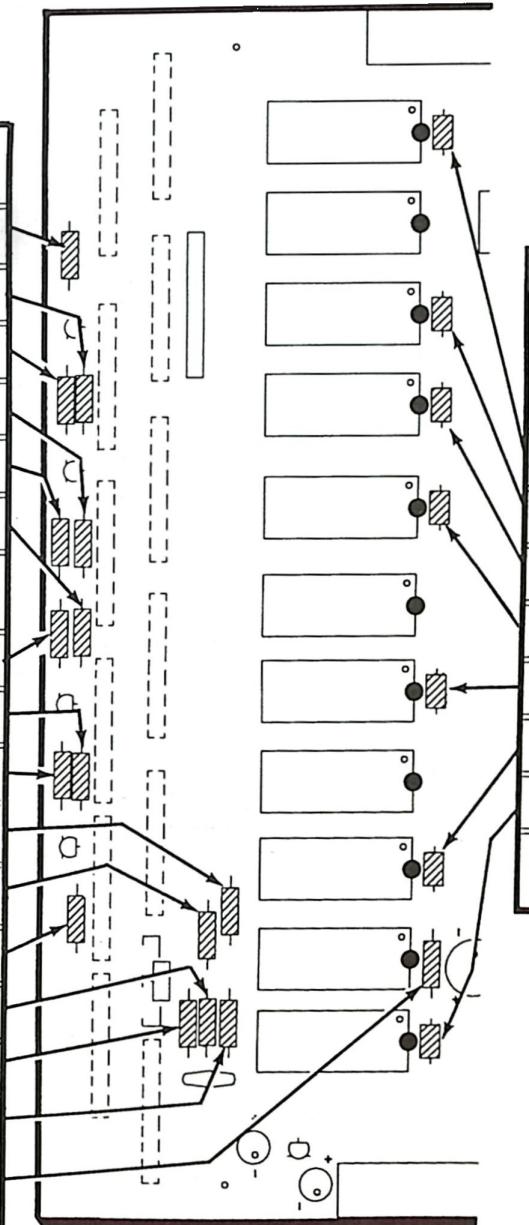
(✓) C326: .01 μF (103) glass capacitor.

(✓) C327: .01 μF (103) glass capacitor.

(✓) C328: .01 μF (103) glass capacitor.

(✓) C329: .01 μF (103) glass capacitor.

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

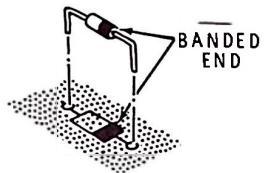


PICTORIAL 10-1

START ▶

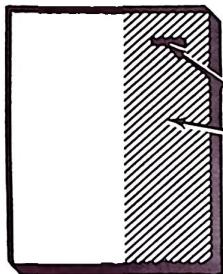
- (✓) C304: .01 µF (103) glass capacitor.
- (✓) C305: .01 µF (103) glass capacitor.
- (✓) C314: .01 µF (103) glass capacitor.
- (✓) C307: .01 µF (103) glass capacitor.

NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board. A DIODE WILL NOT WORK PROPERLY IF IT IS INSTALLED BACKWARD.



If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass.

- (✓) D301: 1N4149 diode (#56-56).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) C317: .01 µF (103) glass capacitor.
- Install six 1N4149 diodes (#56-56) in the following steps. Position the banded end as shown.
- (✓) D303
- (✓) D304
- (✓) D302
- (✓) D307
- (✓) D306
- (✓) D305
- (✓) D308: 1N3017B diode (#56-97).
- (✓) R339: 4700 Ω (yel-viol-red).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

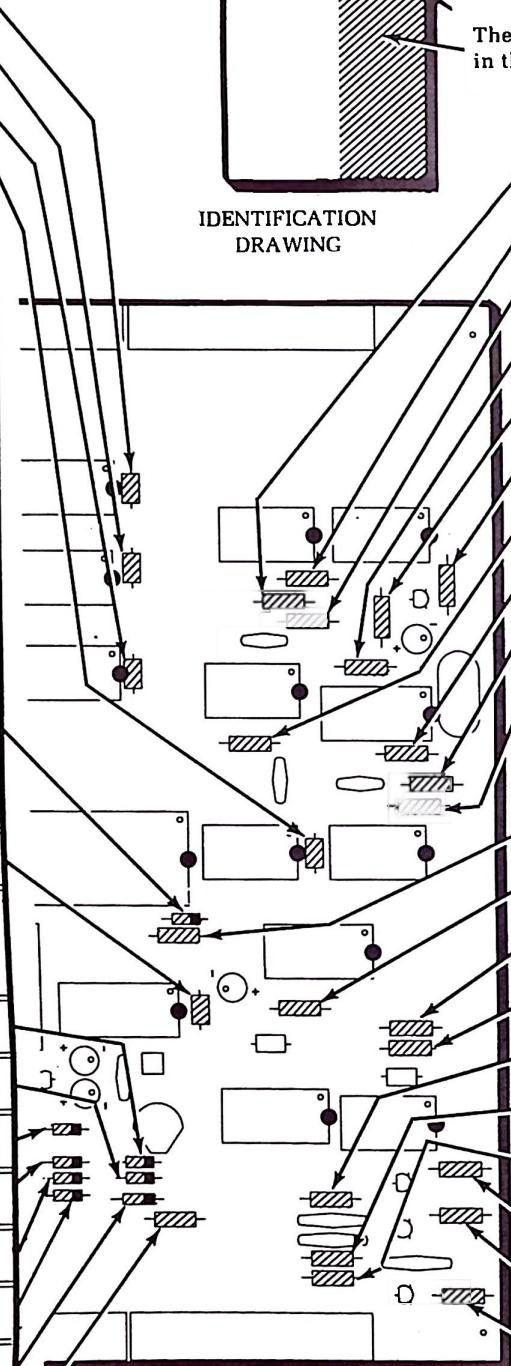


PART
NUMBER

The steps performed in this Pictorial are in this area of the circuit board.

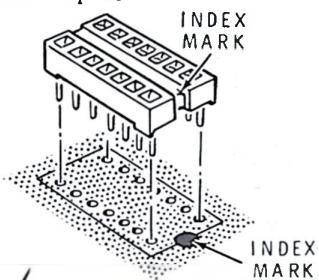
CONTINUE ▶

- (✓) R316: 10 kΩ (brn-blk-org).
- (✓) R314: 10 kΩ (brn-blk-org).
- (✓) R303: 47 kΩ (yel-viol-org).
- (✓) R318: 2.2 MΩ (red-red-grn).
- (✓) R321: 2700 Ω (red-viol-red).
- (✓) R322: 2200 Ω (red-red-red).
- (✓) R304: 47 kΩ (yel-viol-org).
- (✓) R319: 1000 Ω (brn-blk-red).
- (✓) R317: 100 kΩ (brn-blk-yel).
- (✓) R302: 47 kΩ (yel-viol-org).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) R315: 47 kΩ (yel-viol-org).
- (✓) R307: 100 kΩ (brn-blk-yel).
- (✓) R305: 270 Ω (red-viol-brn).
- (✓) R306: 100 kΩ (brn-blk-yel).
- (✓) R308: 2700 Ω (red-viol-red).
- (✓) R311: 2700 Ω (red-viol-red).
- (✓) R313: 2700 Ω (red-viol-red).
- (✓) R309: 470 Ω (yel-viol-brn).
- (✓) R312: 470 Ω (yel-viol-brn).
- (✓) R310: 470 Ω (yel-viol-brn).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 10-2

START

NOTE: When you install an IC socket, be sure the index mark on the circuit board is still visible after the socket is installed. Insert the socket pins through the holes and solder them to their foil pads.

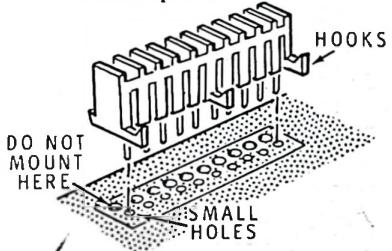


- (✓) Install a 20-pin IC socket at each of the twelve 20-PIN locations.
- (✓) 24-pin IC socket at U316.
- (✓) 18-pin IC socket at U315.

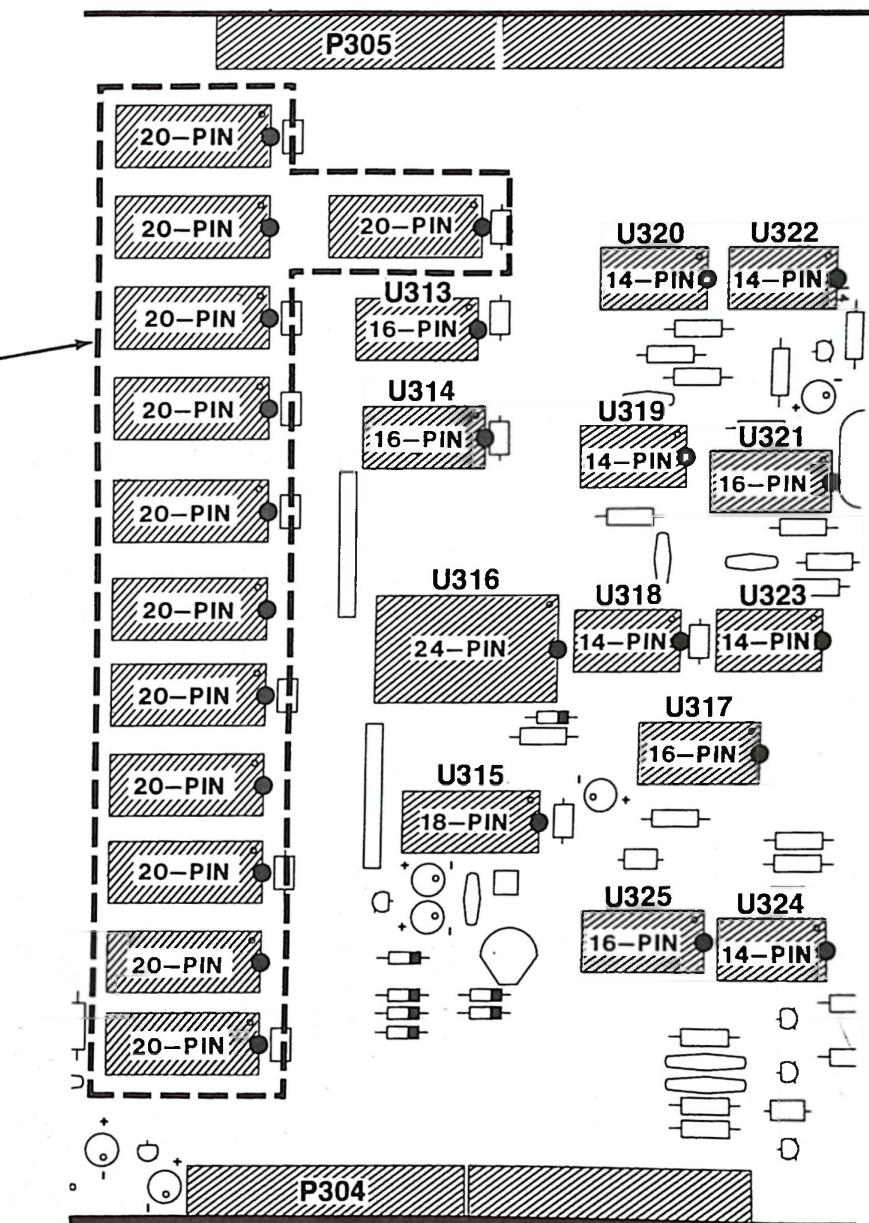
- (✓) Five 16-pin IC sockets at:
U313.
U314.
U317.
U321.
U325.

- (✓) Six 14-pin IC sockets at:
U320. U318.
U322. U319.
U323. U324.

- (✓) Install two 12-pin connectors at P305 as shown. Press the body of each connector firmly against the circuit board and solder the pins to the foil pads.



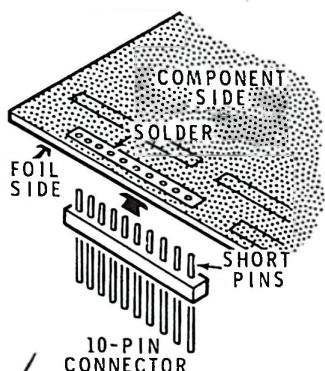
- (✓) As before, install two 12-pin connectors at P304.



PICTORIAL 10-3

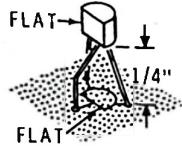
START

NOTE: When you install 10-pin connectors in the next step, insert the shorter pins through the circuit board holes from the foil side and press the body of the connector to the circuit board. Then solder the pins to their pads on the component side.

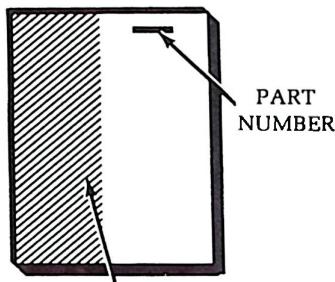


- (✓) P306 through P317: Install twelve 10-pin connectors as shown.

When you install a transistor, position its flat side over the flat of the outline on the circuit board and insert the leads through their holes until the bottom of the transistor is $1/4"$ above the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.



- (✓) Q307: MPSA20 transistor (#417-801).
- (✓) Q308: 2N4121 transistor (#417-235).
- (✓) Q306: 2N4121 transistor (#417-235).
- (✓) Q305: MPSA20 transistor (#417-801).
- (✓) U327: 78L05 IC (#442-627).
- (✓) U326: 78L05 IC (#442-627).

IDENTIFICATION DRAWING

The steps performed in this Pictorial are in this area of the circuit board.

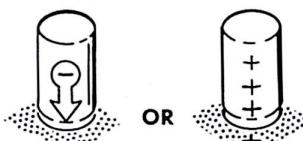
CONTINUE

- (✓) RP303: $10\text{ k}\Omega$ resistor pack (#9-119). The resistor pack may be installed in either direction. Solder all of its leads to the foil and cut off the excess lead lengths.

- (✓) RP301: In the same manner install a $10\text{ k}\Omega$ resistor pack (#9-119) at RP301.

- (✓) RP302: In the same manner, install a $10\text{ k}\Omega$ resistor pack (#9-119) at RP302.

NOTE: When you install an electrolytic capacitor, match the positive (+) or negative (-) side of the capacitor with the corresponding + or - mark on the circuit board.



- (✓) C319: $.33\ \mu\text{F}$ electrolytic.

- (✓) C321: $.33\ \mu\text{F}$ electrolytic.

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

- (✓) Install the 3-pin connector at LO-HI. Insert the shorter pins through the circuit board and solder them to the foil side.

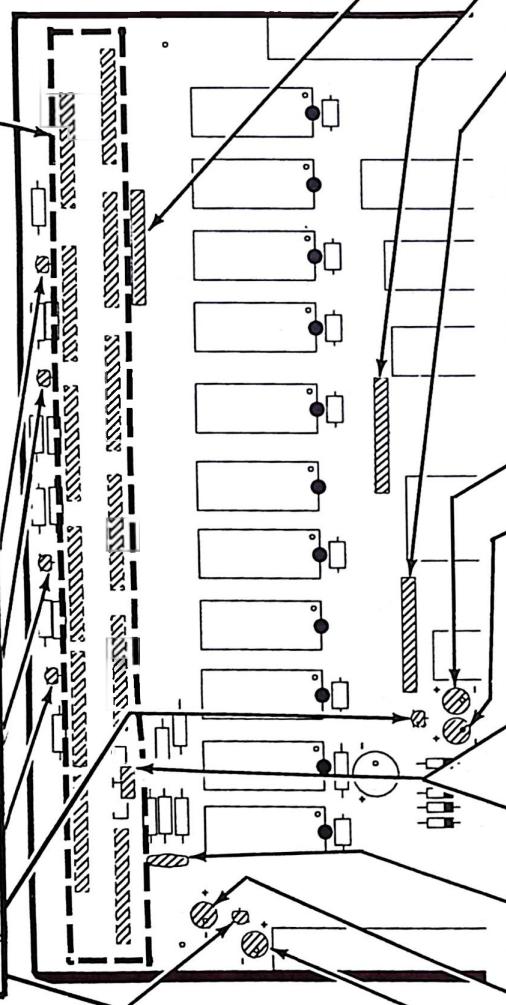
- (✓) Install the jumper plug on the two pins of the connector nearest the LO marking on the circuit board.

- (✓) C331: $.005\ \mu\text{F}$ ceramic capacitor. Solder the leads to the foil and cut off the excess lead lengths.

- (✓) C322: $.33\ \mu\text{F}$ electrolytic.

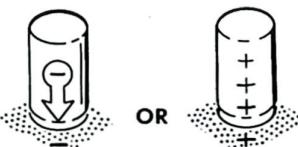
- (✓) C323: $.33\ \mu\text{F}$ electrolytic.

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

PICTORIAL 10-4

START ▾

NOTE: When you install an electrolytic capacitor, match the positive (+) or negative (-) side of the capacitor with the corresponding + or - mark on the circuit board.



(✓) C324: 4.7 μ F electrolytic.

(✓) C318: .33 μ F electrolytic.

(✓) Y301: 32.768 kHz crystal (#404-624).

(✓) C315: 10 pF (10k) ceramic capacitor.

(✓) C316: 2.7 - 20 pF trimmer capacitor. Position the capacitor as shown and insert its pins through the circuit board. Then solder the pins to the foil.



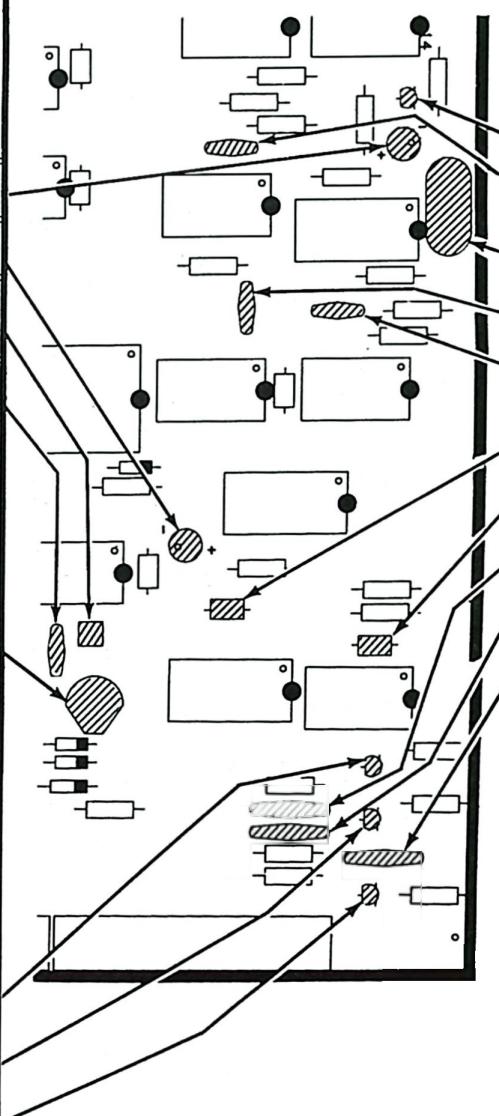
NOTE: As you install three MPSA20 (#417-801) transistors in the following steps, be sure to match the flat on the transistor with the flat outline on the board. Solder the leads to the foil and cut off the excess lead lengths.

(✓) Q302

(✓) Q303

(✓) Q304

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

**CONTINUE** ▾

(✓) Q301: MPSA20 (#417-801) transistor.

(✓) C308: 220 pF (220 k) ceramic.

(✓) C325: .22 μ F Mylar.

(✓) C309: 220 pF (220 k) ceramic.

(✓) C306: 220 pF (220 k) ceramic.

(✓) C312: .1 μ F Mylar.

(✓) C311: .01 μ F (103) glass.

(✓) C332: .2 μ F ceramic.

(✓) C333: .2 μ F ceramic.

(✓) C313: .2 μ F ceramic.

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

(✓) Check to see that all pins and leads are properly soldered, and that there are no solder bridges between foils. Cut off any excess lead lengths.

PICTORIAL 10-5

START ▶

CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad from the IC, DO NOT let go of the IC. Install the IC 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 the other hand.
5. Align the pin 1 end of the IC with the index mark on the circuit board. See Detail 10-6A.
6. Then push the IC pins into the IC socket. Once in the socket, the IC is protected.

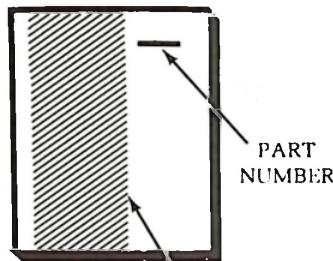
Refer to Detail 10-6A to identify the pin 1 (indexed) end of an integrated circuit. Then install five 74LS244 integrated circuits (#443-791) at the following locations:

- (✓) U301.
- (✓) U303.
- (✓) U302.
- (✓) U304.
- (✓) U312.

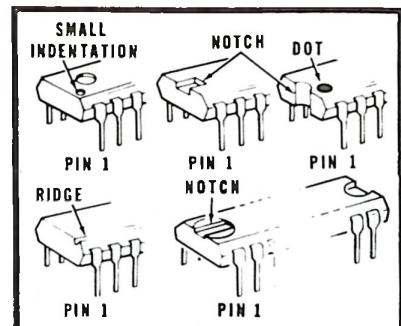
Install seven 74LS374 ICs (#443-863) at the following locations:

- (✓) U305.
- (✓) U308.
- (✓) U306.
- (✓) U309.
- (✓) U307.
- (✓) U310.
- (✓) U311.

(✓) C334: 100 μ F electrolytic (#25-948).

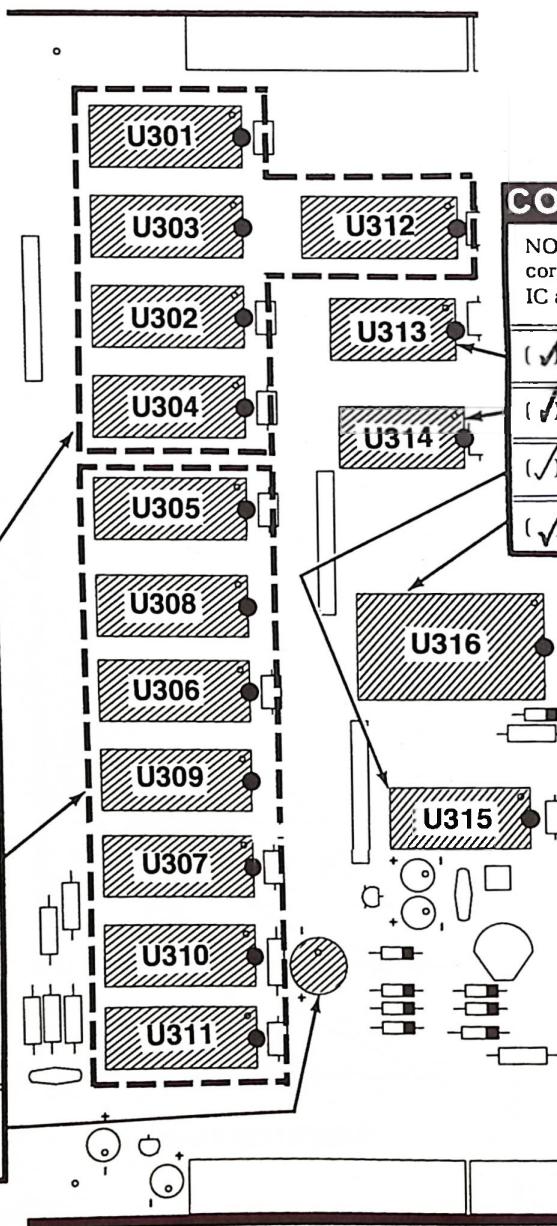
IDENTIFICATION DRAWING

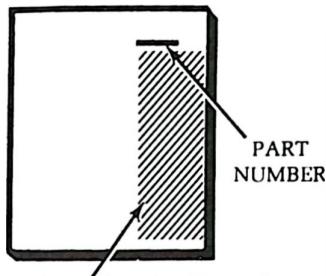
The steps performed in this Pictorial are in this area of the circuit board.

**Detail 10-6A****CONTINUE** ▶

NOTE: In the next four steps, be sure to correctly position the pin 1 end of each IC as you install it.

- (✓) U313: 4040 IC (#443-760).
- (✓) U314: 80C97 IC (#443-720).
- (✓) U315: 5832 IC (#443-1055).
- (✓) U316: 4508 IC (#443-736).

**PICTORIAL 10-6**

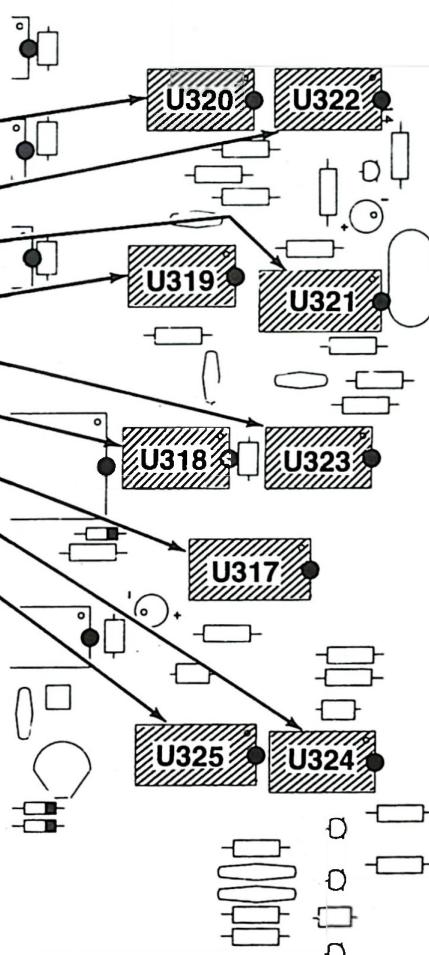
IDENTIFICATION
DRAWING

The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: In the following steps, install ICs in exactly the same manner as in the previous steps.

- (✓) U320: 74LS02 IC (#443-779).
- (✓) U322: 74LS32 IC (#443-875).
- (✓) U321: 4538 IC (#443-916).
- (✓) U319: 4011 IC (#443-603).
- (✓) U323: 4071 IC (#443-706).
- (✓) U318: 4013 IC (#443-607).
- (✓) U317: 4049 IC (#443-701).
- (✓) U324: 4093 IC (#443-778).
- (✓) U325: 74C221 IC (#443-785).

**CONTINUE**

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

- (✓) Unsoldered connections.
- (✓) Poor solder connections.
- (✓) Solder bridges between foil pads.
- (✓) Protruding leads which could touch together.
- (✓) Transistors and ICs for the proper type and installation.
- (✓) Electrolytic capacitors for the correct position of the positive (+) or negative (-) lead.
- (✓) Diodes for the correct position of the banded end.

This completes the assembly of the I/O circuit board.

FINISH**PICTORIAL 10-7**

CPU CIRCUIT BOARD

PARTS LIST

The CPU (Central Processing Unit) circuit board (#181-4354 — in the final pack) was assembled and tested at the factory before it was packed in this kit. Carefully examine the circuit board for any possible shipping damage, then set the CPU Board aside. Any shipping damage must be reported to the carrier who delivered your kit, NOT to Heath Company.

Do not attempt to repair or modify your CPU circuit board. To do so will void its warranty. Refer to your Robot Technical Manual for information on Technical Consultation and Repair service.

The following Parts list is presented for your reference only, so you can identify components on the Schematic and on the X-Ray View.

<u>CIRCUIT Comp. No.</u>	<u>HEATH Part No.</u>	<u>DESCRIPTION</u>
------------------------------	---------------------------	--------------------

RESISTORS

All resistors are 1/4 watt, 5%.

R401	6-332-12	3300 Ω
R402	6-101-12	100 Ω
R403	6-103-12	10 k Ω
R404	6-104-12	100 k Ω
R405	6-102-12	1000 Ω
R406	6-102-12	1000 Ω
R407	6-103-12	10 k Ω
R408	6-332-12	3300 Ω
R409	6-104-123	100 k Ω
R410	Not used	
R411	6-332-12	3300 Ω
R412	6-332-12	3300 Ω
R413	6-332-12	3300 Ω
R414	6-332-12	3300 Ω
R415	6-332-12	3300 Ω
R416	6-104-12	100 k Ω
R417	6-223-12	22 k Ω
R418	6-332-12	3300 Ω
R419	6-332-12	3300 Ω
R420	Not used	
R421	6-332-12	3300 Ω
R422	6-104-12	100 k Ω
RP401	9-119	Resistor pack (8 - 10 k Ω)

<u>CIRCUIT Comp. No.</u>	<u>HEATH Part No.</u>	<u>DESCRIPTION</u>
------------------------------	---------------------------	--------------------

CAPACITORS

C401-C404	21-769	.01 μ F glass capacitor
C405	27-73	.047 μ F Mylar
C406-C409	21-769	.01 μ F glass capacitor
C410	Not used	
C411-C415	21-769	.01 μ F glass capacitor
C416	20-100	30 pF mica capacitor
C417	20-100	30 pF mica capacitor
C419	21-769	.01 μ F glass capacitor
C420	Not used	
C421-C428	21-769	.01 μ F glass capacitor

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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DIODES - CRYSTAL - INTEGRATED CIRCUITS

D401	56-56	1N4149 diode
D402	56-56	1N4149 diode
D403	56-56	1N4149 diode
Y401	404-238	3579.545 kHz crystal

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers and letters listed. Any additional letters or numbers on an IC are not significant.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

U401	443-939	6808 microprocessor
U402	443-791	74LS244 integrated circuit
U403	443-877	74LS138 integrated circuit
U404	443-791	74LS244 integrated circuit
U405	443-822	74LS139 integrated circuit
U406	443-877	74LS138 integrated circuit

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

INTEGRATED CIRCUITS (Cont'd.)

U407	443-828	74LS73 integrated circuit
U408	443-828	74LS73 integrated circuit
U409	443-828	74LS73 integrated circuit
U410	443-828	74LS73 integrated circuit
U411	443-863	74LS374 integrated circuit
U412	443-791	74LS244 integrated circuit
U413	443-732	74LS30 integrated circuit
U414	443-875	74LS32 integrated circuit
U415	443-1027	6116 integrated circuit
U416	443-1027	6116 integrated circuit
U417		ROM #2 integrated circuit (optional)
U418	444-198-1	ROM #1 integrated circuit
U419	443-791	74LS244 integrated circuit
U420	443-791	74LS244 integrated circuit
U421	443-877	74LS138 integrated circuit
U422	443-877	74LS138 integrated circuit
U423	443-728	74LS00 integrated circuit
U424	443-728	74LS00 integrated circuit
U425	442-616	LM2901 integrated circuit

Refer to your Technical Manual for the location of these components on the X-Ray View and Schematic.

REMOTE CONTROL UNIT

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #11. Check each part against the following list. The key numbers correspond to the numbers on the "Remote Control Unit Parts Pictorial" (Illustration Booklet, Page 6). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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

CIRCUIT BOARD PARTS

A1	6-332-12	6	3300 Ω , 1/4-watt resistor (orange-orange-red)	R901-R906
A2	56-56	11	1N4149 diode	D901-D912
A3	64-882	1	Pushbutton switch	SW901
A4	434-298	1	14-pin IC socket	

CAUTION: The following part is a "protected IC". DO NOT remove it from its foam pad until you are instructed to do so.

A5	443-603 85-2559-1	1	4011 integrated circuit Remote printed circuit board	U901
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CASE AND OTHER PARTS

B1	305-113	1	Remote Control case, consisting of:	
B2	95-655	1	Case, right side	
B3	95-656	1	Case, left side	
B4	462-1134	1	Trigger	
B5	205-1884	1	Top panel	
B6	205-1885	1	Sub-panel	
	390-2481	1	Panellabel	

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. For prices, refer to the separate "Heath Parts Price List."

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

B7	60-91	1	Slide switch	SW902
B8	61-44	1	Rocker switch*	SW903
B9	63-1404	1	Rotary switch (with hardware)	SW904
B10	462-1135	1	Knob	

*Discard any hardware packaged with the rocker switch.

WIRE — CABLE — CONNECTORS

C1	344-50	12"	Black wire
	347-75	8'	Multiconductor cable
C2	432-147	1	Connector shell
C3	432-854	9	Male connector pin
	75-822	2	Cable clamp (two halves)
	354-5	1	Small cable tie

HARDWARE

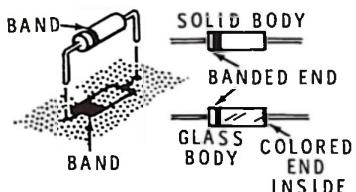
D1	250-1411	3	4-40 x 1/4" screw
D2	250-1415	2	4-40 x 3/8" screw
D3	250-1362	4	4-40 x 9/16" flat head screw
D4	250-1325	2	6-32 x 1/4" screw
D5	252-2	4	4-40 hex nut
D6	254-9	4	#4 lockwasher
D7	254-5	1	3/8" lockwasher
D8	252-731	5	4-40 threaded insert

STEP-BY-STEP ASSEMBLY

START

Position the circuit board as shown for the following steps.

NOTE: When you install a diode, always match the banded end of the diode with the band mark on the circuit board. THE CIRCUIT WILL NOT WORK PROPERLY IF A DIODE IS INSTALLED BACKWARD.



If your diode has a solid body, the band is clearly defined. If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the diode.

() D901 through D912: Install a 1N4149 diode (#56-56) at each diode location (There is no D910).

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

{) Install a 3300 Ω (org-org-red) resistor at each of the following six locations:

R906
R901
R903
R905
R902
R904

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

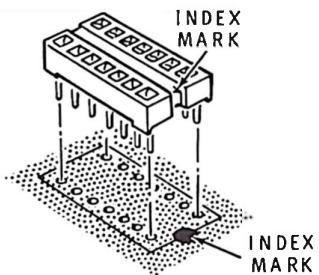
CONTINUE

() Remove all of the insulation from a 3" length of black wire. Then cut this bare wire into three 1" pieces. Bend each piece into a U shape for use as jumper wires in the next step.

() Install a jumper wire at each of the three locations marked J.

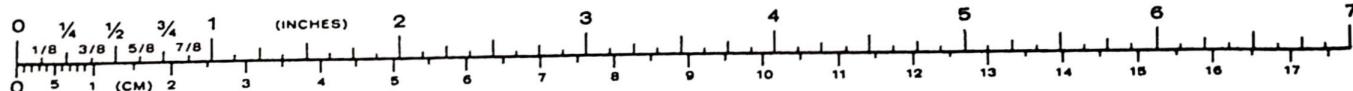
() Solder the wires to the foil and cut off the excess lengths.

NOTE: When you install an IC socket, position it so the index mark on the circuit board is visible after the socket is installed. Be sure all of the pins go through the holes in the circuit board. Solder each pin to a foil pad.



() Install a 14-pin IC socket at U901 and solder the pins to the foil.

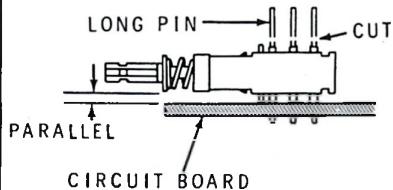
PICTORIAL 11-1



START

- () Install the pushbutton switch (#64-882) at SW901. Insert six of the switch pins into the circuit board holes and solder them to their foil pads. Be sure the switch body is parallel to the circuit board.

CUT OFF ALL THE PINS AS CLOSE AS POSSIBLE.



CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad from the IC, DO NOT let go of the IC. Install the IC 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 the other hand.
5. Align the pin 1 end of the IC with the index mark on the circuit board. See Detail 11-2A.
6. Then push the IC pins into the IC socket. Once in the socket, the IC is protected.

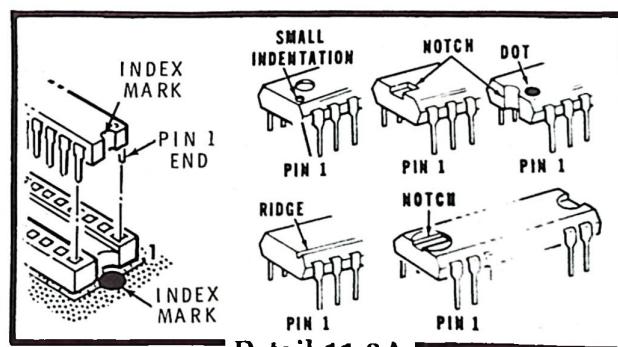
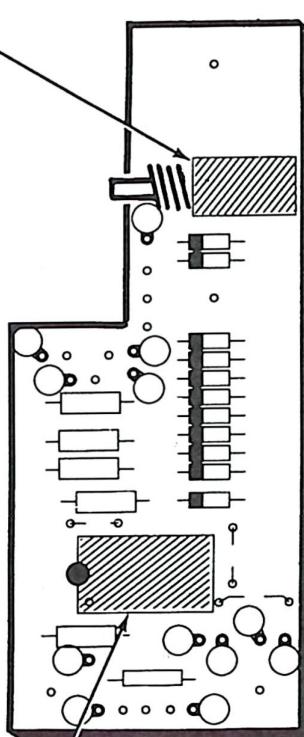
- () Install the 4011 integrated circuit (#443-603) at U901.

CONTINUE**CIRCUIT BOARD CHECKOUT**

Carefully inspect the circuit board for the following conditions:

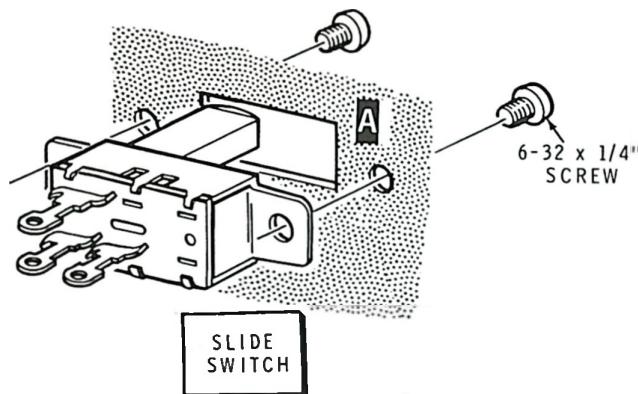
- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil pads.
- () Component leads in the wrong holes.
- () Diodes installed backwards (banded end the wrong way).
- () Integrated circuit (or its socket) incorrectly installed.

- () Set the circuit board aside and proceed with the steps on the next page.



Detail 11-2A

PICTORIAL 11-2

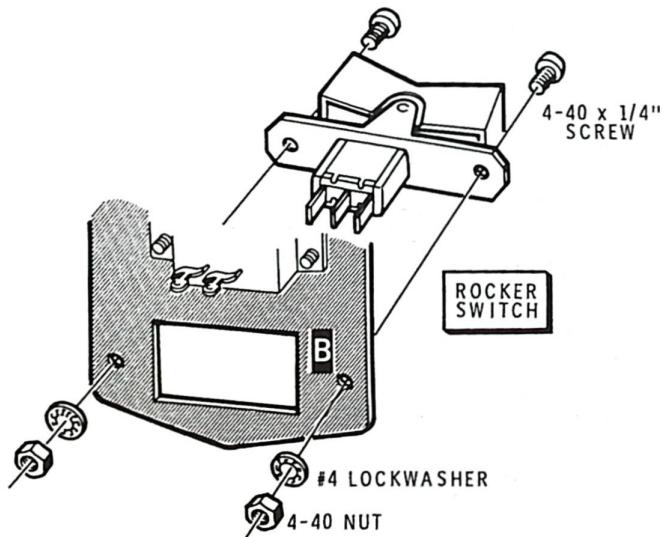
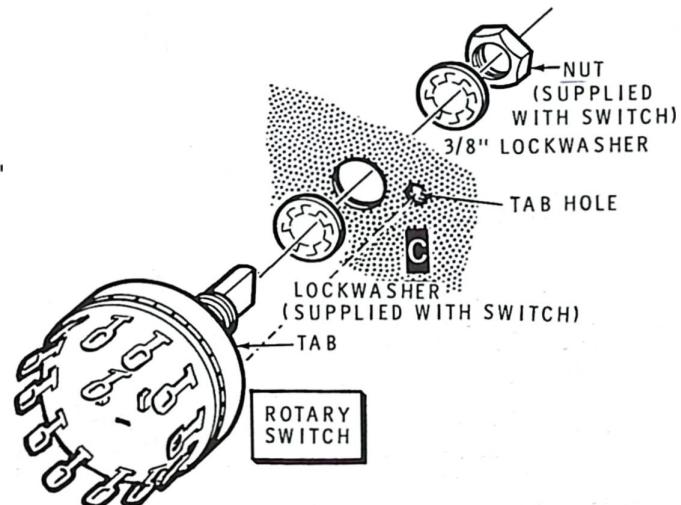
**Detail 11-3A****SUB-PANEL ASSEMBLY****Switch Mounting**

Refer to Pictorial 11-3 (Illustration Booket, Page 7) for the following steps.

- () Position the sub-panel as shown. Note the position of the tab hole.
- () SW902: Mount a slide switch (#60-91) at A as shown in Detail 11-3A. Position the switch as shown and secure it to the sub-panel with two 6-32 x 1/4" screws.

- () SW903: Mount a rocker switch (#61-44) at B with two 4-40 x 1/4" screws, two #4 lockwashers, and two 4-40 nuts, as shown in Detail 11-3B. Do not use any hardware that might have been packaged with the rocker switch.

- () SW904: Mount a rotary switch (#63-1404) at C with a 3/8" lockwasher and the hardware supplied with the switch. Position the switch tab as shown in Detail 11-3C. Caution: Do not overtighten the nut on the switch shaft. NOTE: Your rotary switch may look slightly different than the one shown.

**Detail 11-3B****Detail 11-3C**

Cable and Wire Preparation

NOTE: When you are told to prepare a cable, first cut the cable to the length specified. Then refer to the Detail and remove the indicated amount of insulation from each end. Be careful not to cut through the insulation on the individual wires. Cut the wires to the lengths indicated and remove $1/4"$ of insulation from each end. Finally, twist the ends of each wire and apply a thin film of solder to hold the wire strands together.

- () Cut and prepare a 6" length of cable as shown in Detail 11-3D (Illustration Booklet, Page 7).

Refer to Pictorial 11-3 and connect and solder the wires at the shorter end of the cable to the circuit board as follows:

- () Brown wire to hole Y.
- () White wire to hole Z.
- () Black wire to hole X.
- () Orange wire to hole W.
- () Red wire to hole V.
- () Green wire to hole A.
- () Yellow wire to hole U.

- () Violet wire to hole C.

- () Blue wire to hole D.

- () Check the wires that you just connected to be sure they are properly soldered and that you have not created a solder bridge. Cut off any excess wire lengths on the foil side of the circuit board.

- () Prepare the following lengths of black wire. First cut each wire to the length indicated, and then remove $1/4"$ of insulation from each end:

3-1/2"

1-1/4"

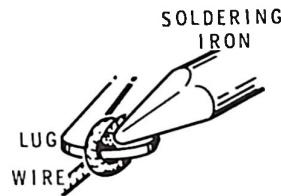
2-1/2"

- () Connect and solder one end of the 3-1/2" black wire to hole B of the circuit board. Cut off any excess wire length on the foil side of the circuit board.

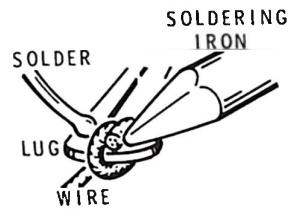
NOTE: When you connect a wire to a lug, as in the following steps, form a hook in the end of the wire and insert it through the lug. Crimp the hook to the lug then follow the soldering instruction. (NS) means not to solder because another wire will be connected later. (S-) with a number such as (S-2) means to solder the connection. The number following the "S" tells how many wires are at the connection.



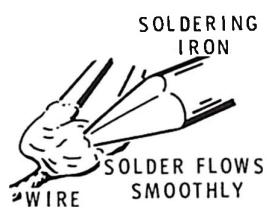
- Push the soldering iron tip against the wire and the lug. Heat both the wire and the lug for two to three seconds.



- Apply solder to the wire and the lug, not to the soldering iron. **IMPORTANT:** Let the heat of the wire and lug melt the solder.

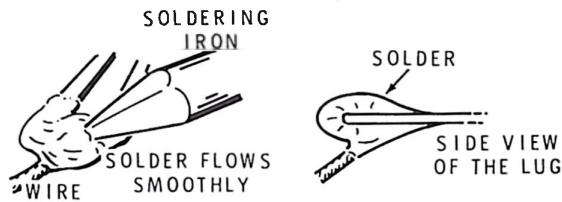


- As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.



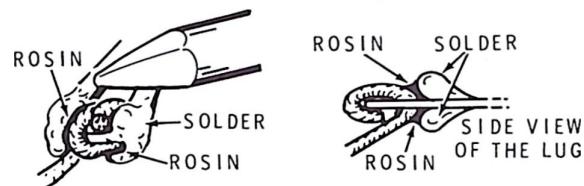
A GOOD SOLDER CONNECTION

A good connection flows evenly and blends with the lug and the wire.



POOR SOLDER CONNECTIONS

When solder does not flow onto the wire, it causes a poor connection. A dark rosin bead surrounds and insulates the lead from the lug.

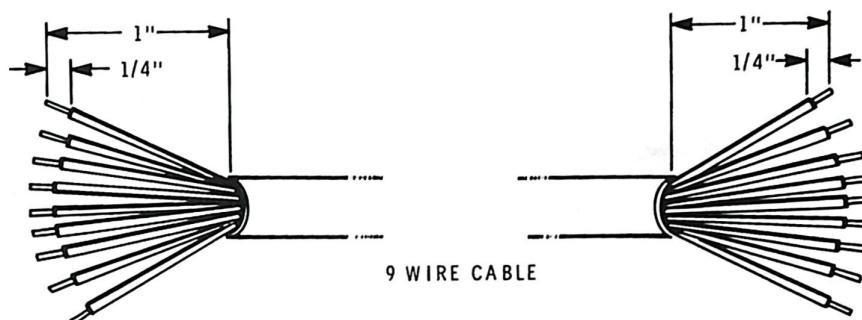


The above illustration shows a "rosin connection." With this type of connection, your kit will not operate correctly or it may not operate at all. To correct this type of connection, reheat the connection and allow time for the solder to flow around the wire. You may need to add some new solder to the connection to get it to flow properly.

Here, the solder appears to sit on top of the lug and wire and does not flow.



The above illustration shows a "cold solder connection". In this case, the solder was applied to the soldering iron instead of the lug and wire, or only the lug or only the wire was heated. Both the lug and the wire must be heated together. To correct this type of connection, reheat the connection and add some new solder.



Detail 11-3E

Position the circuit board near the sub panel assembly as shown in Pictorial 11-3. Then connect the wires coming from the circuit board to the switches on the sub-panel as follows.

- () Connect the free end of the 3-1/2" black wire to lug 2 of switch B (NS).
- () Connect the 1-1/4" black wire from lug 2 of switch B (S-2) to lug 2 of switch A (NS).
- () Connect the 2-1/2" black wire from lug 2 of switch A (S-2) to lug A of rotary switch C (S-1).

NOTE: In the following steps you will connect the cable wires to the switches. Hook, crimp, and solder each connection as follows:

- () At switch B, connect the violet wire to lug 1 (S-1), and the blue wire to lug 3 (S-1).
- () Connect the green wire to lug 3 of switch A (S-1).

Connect the remaining cable wires to switch C as follows:

- () White to lug 7 (S-1).
- () Brown to lug 6 (S-1).
- () Black to lug 5 (S-1).

NOTE: There is no wire at lug 4.

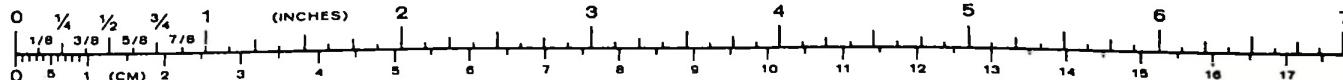
- () Orange to lug 3 (S-1).

- () Red to lug 2 (S-1).
- () Yellow to lug 1 (S-1).
- () Prepare the remaining length of cable as shown in Detail 11-3E.

Refer to Pictorial 11-3 and connect and solder the wires at one end of the cable to the circuit board as follows:

- () Black wire to hole G.
- () Yellow wire to hole M.
- () Brown wire to hole S.
- () Red wire to hole T.
- () Orange wire to hole R.
- () Blue wire to hole N.
- () Green wire to hole O.
- () White wire to hole L.
- () Violet wire to hole Q.
- () Carefully check the circuit board to be sure you have connected the wires to the right holes and that they are properly soldered. Be sure there are no solder bridges. Cut off any excess wire lengths on the foil side of the circuit board.

NOTE: There should be no connections to hole E or hole P.



CASE ASSEMBLY

Refer to Pictorial 11-4 (Illustration Booklet, Page 8) for the following steps.

- () Lay the case right side on a clean soft cloth to avoid marring its surface.

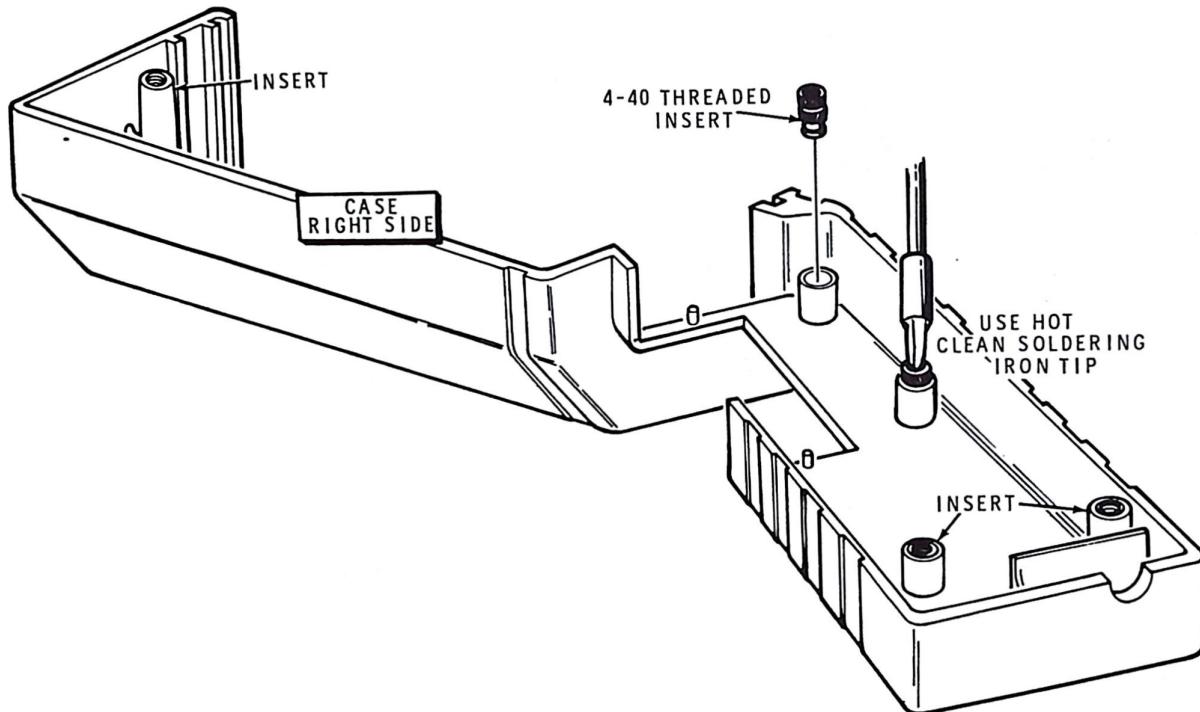
Refer to Detail 11-4A and install threaded inserts in the indicated holes of the case right side as directed in the next five steps.

- () 1. Set a 4-40 threaded insert with its small end in one of the indicated holes.
- () 2. Clean the tip of your soldering iron. Then touch the tip of the iron to the top of the insert.

CAUTION: Do not let the hot soldering iron touch anything except the top of the insert.

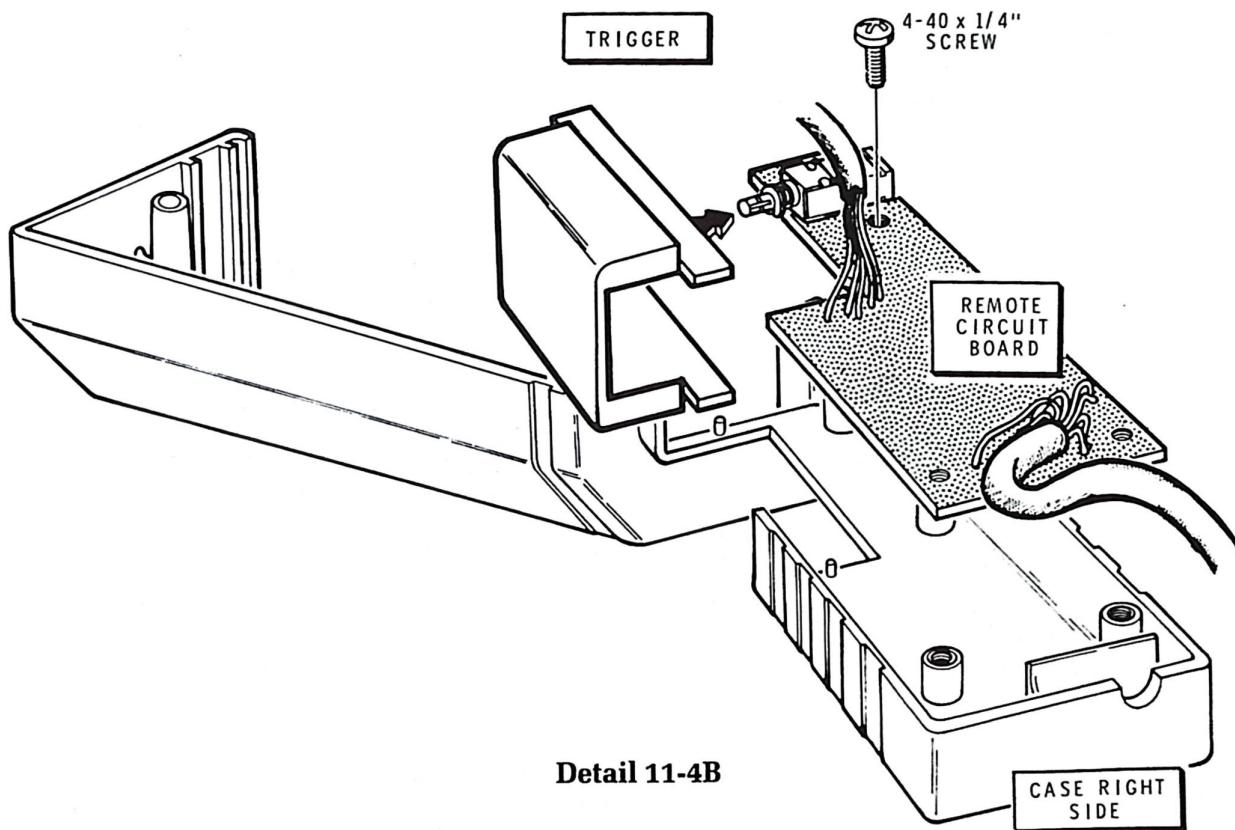
() 3. As the heated insert softens the plastic around the hole, press the insert straight into the hole so its top is just even with the top of the hole.

- () 4. Remove the soldering iron tip and let the insert cool while you install another insert in another hole.
- () 5. Repeat the above steps until you have installed all five threaded inserts.

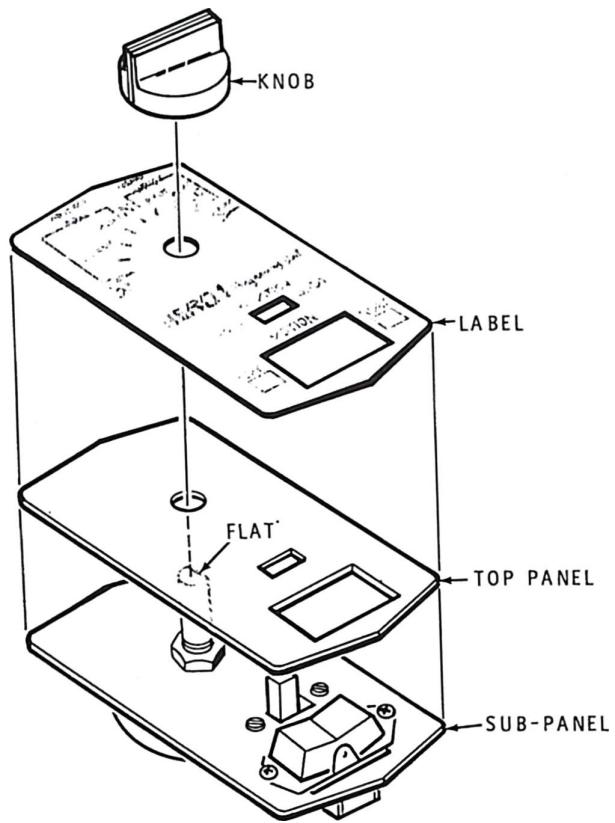


Detail 11-4A

- () Refer to Detail 11-4B and press the trigger onto the shaft of the circuit board pushbutton switch. Then place the circuit board and trigger in position in the case side and secure them with a 4-40 × 1/4" screw as shown. Make sure the other three mounting holes line up with the inserts in the case before you tighten the screw.



- () Remove the paper backing from the panel label, and carefully press the label onto the top panel. Then place the top panel over the sub-panel as shown in Detail 11-4C.
- () Install the knob part way on the shaft of rotary switch C. Note the flat on the switch shaft and the flat of the knob insert. NOTE: When you are installing the knob, hold onto the back of the rotary switch.
- () Refer to the inset drawing on Pictorial 11-4 and slide the top panel and sub-panel into the grooves of the case right side. Be sure the panels seat in the bottom grooves and that no wires are pinched.

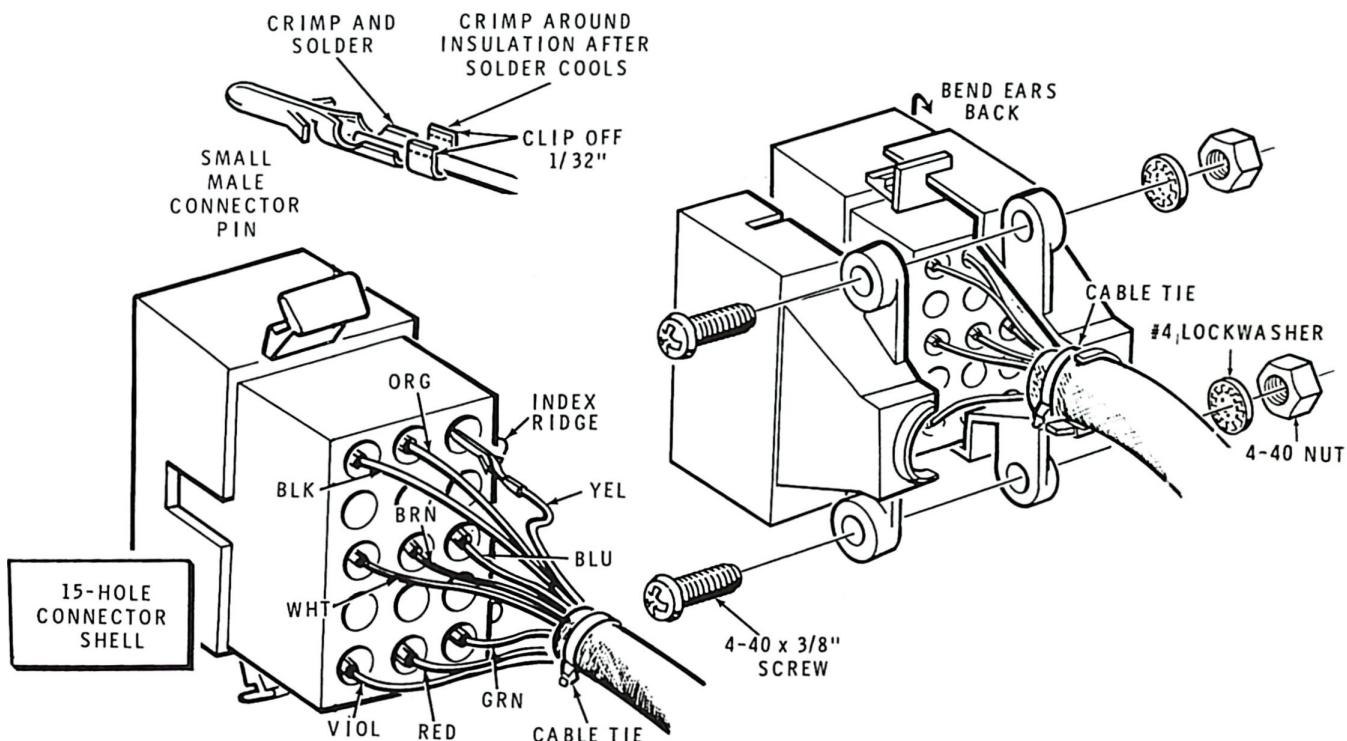


Detail 11-4C

Heathkit®

- () Position the long cable in the notch in the end of the case handle as shown.
- () Position the case left side over the case right side so the top panel and sub-panel slide into the grooves of the case left side, and the notches in the handle end clamp the cable. Secure the two case sides with four 4-40 × 9/16" flat head screws.
- () Test the action of the switches and the trigger. If they bind on the case, remove the case side, reposition the switch slightly, and reinstall the case side.
- () Refer to Part A of Detail 11-4D and install male connector pins on the ends of the nine cable wires.
- () Note the location of the index ridges on the connector shell. Then insert the male connector pins into the shell as shown.
- () Wrap a small cable tie tightly around the cable near the end of the outer insulation. Cut off the excess end of the cable tie.
- () Refer to Part B of Detail 11-4D and install a cable clamp over the connector shell as shown. Use two 4-40 × 3/8" screws, two #4 lock-washers, and two 4-40 nuts. Be sure the outer insulation of the cable and the cable tie is inside the clamp.

This completes the assembly of your Remote Control unit. Set it aside until you complete the remaining assembly of your Robot. In the Robot User's Manual, the Remote Control will be used as a Teaching Pendant.



CHARGER

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #12. Check each part against the following list. The key numbers correspond to the numbers on the "Charger Parts Pictorial" (Illustration Booklet, Page 9). Return any part that is packed in an individual envelope, with the part number on it, back into its envelope until that part is called for in a step. Do not throw away any packing material until you account for all of the parts.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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ELECTRONIC COMPONENTS

A1	✓ 6-102-1	1	1000 Ω, 1-watt (brn-blk-red) 5% resistor	R3
A2	✓ 3-22-10	2	2.5 Ω, 10-watt, 5% wire-wound resistor	R1, R2
A3	✓ 25-910	1	3300 μF electrolytic capacitor	C1
A4	✓ 54-1027	1	Power transformer	T1
A5	✓ 57-88	1	Bridge rectifier	BR1
A6	✓ 61-49	1	Switch	SW1
A7	✓ 65-77	1	.4-ampere circuit breaker (120 VAC)	CB1
A7	✓ 65-78	1	.2-ampere circuit breaker (240 VAC)	CB1
A8	✓ 412-87	1	6-volt lamp (white leads)	V2
A8	✓ 412-72	1	28-volt lamp (dark leads)	V1

LINE CORD—WIRE—CABLE

89-66-1	1	Line cord
344-15	18"	Black wire
346-30	1"	Sleeving
347-35	8'	2-conductor shielded cable

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

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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STRAIN RELIEFS—TERMINAL STRIPS

B1	75-107	1	Small strain relief
B2	75-736	1	Large strain relief
B3	431-10	1	✓ 3-lug terminal strip
B4	431-86	1	✓ 6-lug terminal strip

HARDWARE

NOTE: Hardware may be packed in more than one packet. Open all of the hardware packets (marked HDW) before you check the hardware against the Parts List.

#4 Hardware

C1	250-1415	2	4-40 × 3/8" screw
C2	252-2	2	4-40 nut
C3	254-9	2	#4 lockwasher

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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#6 Hardware

D1	250-1325	2	6-32 x 1/4" screw	
D2	250-1280	5	6-32 x 3/8" screw	
D3	250-1434	4	#6 x 3/8" self-tapping screw	
D4	250-1240	1	6-32 x 7/8" screw	
D5	252-3	4	6-32 nut	
D6	254-1	5	#6 lockwasher	
D7	255-705	1	6-32 x 7/16" plastic spacer	
D8	255-42	1	6-32 x 3/4" fiber spacer	
D9	259-1	1	#6 solder lug	

#8 Hardware

E1	250-1436	2	8-32 x 3/8" screw	
E2	252-4	2	8-32 nut	
E3	253-9	2	#8 flat washer	
E4	254-2	2	#8 lockwasher	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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Other Hardware

F1	252-32	2	Push-on nut	
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MISCELLANEOUS

G1	73-21	1	Cable insulator	
G2	73-78	1	Grommet strip (1-3/4" long)	
G3	75-821	2	Cable clamp (two halves)	
G4	75-855	2	Paper insulator	
G5	90-1316-2	1	Chassis cover	
G6	200-1453-2	1	Chassis	
G7	206-1474	1	Shield	
G8	261-49	4	Foot	
G9	413-10	1	Red lens	
G9	413-11	1	Clear lens	
G10	432-72	8	Male connector pin	
G11	432-1246	1	12-pin socket shell	
G12		1	Blue and white label	
	597-3289	1	Safety instructions	

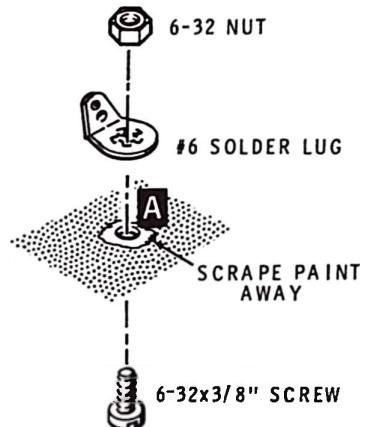
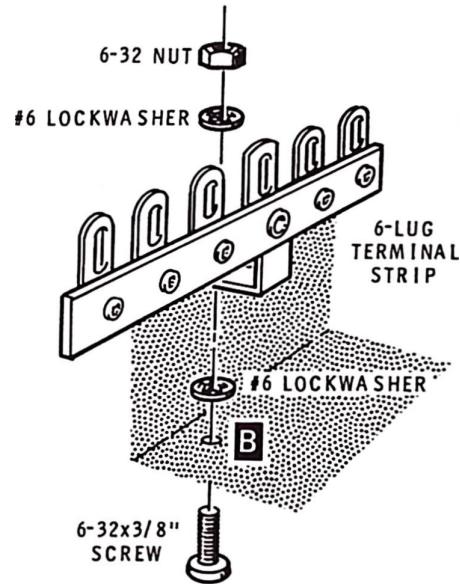
STEP-BY-STEP ASSEMBLY**PARTS MOUNTING**

Refer to Pictorial 12-1 (Illustration Booklet, Page 10) for the following steps.

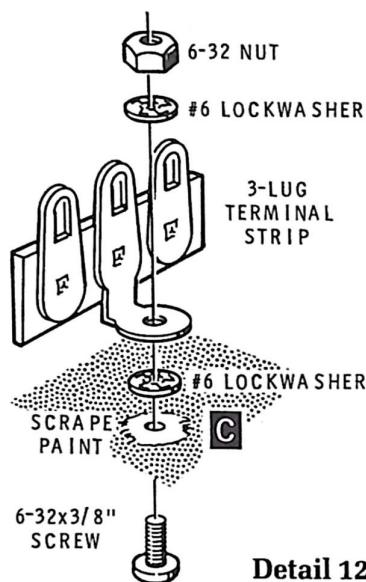
- (✓) Position the chassis bottom side up as shown in the inset drawing on the Pictorial.
- (✓) Carefully peel away the backing paper from one of the feet. Then press the foot into place on the bottom of the chassis so it is $1/8$ " away from each edge at one of the corners.
- (✓) Similarly, install feet at the other three chassis corners.
- (✓) Reposition the chassis right side up as shown in the Pictorial (note the locations of the two large rectangular end panel holes).

NOTES:

1. When a step calls for hardware, only the screw size is given. If a step calls for "6-32 \times 3/8" hardware", for example, it means you should use a 6-32 \times 3/8" screw, one or more #6 lockwashers, and a 6-32 nut. The Pictorial or Detail referred to in the step shows the proper number of lockwashers and their proper use.
 2. Use the plastic nut starter supplied with this kit to hold and start 4-40 and 6-32 nuts on screws.
- (✓) Scrape or sand any excess paint from around holes A and C on the inside of the chassis.
 - (✓) Refer to Detail 12-1A and use 6-32 \times 3/8" hardware to mount a #6 solder lug to the chassis at hole A. Be sure to position the solder lug as shown in the Pictorial before you tighten the hardware.
 - (✓) Refer to Detail 12-1B and use 6-32 \times 3/8" hardware to mount a 6-lug terminal strip to the chassis at hole B. Be sure to position the terminal strip as shown in the Pictorial before you tighten the hardware.

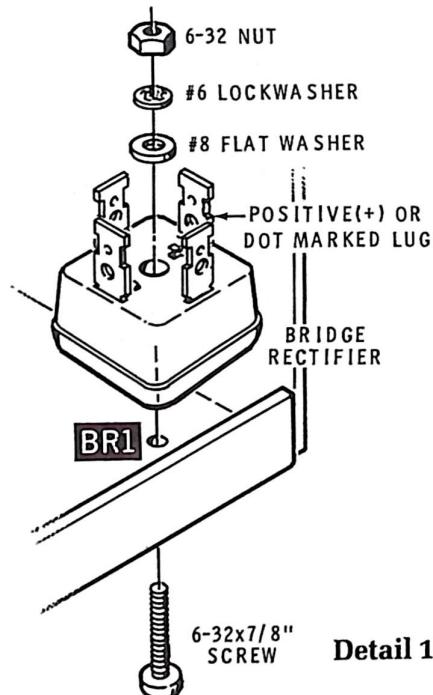
**Detail 12-1A****Detail 12-1B**

- (✓) Refer to Detail 12-1C and use $6-32 \times 3/8"$ hardware to mount a 3-lug terminal strip to the chassis at hole C. Be sure to position the terminal strip as shown in the Pictorial before you tighten the hardware.



Detail 12-1C

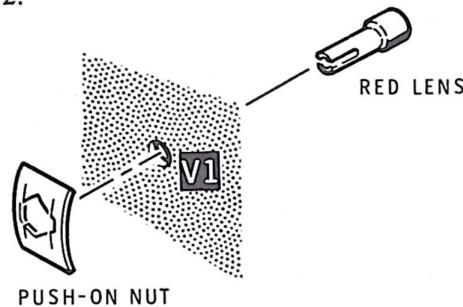
- (✓) BR1: Refer to Detail 12-1D and use $6-32 \times 7/8"$ hardware and a #8 flat washer to mount the bridge rectifier to the chassis at BR1 as shown. Be sure to position the rectifier so the positive (+) or dot marked lug is toward the front of the chassis as shown in the Pictorial before you tighten the hardware.



Detail 12-1D

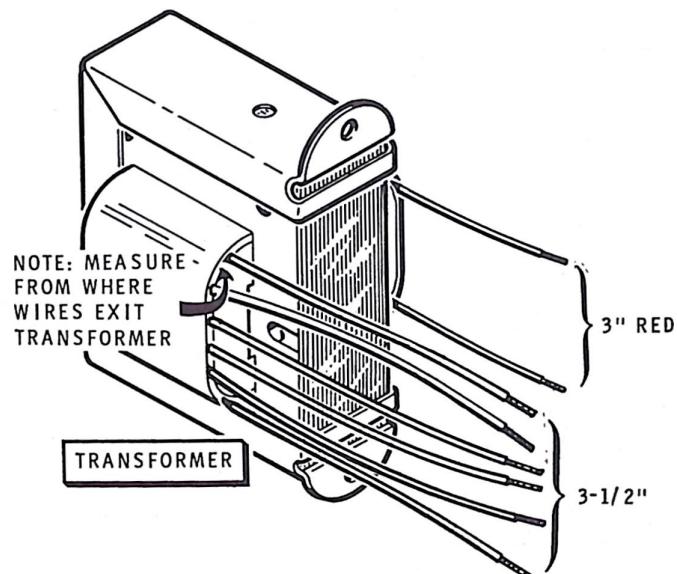
- (✓) Refer to Detail 12-1E and use a push-on nut to mount the red lens to the chassis at hole V1.

- (✓) Similarly, mount the clear lens to the chassis at hole V2.



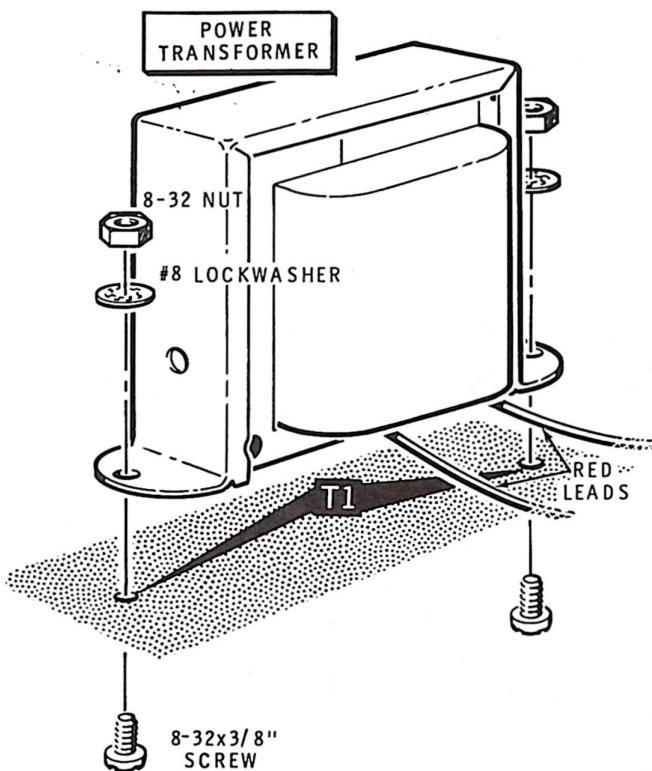
Detail 12-1E

- (✓) Refer to Detail 12-1F and cut the two solid red power transformer leads to 3". Measure the leads from the point where they exit the transformer. Cut the other six power transformer leads to 3-1/2". Then remove 3/8" of insulation from the end of each lead.



Detail 12-1F

- (✓) T1: Refer to Detail 12-1G and use $8-32 \times 3/8"$ hardware to mount the power transformer to the chassis at T1. Be sure to position the transformer so the red leads are toward the front of the chassis as shown in the Pictorial.

**Detail 12-1G****WIRING**

Refer to Pictorial 12-2 (Illustration Booklet, Page 10) for the following steps.

NOTE: Refer to inset drawing #1 on the Pictorial when a step directs you to make a "mechanically secure connection."

- (✓) Connect the free end of the black power transformer lead to terminal strip B lug 1 (NS). Make a mechanically secure connection.
- (✓) Connect the free end of the black-red power transformer lead to terminal strip B lug 3 (NS). Make a mechanically secure connection.
- (✓) Connect the free end of the black-white power transformer lead to terminal strip B lug 5 (S-1). Make a mechanically secure connection. NOTE: This lead will not be used in this kit.

(✓) Connect the free end of the black-gray power transformer lead to terminal strip B lug 6 (S-1). Make a mechanically secure connection. NOTE: This lead will not be used in this kit.

(✓) Connect the free end of the indicated red power transformer lead to bridge rectifier BR1 lug 2 (NS). Make a mechanically secure connection.

(✓) Connect the free end of the remaining red power transformer lead to terminal strip C lug 1 (NS). Make a mechanically secure connection.

NOTE: When a step directs you to prepare a wire, cut the wire to the length specified and remove 1/4" of insulation from each end. Twist together the fine strands at each end and melt a small amount of solder on these ends to hold the fine strands together.

(✓) Prepare a 6" black wire. Then connect the wire from bridge rectifier BR1 (NS) lug 3 to terminal strip C lug 2 (NS).

(✓) Locate the 28-volt lamp (dark leads). Then cut one lead to 3-1/2" and the other lead to 5-1/2". Measure the leads from where they exit the lamp body. Remove 1/4" of insulation from the end of each lead, twist together the fine strands at the end of each lead, and melt a small amount of solder on these ends to hold the strands together.

(✓) Similarly, prepare the leads of the 6-volt lamp (white leads) so one lead is 3-1/2" and the other lead is 5-1/2" long.

(✓) V1: Push the 28-volt lamp (dark leads) into the red lens at V1. Then connect the leads coming from this lamp as follows:

(✓) Longer lead to bridge rectifier BR1 lug 2 (S-2).

(✓) Shorter lead to terminal strip C lug 1 (NS).

(✓) V2: Push the 6-volt lamp (white leads) into the clear lens at V2. Then connect the leads coming from this lamp as follows:

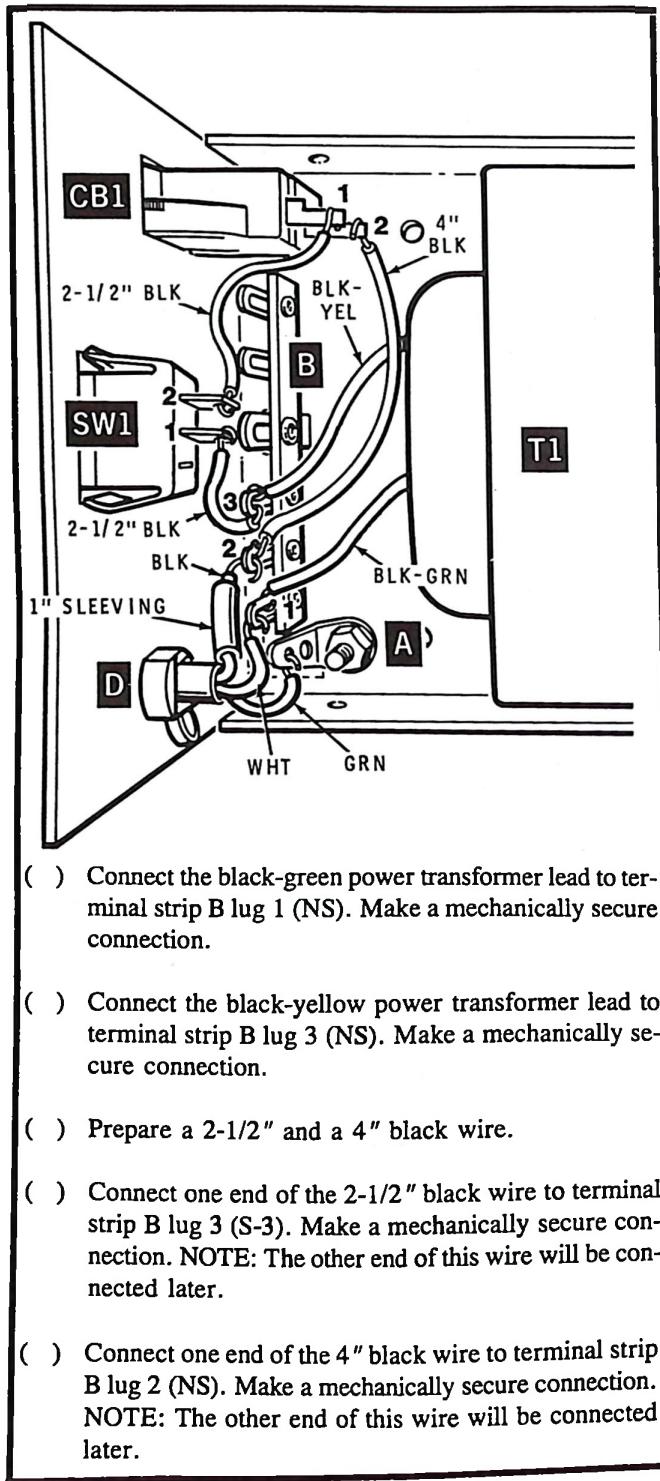
(✓) Shorter lead to bridge rectifier BR1 lug 4 (NS).

(✓) Longer lead to terminal strip C lug 1 (NS).



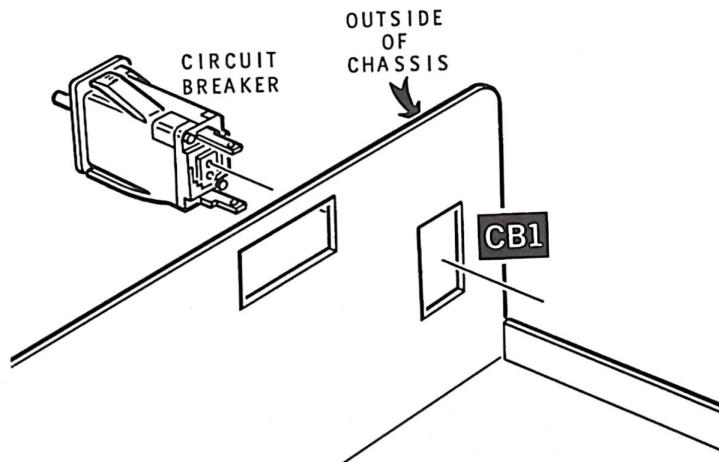
ALTERNATE LINE VOLTAGE WIRING

You can wire your Charger to operate from a 120 VAC source or from a 240 VAC source. Select the appropriate set of steps below and refer to the corresponding illustration on the Pictorial as you perform the steps.

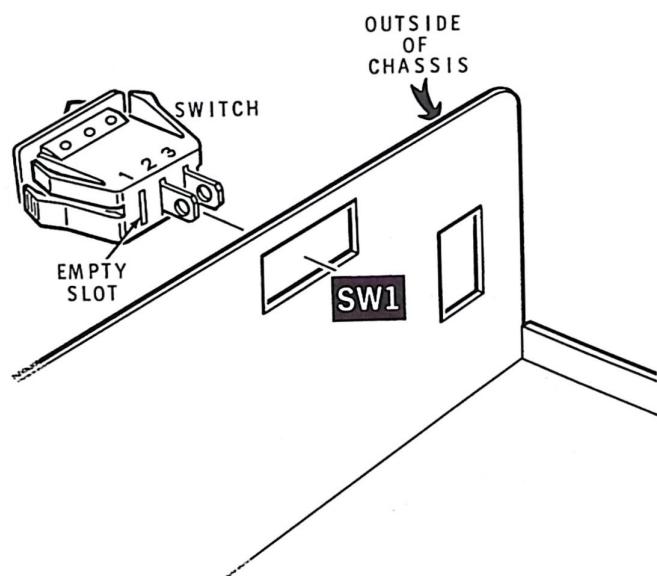
120 VAC Wiring

- () Connect the black-green power transformer lead to terminal strip B lug 1 (NS). Make a mechanically secure connection.
- () Connect the black-yellow power transformer lead to terminal strip B lug 3 (NS). Make a mechanically secure connection.
- () Prepare a 2-1/2" and a 4" black wire.
- () Connect one end of the 2-1/2" black wire to terminal strip B lug 3 (S-3). Make a mechanically secure connection. NOTE: The other end of this wire will be connected later.
- () Connect one end of the 4" black wire to terminal strip B lug 2 (NS). Make a mechanically secure connection. NOTE: The other end of this wire will be connected later.

- (✓) CB1: Refer to Detail 12-2A and push the .4-ampere circuit breaker (#65-77) into hole CB1 of the chassis until it locks into place. NOTE: It does not matter which lug of the circuit breaker is up.

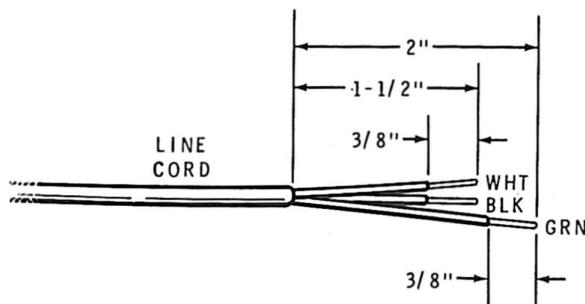
**Detail 12-2A**

- (✓) SW1: Position the switch so the empty slot in the rear of the switch is toward you as shown in Detail 12-2B. Then push the switch into chassis hole SW1 until it locks into place.

**Detail 12-2B**

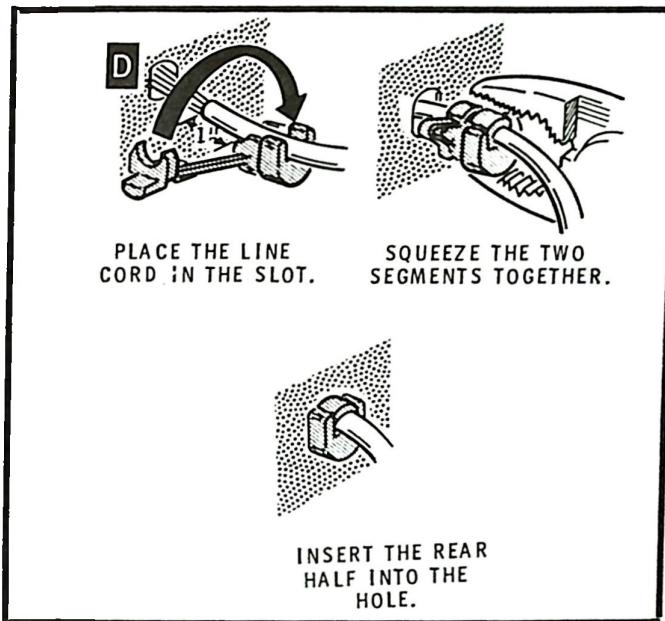
- () Connect the free end of the black wire coming from terminal strip B lug 2 to circuit breaker CB1 lug 2 (S-1). Make a mechanically secure connection. NOTE: If the end of the wire will not fit through the lug hole, securely wrap the wire around the lug.

- () Connect the free end of the black wire coming from terminal strip B lug 3 to switch SW1 lug 1 (S-1). Make a mechanically secure connection.
- () Prepare a 2-1/2" black wire. Then connect the wire from switch SW1 lug 2 (S-1) to circuit breaker CB1 lug 1 (S-1). Make mechanically secure connections. NOTE: If the end of the wire will not fit through the lug hole, securely wrap the wire around the lug.
- () Refer to Detail 12-2C and use the following procedure to prepare the end of the line cord:



Detail 12-2C

1. Carefully remove 2" of outer insulation. Be careful not to cut through the insulation on the three inner line cord leads.
 2. Shorten the white and the black line cord leads to 1-1/2". Then remove 3/8" of insulation from the end of each lead, twist together the fine strands at both ends of each lead, and melt a small amount of solder on these ends to hold the strands together.
- () Refer to Detail 12-2D and install the large strain relief 1" from the end of the outer insulation on the prepared end of the line cord. Then push the strain relief into chassis hole D until it locks into place.
 - () Connect the free end of the green line cord lead to solder lug A (S-1). Make a mechanically secure connection.

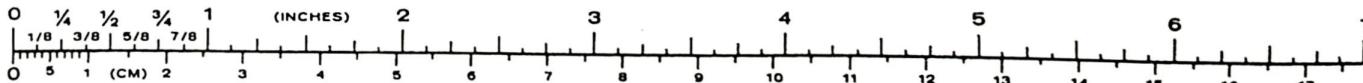


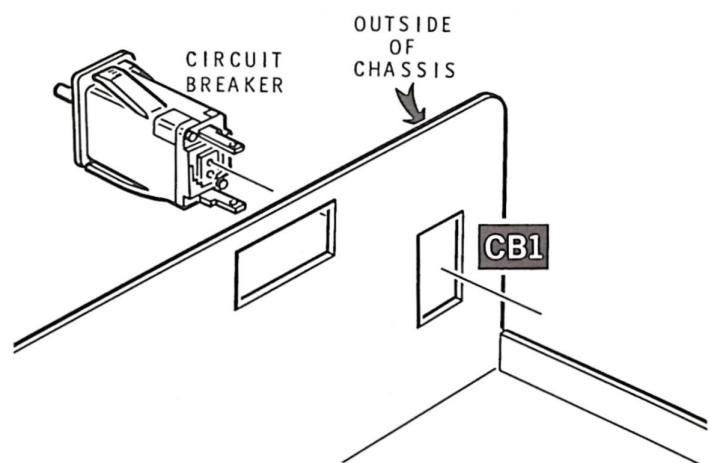
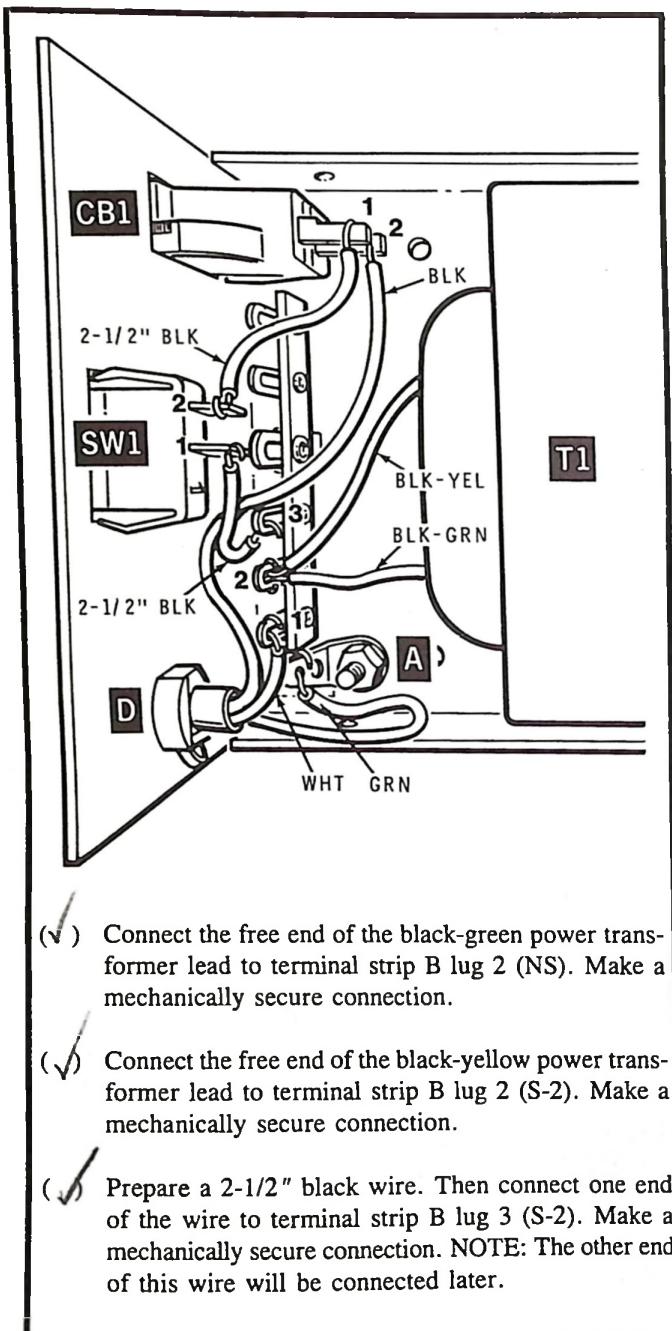
Detail 12-2D

- () Connect the free end of the white line cord lead to terminal strip B lug 1 (S-3). Make a mechanically secure connection.
- () Cut the length of sleeving to 1", if this has not already been done. Slide the sleeving onto the free end of the black line cord lead. Then connect the end of the lead to terminal strip B lug 2 (S-2). Make a mechanically secure connection.
- () Carefully peel away the backing paper from the blue and white label. Then refer to inset drawing #2 on the Pictorial and press the label onto its area on the rear of the chassis as shown (so "120 VAC 50/60 Hz 50 watts" still shows). Be sure to refer to the numbers on this label in any communications you may have with the Heath Company about your kit.

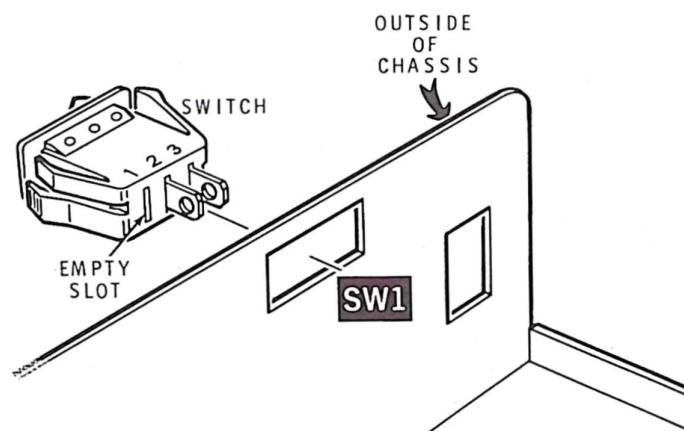
NOTE: The .2-ampere circuit breaker (#65-78) will not be used when you assemble your Charger for operation from a 120 VAC source.

Skip the following steps and proceed directly to "Final Wiring."



240 VAC Wiring**Detail 12-2A**

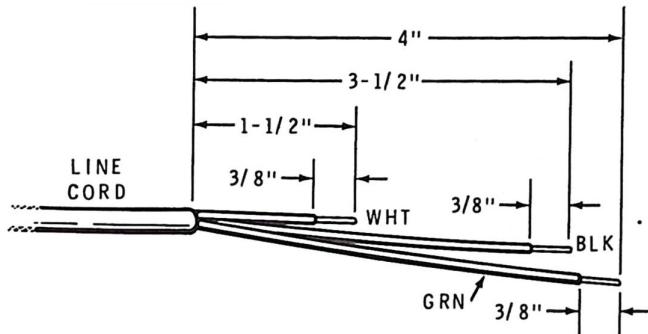
- (✓) SW1: Position the switch so the empty slot in the rear of it is toward you as shown in Detail 12-2B. Then push the switch into chassis hole SW1 until it locks into place.

**Detail 12-2B**

- (✓) Refer to Detail 12-2E and use the following procedure to prepare the end of the line cord:

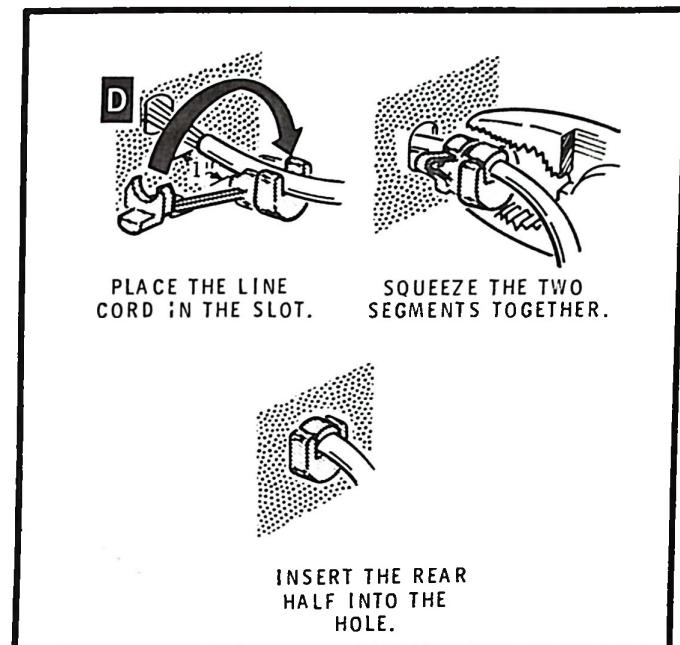
1. Carefully remove 4" of outer insulation from the line cord. Be careful not to cut into the insulation on the three inner line cord leads.
2. Shorten the white line cord lead to 1-1/2" and the black line cord lead to 3-1/2". Then remove 3/8" of insulation from the end of each lead, twist together the fine strands at both ends of each lead, and melt a small amount of solder on these ends to hold the strands together.

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Detail 12-2E

- (✓) Refer to 12-2D and install the large strain relief 1" from the end of the outer insulation on the line cord. Then push the strain relief into chassis hole D until it locks into place.
- (✓) Connect the free end of the green line cord lead to solder lug A (S-1). Make a mechanically secure connection.
- (✓) Connect the free end of the white line cord lead to terminal strip B lug 1 (S-2). Make a mechanically secure connection.
- (✓) Connect the free end of the black line cord lead to circuit breaker CB1 lug 2 (S-1). Make a mechanically secure connection. NOTE: If the end of the wire will not fit through the lug hole, securely wrap the wire around the lug.
- (✓) Connect the free end of the black wire coming from terminal strip B lug 3 to switch SW1 lug 1 (S-1).
- (✓) Prepare a 2-1/2" black wire. Then connect the wire from switch SW1 lug 2 (S-1) to circuit breaker CB1 lug 1 (S-1). Make mechanically secure connections. NOTE: If the end of the wire will not fit through the lug hole, securely wrap the wire around the lug.
- (✓) Carefully peel away the backing paper from the blue and white label. Then refer to inset drawing #3 on the Pictorial and press the label into its area on the rear of the chassis (so "240 VAC 50/60 Hz 50 watts" still shows). Be sure to refer to the numbers on this label in any communications you may have with the Heath Company about your kit.



Detail 12-2D

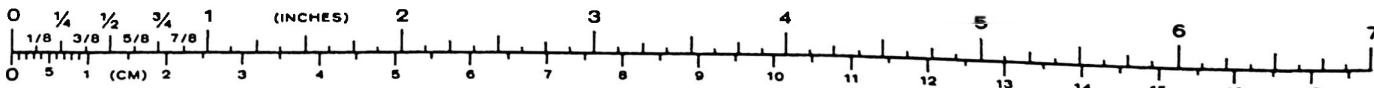
NOTES:

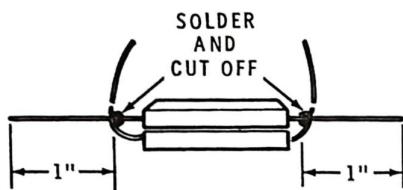
1. ✓ The sleeving and the .4-ampere circuit breaker (#65-77) will not be used when you assemble your Charger for operation from a 240 VAC source.
2. ✓ The plug on the end of the line cord included with this kit is for standard 120 VAC outlets. For 240 VAC operation in the U.S.A., cut off the plug and replace it with a permanent plug that matches your 240 VAC receptacle. Be sure your power connection conforms with section 210-21 (b) of the National Electric Code, which reads in part:

"Receptacles connected to circuits having different voltages, frequencies, or types of current (AC or DC) on the same premises shall be of such design that attachment plugs used on such circuits are not interchangeable."

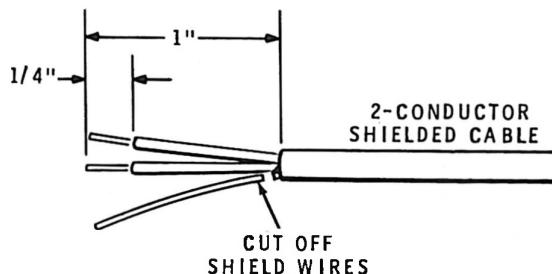
✓ When you install a new plug, make sure it is connected according to your local electrical code. Keep in mind that the green line cord lead is connected to the chassis of the Charger.

Proceed to "Final Wiring."





Detail 12-3A

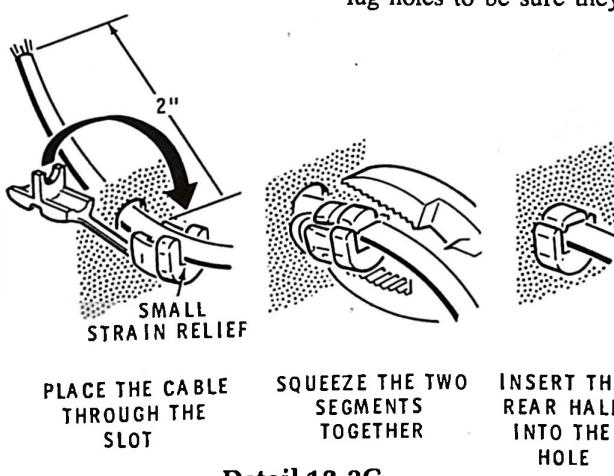


Detail 12-3B

FINAL WIRING

Refer to Pictorial 12-3 (Illustration Booklet, Page 11) for the following steps.

- (✓) R3: Cut both leads of the $1000\ \Omega$, 1-watt (brn-blk-red) resistor to $1/2"$. Then connect the resistor between bridge rectifier BR1 lugs 1 (NS) and 3 (NS).
- (✓) C1: Connect the positive (+) lead of the $3300\ \mu F$ electrolytic capacitor to bridge rectifier BR1 lug 1 (NS). Pass the negative (-) lead of this capacitor through terminal strip C lug 3 and connect it to lug 2 (S-2). Now solder the lead to lug 3. Position this capacitor down against the bottom of the chassis and as far toward the front of the chassis as possible.
- (✓) Refer to Detail 12-3A and combine the two $2.5\ \Omega$, 10-watt wire-wound resistors to make a $1.25\ \Omega$, 20-watt resistor. Cut the leads of this combination 1" from the solder connection.
- (✓) R2/R3: Connect the resistor combination from bridge rectifier BR1 lug 4 (S-2) to terminal strip C lug 1 (S-4). Position the resistor combination down against the bottom of the chassis. Also, since this resistor combination becomes hot during charging, position all wires and other components away from this combination.
- () Refer to Detail 12-3B and use the following procedure to prepare one end of the 2-conductor shielded cable:



Detail 12-3C

1. ✓ Carefully remove 1" of outer insulation from the cable. Be careful not to cut into the insulation on the inner wires.
 2. ✓ Cut off the shield wires as close to the outer insulation as possible.
 3. ✓ Remove $1/4"$ of insulation from the end of each wire, twist together the fine strands at the end of each wire, and melt a small amount of solder on these ends to hold the strands together.
NOTE: You will prepare the other end of this cable later.
- (✓) Refer to Detail 12-3C and install the small strain relief 2" away from the end of the outer insulation on the prepared end of the cable. Then push the strain relief into chassis hole E until it locks into place.

Route the prepared end of the cable as shown in the Pictorial. Then connect the wires at the end of this cable as follows:

- (✓) White or clear wire to bridge rectifier BR1 lug 1 (S-3).
- (✓) Black wire to bridge rectifier BR1 lug 3 (S-3).

This completes the wiring inside the chassis. Check all of the connections to make sure they are properly connected and soldered. Especially check the wires in the bottom of lug holes to be sure they are soldered.

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Refer to Pictorial 12-4 (Illustration Booklet, Page 12) for the following steps.

- (✓) Cut the grommet strip to a length of 1-3/4", if this has not already been done. Then refer to Detail 12-4A and bend the grommet strip in the center and push it into the cutout in the shield as shown.
- (✓) Use two 6-32 × 3/8" screws to mount the shield to the chassis as shown in the Pictorial. Be sure to position the wires coming from the power transformer so they all pass through the cutout and grommet strip in the shield as shown. Also make sure there are no wires pinched between the shield and the chassis.
- (✓) Refer to Detail 12-4B and use the following procedure to mount one of the paper insulators to bridge rectifier BR1:

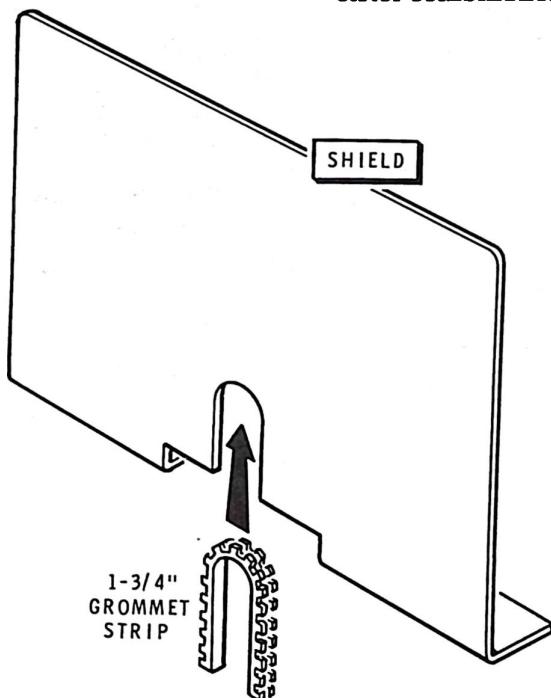
1. Turn the 6-32 × 7/16" plastic spacer onto the end of the screw extending from bridge rectifier BR1.

2. Position the paper insulator onto the 7/16" spacer as shown. Then use the 6-32 × 1/4" screw and #8 flat washer to secure the insulator to the space. Be sure to position the sides of the paper insulator inside the chassis as shown in the Pictorial.

- (✓) Refer again to Detail 12-4B and use the following procedure to mount the remaining paper insulator on terminal strip C:

1. Turn the 6-32 × 3/4" fiber spacer onto the end of the mounting screw of terminal strip C.
2. Position the paper insulator onto the spacer as shown. Then use a 6-32 × 1/4" screw and a #8 flat washer to secure the insulator to the spacer. Be sure to position the sides of the paper insulator inside the chassis as shown in the Pictorial.

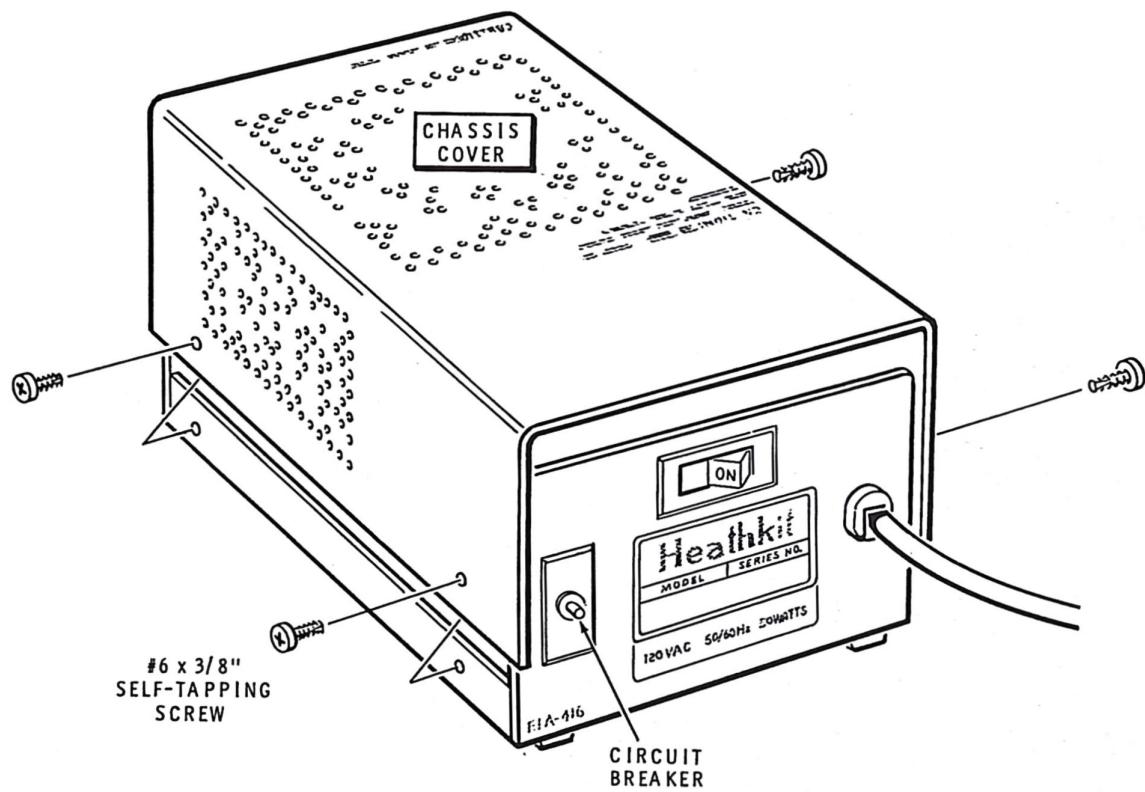
- (✓) Make sure the resistor combination is not touching paper insulators. Reposition the resistor combination as necessary.



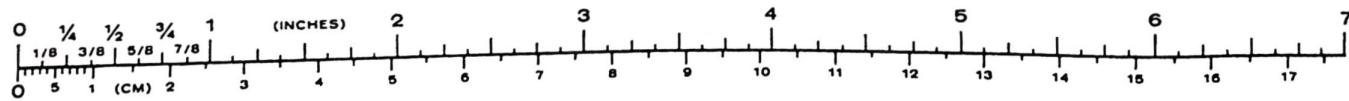
Detail 12-4A

Refer to Pictorial 12-5 for the following steps.

- (✓) Position the chassis cover onto the chassis so the end that has the holes is toward the front of the chassis as shown. Then use four #6 x 3/8" self-tapping screws to secure the cover to the chassis.
- (✓) Push in on the plunger of circuit breaker CB1 to make sure it is reset.



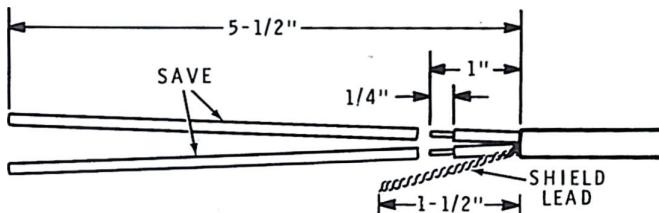
PICTORIAL 12-5



CONNECTOR WIRING

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

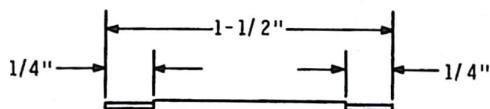
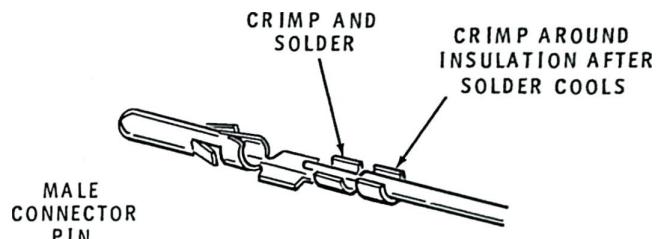
- (✓) Refer to Detail 12-6A and use the following procedure to prepare the free end of the 2-conductor shielded cable coming from the chassis:

**Detail 12-6A**

1. ✓ Remove 5-1/2" of outer insulation from the free end of the cable.
 2. Cut off the white (or clear) and black wires 1" from the end of the outer insulation. Save the cutoff wires for use later.
 3. Shorten the shield lead to 1-1/2".
- (✓) Refer to the inset drawing on the Pictorial and cut the cable insulator to 1". Then slide the insulator onto the end of the cable as shown in the Pictorial.

When you are directed to prepare a wire or shielded cable, remove 1/4" of insulation from the end(s) and twist together the fine wire strands. Then melt a small amount of solder on the exposed wire end(s), and on the end of the shield lead for a shielded cable.

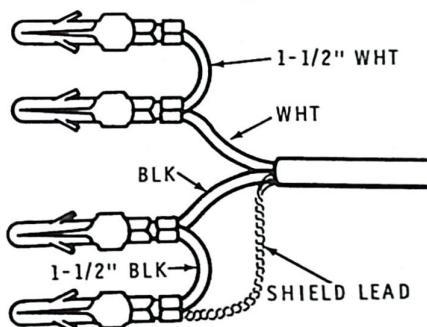
- (✓) Prepare the wires at the end of the 2-conductor shielded cable.
- (✓) Refer to Detail 12-6B and prepare the ends of one white and three black 1-1/2" wires. Use the wires that you cut from the end of the cable.

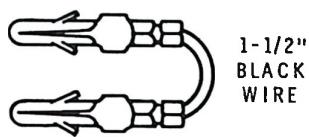
**Detail 12-6B****Detail 12-6C**

- (✓) Refer to Detail 12-6C and install a male connector pin on one end of a 1-1/2" white wire.

NOTE: When you join two wires in a single connector pin, as in the following steps, remove an extra 1/8" of insulation from the end of both wires. Position the wires in the connector so the wire insulation is just outside the end tab. Then proceed as for a single wire.

- (✓) Refer to Detail 12-6D and use a male connector pin to connect the white wire with the connector on one end to the white conductor of the 2-conductor cable.
- (✓) Similarly, use a male connector pin to connect a 1-1/2" black wire to the black conductor of the 2-conductor cable.
- (✓) Use a male connector pin to join the free end of the 1-1/2" black wire with the free end of the shield lead of the 2-conductor cable.

**Detail 12-6D**

**Detail 12-6E**

(✓) Refer to Detail 12-6E and make two assemblies, each with a male connector pin on both ends of a 1-1/2" black wire.

(✓) Position the 12-pin socket shell so its grooves are toward the right as shown in the Pictorial.

NOTE: When you perform the following steps, be sure you insert the wires in their correct holes the first time. It is almost impossible to remove a pin from the socket shell once it snaps into place. Start all of the pins into their holes; then check to be sure they are all in the correct holes before you push them all the way in.

- () At the end of the 2-conductor shielded cable, push the connector pin on the black wire and shield lead into hole 1 of the socket shell. Push on the connector pin until it snaps into place.
- () Push the connector pin with two black wires into hole 4 of the socket shell.

- () Push the connector pin with two white wires into hole 8 of the socket shell.
- () Push the connector pin with one white wire into hole 9 of the socket shell.
- () Locate one of the black wires that has a male connector pin on both ends. Then push the connector pins into holes 5 and 6 of the socket shell.
- () Similarly, push the connector pins on the other black wire into holes 2 and 3 of the socket shell.
- () Install a cable clamp over the socket shell as shown in the Pictorial. Use 4-40 × 3/8" hardware. Be sure to position the cable insulator in the cable clamp as shown. Also be sure to cut off the indicated tabs.

This completes the assembly of the Charger. Set it aside temporarily.

BASE ASSEMBLY

PARTS LIST

Open carton #2. Then refer to the "Pack Index Sheet" and remove the parts from pack #13. Check each part against the following list. The key numbers correspond to the numbers on the "Base Assembly Parts Pictorial" (Illustration Booklet, Page 13). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do

not discard any packing materials until all parts are accounted for.

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. For prices, refer to the separate "Heath Parts Price List."

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

CIRCUIT COMPONENTS

A1	150-131	1	Light sensor	VS1
A2	420-637	1	Drive motor	A1
A3	420-640	1	Steering motor	A2
A4	442-674	2	7812 integrated circuit	U201, U204

RUBBER GROMMET — FOAM TAPE — INSULATOR

B1	73-23	1	11/16" O.D. rubber grommet
B2	73-64	8	1/2" x 1/2" x 2" foam tape
	75-737	1	6" x 8" insulator sheet

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

HARDWARE

#4 Hardware

C1	250-1450	1	4-40 x 5/16" flat head phillips screw
C2	250-1415	3	4-40 x 3/8" screw
C3	252-2	3	4-40 nut
C4	253-80	1	#4 flat washer
C5	254-9	4	#4 lockwasher
C6	253-198	2	#4 insulator bushing

#6 Hardware

D1	250-1280	5	6-32 x 3/8" black phillips head screw
D2	250-1264	18	6-32 x 3/8" hex head screw

<u>KEY</u>	<u>HEATH</u>	<u>QTY.</u>	<u>DESCRIPTION</u>
<u>No.</u>	<u>Part No.</u>		

#6 Hardware (cont'd.)

D3	250-26	3	6-32 x 5/8" screw
D4	252-3	23	6-32 nut
D5	253-1	2	#6 fiber flat washer
D6	253-2	2	#6 fiber shoulder washer
D7	253-21	2	#6 flat washer
D8	254-1	32	#6 lockwasher (3 extra supplied)
D9	255-724	2	7/8" long hex bushing
D10	255-129	2	1-1/2" long round bushing
D11	259-1	2	#6 solder lug

#8 Hardware

E1	250-1481	1	8-32 setscrew pin
E2	250-1485	1	8-32 x 1/4" setscrew
E3	250-286	4	8-32 x 1-1/4" screw
E4	252-4	4	8-32 nut
E5	254-2	4	#8 lockwasher

#10 Hardware

F1	252-5	4	10-32 nut
F2	254-3	4	#10 lockwasher

1/2" Hardware

G1	250-1404	2	1/2-13 x 2-1/2" bolt
G2	252-729	2	1/2-13 nut

Other Hardware

H1	254-15	1	.326 x .600 lockwasher
H2	255-795	2	3/4" x 1/4" long spacer
H3	258-43	2	Coil spring

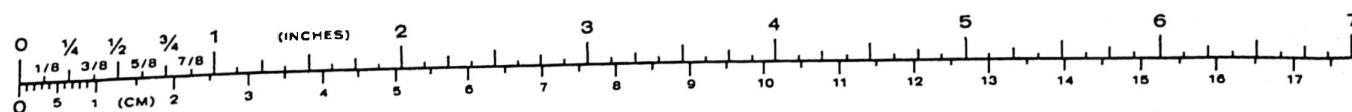
<u>KEY</u>	<u>HEATH</u>	<u>QTY.</u>	<u>DESCRIPTION</u>
<u>No.</u>	<u>Part No.</u>		

MISCELLANEOUS

K1	431-11	1	5-lug terminal strip
K2	432-753	5	Spring connector
K3	352-13	1	Silicone grease
K4	422-1	2	Fuseholder
K5	204-2645	1	Right support bracket
K6	204-2644	1	Left support bracket
K7	204-2671	1	Sensor bracket
K8	456-48	1	Shoulder bushing
K9	75-704	2	Transistor insulator
	490-85	1	5/64" allen wrench
	352-33	1	Setscrew locking compound

PARTS FROM FINAL PACK

L1	205-1882	1	Base plate
L2	204-2598	1	Rear wheel bracket
L3	204-2602	1	Drive motor bracket
L4	200-1413	1	Battery holder
	390-2452	1	Connector label sheet (from label pack)

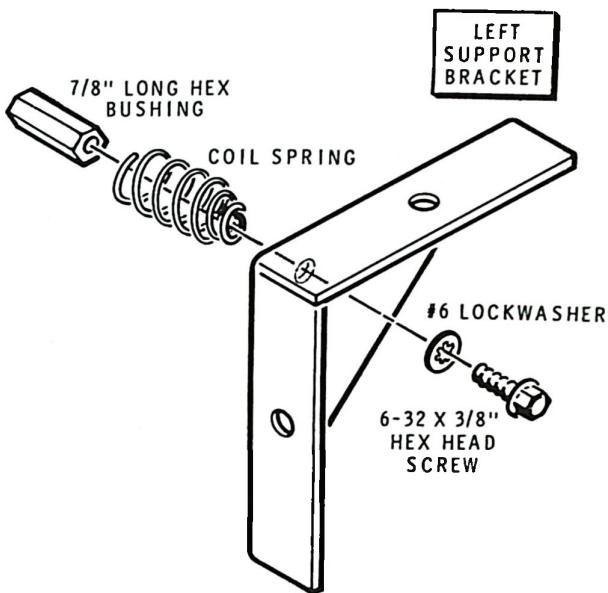


STEP-BY-STEP ASSEMBLY

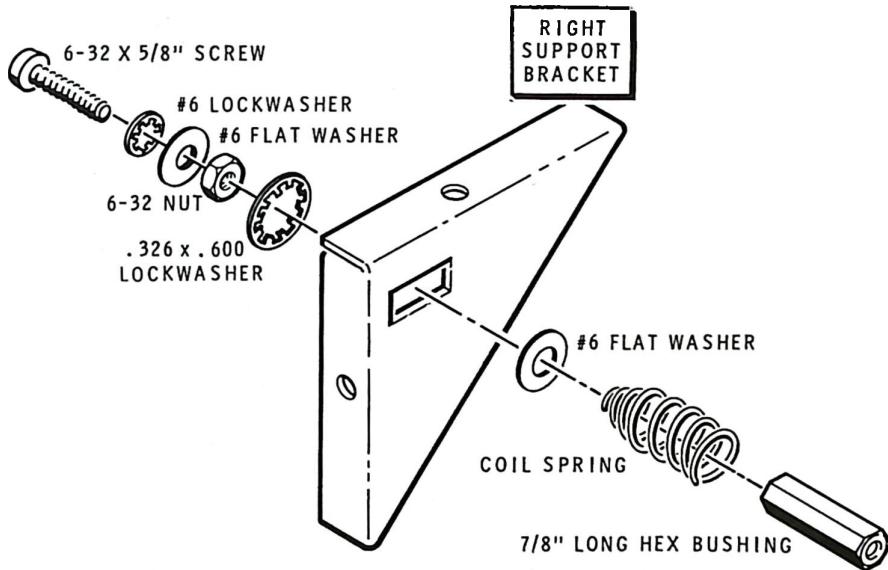
MAIN DRIVE ASSEMBLY

Refer to Pictorial 13-1 (Illustration Booklet, Page 15) for the following steps.

- () Refer to Detail 13-1A and mount a coil spring and a $7/8"$ long hex bushing at the side hole in the left support bracket. Use a $6-32 \times 3/8"$ hex head screw and a #6 lockwasher. Do not overtighten the hardware.
- () Refer to Detail 13-1B and install a #6 lockwasher and a #6 flat washer on a $6-32 \times 5/8"$ screw with a 6-32 nut. Securely tighten the nut. Center a $.326 \times .600$ lockwasher over the nut and then fit the nut into the slot in the right support bracket. Secure the screw in place in the bracket with a #6 flat washer, a coil spring and a $7/8"$ long hex bushing.

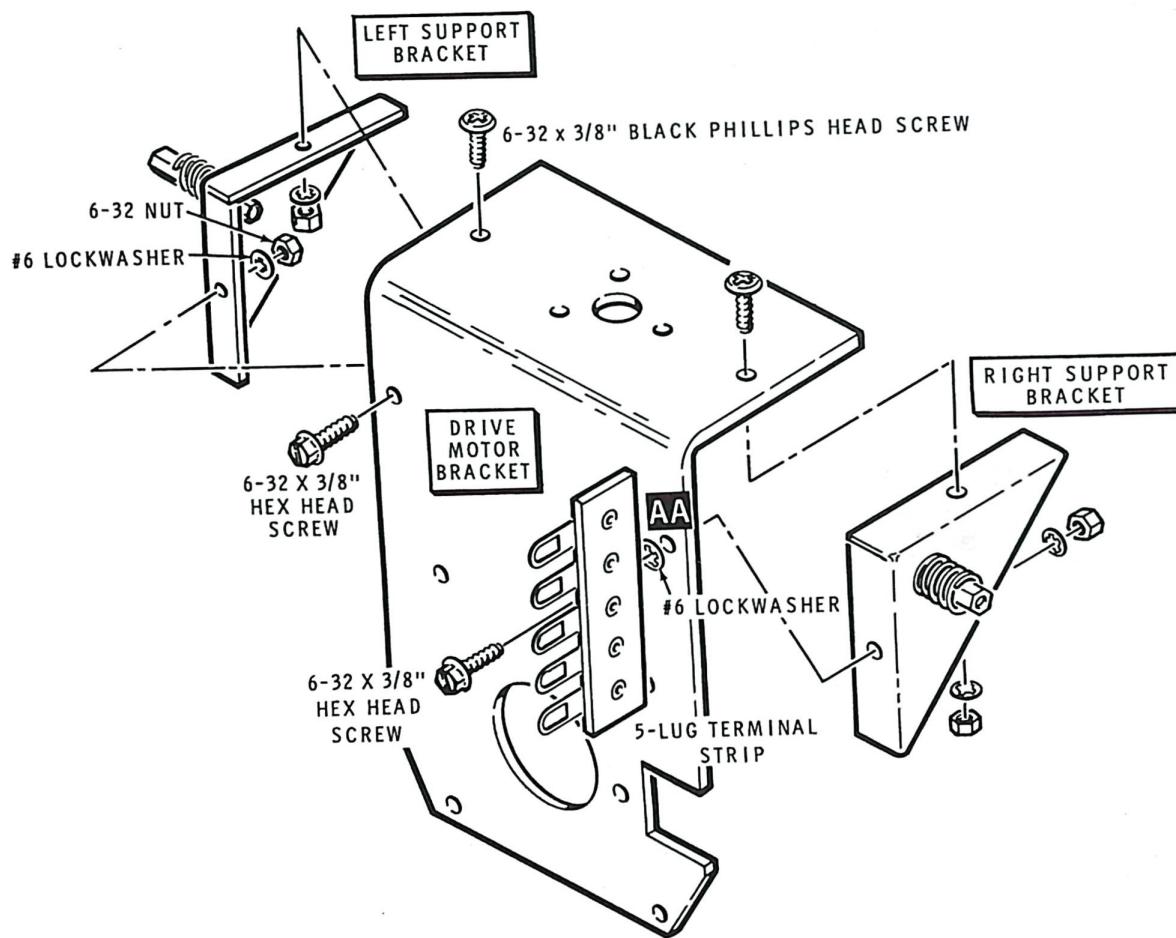


Detail 13-1A



Detail 13-1B

- () Refer to Detail 13-1C and mount the left support bracket at the indicated location on the drive motor bracket. Use 6-32 × 3/8" black phillips head hardware in the top hole, and 6-32 × 3/8" hex head hardware in the front hole.
- () In a similar manner, mount the right support bracket and a 5-lug terminal strip to the drive motor bracket. Use 6-32 × 3/8" black phillips head hardware in the top hole, and 6-32 × 3/8" hex head hardware at front hole AA. Note the extra lockwasher used when you mount a terminal strip. Position the terminal strip as shown.



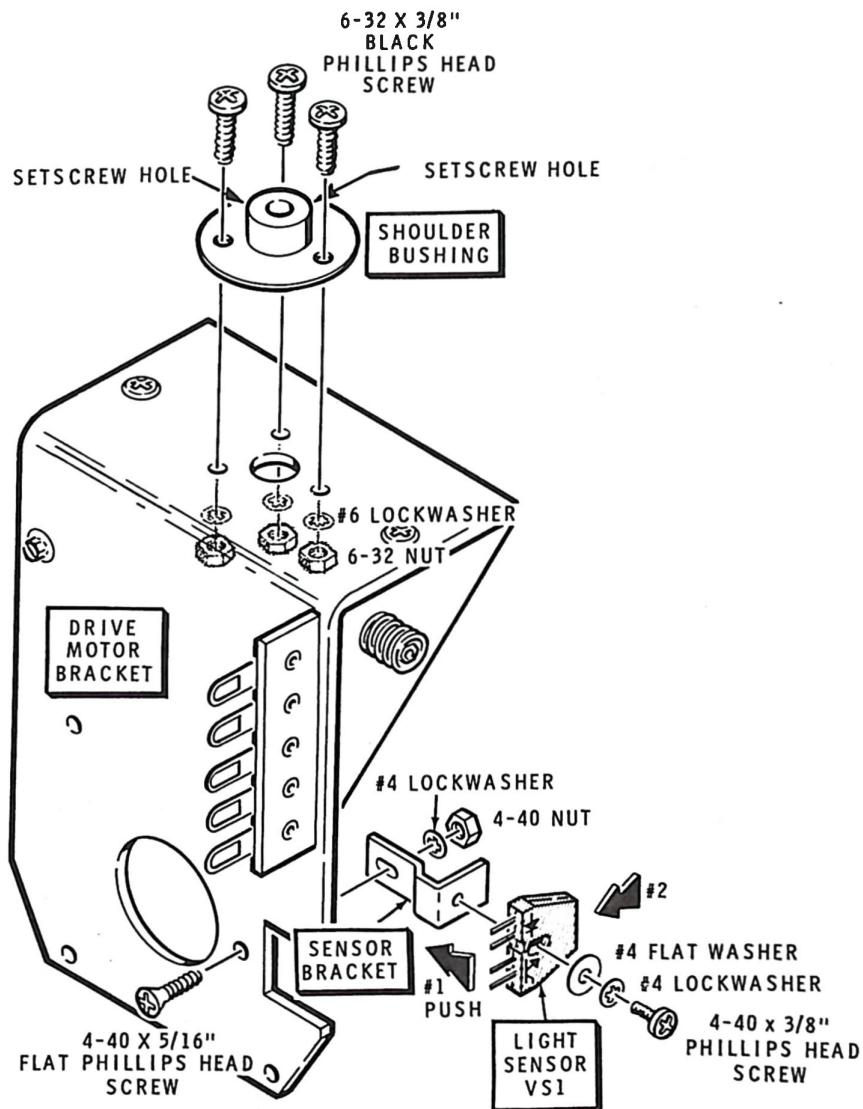
Detail 13-1C

Heathkit®

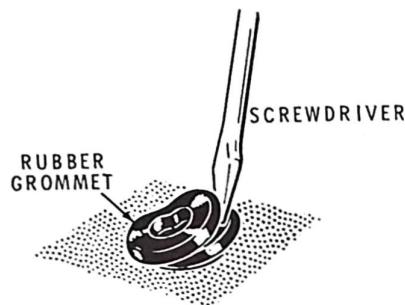
- () Refer to Detail 13-1D and mount the shoulder bushing on the top of the motor drive bracket with 6-32 × 3/8" black phillips head hardware. Position the bushing so its setscrew holes are located as shown.
- () Refer to Detail 13-1D and mount the sensor bracket at the notch in the drive motor bracket with 4-40 × 5/16" flat head hardware. Push the bracket as far in the direction of arrow #1 as the slot in the sensor bracket will permit.

- () VS1: Refer to Detail 13-1D and mount the light sensor (#150-131) on the sensor bracket with a 4-40 × 3/8" screw, a #4 lockwasher, and a #4 flat washer. Be sure the symbols on the sensor are located as shown on the detail. Push the sensor as far as possible in the direction of arrow #2. DO NOT overtighten the screw, as this would break the sensor.
- () Mount the drive motor (#420-637) to the drive motor bracket with 8-32 × 1-1/4" hardware as shown in Pictorial 13-1.

Set the main drive assembly aside temporarily.



Detail 13-1D

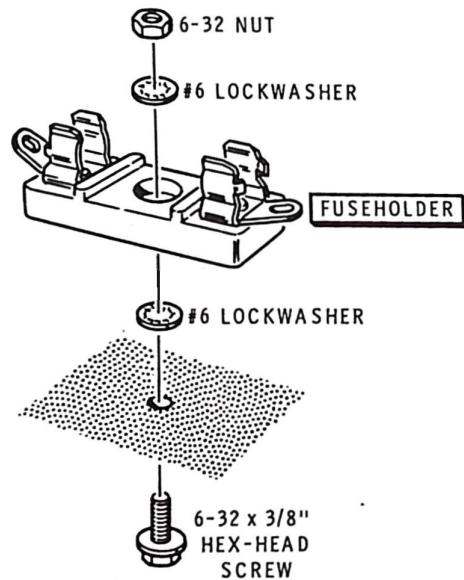
**Detail 13-2A****BASE PLATE ASSEMBLY**

Refer to Pictorial 13-2 (Illustration Booklet, Page 16) for the following steps.

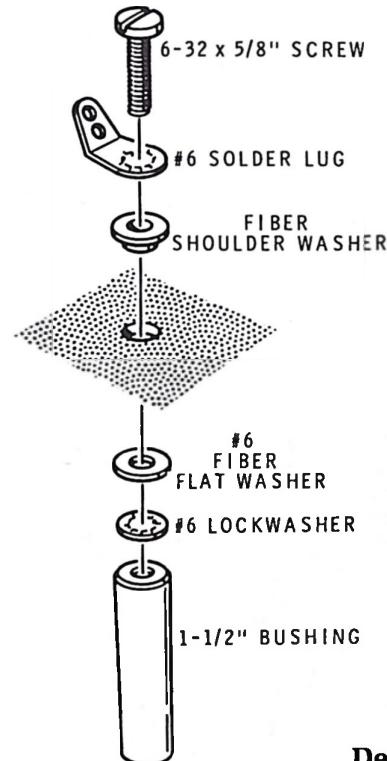
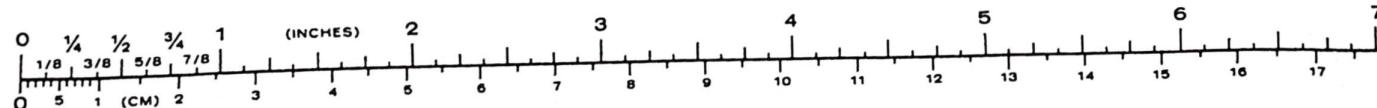
- () Refer to Detail 13-2A and install the 11/16" O.D. rubber grommet in hole BA in the base plate.

NOTE: Be sure the base plate is positioned with its top side up. Note the location of holes BB and BC.

- () Refer to Detail 13-2B and mount a fuseholder at location F1 with 6-32 × 3/8" hex head hardware. Note the extra #6 lockwasher between the fuse-holder and the base plate. Do not overtighten the hardware.

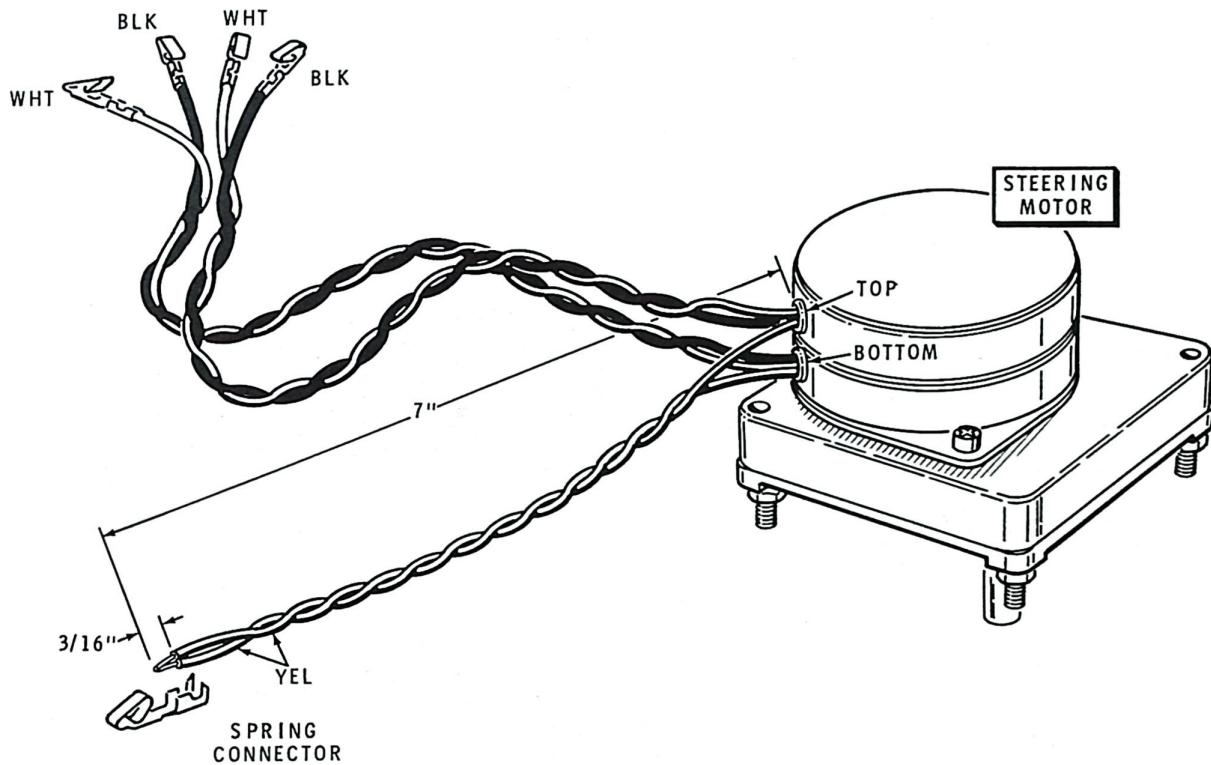
**Detail 13-2B**

- () In the same manner, install a fuseholder at location F2.
- () Peel the "Motor Battery F2 Fuse 4 AMP" label from the connector label sheet. Press this label into place near fuseholder F2.
- () In the same manner, install the "Logic Battery F1 Fuse 3 AMP" label near fuseholder F1.
- () Refer to Detail 13-2C and mount a 1-1/2" long bushing at location BB. Use a 6-32 × 5/8" screw, a #6 solder lug, a #6 fiber shoulder washer, a #6 fiber flat washer and a #6 lockwasher. Be sure the small diameter portion of the shoulder washer is in the hole in the base plate. Position the solder lug as shown in Pictorial 13-2.
- () In the same manner, install a 1-1/2" long bushing at BC in the base plate.

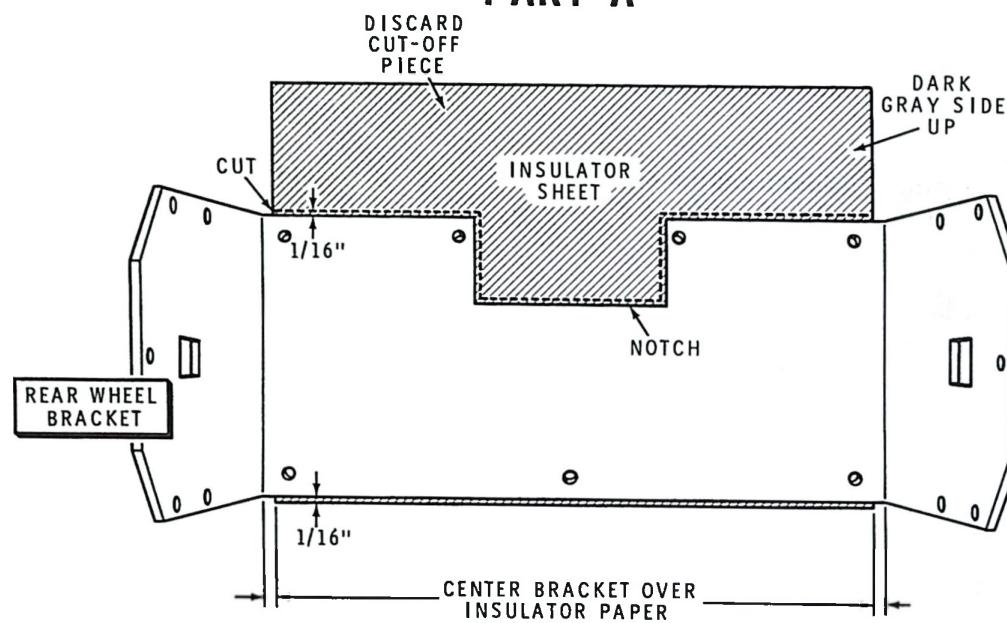
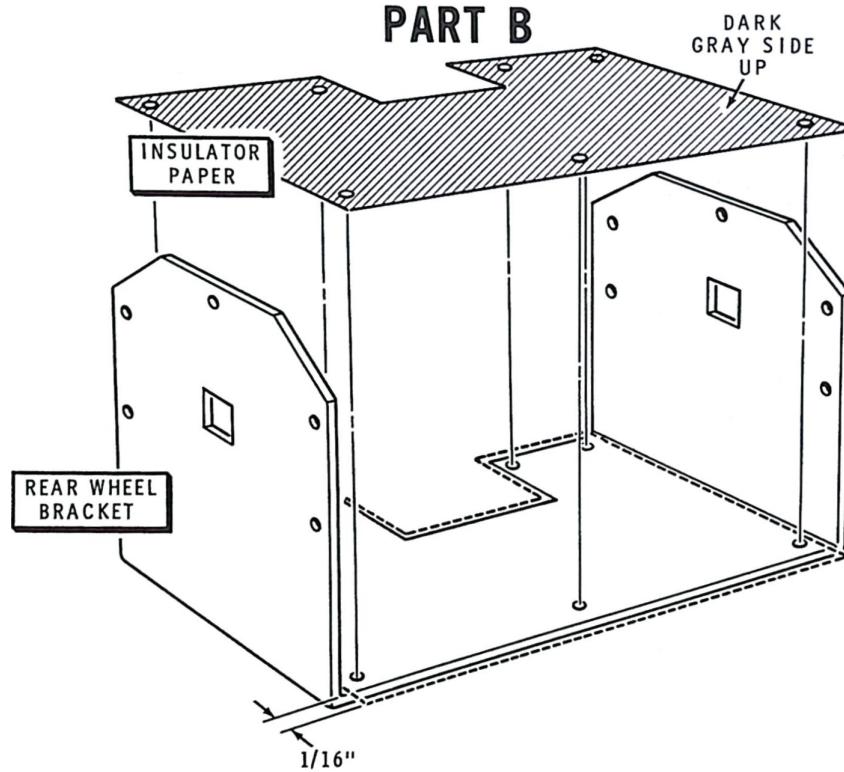
**Detail 13-2C**

- () Refer to Detail 13-2D, and cut all six leads of the steering motor (#420-640) to 7" in length. Then remove 3/16" of insulation from each lead end.
- () Install a spring connector on each of the two black leads and on each of the two white leads of the steering motor.
- () Twist together the yellow leads (from the top and bottom holes) of the motor and install a single spring connector on both these leads.

- () A2: Refer to Detail 13-2E (Illustration Booklet, Page 16) and mount the steering motor at A2 on the base plate with #10 lockwashers and 10-32 nuts. Do not pinch any of the leads between the motor and the base plate.



Detail 13-2D

PART A**PART B****Detail 13-2F**

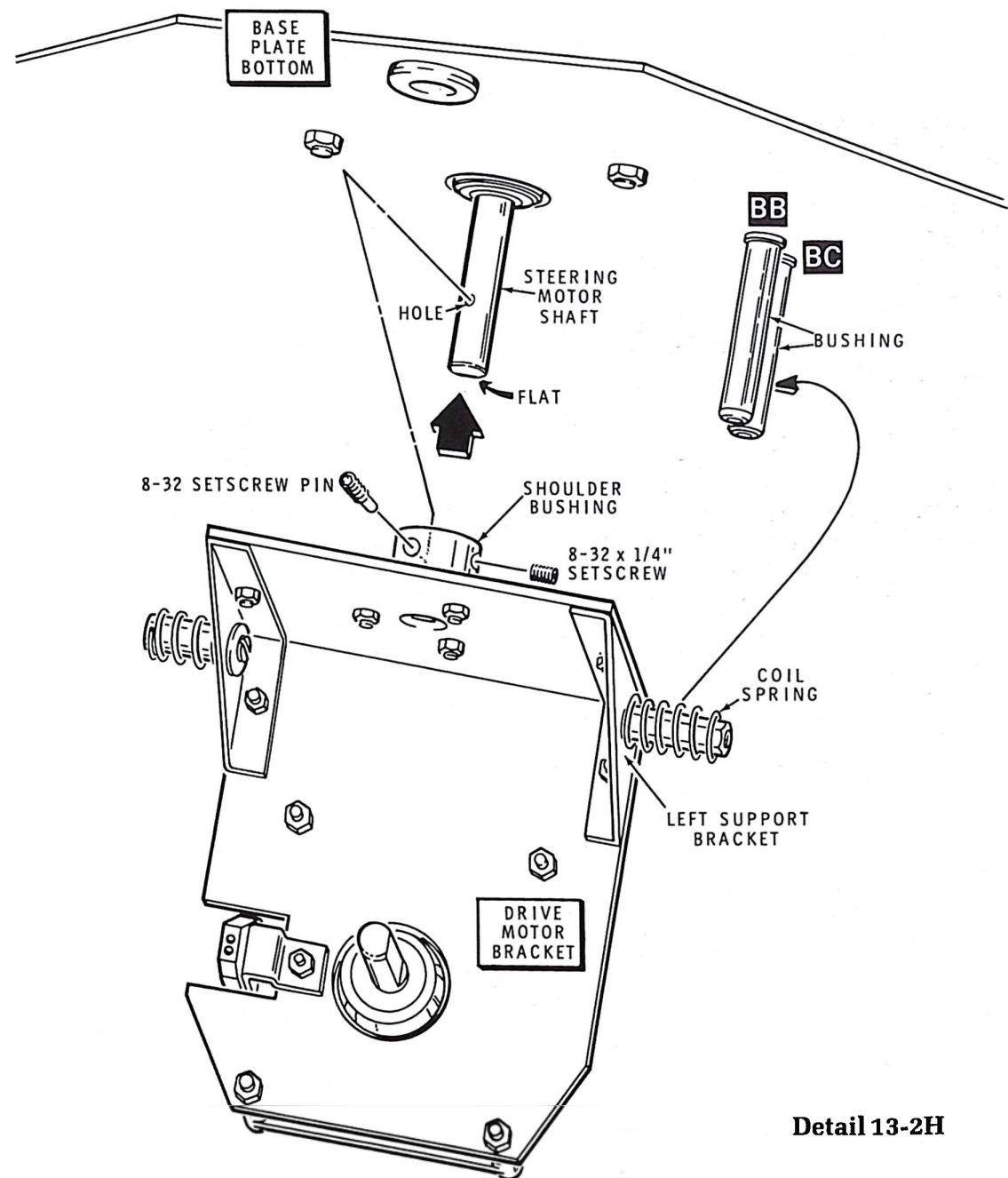
Refer to Part A of Detail 13-2F for the following steps.

- () Position the 6" × 8" insulator sheet with its dark gray side up on your work area.
- () Center the rear wheel bracket from side-to-side on the insulator sheet. The bracket should be back 1/16" from the nearest edge of the insulator sheet.
- () Carefully mark the insulator sheet (with a sharp pencil) at each of the seven holes in the bracket.
- () Mark the insulator sheet along the rear edge and notch 1/16" from the bracket.
- () Set the bracket aside and cut the insulator sheet along the line on the insulator.
- () Use a pointed tool or a drill bit (the same size as the holes in the bracket) and punch or drill holes through the insulator at the seven hole markings.
- () Remove the paper backing from the prepared insulator sheet.
- () Refer to Part B of Detail 13-2F and carefully align the seven holes in the insulator sheet with the corresponding holes in the bracket. Then carefully press the insulator sheet into place on the bracket. The insulator should extend 1/16" to the front and 1/16" to the rear of the bracket.

Refer to Pictorial 13-2 (Illustration Booklet, Page 16) for the following steps.

- () Refer to Detail 13-2G (Illustration Booklet, Page 17) and mount the rear wheel bracket to the bottom of the base plate with 6-32 × 3/8" hex head hardware in the seven indicated holes.
- () Refer to inset drawing #1 on Detail 13-2G and install a 1/2" × 2-1/2" bolt in the square hole in either side of the rear wheel bracket with a 3/4" spacer and a 1/2-13 nut. Note: The nut will turn hard on the bolt after the first few turns. Use an 8" adjustable or open-end wrench.
- () In the same manner, install the other 1/2" × 2-1/2" bolt in the square hole in the other side of the rear wheel bracket.
- () Refer to inset drawing #2 on Detail 13-2G and note the position of the beveled corners. Press the three 1/2" × 1/2" × 2" pieces of foam tape onto the inside rear surface of the battery holder. Use the dimensions in the inset drawing and remove **only** the thinnest paper backing from **one** side of the foam tape.
- () Refer again to inset drawing #2 on Detail 13-2G and mount the battery holder to the rear wheel bracket with 6-32 × 3/8" hex head hardware in the three indicated holes at each side of the holder and bracket.

- () Apply a small amount of setscrew locking compound on the threads of an 8-32 × 1/4" setscrew. Then refer to Detail 13-2H and start the setscrew into the indicated hole in the shoulder bushing (on the drive motor bracket).
- () Slide the shoulder bushing onto the steering motor shaft with the remaining setscrew hole positioned over the hole opposite the flat of the steering motor shaft. Be sure the coil spring (on the left support bracket) is to the rear of bushing BC that is mounted on the base plate.
- () Insert the pin end of an 8-32 setscrew pin through the setscrew hole and into the hole of the motor shaft.
- () Apply a small amount of setscrew locking compound to the threads of the setscrew pin and tighten the setscrew pin into its hole.
- () Tighten the 8-32 × 1/4" setscrew onto the motor shaft.

**Detail 13-2H**

Heathkit

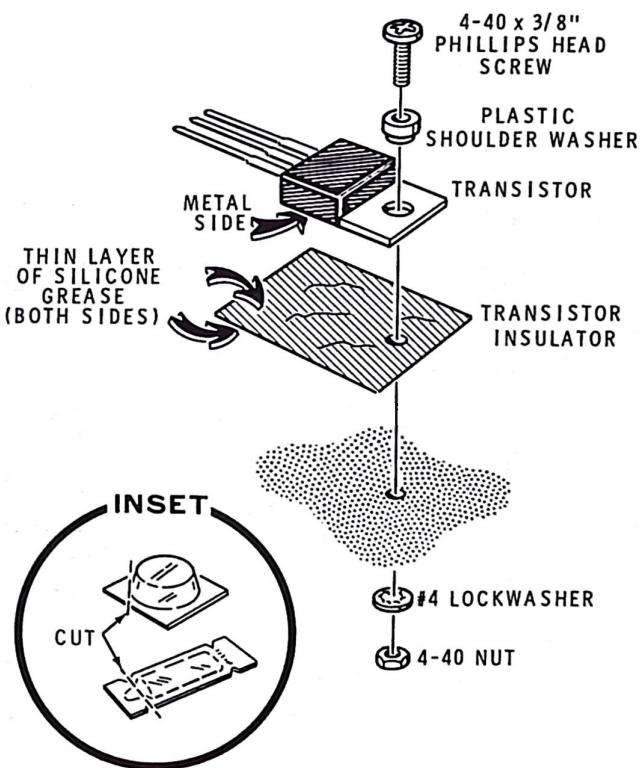
Refer to Pictorial 13-2 (Illustration Booklet, Page 16) and Detail 13-2J (below) for the following steps.

WARNING: The silicone grease you will use in the following step(s) helps transfer heat from the transistor to the base plate. The grease is not caustic, but make sure you do not get it into your eyes, ears, nose, mouth, or clothing. Always wash your hands after you use the grease. Keep this and all chemicals out of the reach of children.

- () Open the silicone grease as shown in the inset drawing on Detail 13-2J.
- () Apply a thin layer of silicone grease to both sides of a transistor insulator. DO NOT use more than half the grease on this insulator.
- () Position the transistor insulator at location U204 on the base plate. Align their holes with each other.

- () U204: Install a UA7812 IC (#442-674) on the transistor insulator at location U204 on the base plate with 4-40 × 3/8" hardware and a plastic shoulder washer. Be sure the small diameter portion of the shoulder washer fits into the hole in the IC, and that the metal side of the IC does not touch the bare base plate.
- () U201: In the same manner, install another UA7812 IC (#442-674) and a transistor insulator at location U201 on the base plate.

These IC's will be connected later. Set the base assembly aside temporarily.



Detail 13-2J

TORSO ASSEMBLY

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #14. Check each part against the following list. The key numbers correspond to the numbers on the "Torso Assembly Parts Pictorial" (Illustration Booklet, Page 18). Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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. For prices, refer to the separate "Heath Parts Price List."

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

A1	45-62	2	26 μ H choke	L1, L2
A2	418-45	3	6-volt battery (from Carton #1)	B1, B2, B3
A3	420-646	1	Head motor (may be marked 420-623)	A3
A4	421-2	1	3-ampere fuse	F1
A4	421-5	1	4-ampere fuse	F2
A5	417-857	2	MJE5976 transistor	Q703, Q706
A6	21-21	2	200 pF ceramic capacitor	C4, C5
A7	27-85	1	.22 μ F Mylar capacitor	C6
A8	61-3	1	Toggle switch (with hardware)	SW1

HARDWARE

#4 Hardware

B1	250-1415	2	4-40 \times 3/8" screw
B2	252-2	2	4-40 nut
B3	253-198	2	#4 shoulder washer
B4	254-9	2	#4 lockwasher

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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#6 Hardware

C1	250-1264	33	6-32 \times 3/8" hex head screw
C2	250-1150	3	6-32 \times 1/2" phillips head screw
C3	250-1157	4	6-32 \times 1/4" hex stud
C4	250-1158	4	6-32 \times 3/4" set screw
C5	252-3	52	6-32 nut
C6	253-89	1	D washer
C7	252-725	8	6-32 tapped insert
C8	253-1	2	#6 fiber flat washer
C9	253-2	2	#6 fiber shoulder washer
C10	253-27	6	#6 flat washer
C11	254-1	57	#6 lockwasher (6 extra supplied)
C12	259-1	2	#6 solder lug
C13	262-4	8	6-32 \times 11/16" retainer pin

#10 Hardware

D1	252-5	4	10-32 nut
D2	254-3	4	#10 lockwasher

KEY	HEATH	QTY.	DESCRIPTION
No.	Part No.		

Other Hardware

D3	250-1485	1	8-32 x 1/4" setscrew
D4	252-729	3	1/2-13 nut
D5	254-45	1	1/2" split washer
D6	453-339	1	Drive shaft
D7	452-28	1	Drive pin
D8	253-30	2	1/2" flat washer
D9	262-57	4	Tapered pin
D10	262-50	4	Tapered hexpin

SLEEVING — HARNESS

346-64	3"	Heat shrink sleeving
346-26	7"	Large clear sleeving
134-1368	1	Main harness (in final pack)
134-1215	1	Arm harness

CONNECTORS — CONNECTOR SHELLS — PHONO SOCKET

E1	432-753	5	Spring connector
E2	432-924	7	4-pin connector
E3	432-951	1	6-pin connector
E4	432-832	14	12-pin connector
E5	432-974	1	Large 2-hole connector shell
E6	432-954	1	Large 4-hole connector shell
E7	434-212	2	Phono socket (with hardware)

KEY	HEATH	QTY.	DESCRIPTION
No.	Part No.		

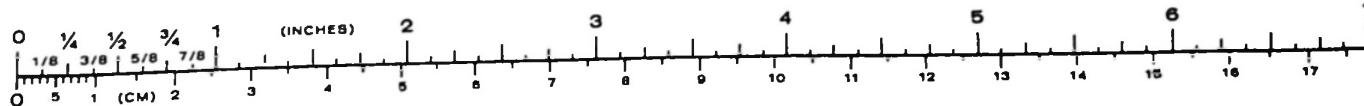
MISCELLANEOUS

F1	75-144	20	Circuit board clip* (See Note below)
F2	205-1883-1	1	Encoder disk
F3	204-2604	1	Harness clamp bracket
F4	207-38	1	Cable clamp
F5	208-50	3	Cable clip
F6	265-26	1	Hinge
F7	354-5	5	Small cable tie
F8	352-13	1	Silicone grease
F9	73-4	16	3/8" O.D. rubber grommet
	73-3	1	5/8" O.D. rubber grommet
	75-737	2	6" x 8" insulator sheet
F10	73-78	1	Hole insulator
F11	75-704	2	Transistor insulator
	354-10	1	Large cable tie
	655-17	1	Drive wheel
	655-18	2	Rear wheel

* NOTE: Place these circuit board clips in a container of water until they are called for in a step. Otherwise, they will break when they are installed.

PARTS FROM FINAL PACK

G1	204-2593	2	Side panel mounting bracket
G2	205-1880	1	Battery cover
G3	205-1881	1	Top plate
G4	203-2113-2	2	Body side panel
G5	95-657	1	Body front
G6	95-658	1	Body rear
G7	200-1414	1	Door
G8	200-1415	1	Front panel
G9	200-1416	1	Left panel
G10	200-1432	1	Right panel
G11	204-2643-1	1	Connector bracket
	390-2072	2	Body label
	390-2314	1	Orange decorative label



STEP-BY-STEP ASSEMBLY

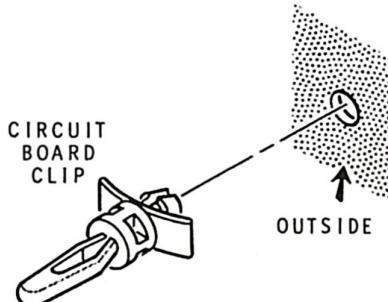
FRONT PANEL ASSEMBLY

Refer to Pictorial 14-1 (Illustration Booklet, Page 20) for the following steps.

- () Locate the front panel and position it with its inside surface up as shown in Detail 14-1A.
- () Locate eight of the circuit board clips you placed in water earlier, and dry them with a paper or cloth towel.
- () Refer to Detail 14-1B and install the circuit board clips in the eight indicated holes (at each end of the rectangular cutouts) from the outside of the front panel. Push on the outside of the clips until they snap into place. Position the slots of the clips as shown.
- () Refer to Detail 14-1C and install a 4-pin connector at the "Sonar TX (sonar transmitter) 7 through 10" rectangular slot in the front panel. Install the connector from the inside of the panel.

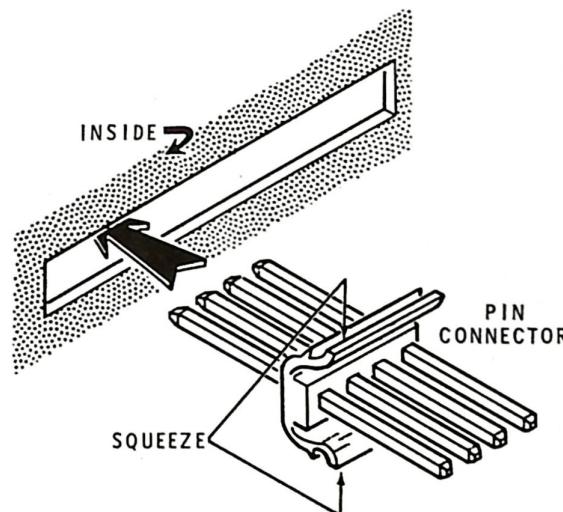
In the same manner, install pin connectors at the following locations in the front panel:

- () A 6-pin connector at "Sonar TX 1 through 6."



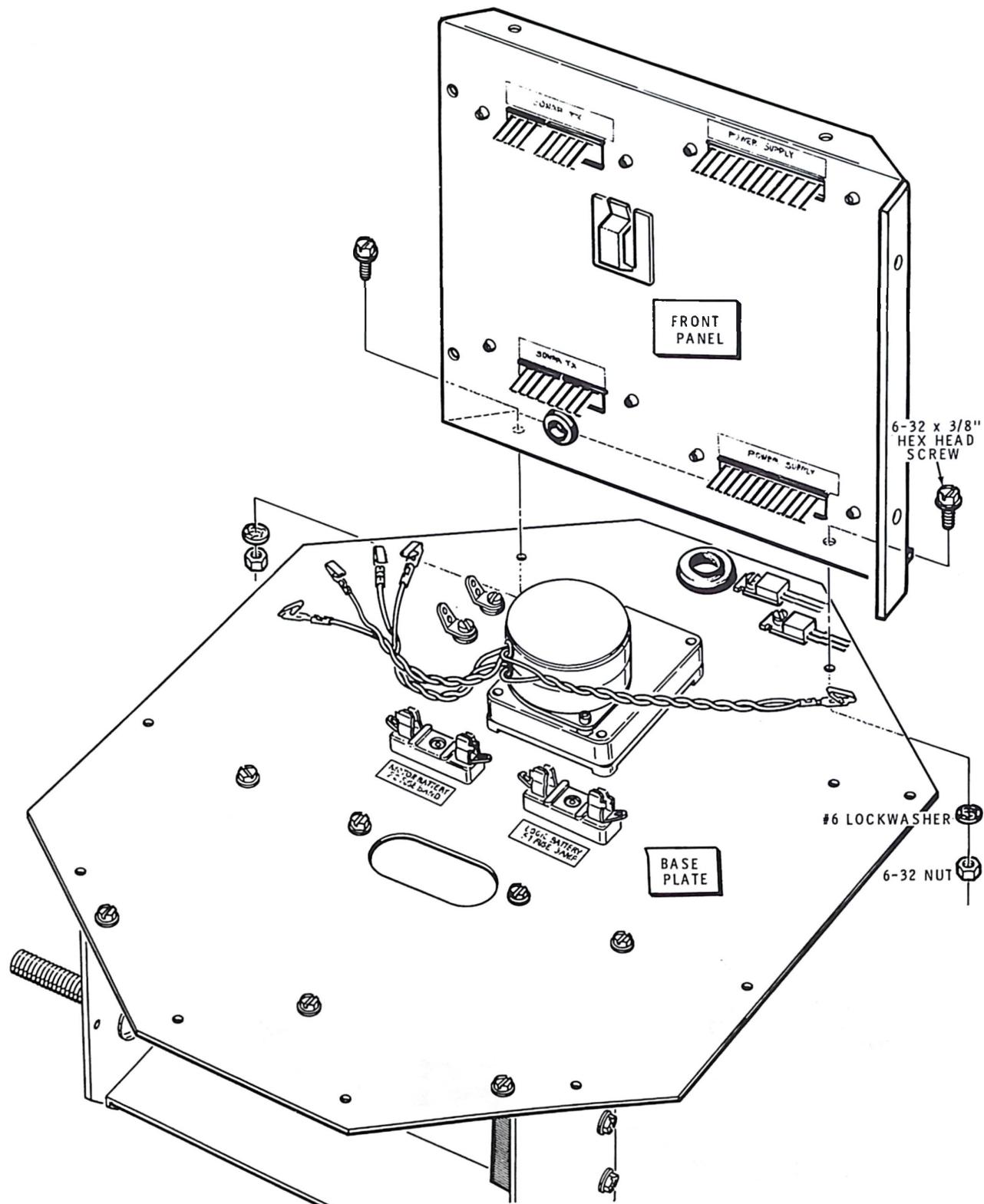
Detail 14-1B

- () Two 4-pin connectors at "Sonar TX 11 through 18."
 - () A 12-pin connector at "Power Supply 1 through 12."
 - () A 12-pin connector at "Power Supply 13 through 24."
 - () Peel the "Sonar TX 1 through 10" label from the label sheet and press it into place on the inside surface of the front panel. Align the label numbers with the pins of the pin connectors.
 - () In the same manner, install the other three labels on the front panel.
 - () Install the 5/8" O.D. rubber grommet into hole FC in the front panel.
- NOTE: Before you mount a cable clip, as in the next step, clean the metal surface with a window cleaner or ammonia, then dry the surface.
- () Peel the paper backing from a cable clip and press the clip onto the inside of the front panel, at the center, as shown in Detail 14-1A.



Detail 14-1C

() Refer to Detail 14-1D and loosely mount the front panel at its location on the base plate with 6-32 x 3/8" hex head hardware. You will tighten the hardware later.



Detail 14-1D

LEFT PANEL ASSEMBLY

Refer to Pictorial 14-2 (Illustration Booklet, Page 21) for the following steps.

- () Locate the left panel and position it with its inside surface up as shown.
- () Locate eight of the circuit board clips and dry them off.
- () Install the circuit board clips in the eight indicated holes (at each end of the rectangular slots) from the outside of the panel. Be sure to position the slots of the circuit board clips on the inside of the panel as shown.
- () Install a 12-pin connector at the "Arm Drive 1 through 12" rectangular slot in the left panel. Install the connector from the inside of the panel.

In the same manner, install pin connectors at the following locations in the left panel.

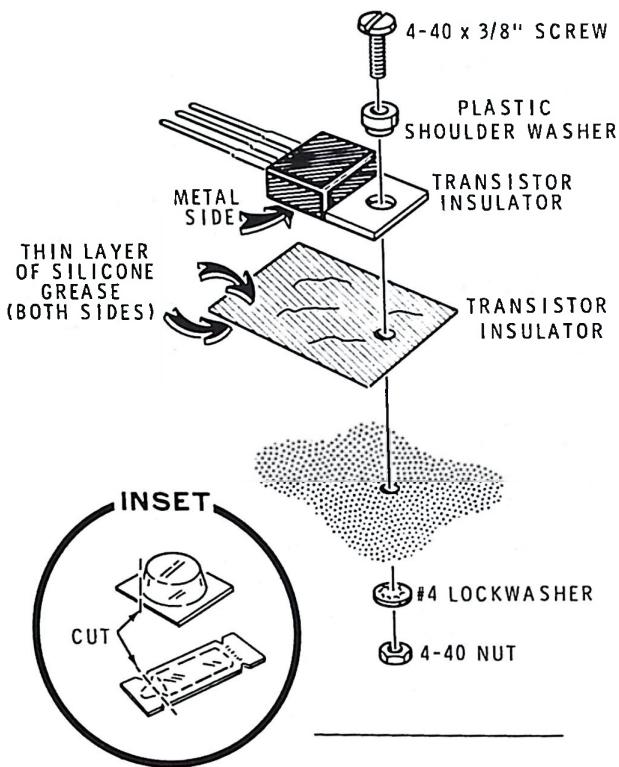
- () A 12-pin connector at "Arm Drive 13 through 24."

- () A 4-pin connector at "Arm Drive 25 through 28."
- () A 12-pin connector at "Arm Drive 29 through 40."
- () A 4-pin connector at "Arm Drive 41 through 43."
- () A 12-pin connector at "Main Drive 1 through 12."
- () A 12-pin connector at "Main Drive 13 through 24."
- () A 4-pin connector at "Main Drive 25 through 28."
- () Peel the "Arm Drive 1 through 12" label from the label sheet and press it into place at its location on the left panel. Carefully align the label numbers with the pins of the pin connector.
- () In the same manner, install the other labels at their proper locations on the left panel. Note that the "Arm Drive 41 through 43" label will leave the end pin unnumbered. This pin will be used for a single connector later.

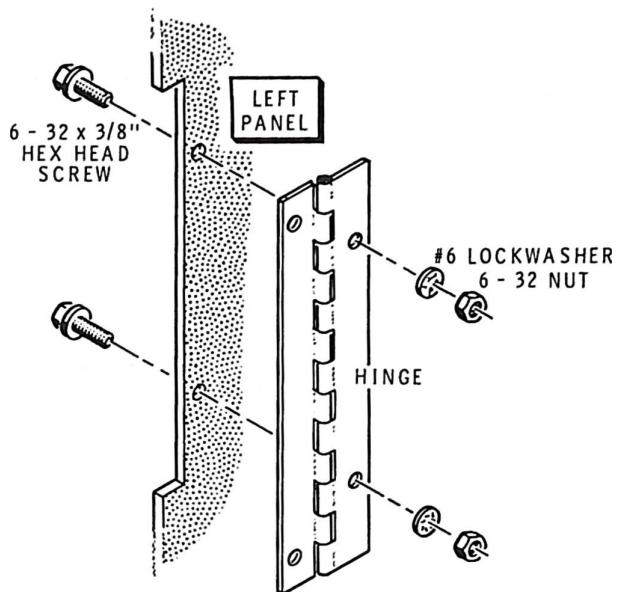
Refer to Pictorial 14-2 and Detail 14-2A for the following steps.

- () Apply a thin layer of silicone grease to both sides of a transistor insulator.
- () Position the transistor insulator at location Q703 on the **outside** of the left panel. Align their holes with each other.

- () Q703: Install an MJE5976 transistor (#417-857) on the insulator at location Q703 with 4-40 × 3/8" hardware and a plastic shoulder washer. Be sure the small diameter portion of the shoulder washer fits into the hole in the transistor.
- () Q706: In the same manner, install another MJE5976 transistor (#417-857) and a transistor insulator at location Q706 on the outside of the left panel.



Detail 14-2A

**Detail 14-2B**

Refer to Pictorial 14-2 for the following steps.

- () Refer to Detail 14-2B and install the hinge at its location on the inside of the left panel with 6-32 \times 3/8" hex head hardware. Be sure the hinge is positioned on the inside of the panel as shown in Pictorial 14-2.

NOTE: Before you mount a cable clip, as in the next step, clean the surface with a window cleaner or ammonia. Then dry the surface.

- () Peel the thin protective backing from a cable clip and press the clip into place on the left panel at location LA. Use the dimensions on Pictorial 14-2.

Set the left panel aside temporarily.

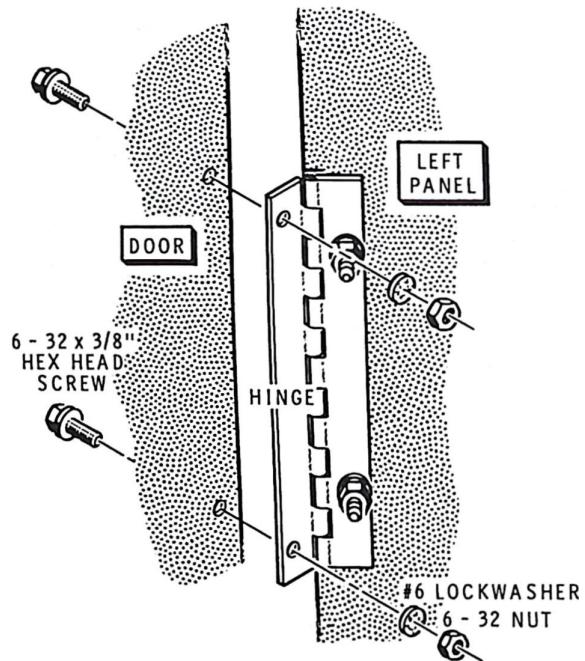
DOOR ASSEMBLY

Refer to Pictorial 14-3 (Illustration Booklet, Page 22) and position the door as shown for the following steps.

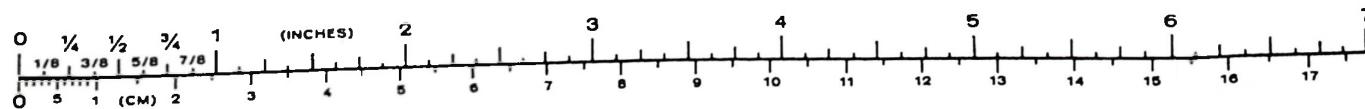
- () Locate the remaining four circuit board clips and dry them off. Install these clips at their indicated locations from the **outside** of the door.
- () Install a 4-pin connector from the **inside** of the door at the "Speech 13 through 16" location.
- () In the same manner, install 12-pin connectors at the three remaining rectangular cutouts in the door.

- () Peel the "Speech 13 through 16" label from the label sheet and press the label into place at its correct location on the **inside** of the door.
- () In the same manner, install the three other labels at their correct locations on the door.
- () Use the dimensions on Pictorial 14-3 and install a cable clip on the inside of the door at location DC. Clean the surface before you install the clip.
- () Refer to Detail 14-3A and fasten the door to the hinge that is already mounted on the left panel. Use 6-32 × 3/8" hex head hardware.

Set this assembly aside temporarily.



Detail 14-3A

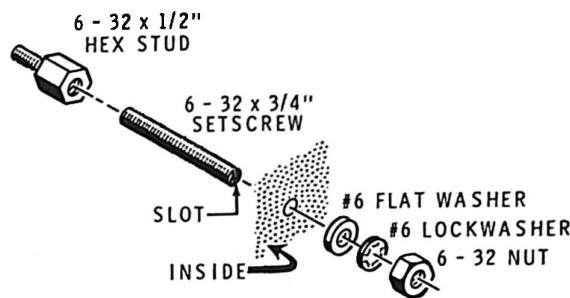


Heathkit®

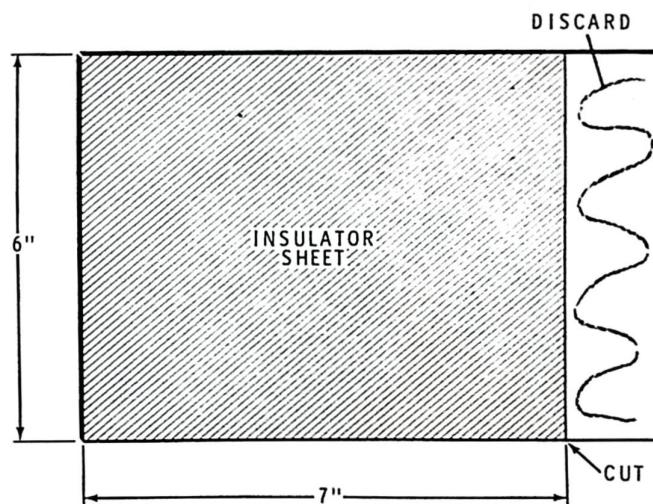
RIGHT PANEL ASSEMBLY

Refer to Pictorial 14-4 (Illustration Booklet, Page 23) for the following steps.

- () Position the right panel with its inside surface up.
- () Peel the "31 through 54" label from the label sheet and press it into place on the left edge of the right panel. Carefully align the label numbers so the top and bottom numbers are equally spaced from the top and bottom of the cutout.
- () In the same manner, press the "55 through 78" label on the right side of the right panel.
- () Install two 12-pin connectors in each of the vertical rectangular cutouts from the inside of the right panel.
- () Refer to Detail 14-4A and tightly thread a 6-32 \times 3/4" setscrew into a 6-32 \times 1/2" hex stud. Then install this assembly at hole RC in the right panel with a #6 flat washer, a #6 lock-washer, and a 6-32 nut. Be sure the hex stud is on the outside of the panel.
- () In the same manner, install 6-32 \times 1/2" hex studs at holes RD, RE, and RF in the right panel.
- () Refer to Detail 14-4B and cut a 6" \times 8" insulator sheet as shown.
- () Remove the protective backing from this insulator sheet and press the insulator sheet into place on the **inside** of the right panel. Center the insulator sheet (from side-to-side) between the pin connectors and keep its bottom edge even with the top edge of the horizontal rectangular cutout in the panel.
- () In the same manner, cut another 6" \times 8" insulator sheet to 6" \times 7", and then install it on the **outside** of the right panel. Position it the same as the insulator sheet on the inside of the panel.
- () Peel the CPU label from the label sheet and press it into place at the top center on the **inside** of the right panel.



Detail 14-4A



Detail 14-4B

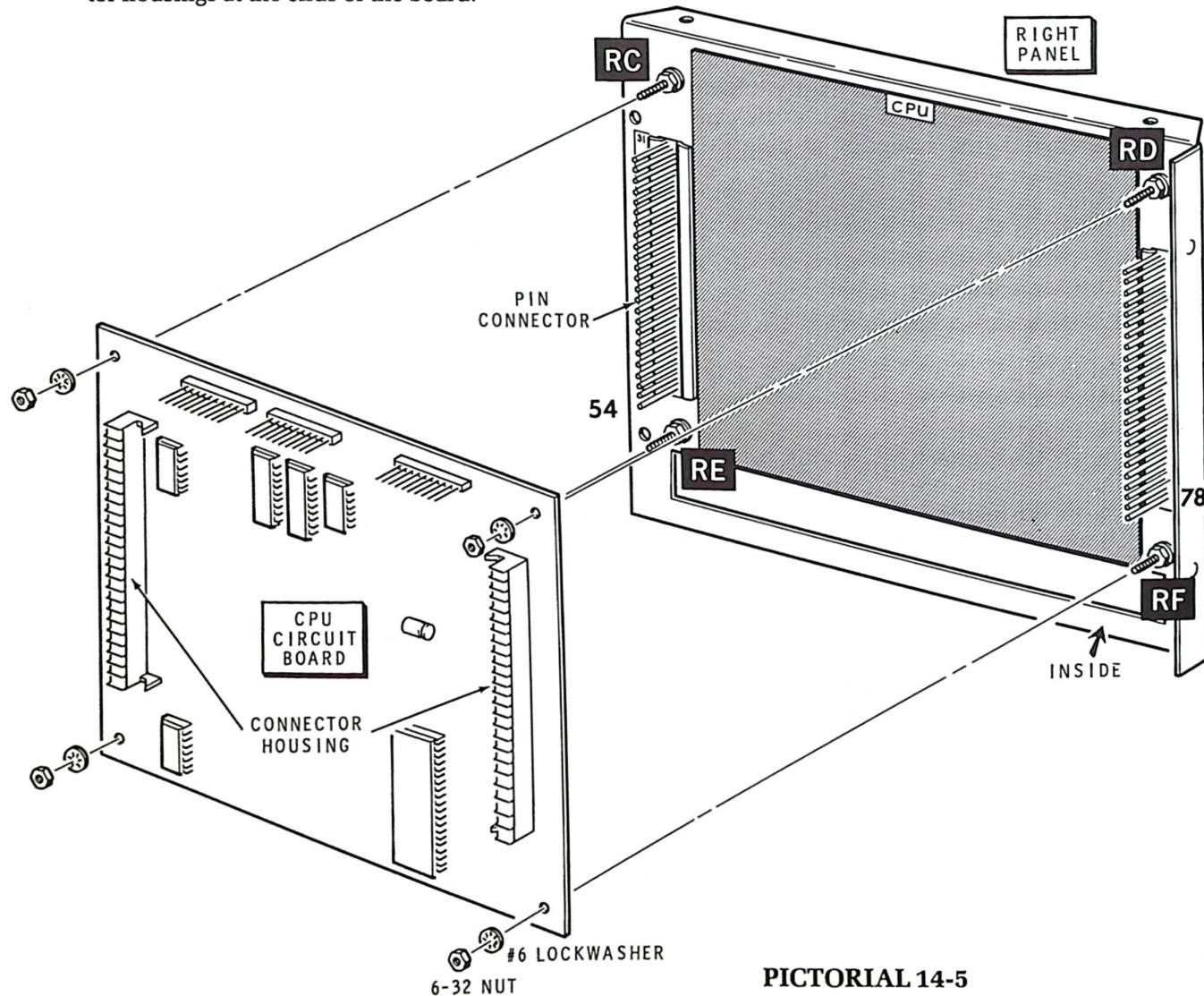
NOTE: If you have an Accessory ROM, such as the Model ET-18-4, refer to the Accessory Manual and install the ROM and position the jumper as directed. Then return to this page and install the CPU circuit board.

Refer to Pictorial 14-5 for the following steps.

Use the following procedure to mount the CPU circuit board on the inside of the right panel. Read all five of these steps completely through before you begin to mount the circuit board.

- () 1. Check the connector pins on the panel to be sure they are straight and evenly spaced.
- () 2. Handle the circuit board only by the connector housings at the ends of the board.

- () 3. Start the bottom connector holes (54 and 78) of the circuit board onto the corresponding connector pins on the inside of the right panel.
- () 4. Press evenly along the connector housings so the remaining pins enter their holes in the circuit board. Be sure that no pins bend as you press on the housing.
- () 5. Once the four corner holes meet the nuts that secure mounting studs at RC, RD, RE, and RF, see that the board is parallel with the panel and is not bowed in the middle.
- () 6. Secure the board to the mounting studs with #6 lockwashers and 6-32 nuts as shown.



PICTORIAL 14-5

Heathkit

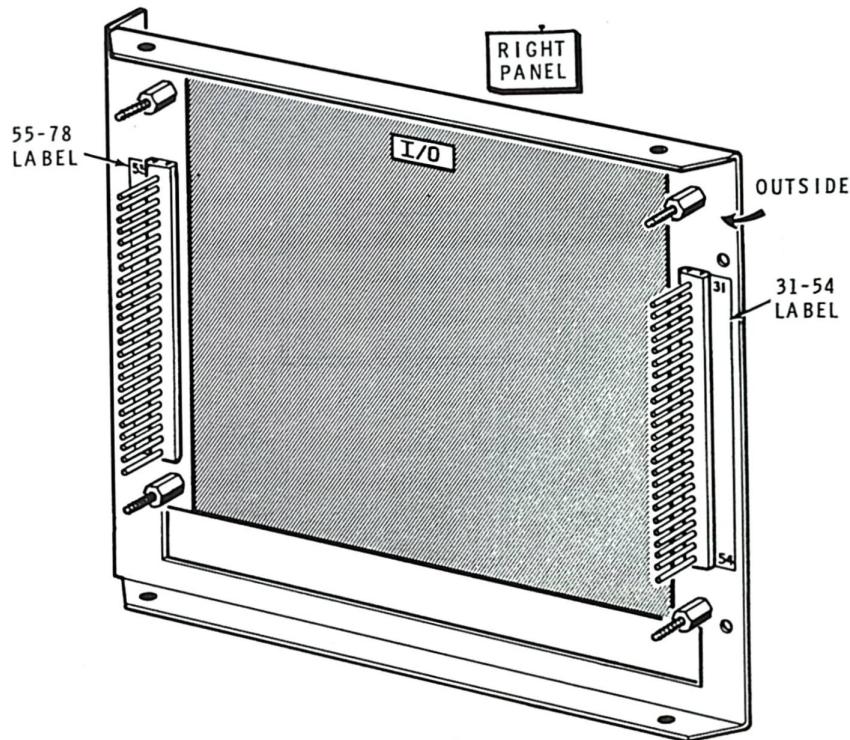
Refer to Pictorial 14-6 for the following steps.

- () Turn the right panel over so its outside surface is up.
- () Peel the "I/O" label from the label sheet and press it into place at the top center of the panel. Position the label as high as possible on the panel.

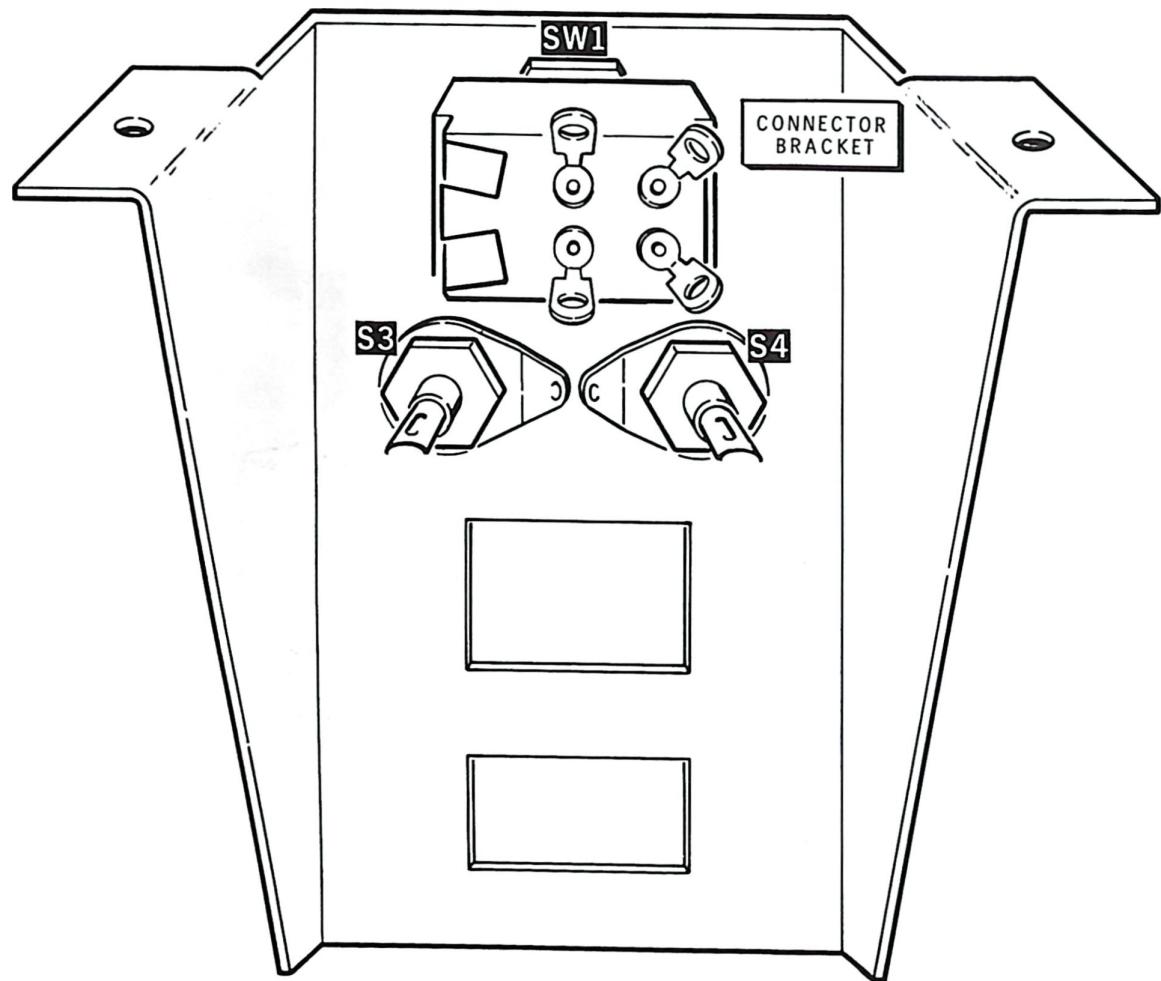
() Press the "31 through 54" label into place on the right edge of the panel. Align the label numbers with the pins of the pin connectors.

() In the same manner, press the "55 through 78" label on the left side of the panel.

Set the right panel aside temporarily.



PICTORIAL 14-6

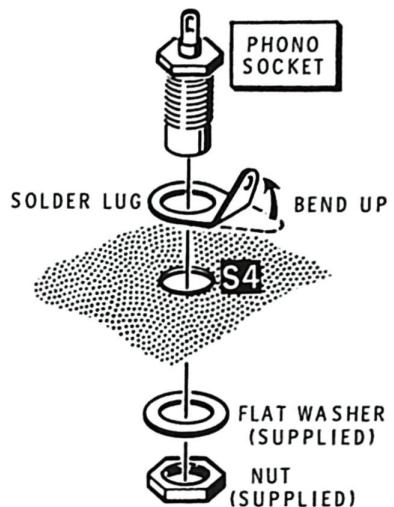


PICTORIAL 14-7

CONNECTOR BRACKET ASSEMBLY

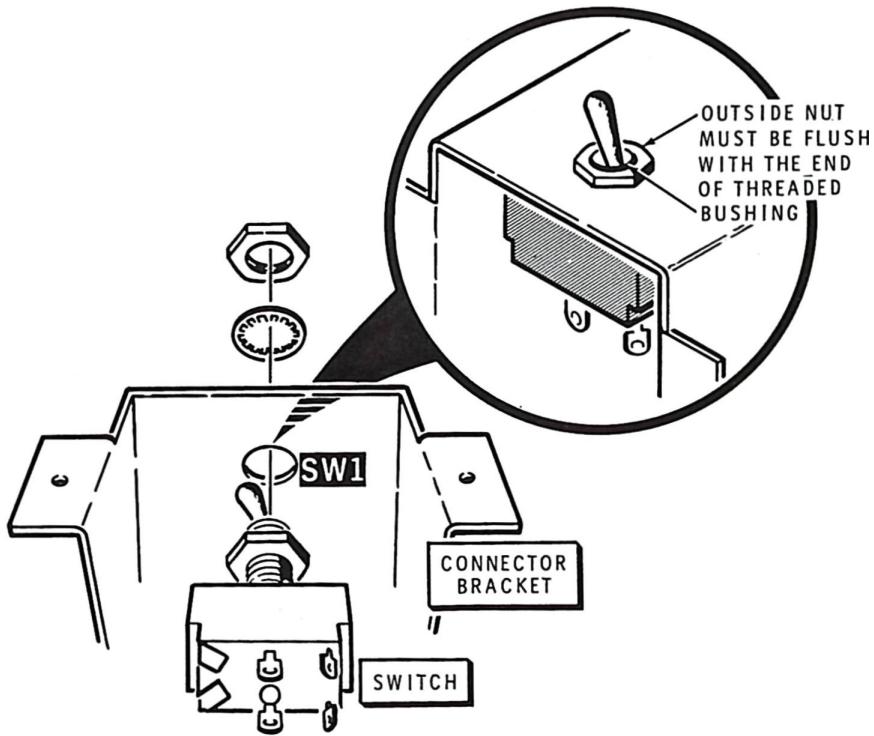
Refer to Pictorial 14-7 for the following steps.

- () S4: Refer to Detail 14-7A and install a phono socket at location S4 on the connector bracket. Use the nut and solder lug supplied with the socket. Position and bend the solder lug up as shown.
- () S3: In the same manner, install a phono socket at S3 on the connector bracket.
- () SW1: Refer to Detail 14-7B and install the switch at SW1 in the connector bracket. Use the hardware provided with the switch. Position the switch so its lugs are located as shown. Adjust the nuts of the switch so the outside nut is flush with the end of the threaded switch bushing.



Detail 14-7A

Set the connector bracket aside temporarily.



Detail 14-7B

INITIAL HARNESS INSTALLATION

Refer to Pictorial 14-8 (Illustration Booklet, Page 24) for the following steps.

- () Loosely mount the left panel (with the door attached) to the base plate. Use two 6-32 × 3/8" hex head screws, two #6 lockwashers, and two 6-32 nuts. Do not tighten the hardware.
- () Locate the main harness and shape it's break-outs as shown in Detail 14-8A. You can identify the breakouts by the numbers on the plugs.
- () At breakout #5, separate the four short wires (red, orange, and two blue) from the rest of the wires.
- () Pass plugs P1 and P2, and all of the wires except the four short ones, down through hole BD in

the base plate. Position these wires and plugs into the battery compartment as shown in Pictorial 14-8.

- () Identify the "Sense 1-12" plug at breakout #3. Position the plug so its numbers match those on the door at "Sense 1-12"; then press the plug onto the pins.
- () In the same manner, identify and connect the "Sense 13-24", "Speech 1-12", and "Speech 13-16" plugs onto their pins.
- () Near breakout #3, insert the cable into cable clip DC. Then position the wires from all break-outs on the door flat against the door.
- () Position the cable against the left panel as shown in Pictorial 14-8 and insert it into cable clip LA.

CONNECTOR BRACKET WIRING

Refer to Pictorial 14-9 (Illustration Booklet, Page 26) for the following steps.

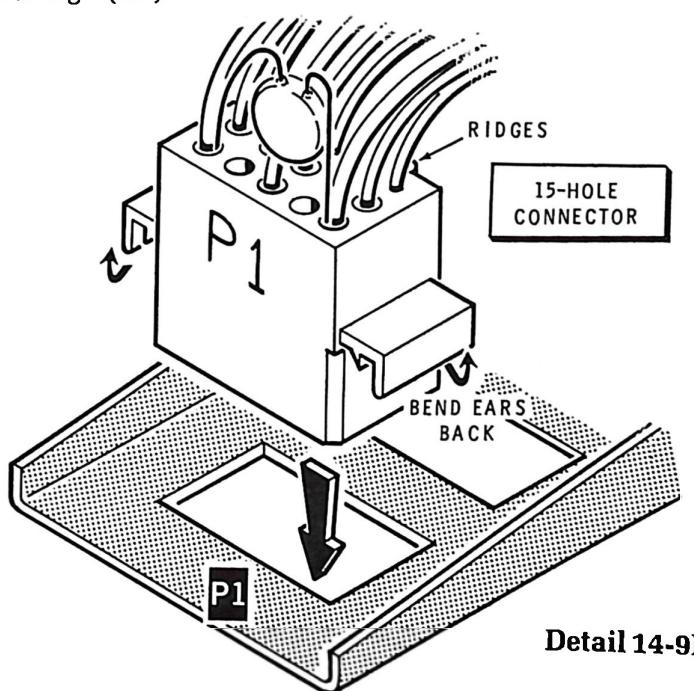
- () Separate the wires with six push-on connectors that come down from hole BD and position them to one side.
- () Refer to Detail 14-9A (Illustration Booklet, Page 27) and position the connector bracket as shown. Then make the following connections.
- () Locate the longer of the two shielded cables (one with a white tag). Connect its inner lead to phono socket S3 lug 1 (S-1) and its shield lead to lug 2 (NS).
- () Connect the remaining shielded cable to phono socket S4: inner lead to lug 1 (S-1) and shield lead to lug 2 (NS).
- () Connect the green wire to switch SW1 lug 4 (S-1).
- () Connect the small blue wire to switch SW1 lug 2 (S-1).
- () Twist the orange and large blue wires together to form a twisted pair.
- () Connect the orange wire to SW1 lug 3 (NS) and connect the blue wire to lug 1 (NS).

- () Refer to Detail 14-9B and mount the 15-hole connector at P1 from the inside of the connector bracket. Position the connector so its ridges are as shown in Pictorial 14-9 and press on the shell until the connector snaps into place.

Refer to Detail 14-9C (Illustration Booklet, Page 27) for the following steps.

- () Connect the black wire from hole 15 of P1 to phono socket S4 lug 2 (NS).
- () Install the 12-hole connector from inside the connector bracket at P2. Position the connector so its ridges are as shown.
- () Connect the free lead of capacitor C1 to phono socket S4 lug 2 (S-3).
- () Connect the free lead of capacitor C2 to phono socket S3 lug 2 (NS).
- () Connect the black wire from hole 1 of plug P2 to phono socket S3 lug 2 (S-3).
- () Connect the orange wire from P2 hole 2 to switch SW1 lug 3 (S-2).
- () Connect the blue wire from P2 hole 6 to switch SW1 lug 1 (S-2).

This completes the wiring of the connector bracket.



TORSO WIRING

Refer to Pictorial 14-10 (Illustration Booklet, Page 28) for the following steps.

Connect the four wires from breakout #5 to fuseholders F1 and F2 as follows:

- () Either blue wire to F2 lug 1 (S-1) and the other blue wire to F2 lug 2 (S-1).
- () Orange wire to F1 lug 1 (S-1) and the red wire to F1 Lug 2 (S-1).
- () At breakout #14, locate the long brown, red, and orange wires that have connectors attached. Route these wires between the steering motor and the front panel. Then pass the connectors on the ends of the wires through grommet FC in the front panel.
- () Connect the gray wire from breakout #14 to solder lug BC (S-1) and connect the violet wire to solder lug BB (S-1). Route these wires between the steering motor and the front panel.
- () At breakout #11, locate the shielded cable and the wires with two #6 solder lugs attached.

Refer to the inset drawing and mount the two solder lugs at LB with a 6-32 × 3/8" hex head screw and a 6-32 nut. Be sure there are no wires or cables pinched between the left panel and the front panel. The shielded cable will be connected later.

- () Secure the front panel to the left panel with a 6-32 × 3/8" hex head screw, #6 lockwasher, and 6-32 nut in the upper hole as shown.
- () Tighten the hardware that secures the left panel and front panel to the base plate.
- () Route the shielded cable from breakout #11 through grommet FC.
- () Push the connector from breakout #8 onto the pins at "Main Drive 13-20", and from breakout #7 onto the pins at "Main Drive 21-28". Be sure the label numbers on the plugs mate with the numbers at the pins.
- () In the same manner, install the connectors from breakouts #9 and #10 onto their corresponding pins at "Arm Drive 13-24" and "Arm Drive 1-12".

Refer to Pictorial 14-11 (Illustration Booklet, Page 29) for the following steps.

- () Twist together the black and white leads from the lower hole of the steering motor. Then locate the "Main Drive 1-12" plug from breakout #11. Insert the spring connector on the black lead into hole 1 and insert the white lead into hole 2, as shown in inset drawing #1.
- () In the same manner, twist together the black and white leads from the upper hole of the steering motor and insert their spring connectors into the "Main Drive 1-12" plug, black to hole 3 and white to hole 4.
- () Install the "Main Drive 1-12" plug on the corresponding pins on the left panel.
- () At breakout #12, install the "Sonar TX 11-18" and "Sonar TX 1-12" plugs into their corresponding pins on the front panel.
- () Install the "Power Supply 1-12" plug on its pins and insert the cable in the cable clip.
- () At breakout #14, locate the "Power Supply 13-24" plug. Then refer to inset drawing #2 and insert the spring connector on the end of the two yellow wires (from the steering motor) into hole 20.
- () Install the "Power Supply 13-24" plug on its pins on the front panel.
- () Refer again to Pictorial 14-11 and position plugs P401 and P402 as shown. Then position the remainder of the cable harness above breakout #15 over the top of the front panel.

NOTE: At this point, there should be no unconnected wires or plugs except the fifteen 10-pin plugs (P401-P403 and P306-P317) on the top of the base plate or inside the panels. Do not install fuses F1 or F2 until you are instructed to do so.

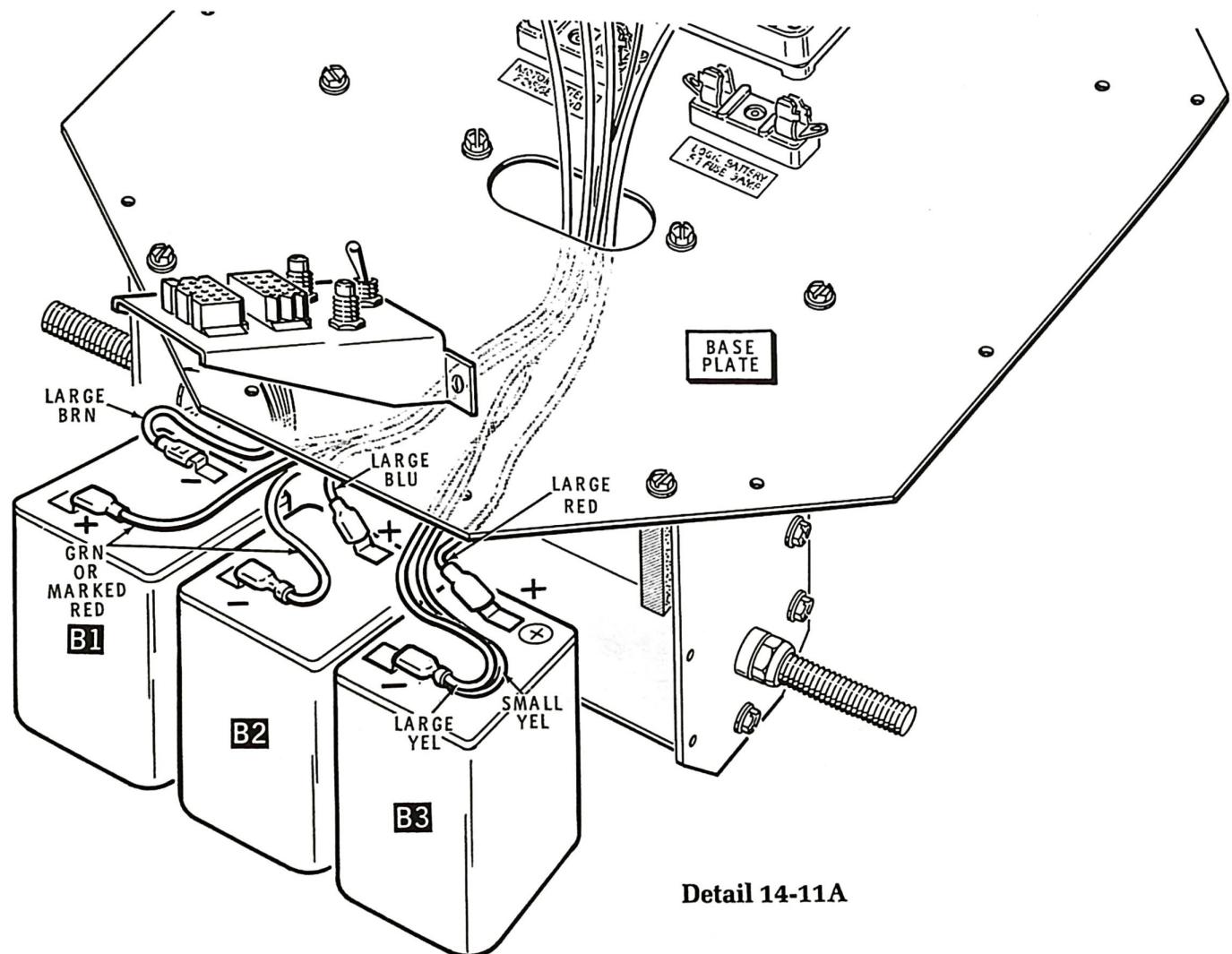
Refer to Detail 14-11A for the following steps.

WARNING: The batteries you will install in the following steps may have a considerable charge on them. Although they are only 6-volt batteries and can not give you an electrical shock, they are of a high current type and can cause injury from sparks or even a burn if both their terminals come in contact with a metal object. If you wear a ring or a watch with a metal band, be sure it does not touch the battery terminals. Also do not allow the battery terminals to touch the metal parts of the kit. After the batteries are connected and installed, it is safe to continue with the assembly without fear of shorting the batteries. Even the voltage-carrying wires are protected by the plastic plug shells.

- () Be sure the switch (SW1) on the connector bracket is in its OFF (left) position. Then position the connector bracket as shown.

Connect the wires from under the base plate (BO #5) to the batteries as follows:

- () Brown wire to battery #1 negative (-) lug.
- () Blue wire to battery #2 positive (+) lug.
- () Red wire to battery #3 positive (+) lug.
- () Large and small yellow wires to battery #3 negative (-) lug.
- () Either green or marked red wire to battery #1 positive (+) lug, and the other green or marked red wire to battery #2 negative (-) lug.



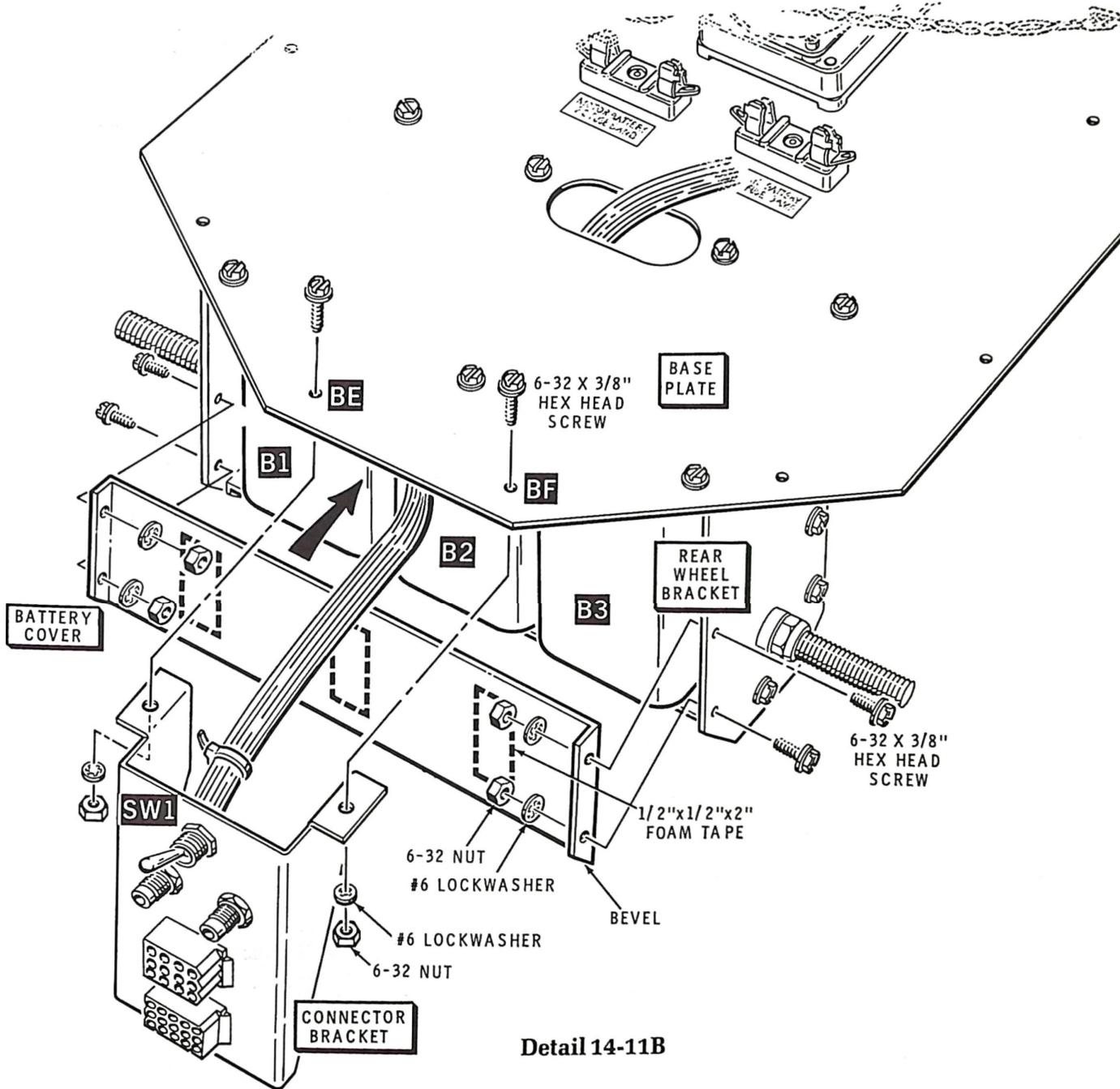
Detail 14-11A

Refer to Detail 14-11B for the following steps.

- () B1, B2, B3: Carefully position all three batteries into the battery holder.
- () Remove the backing from three $1/2'' \times 1/2'' \times 2''$ pieces of foam tape and press them in place on the inside of the battery cover as shown. Center each tape over one of the batteries.

NOTE: When you install the battery cover in the next step, be sure the beveled ends of the battery holder are at the bottom.

- () Mount the battery cover in place between the ends of the rear wheel bracket with $6-32 \times 3/8''$ hex head hardware.
- () Install the connector bracket to the bottom of the base plate with $6-32 \times 3/8''$ hex head hardware at holes BE and BF.



Detail 14-11B

Refer to Pictorial 14-12 (Illustration Booklet, Page 30) for the following steps.

- () Hold the right panel (with the CPU board installed) near the right side of the torso. Then push plugs P401, P402, and P403 onto their connector pins on the CPU board.
- () Refer to Detail 14-12A and secure the right panel to the front panel and to the bottom plate with 6-32 × 3/8" screws and #6 lockwashers.
- () Pass plugs P306 through P317 from inside the torso out through the cutout in the right panel.

In the next two steps, you will install plugs P306 through P317 onto connectors on the I/O board. Be sure you install each plug on its correct connector.

- () Hold the I/O circuit board near the plugs and push plug P317 onto its connector pins on the I/O board. Be sure the labeled side of the plug is upward and that the pins enter the correct holes of the plug.
- () In the same manner, install the remaining plugs (P316 through P306, in that order) to their connector pins on the I/O board.
- () Refer again to Detail 14-12A and carefully push the connectors at the sides of the I/O circuit board onto the connector pins on the outside of the right panel. Be sure all pins enter their holes in the circuit board.
- () Secure the circuit board with #6 lockwashers and 6-32 nuts at locations RC, RD, RE, and RF.

MAIN DRIVE WIRING

Refer to Pictorial 14-13 (Illustration Booklet, Page 31) for the following steps.

- () Twist together the red and black leads coming from main drive motor A1 and position them against the motor as shown.
- () Connect the red lead from main drive motor A1 to terminal strip AA lug 5 (NS).
- () Connect the black lead from main drive motor A1 to terminal strip AA lug 4 (NS).
- () Pass the brown, red, and orange wires (with plugs) and the 2-conductor shielded cable coming from rubber grommet FC in the front panel down through rubber grommet BA in the base plate.
- () Refer to inset drawing #1 on Pictorial 14-3 and push the two plugs on the ends of the brown, red, and orange wires through a 7" length of large clear sleeving.
- () Also push the free end of the 2-wire shielded cable through this large clear sleeving.
- () Loop these cables and the sleeving back and around the shaft of steering motor A2 in the direction shown. This loop around the steering motor shaft provides the necessary slack so the cables will not be damaged when the Robot turns. Position the wires and cables so they will not rub on any hardware on the base plate.

Connect the wires from the 2-wire shielded cable to terminal strip AA as follows:

- () Cut the shield wire to 3/4", then connect it to lug 3 (NS).
- () Clear wire to lug 2 (NS).
- () Black wire to lug 1 (NS).

NOTE: In the next two steps, bend the leads of the choke toward the notches at the ends of the choke

form. Then when you mount a choke, be sure its leads do not touch leads on other terminal strip lugs.

() L2: Cut both leads of a 22 μ H choke (#45-62) to 1". Connect the choke to terminal strip AA between lugs 1 (S-2) and 4 (NS).

() L1: Cut both leads of the other 22 μ H choke (#45-62) to 1/2" and connect the choke to terminal strip AA between lugs 2 (S-2) and 5 (NS).

When you mount the capacitors in the next three steps, be sure their leads do not touch leads on other lugs of the terminal strip.

() C4: Cut both leads of a 200 pF ceramic capacitor to 3/4". Then connect this capacitor to terminal strip AA between lugs 5 (NS) and 3 (NS).

() C5: Cut both leads of another 200 pF ceramic capacitor to 1/2". Then connect this capacitor between lugs 4 (NS) and 3 (S-3).

() C6: Cut both leads of a .22 μ F mylar capacitor to 1/2". Then connect this capacitor between lugs 4 (S-4) and 5 (S-4).

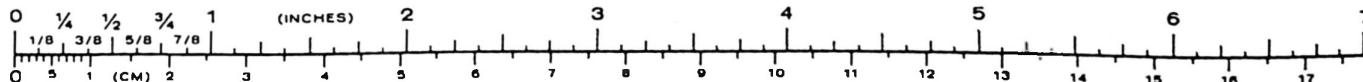
() Push the connectors on the end of the brown, red, and orange wires onto transducer VS1 with the red conductor of plug PVS1 going to pin 1 of VS1 and the orange conductor of plug PVS2 going to pin 4.

() Refer to inset drawing #2 and secure the wires and cable and the end of the large sleeving to the main drive motor and top of the gear box with a large cable tie. Pull the cable tie very tight so the wires and cable and large sleeving will not move. Cut off the excess cable tie.

() Install a small cable tie around these wires and cable through the grommet in the base plate. Cut off the excess cable tie.

() Rotate the main drive assembly while you hold the base plate. Check to be sure that no wires or cables bind, or rub on hardware under the base plate. Reposition any wires that bind.

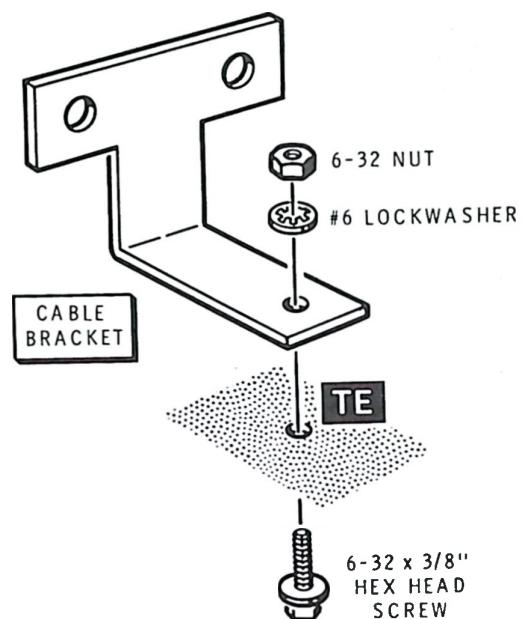
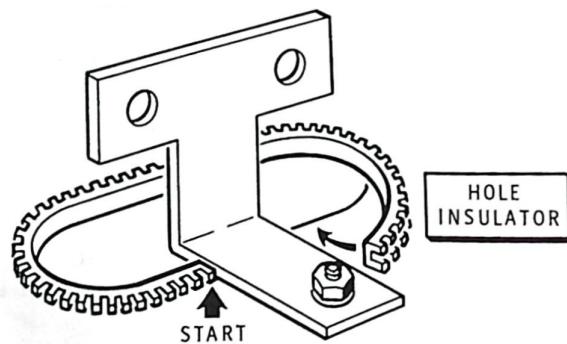
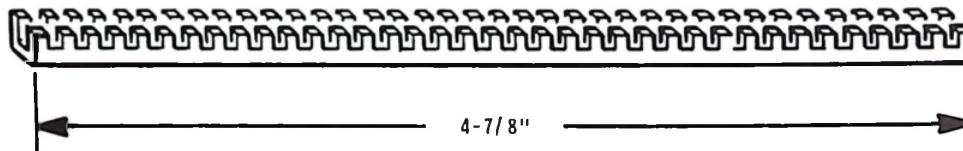
Set the base and torso assembly aside temporarily.



TOP PLATE ASSEMBLY

Refer to Pictorial 14-14 (Illustration Booklet, Page 31) for the following steps.

- () Install a 3/8" O.D. rubber grommet in hole TA in the top plate.
- () In the same manner, install rubber grommets in holes TB, TC, and TD in the top plate.
- () Refer to Detail 14-14A and mount the cable bracket at location TE on the **bottom** side of the top plate. Use 6-32 × 3/8" hex head hardware.
- () Refer to Detail 14-14B and cut a 4-7/8" length from the hole insulator.
- () Refer to Detail 14-14B and install this hole insulator in hole TF in the top plate. Start with one end against the cable bracket and work the hole insulator over the edge of the hole until the insulator is completely installed.

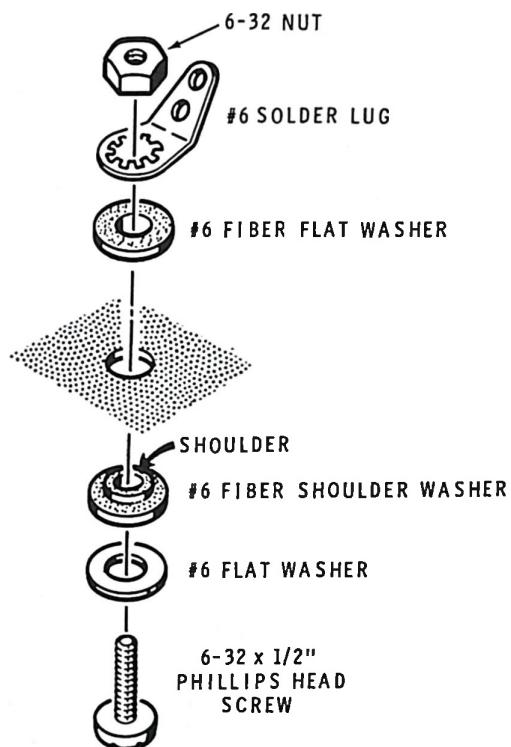
**Detail 14-14A****Detail 14-14B**

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() Refer to Detail 14-14C and install a #6 solder lug at location TG on the bottom of the top plate. Use a #6 fiber shoulder washer, a #6 fiber flat washer, a #6 flat washer, a 6-32 x 1/2" phillips head screw, and a 6-32 nut.

() In the same manner, install a #6 solder lug at location TH on the top plate.

Set the top panel aside temporarily.



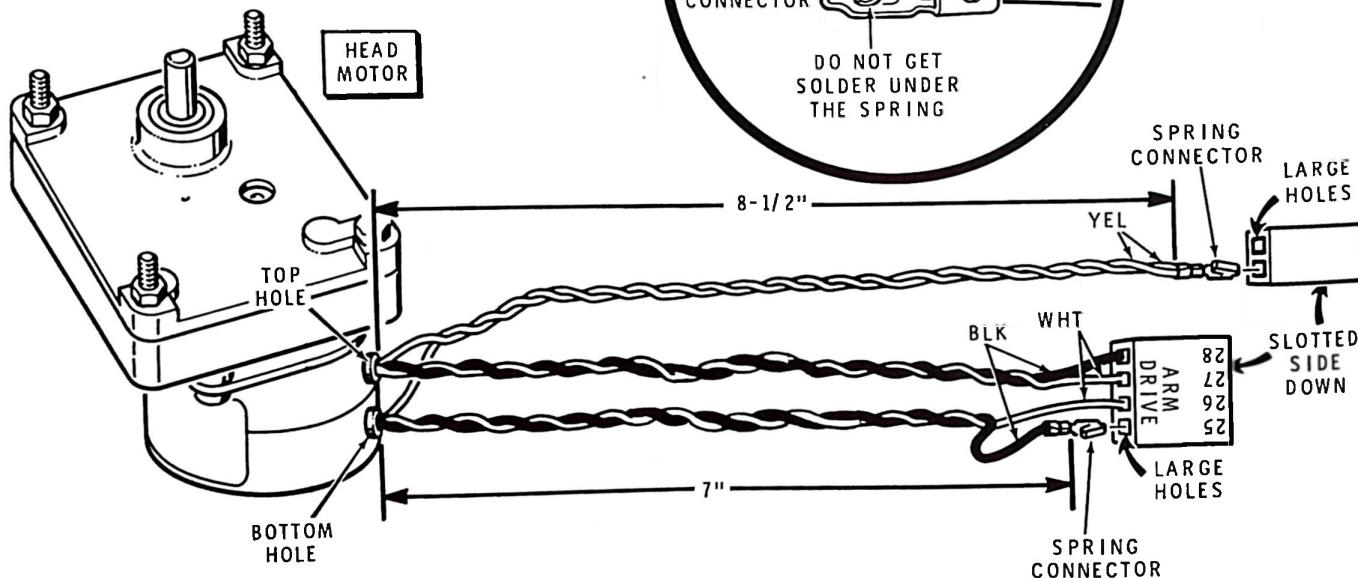
Detail 14-14C

Refer to Detail 14-14D for the following steps.

- () Locate the head motor (#420-646) and position it as shown.
- () Cut the six leads of the motor to the indicated lengths and then remove $3/16"$ of insulation from each lead. Measure the lead lengths from where the leads come out of the holes in the motor.
- () Twist together the black and white leads coming from the top hole in the motor and install a spring connector on each lead, as shown in the inset drawing on Detail 14-14D.
- () In the same manner, twist together the black and white leads from the bottom hole in the motor and install a spring connector on each lead.
- () Install the "Arm Drive 25 through 28" label on a large 4-hole connector shell.

Push the spring connector on the motor wires into this connector shell as follows:

- () Black lead from the bottom motor hole into hole 25.

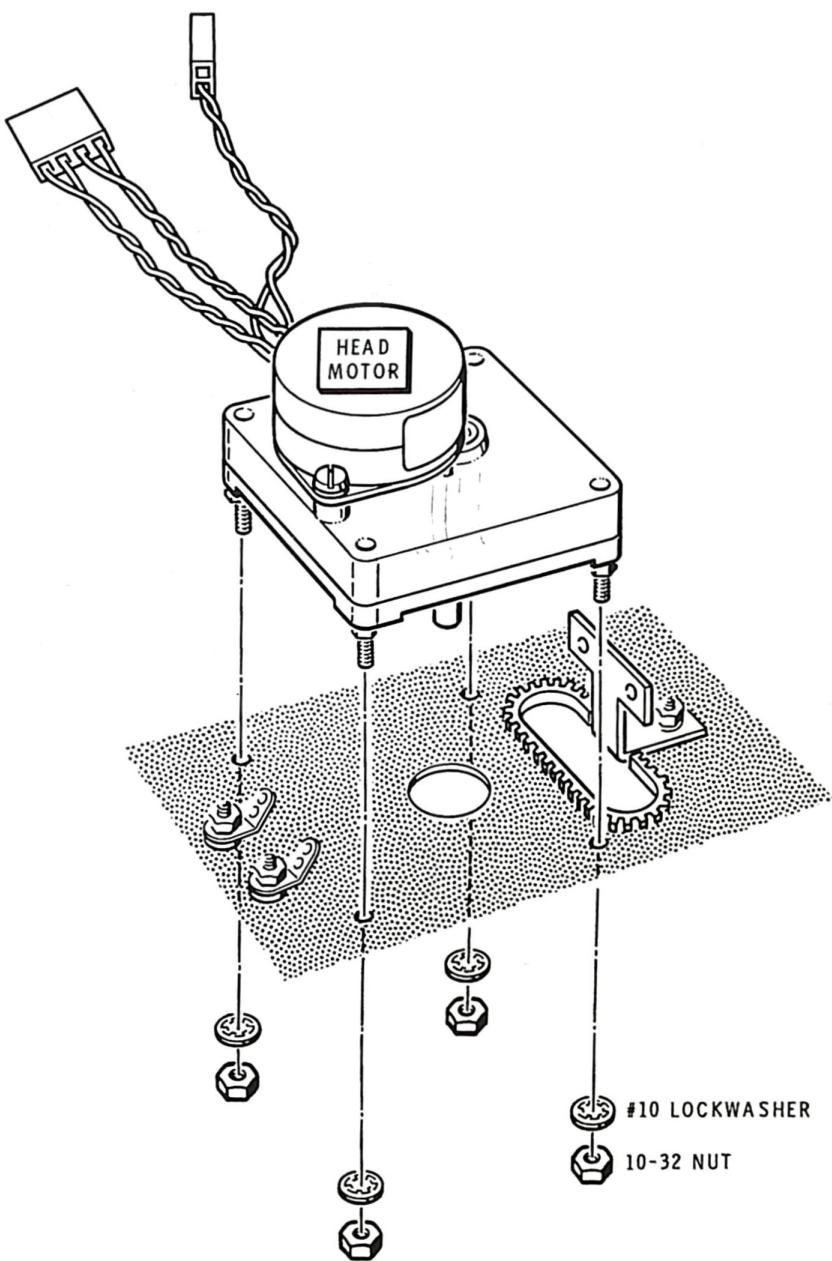


Detail 14-14D

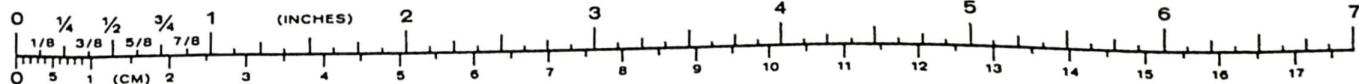
- () White lead from the bottom motor hole into hole 26.
- () White lead from the top motor hole into hole 27.
- () Black lead from the top motor hole into hole 28.
- () Remove an extra $1/16"$ of insulation from the two yellow leads. Twist these leads together and install a single spring connector. Place the wires in the connector so the insulation is just outside the end tabs.
- () Locate a large 2-hole connector shell and position it with its slotted side down, and push the connector on the two yellow motor leads into the indicated hole in the connector shell. This connector shell will not be labeled.

() A3: Refer to Detail 14-14E and mount the head motor on the bottom side of the top plate with #10 lockwashers and 10-32 nuts.

() Set the top plate aside.



Detail 14-14E



Refer to Pictorial 14-15 (Illustration Booklet, Page 32) for the following steps.

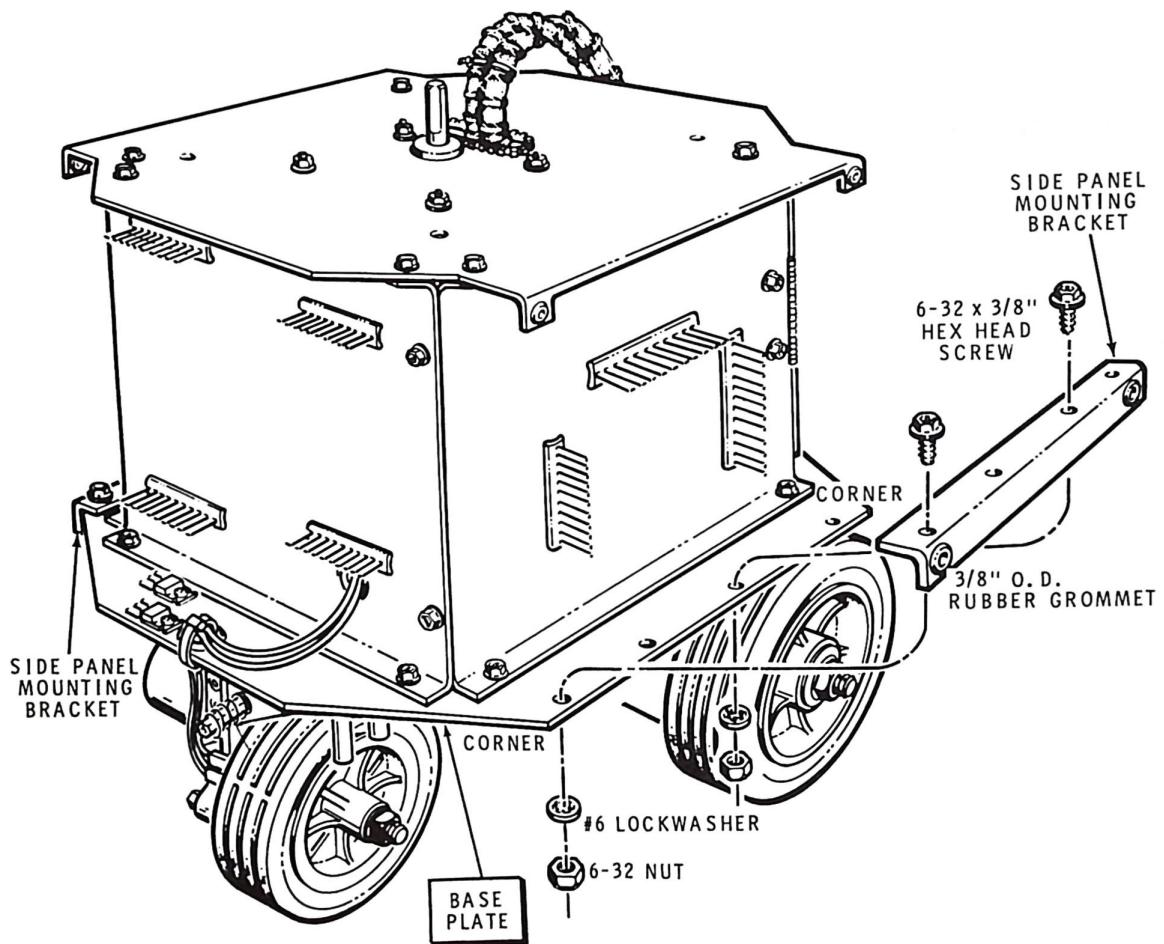
- () Locate the arm cable assembly (#134-1215) and press an "Arm Drive 29 through 43" label onto the smooth side of its long, flat, 15-pin connector (not the slotted side). The "43" on the label should be at the violet wire end of the connector.
- () At the other end of the cable, press a "P1501" label onto either side of the large 15-pin connector shell.
- () Push the "Arm Drive 29 through 43" plug onto its connector pins on the left panel. **Be sure to align the corresponding numbers on both labels with each other.** Four pins to the right of the plug, and the unnumbered pin to the left of the plug will be used later.
- () Position the arm cable assembly over to breakout #15. Then install a cable tie around both harnesses and the two wires at breakout #15.
- () Separate the orange and yellow conductors from the harness above the cable tie. Then twist these wires together to form a twisted pair.
- () Position the top panel as shown in inset drawing #1. Route the orange and yellow wires between the head motor and the top panel. Then connect the orange conductor to solder lug TG (S-1) and the yellow conductor to solder lug TH (S-1).
- () Position the top panel on the top edges of the left and front panels as shown in Pictorial 14-15.
- () Push the "Arm Drive 25 through 28" plug coming from head motor A3 onto its pin connector on the left panel.
- () Push the connector of the 2-hole plug (with two yellow wires) onto its pin connector next to pin 43 of the "Arm Drive 29 through 43" plug. Be sure the connector of the two wires is on the pin and the open connector hole to the left.
- () Refer again to Pictorial 14-15 and pass all the connectors on the free end of the main harness and arm cable assembly, as well as the large yellow and black wires, up through hole TF in the top plate.
- () Slit the 3" length of heat-shrink sleeving open lengthwise with scissors or a knife.
- () Wrap the sleeving around the cables and wire going through hole TF and place a cable clamp over the sleeving as shown in inset drawing #2.
- () Set the top plate on the upper edges of the side panels and position the sleeving and cable clamp so the clamp is even with the clamp bracket. Leave about 1/2" of sleeving below the cable clamp.
- () Secure the cable clamp to the clamp bracket with a 6-32 × 1/2" phillips head screw, #6 D washer, #6 lockwasher, and 6-32 nut.
- () Refer to Detail 14-15A (Illustration Booklet, Page 33) and secure the top plate to the top edges of the front, left, and right panels with 6-32 × 3/8" hex head hardware. Also tighten the hardware that secures the panels to the base plate.
- () Install a small cable tie around the cables and wires, 2" above the top plate. Cut off the excess length of cable tie.
- () Install another small cable tie over the slit sleeving about 1/2" from its top. Cut off the excess cable tie.
- () Close the door and secure it with two 6-32 × 3/8" hex head screws.

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Refer to Pictorial 14-16 (Illustration Booklet, Page 34) for the following steps.

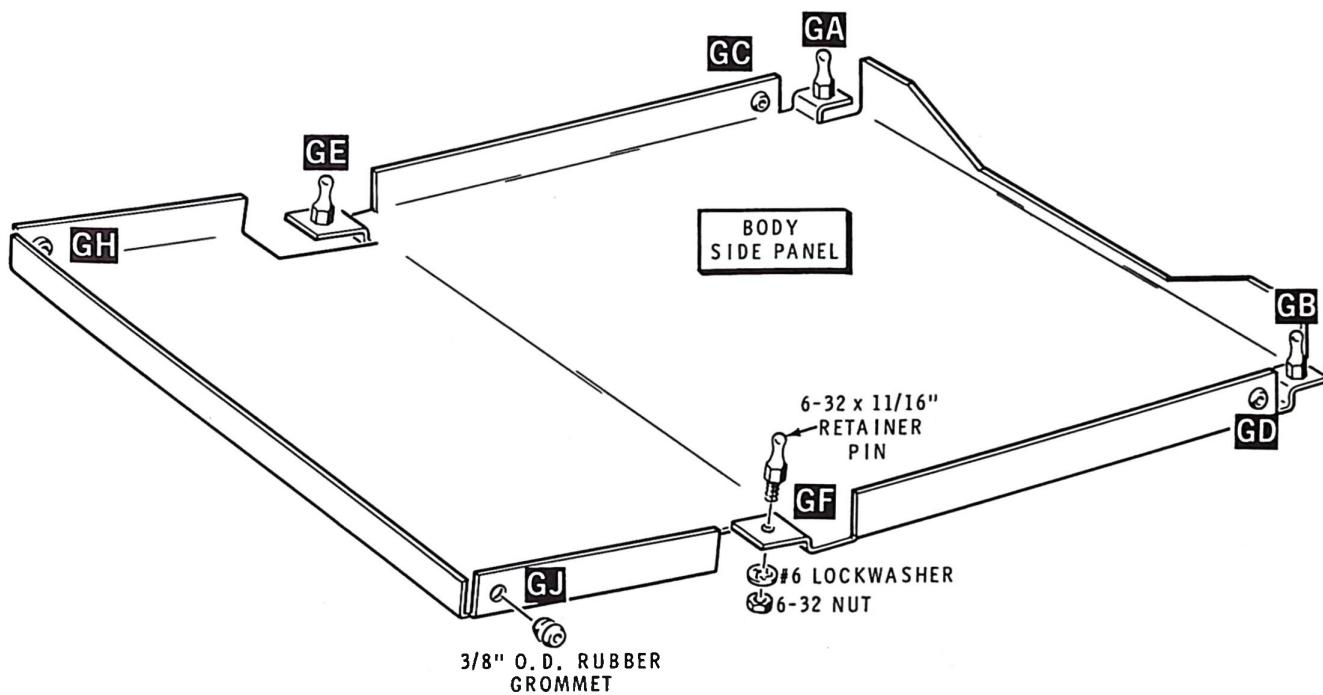
- () Refer to inset drawing #1 on Pictorial 14-16 and install one of the rear (large) wheels on either bolt that extends from the battery holder with a 1/2-13 nut. Be sure the 6-spoke side of the wheel faces outwards. Tighten the nut just enough to hold the wheel bushing so it does not turn on the bolt. The ball bearings will allow the wheel to turn freely. If the nut is too tight, the wheel will bind.
- () In the same manner, install the other rear wheel.
- () Refer to Inset drawing #2 on Pictorial 14-16 and start an 8-32 × 1/4" set screw into the shoulder of the drive shaft.
- () Place the encoder disk and two 1/2" flat washers all the way on the drive shaft as shown.
- () With the flat on the drive motor shaft facing upward, slide the drive shaft onto the motor shaft until the drive pin holes in the drive shaft and motor shaft line up. Then insert the drive pin through the holes. You may have to force the drive pin into the holes with large slip-joint pliers. If you tap the drive pin into the holes, be sure to support the underside of the drive shaft to prevent damage to the motor.
- () Tighten the setscrew onto the motor shaft.
- () Refer again to Inset drawing #2 on Pictorial 14-16 and install the front wheel onto the drive shaft with a 1/2"split lockwasher and a 1/2"-13 nut. Use a 5/8" wrench on the flats of the drive shaft so it will not turn as you tighten the outer nut. Then tighten the nut until the split lock-washer is compressed between the wheel and the nut.

- () Refer to Detail 14-16A and install two 3/8" O.D. rubber grommets in the large holes of both side panel mounting brackets.
- () Refer again to Detail 14-16A and position a side panel mounting bracket along one side of the base plate so the bracket ends are even with the indicated corners of the base plate. Use 6-32 × 3/8" hardware in the bracket holes and align with the holes in the base plate.
- () In the same manner, install the other side panel mounting bracket on the other side of the base plate.

**Detail 14-16A**

Refer to Pictorial 14-17 for the following steps.

- () Install a 6-32 × 11/16" retainer pin as shown at hole GF in one of the body side panels. Use a #6 lockwasher and a 6-32 nut. Be careful not to bend the metal tabs.
- () In the same manner, install retainer pins in holes GB, GE, and GA of the body side panel.
- () Install 3/8" O.D. rubber grommets in holes GC, GD, GH, and GJ.
- () In the same manner, install retainer pins and rubber grommets in the other body side panel.
- () Set the body side panels aside temporarily.

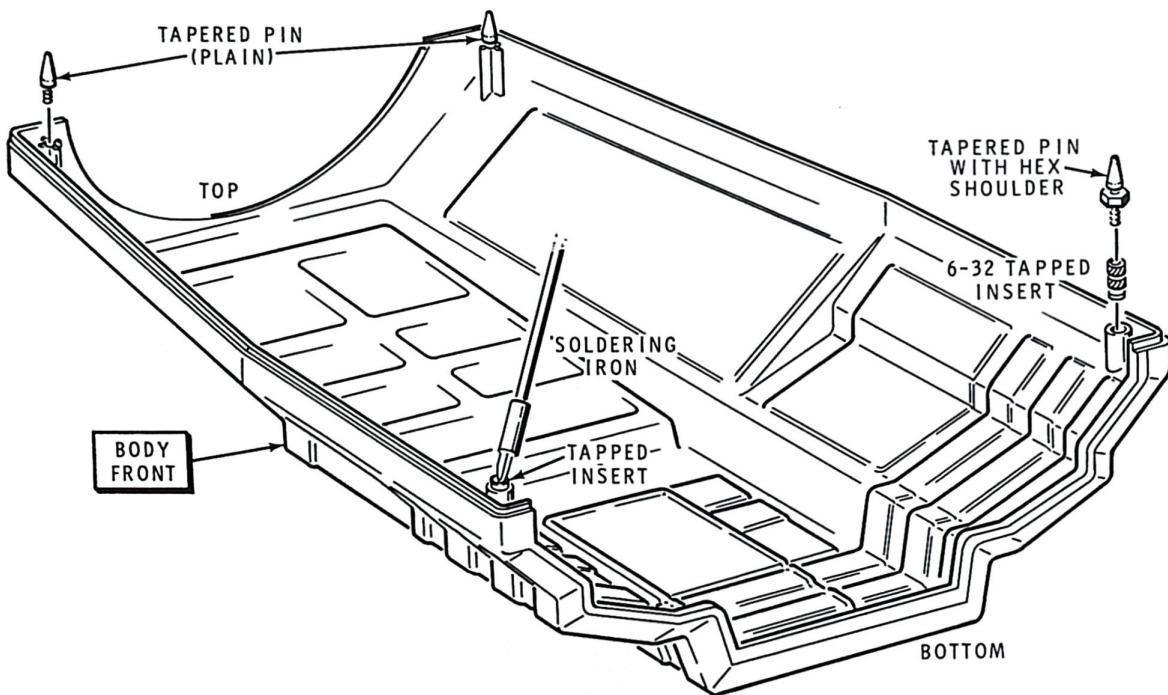


PICTORIAL 14-17

Refer to Pictorial 14-18 for the following steps.

() Install 6-32 tapped inserts into the four inside holes in the body front. Position the tapped insert in the hole and then heat the insert with a soldering iron. When the plastic body front softens, push on the soldering iron until the tapped insert is flush with the surface of the plastic.

- () Set the body front aside momentarily while the plastic and inserts cool. Meanwhile, in the same manner, install tapped inserts in the four holes of the body rear.
- () Again with the body front, screw two tapered pins (with hex shoulder) into the tapped inserts at the bottom, and plain tapered pins into the inserts at the top.
- () In the same manner, install tapered pins in the body rear.



PICTORIAL 14-18

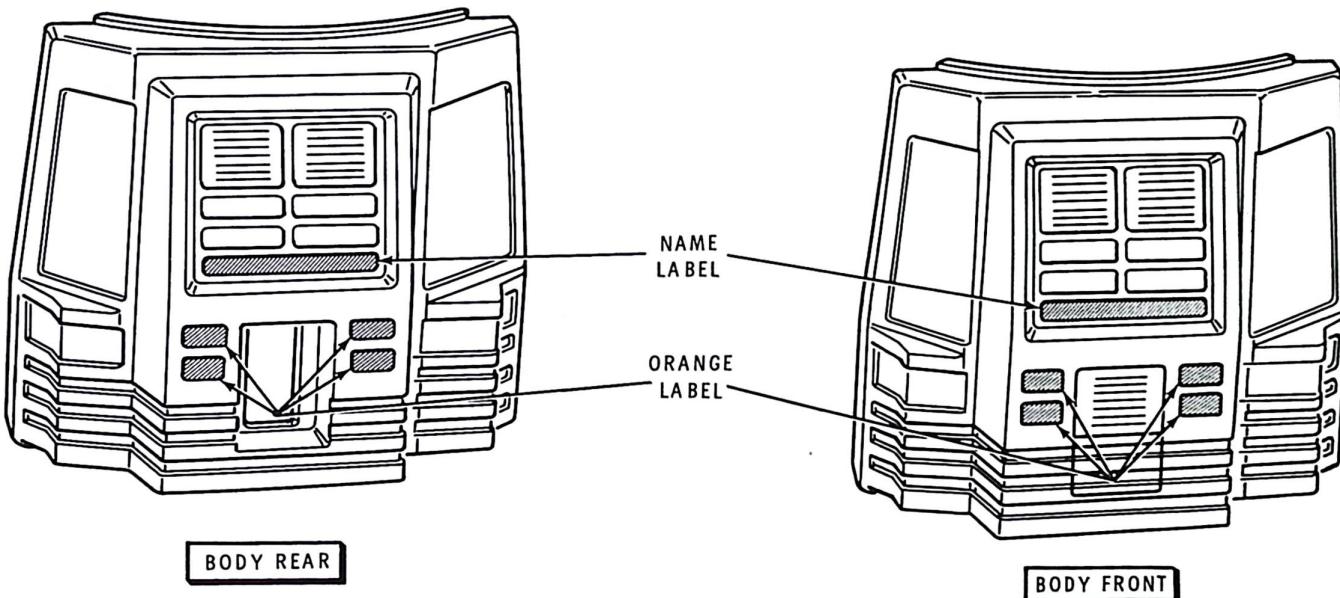
Refer to Pictorial 14-19 for the following steps.

- () Turn both the body front and rear over.
- () Locate one of the body labels.
- () Peel the name label from the sheet and press it into place on the body front.
- () Peel the four orange labels from the sheet and press them into place on the body front.

() In the same manner, install the labels on the body rear.

() Set the body front and rear aside until they are called for later.

This completes the assembly of the base and torso. Save the remaining parts for use later. Proceed to the "Head Assembly" section of the Manual.



PICTORIAL 14-19

HEAD ASSEMBLY

PARTS LIST

Refer to the "Pack Index Sheet" and remove the parts from pack #15. Check each part against the following list. The key numbers correspond to the numbers on the "Head Assembly Parts Pictorial" (Illustration Booklet, Page 35, 36 and 37. Any part that is in an individual envelope with the part number on it should be placed back into the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

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

A1	250-1415	4	4-40 x 3/8" screw	
A2	254-9	4	#4 lockwasher	
A3	250-1157	5	6-32 x 1/4" hex stud	
A4	250-1264	14	6-32 x 3/8" hex head screw	
A5	250-1325	8	6-32 x 1/4" black phillips head screw	
A6	250-1419	5	6-32 x 1/4" black flat phillips head screw	
A7	250-1423	5	6-32 x 3/8" flat phillips head screw	
A8	252-3	31	6-32 nut	
A9	252-178	2	#6 push-on nut	
A10	252-725	4	6-32 brass press-in nut	
A11	253-21	5	#6 flat washer	
A12	253-89	1	#6 D washer	
A13	254-1	57	#6 lockwasher (6 extra supplied)	
A14	255-103	4	6-32 x 5/16" threaded spacer	
A15	255-724	1	6-32 x 7/8" hex threaded spacer	
A16	259-1	1	#6 solder lug	
A17	250-1485	1	8-32 x 1/4" allen setscrew	
A18	255-49	4	5/16" round spacer	
A19	250-1481	1	8-32 setscrew pin	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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FOAM — PLASTIC — RUBBER PARTS

B1	73-180	1	1-1/4" O.D. rubber grommet	
B2	73-183	2	1-1/2" O.D. rubber grommet	
B3	94-633	1	Sonarpad	
B4	73-151	2	Double-adhesive strip	
B5	75-144	4	Circuit board spacer (see Note)	
B6	207-22	1	Cable clamp	
B7	236-549	2	6" sonar tube	
B8	354-5	1	Small cable tie	

NOTE: Place these circuit board spacers in water now, so they will be more flexible when you need to use them.

ELECTRICAL COMPONENTS

C1	9-67	1	Photoresistor, 133 kΩ	LDR1
C2	401-163	1	Speaker	A15
C3	418-45	1	Battery*	
C4	421-2	1	Fuse, 3 ampere	F3
C5	473-34	2	Sonar transducer (pair)	A11 through A14

*The battery is packed in carton #1.

KEY	HEATH	QTY.	DESCRIPTION
No.	Part No.		

WIRING MATERIALS

	343-15	6"	shielded cable
	346-64	3½"	Large heat shrink sleeving
	347-55	12"	8-wire flat cable
D1	422-1	1	Fuseholder
D2	431-11	2	Terminal strip, 5-lug
D3	431-42	1	Terminal strip, 5-lug, wide
D4	431-51	1	Terminal strip, 2-lug, upright
D5	134-1322	2	Cable assembly
	134-1302	1	Head harness
D6	266-857	1	Photo resistor socket

STRUCTURAL METAL PARTS

F1	204-2585	1	Experimental board bracket*
F2	204-2758	1	Battery bracket*
F3	204-2588	1	Speaker bracket*
F4	204-2589	1	Rear display bracket*
F5	204-2590	1	Front display bracket*
F6	205-1877	1	Head plate*
F7	455-658	1	Pivot bearing*

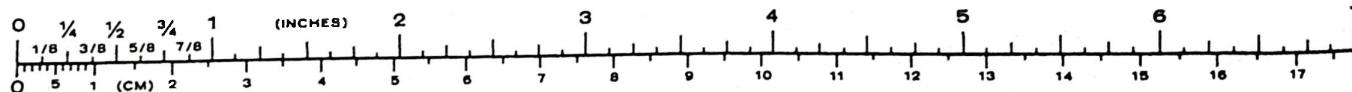
KEY	HEATH	QTY.	DESCRIPTION
No.	Part No.		

MISCELLANEOUS

G1	92-745	1	Head panel*
G2	205-1878	1	Pivot plate
G3	456-48	1	Shoulder bushing
G4	208-6	4	Sonar clip
G5	258-175	2	Spring
G6	209-96	1	Decorative grille
G7	390-2315	1	ET-18 label**
G8	390-2316	1	Keyboard label**
G9	390-2413	1	Experimental board label**
G10	390-2318	1	Shoulder label**
G11	391-34	1	Blue and white label**
G12	446-736	1	Readout window
G13	352-13	1	Silicon grease
		1	FCC label**
	75-737	1	6" × 8" insulator sheet

*Items marked with an asterisk are in the final pack.

**Items in the label pack.



STEP-BY-STEP ASSEMBLY

Head Plate Assembly

PIVOT BEARING

Refer to Pictorial 15-1 for the following steps.

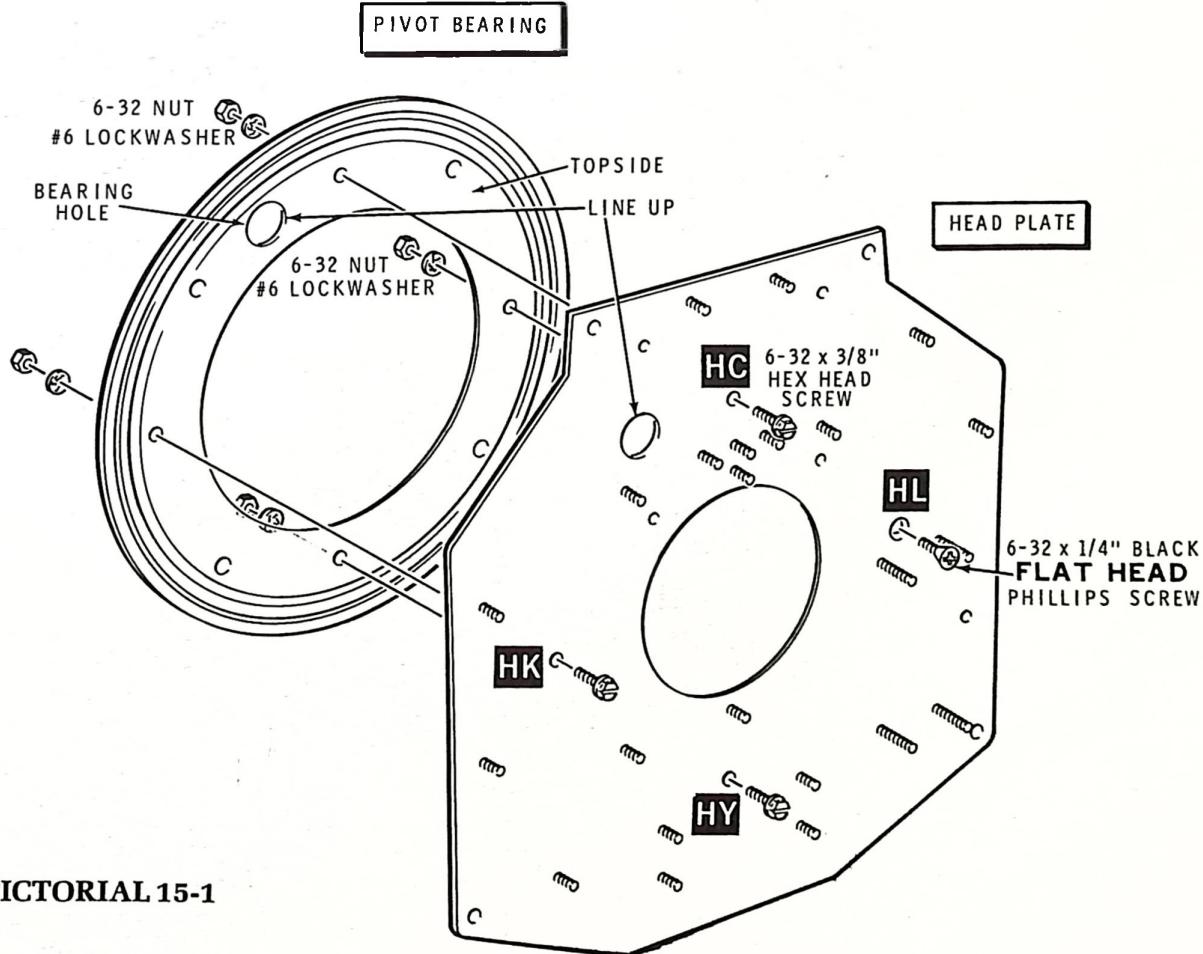
- () Locate the pivot bearing and note that the side with the greatest surface area is its top.

NOTE: The pivot bearing has three sizes of holes in the top. The single largest hole is the penny-sized bearing hole. There are also four medium holes (about 5/16" across) and four smaller holes (about 3/16" across). Make special note of the smaller holes; you will use them in the following steps.

- () Stand the head plate up with the pivot bearing next to it, as shown.

- () Line up the penny-sized bearing holes in the pivot bearing and the head plate as you place them together. This should allow you to place a 6-32 × 3/8" hex head screw in hole HC.
- () Refer to the Pictorial and install #6 hardware at HC to loosely mount the pivot bearing to the head plate.
- () Loosely install two more sets of #6 hardware, at hole HY and hole HK.
- () Use a 6-32 × 1/4" black flat-head phillips screw with #6 hardware at hole HL.
- () Tighten the four sets of hardware, securing the pivot bearing to the head plate.

Set the assembly aside temporarily.

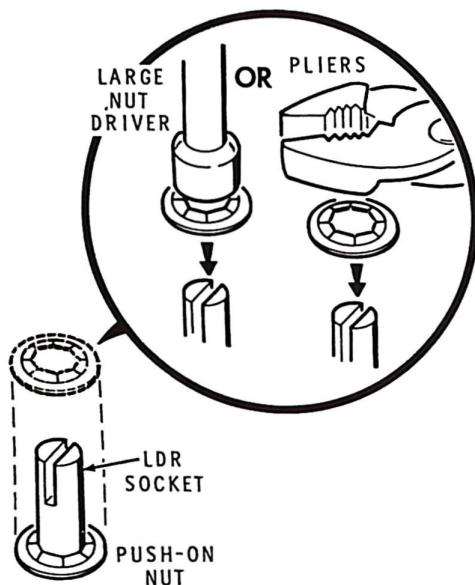


PICTORIAL 15-1

Speaker Bracket Assembly

MOTION SENSOR

NOTE: The procedures for all common operations have been covered repeatedly in the previous assembly sections, and will not be covered in depth for this portion of the Manual. If you have any doubts about how to do a specific operation, refer to a previous section where that operation is fully explained.

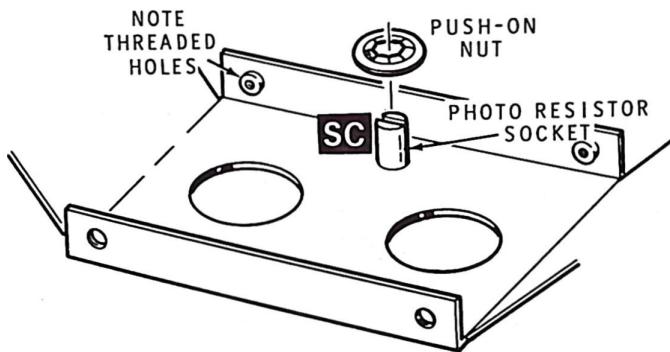


Detail 15-2A

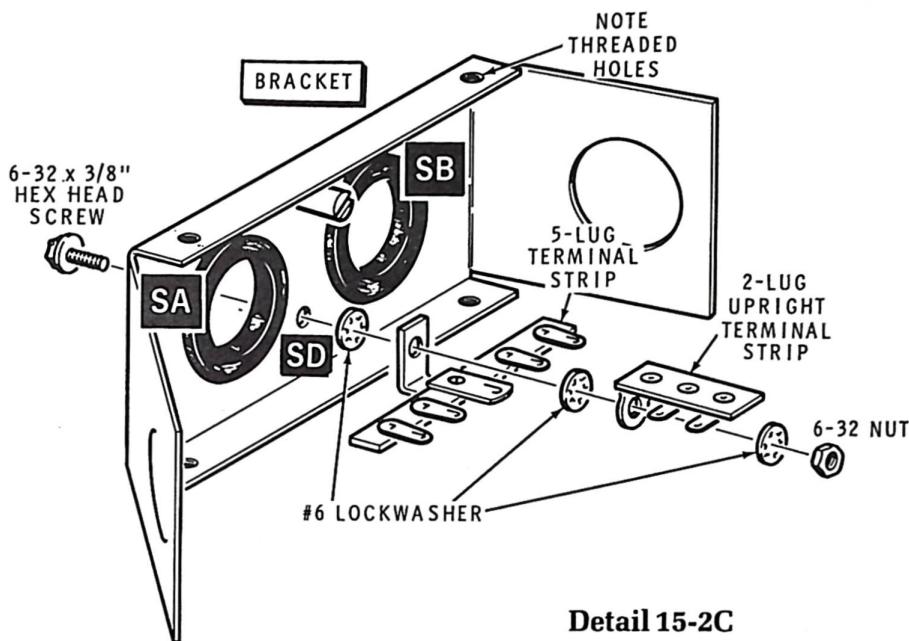
Refer to Pictorial 15-2 (Illustration Booklet, Page 37) for the following steps.

- () Locate the speaker bracket and install the photo resistor socket in the following manner:

1. Press a push-on nut onto the socket as shown in Detail 15-2A. Use a large nut driver or pliers to force the nut all the way onto the socket.
2. Turn the socket so its' notch is horizontal and insert the socket in hole SC from the front of the bracket. Secure the socket with another push-on nut as shown in Detail 15-2B.

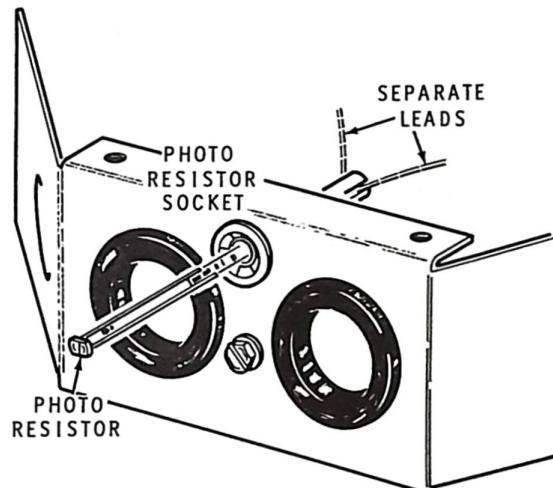


Detail 15-2B



Detail 15-2C

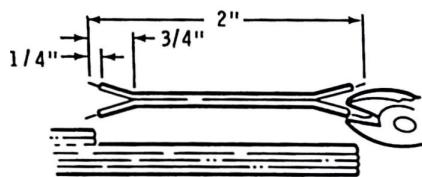
- () Refer to Detail 15-2C and install two 1-1/2" O.D. grommets in holes SA and SB.
- () Mount a wide 5-lug terminal strip (with wide spacing) and a 2-lug upright terminal strip at SD. Use 6-32 x 3/8" hardware and position the terminal strips as shown.
- () Refer to Detail 15-2D and mount the photo resistor in the front of the socket, with the leads separated, as shown.



Detail 15-2D

NOTE: When you prepare a cable, use the following steps:

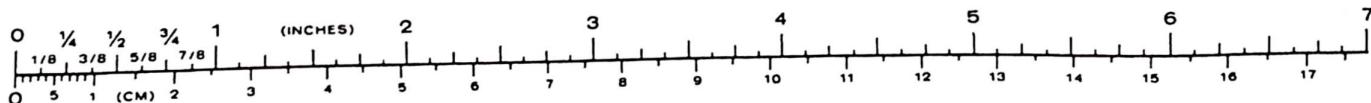
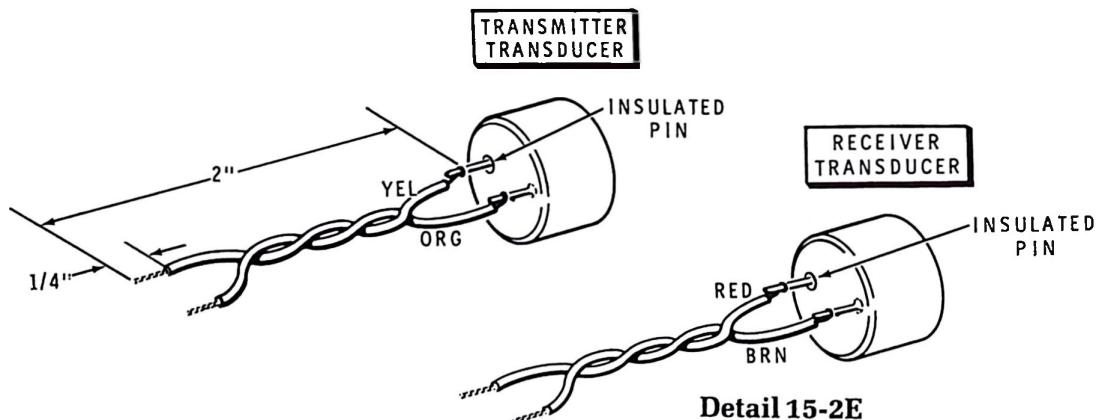
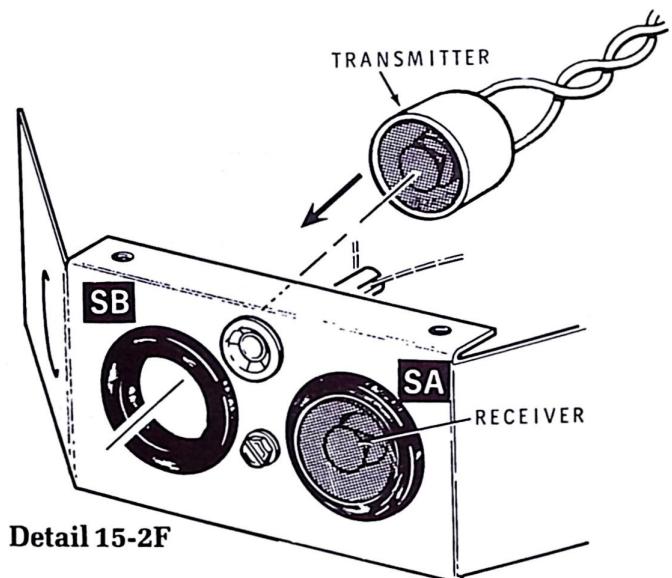
1. Separate the wire colors specified from the length of flat cable.
2. Cut the cable to the indicated length, then separate the wires $3/4"$ at both ends.
3. Remove $1/4"$ of insulation from the wire ends.
4. Twist the wire ends and apply a thin film of solder to hold the strands together.



NOTE: The sonar transducers are identified as transmitter (T) and receiver (R) for each pair. These devices are selected in matching pairs for best efficiency. Do not mix devices or exchange the transmit and receive functions if you want the best operation from these devices.

- () Locate one matched pair of sonar transducers (a transmitter and a receiver). Refer to Detail 15-2E and prepare a 2" brown-red cable from the 8-conductor flat cable.

- () Twist the brown-red cable as shown, then form a hook in the wires at one end.
- () Note the insulated pin on the receiver transducer. Solder the hook of the red wire to the insulated pin and the brown wire to the other pin.
- () In the same manner, prepare a 2" orange-yellow cable and connect it to the pins of the transmitter transducer.
- () Refer to Detail 15-2F and insert the transmitter transducer into grommet SB. Press on the back of the transducer until its front edge is flush with the outside edge of the grommet.
- () In a similar manner, mount the receiver transducer in the grommet at SA.

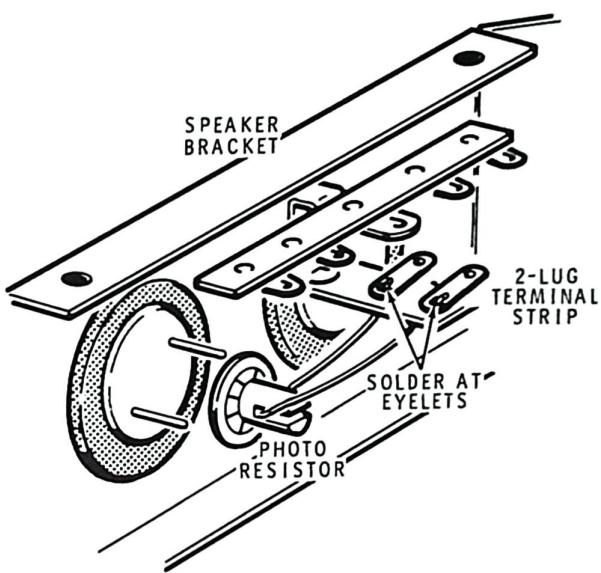


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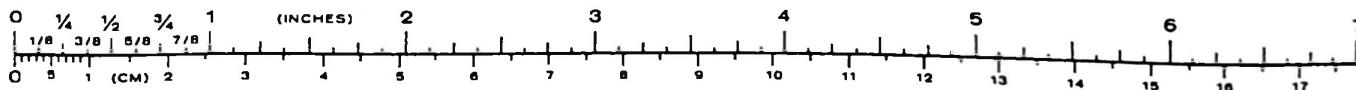
- () Reposition the speaker bracket as shown in Detail 15-2G and place the two wires from the photo resistor in the eyelets of the 2-lug terminal strip as shown. Make sure the wires do not touch each other.
- () Solder the two photo resistor leads to the eyelets only.

Refer to Pictorial 15-2 and connect the wires from the two sonar transducers as indicated in the following four steps. In each case, solder the wire to the eyelet only.

- () 1. The orange wire from the transmitter to the eyelet of lug 1 (S-1).
- () 2. The yellow wire from the transmitter to the eyelet of lug 2 (S-1).
- () 3. The brown wire from the receiver to the eyelet of lug 4 (S-1).
- () 4. The red wire from the receiver to the eyelet of lug 5 (S-1).



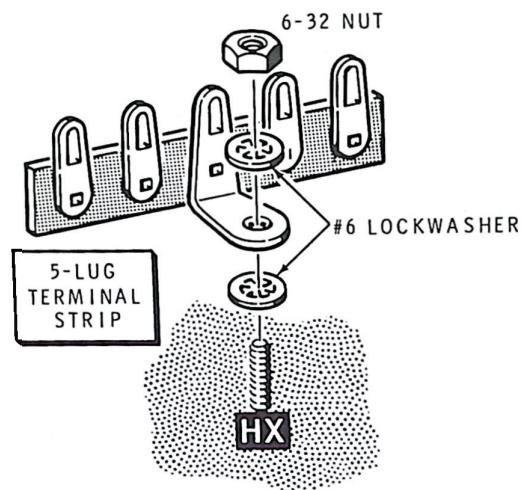
Detail 15-2G



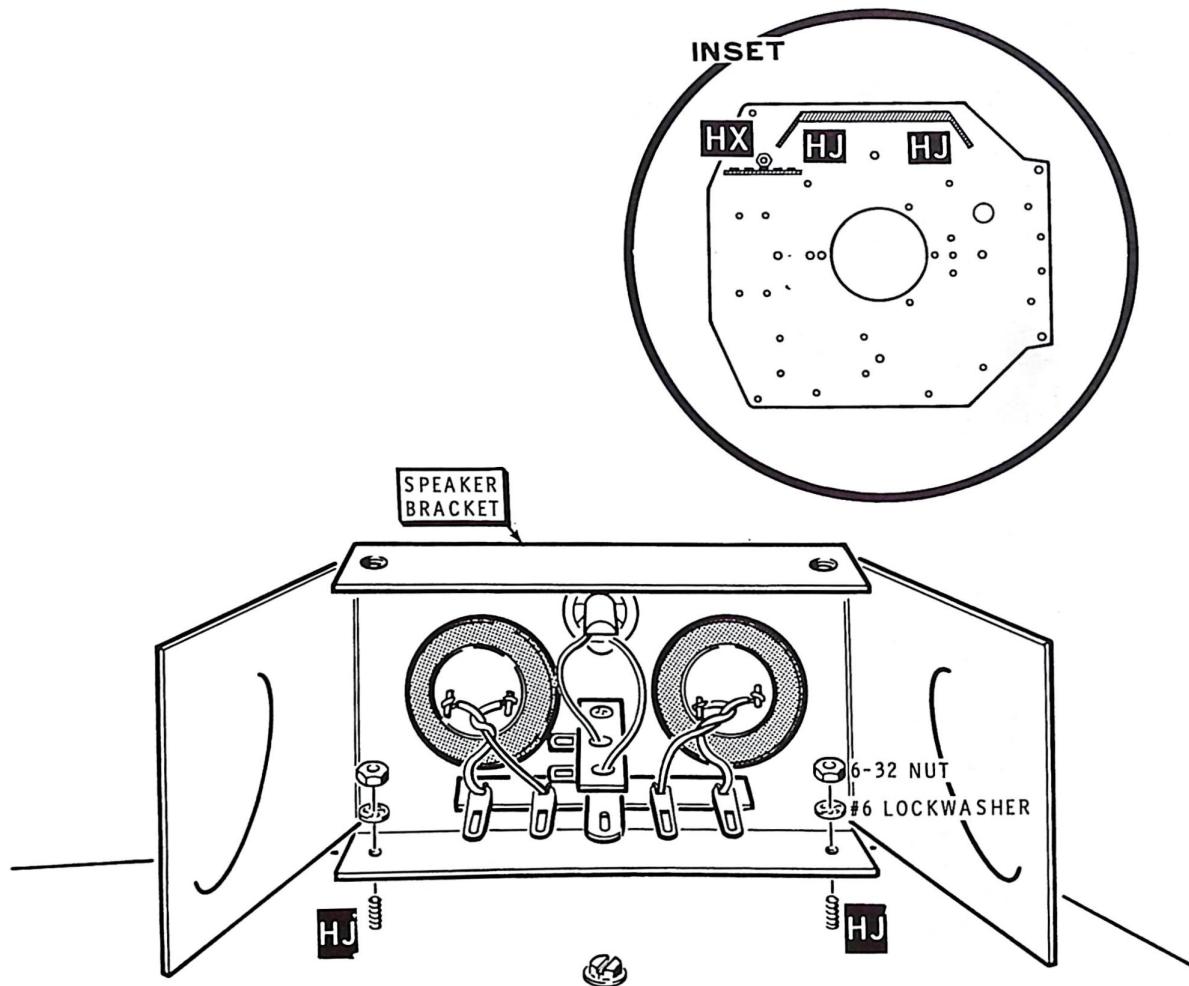
Refer to Pictorial 15-3 (Illustration Booklet, Page 38) for the following steps.

NOTE: An inset drawing is used on this and other Pictorials to show where you will work in the following steps.

- () Refer to Detail 15-3A and mount the speaker bracket to the threaded studs at the two positions marked HJ (note that the threaded holes go to the top of the bracket). Secure (tighten) the bracket in place with #6 lockwashers and 6-32 nuts.
- () Mount a 5-lug terminal strip at threaded stud HX. Use #6 hardware as shown in Detail 15-3B. Position the terminal strip as shown in the Pictorial.



Detail 15-3B



Detail 15-3A

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Head Harness Initial Wiring

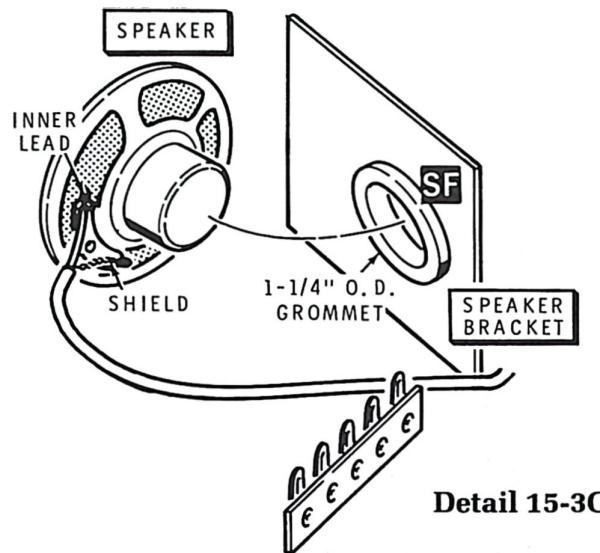
Continue with Pictorial 15-3 for the following steps.

Position the head harness (#134-1302) as shown. Then connect the following eight wires to the terminal strip HX.

- () Three red wires to lug 1 (S-3).
- () Two orange wires to lug 2 (NS).
- () Three brown wires to lug 3 (S-3).
- () At terminal strip HX, connect the yellow wire to lug 4 (S-1) and the orange wire to lug 5 (S-1).
- () Prepare a 6" orange wire (from the flat cable). Then connect one end to lug 2 (S-3) of terminal strip HX.
- () Route the 6" orange wire under the speaker bracket and connect the free end to 2-lug terminal strip SD lug 2 (S-1).
- () Connect the violet wire from the harness to 2-lug terminal strip SD lug 1 (S-1).
- () Press a "P1303" label onto the smooth side (without slots) of the small 10-pin connector.
- () Press a "P1401" label onto the slotted side of the 4-pin connector.
- () Press a "P5" label onto one side of the large 15-pin connector.



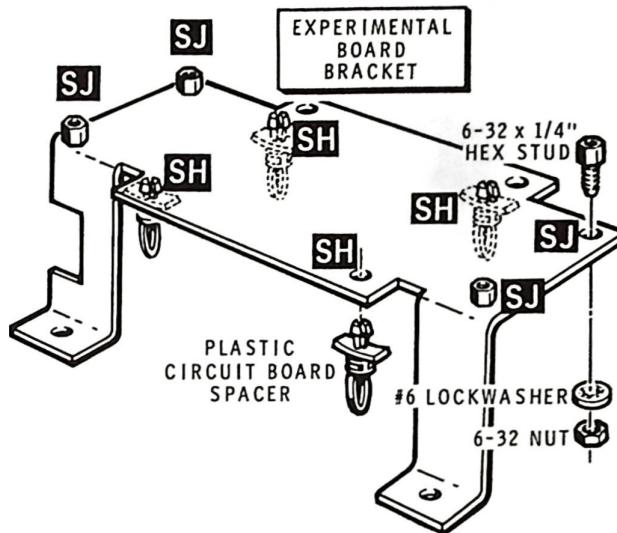
- () Refer to Detail 15-3C and connect the shield lead of the shielded cable to one of the speaker terminals (S-1). Be careful so that the shield will not contact any other part of the speaker. Cut off any excess lead length.
- () Connect the inner lead to the other speaker terminal (S-1).
- () Mount the 1-1/4" O.D. rubber grommet in the speaker bracket at SF.
- () Mount the speaker in the rubber grommet at SF. Press only on the outside rim of the speaker or you may damage the speaker cone.
- () Route the shielded cable around the speaker bracket as shown.



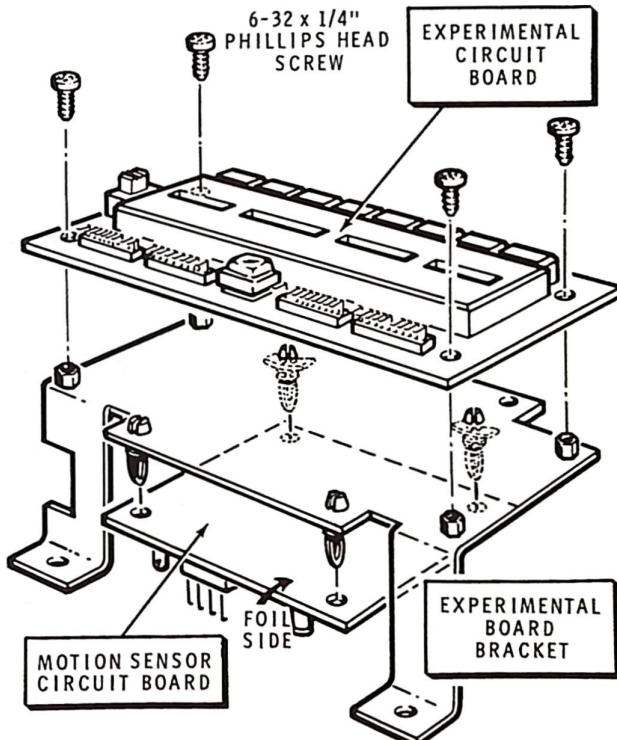
Experimental Board Bracket Mounting

Refer to Pictorial 15-4 (Illustration Booklet, Page 39) for the following steps.

- () Locate the experimental board bracket. Refer to Detail 15-4A and install four plastic circuit board spacers on the underside of the bracket at SH. NOTE: These are the spacers you began soaking when you checked the Parts List. If you have not soaked these spacers in water for at least one hour, do so before you try to insert them in the experimental board bracket.
- () Refer again to Detail 15-4A and install four 6-32 × 1/4" hex studs on the top of the bracket at SJ.
- () Mount the motion board on the underside of the experimental bracket with the four circuit board spacers as shown in Detail 15-4B.
- () Position the experimental bracket next to the speaker bracket, as shown in the Pictorial. Note the wire colors in the Pictorial and carefully slide the push-on connectors coming from the motion board onto the indicated lugs of the 5-lug terminal strip. Support the terminal strip as you press the connectors onto it.
- () Refer again to Pictorial 15-4 and mount the experimental bracket on the speaker bracket and the head plate. Use #6 hardware at threaded studs HE and HR, and 6-32 × 3/8" hex head screws and lockwashers at bracket holes SG. Note the 5-lug terminal strip and extra lockwasher at HE.
- () Locate the experimental board and position it on the bracket as shown in Detail 15-4B. Mount it on the hex studs with 6-32 × 1/4" phillips head screws.



Detail 15-4A

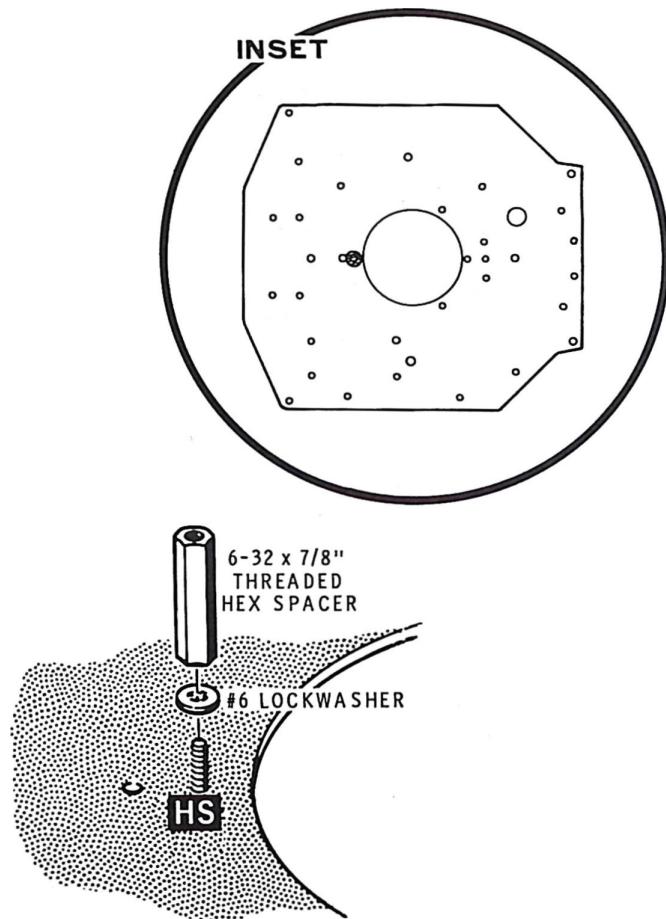


Detail 15-4B

Head Plate Hardware

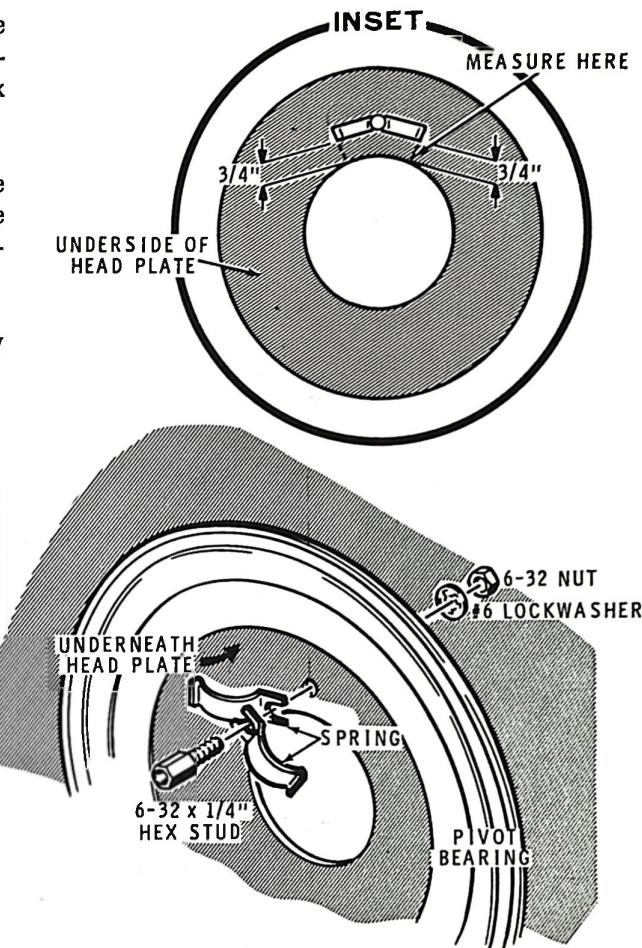
Refer to Pictorial 15-5 (Illustration Booklet, Page 39) while mounting hardware on the head plate in the following steps.

- () Refer to Detail 15-5A and mount a 6-32 × 7/8" threaded hex spacer at HS. Use a #6 lock-washer with it.



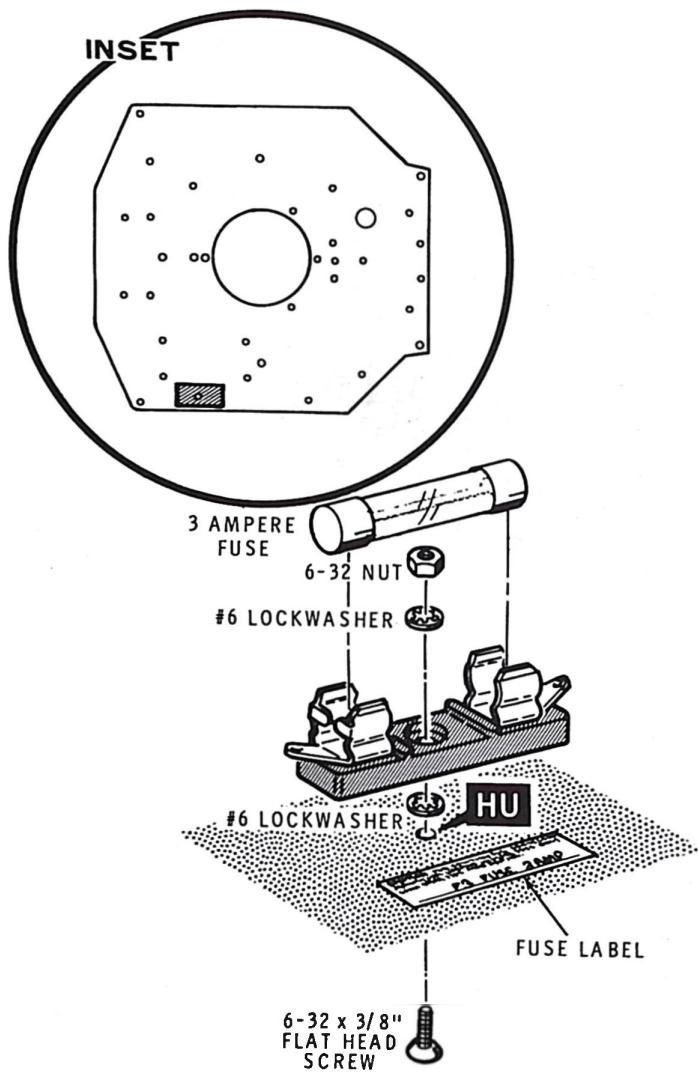
Detail 15-5A

- () Refer to Detail 15-5B and loosely mount the head-turn limit switch hardware at HT underneath the head plate. Use a 6-32 × 1/4" hex stud, #6 hardware, and the two springs.
- () Position the end of each spring so it's inside edge is exactly 3/4" from the edge of the large hole in the head plate; then tighten the hardware.
- () Check to be sure that end of the spring is exactly 3/4" from the hole, and reposition if necessary.



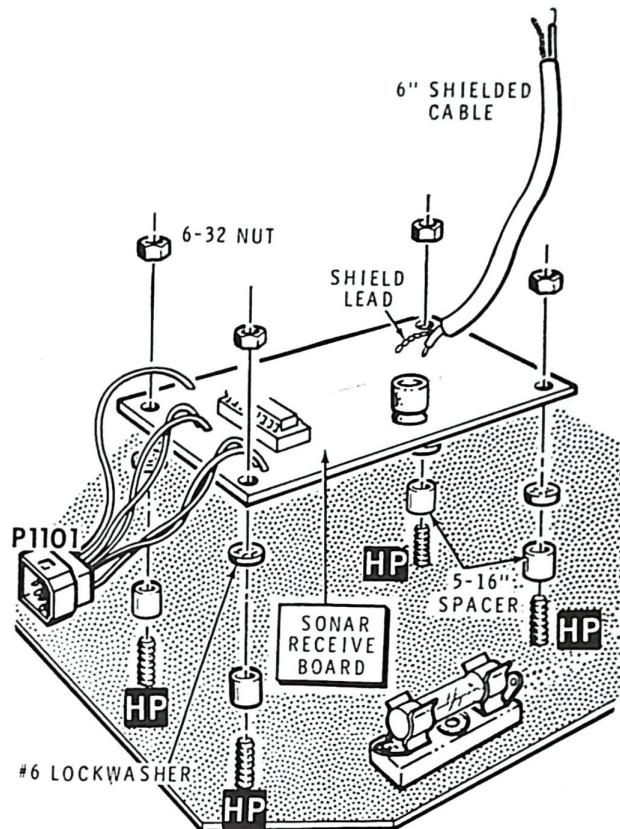
Detail 15-5B

- () Refer to Detail 15-5C and mount the fuseholder at HU with #6 × 3/8" hardware.
- () Install a 3-ampere fuse in the fuse block.
- () Locate the label that says "F3 Fuse 3 AMP" and stick it to the head plate as shown in the Pictorial.

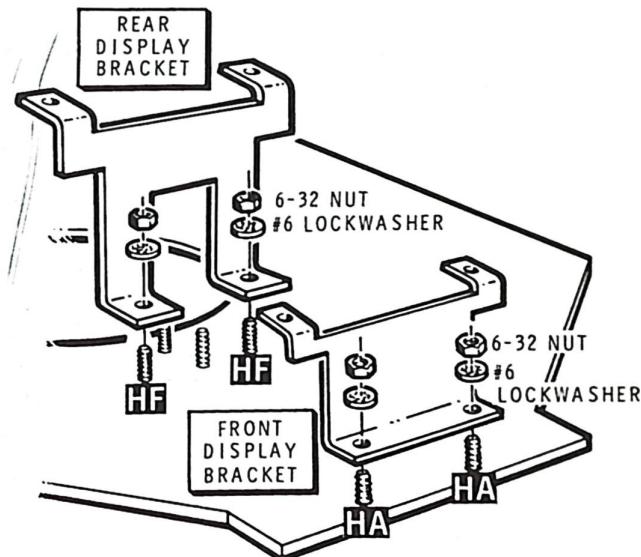


Detail 15-5C

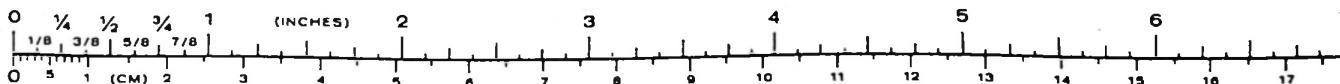
- () Prepare a 6" length of shielded cable. First remove 1" of outer insulation from each end. Separate the shield lead then remove 1/4" of insulation from the center conductor. Finally, twist the strands of each conductor and shield lead and apply a thin film of solder to hold the strands together.
- () Locate the sonar receive circuit board. Then use a knife to scrape any solder-resist coating from the foils around the mounting holes at the four corners of the circuit board.
- () Connect one end of the shielded cable, center conductor to hole A (S-1), and shield lead to hole B (S-1), as shown in Detail 15-5D.
- () Press the label "P1101" onto one of the smooth sides of the 9-pin connector shell.
- () Refer to Detail 15-5D and mount the sonar receive board at studs HP. Use 5/16" spacers and #6 hardware as shown. Place the lockwashers between the spacers and the foil side of the circuit board.
- () Refer to Detail 15-5E and mount the rear display bracket at studs HF. Note which way the top tabs of the bracket point.
- () In a similar manner, mount the front display bracket at studs HA.



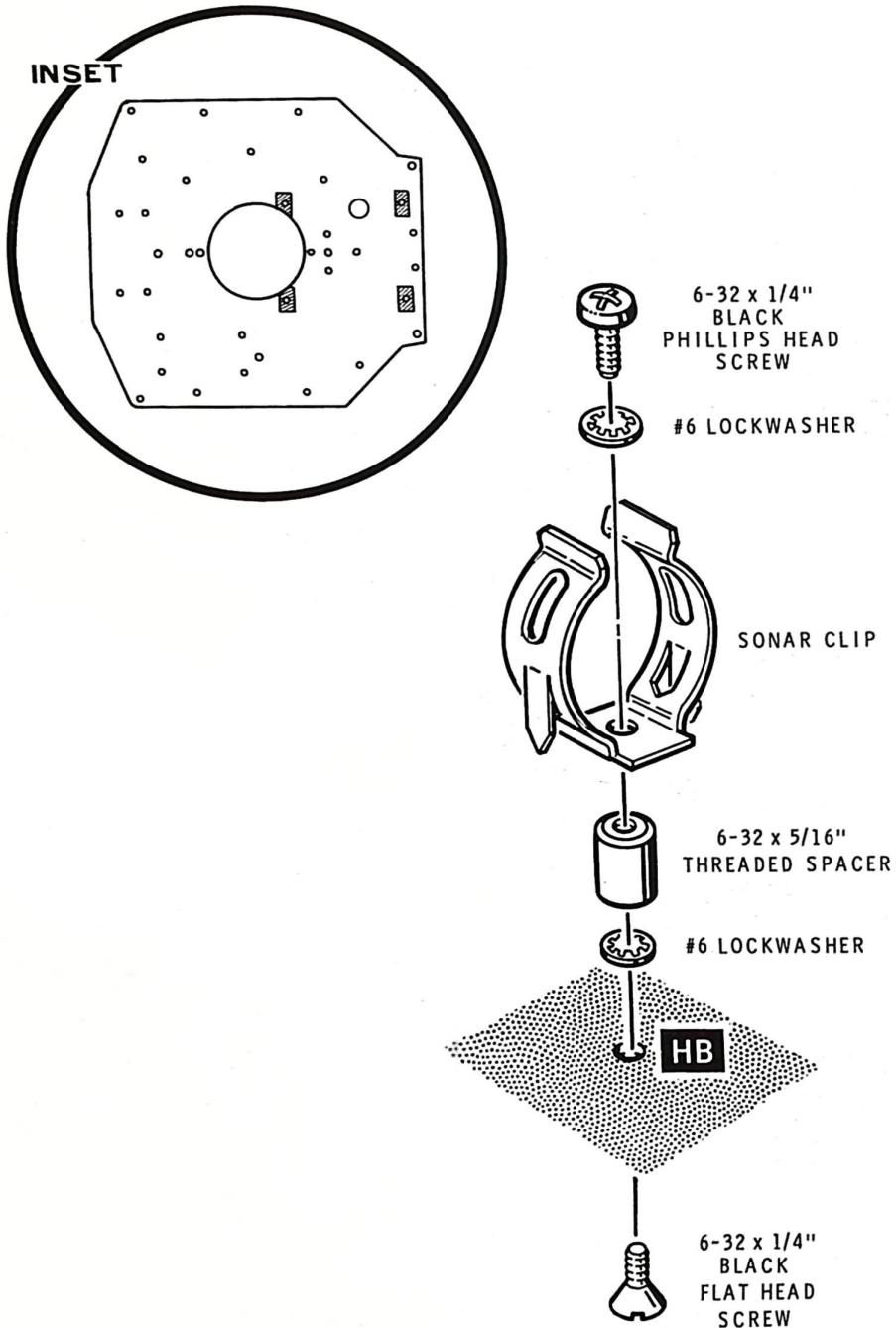
Detail 15-5D



Detail 15-5E



- () Refer to Detail 15-5F and mount a sonar clip to a 6-32 x 5/16" round threaded spacer with a 6-32 x 1/4" black phillips head screw and a lockwasher. Tighten the screw.
- () In a similar manner, mount the other three sonar clips to 5/16" round threaded spacers.
- () Refer again to Detail 15-5F and loosely mount the four clips to the head plate at HB (four locations). Use 6-32 x 1/4" black flat head screws and lockwashers.
- () Refer to the Pictorial and snap the sonar tubes into the sonar clips to keep them aligned. Then tighten the flat head screws holding the sonar clips.

**Detail 15-5F**

Mounting the Head Plate

Refer to Pictorial 15-6 (Illustration Booklet, Page 40) for the following steps.

- () Remove the sonar transmit tube that is over the penny-sized hole in the head plate.

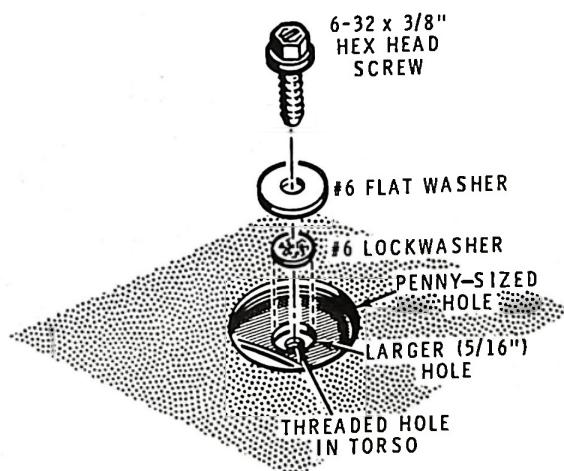
In the following step, you will set the head plate on the torso. You may want to have someone help you with this since you will have to:

1. Bring the wiring harness up through the hole in the center of the head plate while you are setting the head plate on the torso.
2. View down through a hole in the head plate assembly, so you can set the assembly exactly in position on the torso. See the Pictorial.

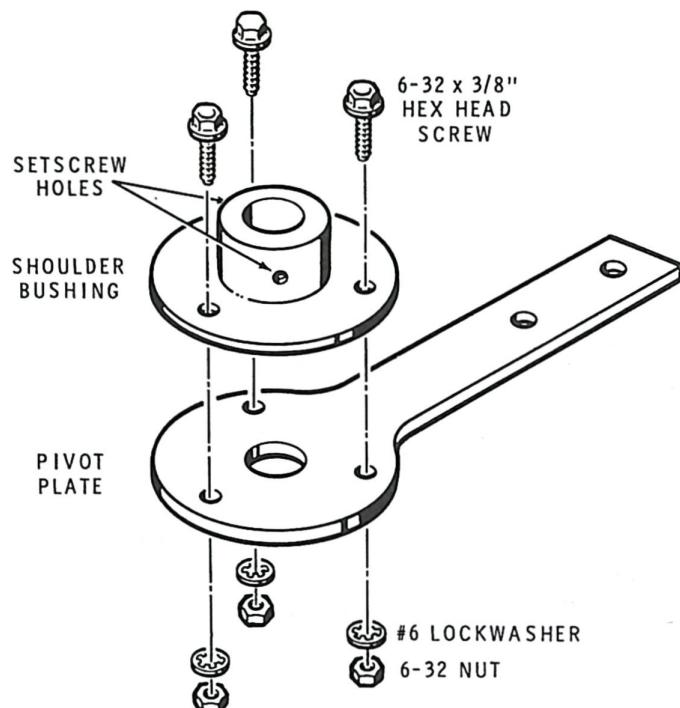
Read the following four steps before you start. Then do them as a single operation.

- () 1. Place the torso so that you can stand over it and look down upon it. Refer to the Pictorial and mark the threaded torso hole indicated as "hole #1." Do this by making an "X" with a crayon or felt type marker.
- () 2. There are two sizes of holes that you will see through the penny-sized hole as you rotate the head plate; small (about 3/16") and larger (about 5/16"). Rotate the head plate until the penny-sized hole is over one of the "larger" holes.

- () 3. Hold the head plate assembly over the torso and start the wiring harness up through the center hole in the head plate. Do not allow the pivot bearing to spin the "larger" hole away from where you placed it.
- () 4. Make sure you can see through the bearing hole/"larger" hole in the head plate assembly. Look down through this hole as you slide the head assembly down. Set the head assembly down with the viewing hole right on top of the hole you marked.
- () Refer to Detail 15-6A and loosely install the 6-32 × 3/8" hardware indicated. Note that the lockwasher fits into the "larger" hole of the pivot bearing, and helps center this hole over the torso hole. The torso hole is threaded, so no nut is required.
- () Rotate the head plate one half turn, without disturbing the placement of the pivot bearing on the torso. Do not force the head plate past the stops. There you will find another "larger" pivot bearing hole. Adjust the pivot bearing slightly, if necessary, until you find the matching hole in the torso. Refer again to Detail 15-6A and loosely install 6-32 × 3/8" hardware.
- () In a similar manner, install 6-32 × 3/8" hardware in the other two indicated torso holes.
- () Tighten these four mounting screws.



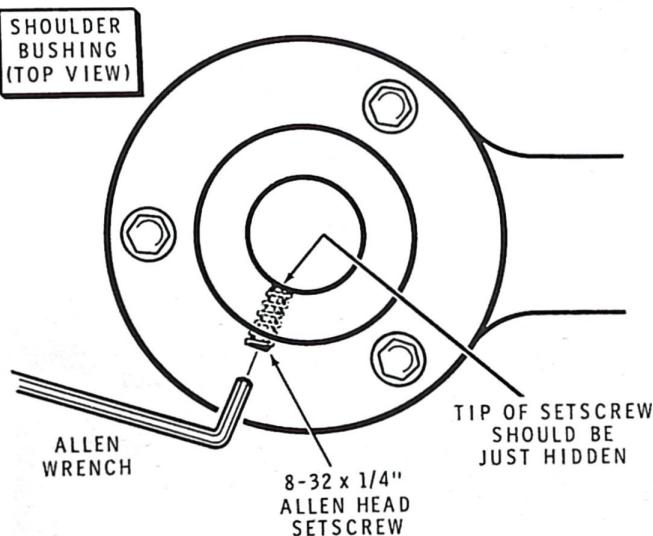
Detail 15-6A

**Detail 15-7A**

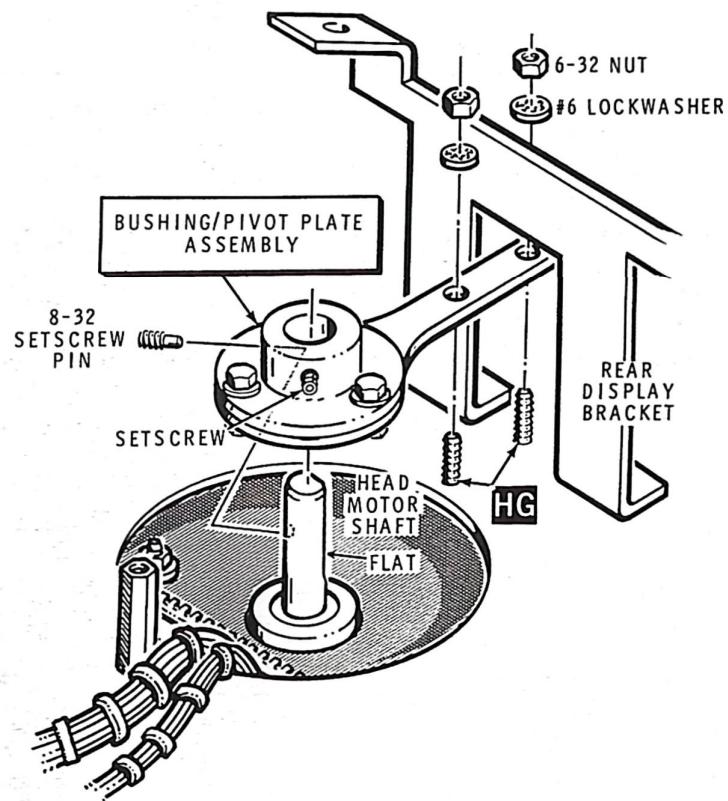
Refer to Pictorial 15-7 (Illustration Booklet, Page 40) for the following steps.

() Mount the shoulder bushing to the pivot plate with $6-32 \times 3/8"$ hardware as shown in Detail 15-7A. Position the setscrew holes as shown.

() Refer to Detail 15-7B and install an $8-32 \times 1/4"$ allen head setscrew (with locking compound) in the shoulder bushing. Turn it into the bushing only until you can see the tip coming into the center; then back it out until the tip no longer is visible. The correct size allen wrench is provided.



- () Refer to Detail 15-7C and slide the bushing/pivot plate assembly onto the head motor shaft with the pivot plate extending through the rear display bracket. The bushing should be up, as shown.
- () Loosely mount the pivot plate to the head plate on studs HG with #6 hardware as shown in Detail 15-7C. Do not tighten the hardware.
- () Rotate the head, if necessary, so the empty setscrew hole in the bushing is aligned with the hole of the motor shaft, *opposite* the flat.
- () Start an 8-32 setscrew pin (with locking compound) into the bushing and motor shaft. Tighten the setscrew pin. Then tighten the setscrew onto the motor shaft.
- () Tighten the pivot plate hardware onto studs HG.
- () Rotate the head in one direction and then the other. You may find it very hard to move at first because of the gear train in the motor. Then you can move it with moderate force until it reaches a stop. Check to see that wires and cables do not rub or bind on hardware.
- () Rotate the head to its mid-point with the sonar tubes toward the front of the Robot (over the single drive wheel).



Detail 15-7C

Head Components and Wiring

SONAR

Refer to Pictorial 15-8 (Illustration Booklet, Page 41) for the following steps.

- () Remove the other sonar tube from its clips.
- () Cut the length of large heat shrink sleeving neatly in half. You will have two pieces, each about 1-3/4" long.
- () Refer to Detail 15-8A (Illustration Booklet, Page 41) and slide one piece of heat shrink sleeving onto the end (not the beveled end) of one of the sonar tubes. Leave 1/2" of heat shrink sleeving extending past the end of the sonar tube.

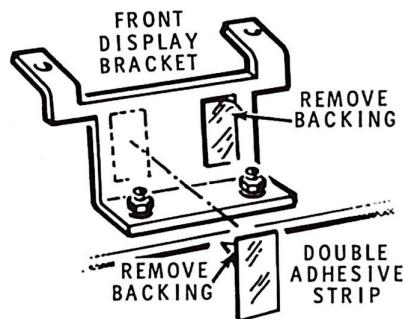
NOTE: When you install the heat shrink sleeving in the following steps, use only enough heat to get the job done. Too much heat can damage the sleeving or the sonar tube. Move the heat source around to distribute the heat evenly and avoid damaging anything.

- () Refer again to Detail 15-8A and heat the end of the heat shrink sleeving (toward the center of the sonar tube) until that end fits snugly. You may use a gas or butane lighter, a match, or a candle to heat the sleeving.
- () Locate the remaining pair of sonar transducers and identify the receiver (R) and transmitter (T).
- () Hold the sonar tube up as shown in Detail 15-8A and place a sonar transducer face down into the heat shrink end so it sets against the end of the tube. Then heat the remainder of the heat shrink (be careful of the wires from the transducer) to hold the transducer in position against the end of the sonar tube.
- () In a similar manner, use the remaining piece of heat shrink sleeving to mount the other transducer at one end of the other sonar tube.

- () Replace the sonar tubes in the sonar clips. Refer to the Pictorial and make sure that you put the receiver tube and the transmitter tube in the proper locations. Position each tube so its end is approximately 1/4" in from the edge of the head plate.

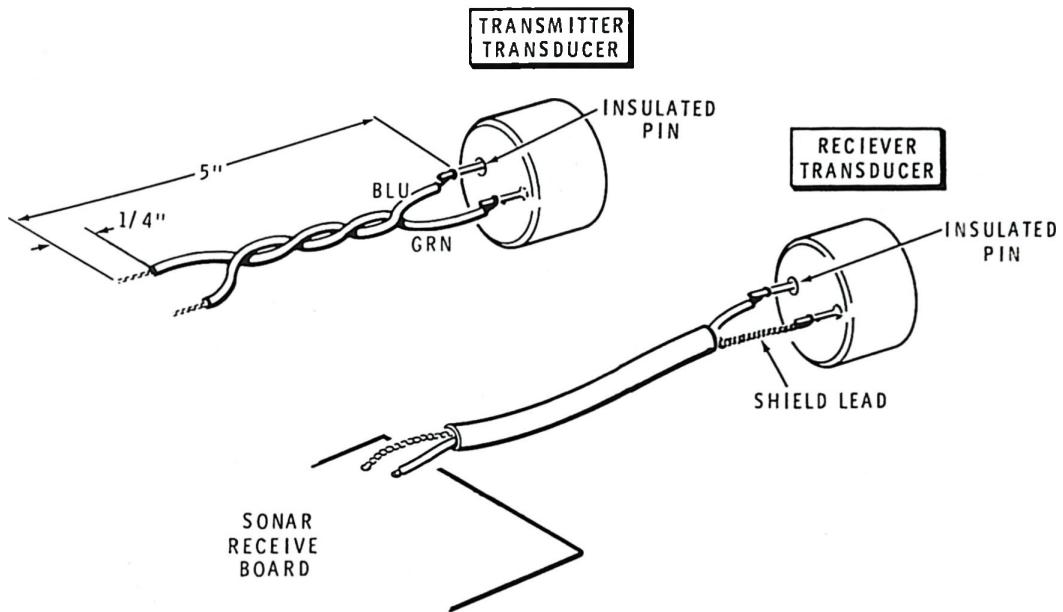
NOTE: The double-adhesive strips used in the next steps have a backing on both sides. One of the backings may peel off easier than the other. Either side may be applied first.

- () Carefully peel one of the backings off of a piece of double-adhesive strip. Then refer to Detail 15-8B and press the strip in one of the two positions on the outside of the front display bracket as shown.
- () In a similar manner, stick the second piece of double-adhesive strip at the other position on the front display bracket.
- () Carefully peel the other backing from the two pieces of double-adhesive, leaving only the adhesive on the bracket.
- () Refer to Pictorial 15-8 and slide the sonar pad onto the sonar tubes. Slide the pad all of the way on until the lower lip fits against the head plate; then gently press the center of the pad to make it seat on the adhesive strips.
- () Adjust the two tubes in their clips until the front of each tube is recessed 1/4" inside the outside edge of the sonar pad as shown in inset drawing #1 on Pictorial 15-8.

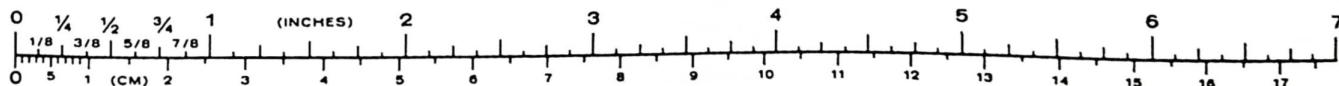


Detail 15-8B

- () Refer to Detail 15-8C and prepare a 5" green-blue cable from the 8-conductor flat cable. Twist the wires as shown and form a hook in each wire at one end.
- () Solder the hook of the blue wire to the insulated pin of the transmitter transducer, and the green wire to the other pin. The free end of these wires will be connected later.
- () Locate the shielded cable from the sonar receive circuit board and form a hook in the end of the shield wire and the center conductor.
- () Solder the hook of the center conductor to the insulated pin of the receiver transducer, and the hook on the shield lead to the other pin.



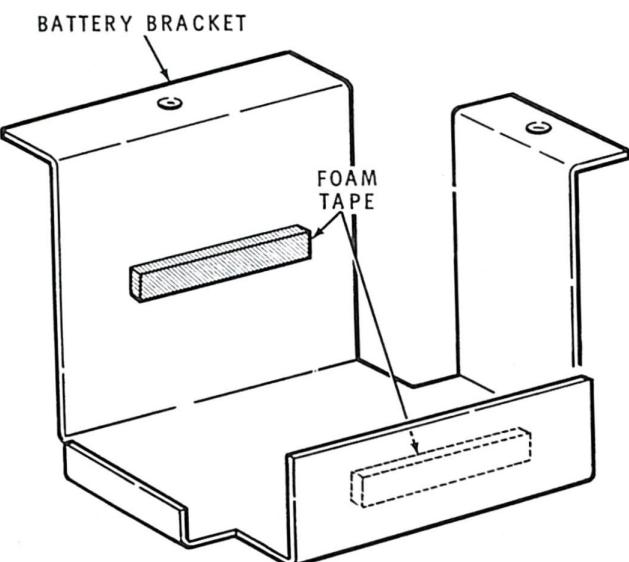
Detail 15-8C



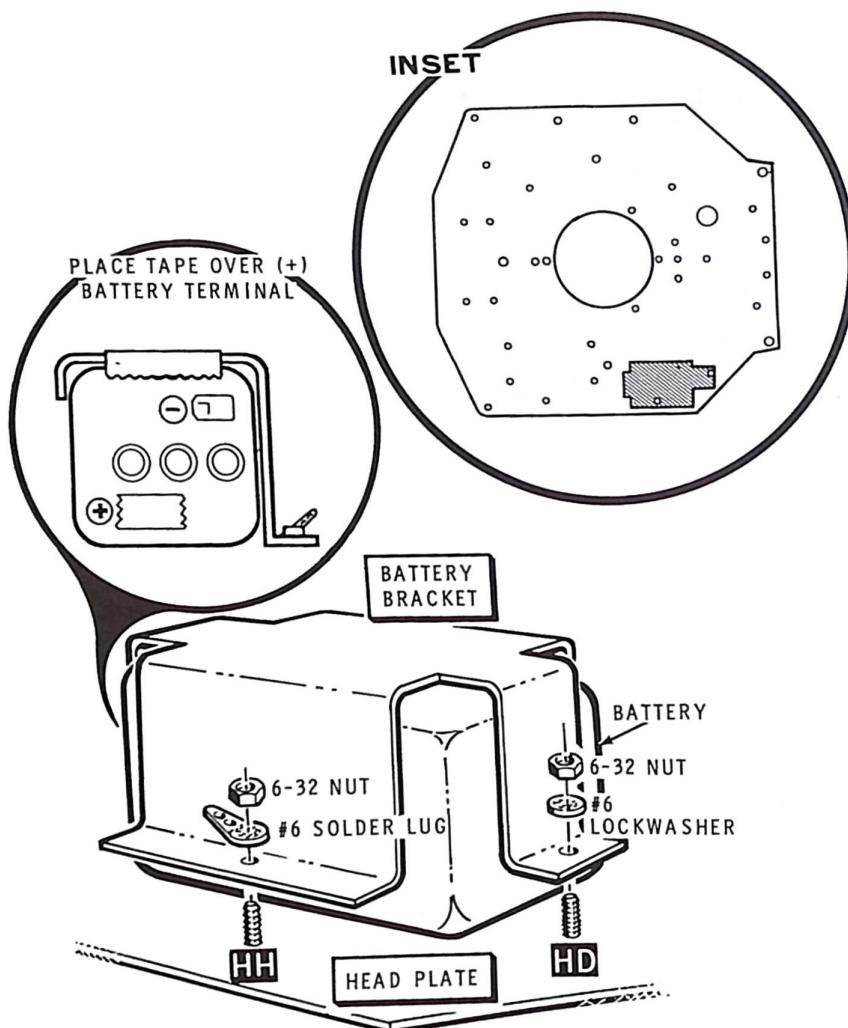
OTHER COMPONENTS

Refer to Pictorial 15-9 (Illustration Booklet, Page 42) for the following steps.

- () Refer to Detail 15-9A and position the battery bracket as shown. Remove the backing from two $1\frac{1}{2}'' \times \frac{1}{2}'' \times 2''$ pieces of foam tape. Stick the tape to the battery bracket as shown.
- () Refer to Detail 15-9B and mount the battery and bracket to head plate studs HD and HH. Position the battery terminals as shown. Note the #6 solder lug at HH.
- () Place a piece of tape over the positive (+) battery terminal to avoid the possibility of shorting the battery during the rest of the assembly.



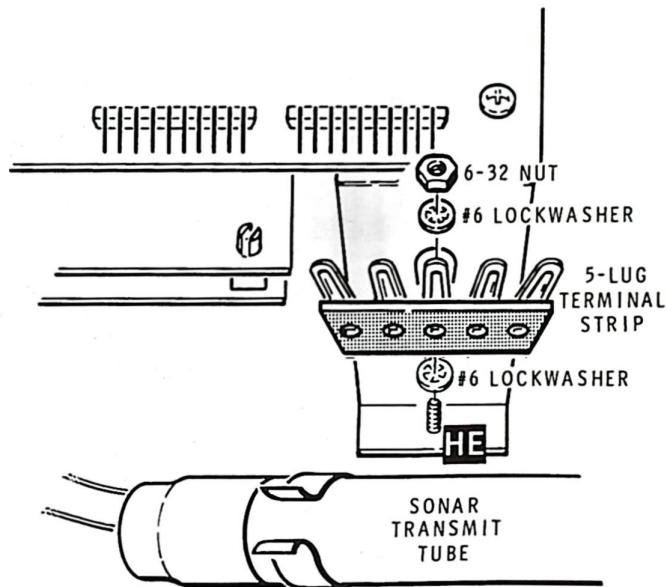
Detail 15-9A



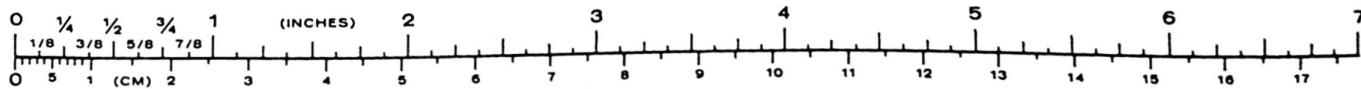
Detail 15-9B

() Locate the 5-lug terminal strip at HE.

NOTE: You will be connecting wires to this terminal strip in the next steps, and there is not much space available. If you need space when you solder, you may wish to remove the sonar transmit tube or the terminal strip from its mounting stud. See Detail 15-9C.



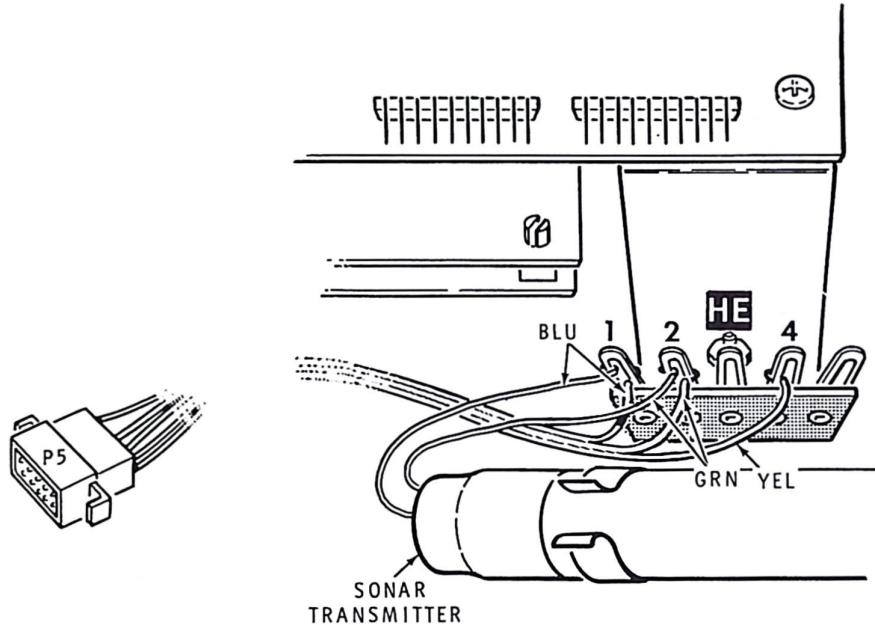
Detail 15-9C



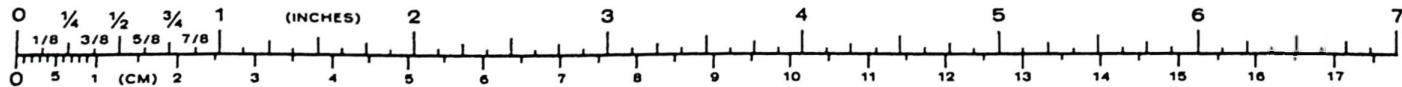
Refer to Detail 15-9D and connect the wires to the terminal strip in the following steps. The wires will come from either the sonar transmit transducer or the head harness connector, P5.

- () 1. Blue wire from P5 to terminal 1 (NS).
 - () 2. Blue wire from the sonar transmitter to terminal 1 (S-2). NOTE: You can gain some extra slack for connecting the sonar wires by sliding the transmitter tube forward in its clips.
 - () 3. Green wire from P5 to terminal 2 (NS).
 - () 4. Green wire from the sonar transmitter to terminal 2 (S-2).

- () 5. Nothing to terminal 3.
 - () 6. Yellow wire to terminal 4 (S-1).
 - () If you have removed the terminal strip, replace it along with a lockwasher and nut as shown in Detail 15-9C on Page 183.
 - () If you moved the sonar tube, return it to its original position (recessed 1/4" from the pad).
 - () Refer to Detail 15-9E and connect connector P1401 to the motion board. Position the connector slots as shown.
 - () Connect plug P1303 to P1303 of the experimental board.



Detail 15-9D

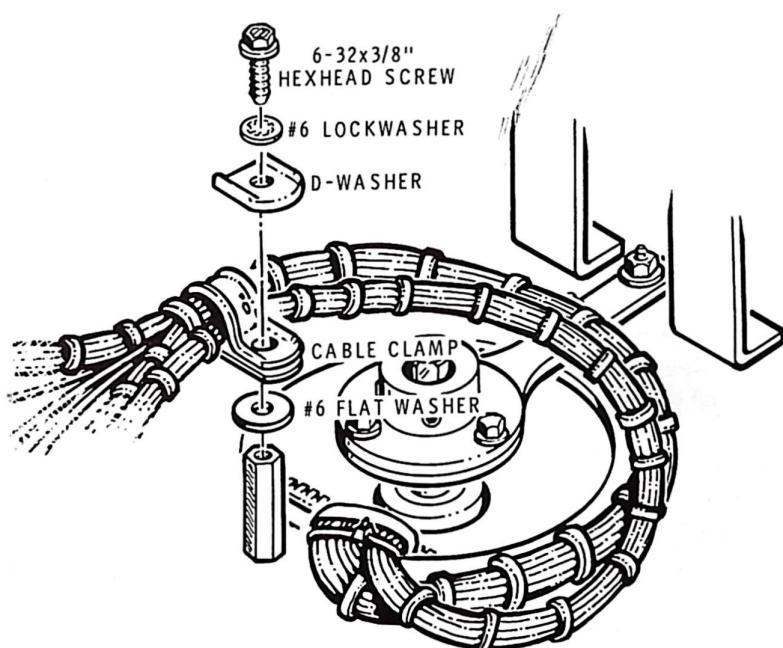


Final Head Wiring

Refer to Pictorial 15-10 (Illustration Booklet, Page 43) for the following steps. In these steps you will finish making the head wiring connections. Note carefully how the wiring is routed and where each connector goes. Reposition the head assembly as shown if it has been moved.

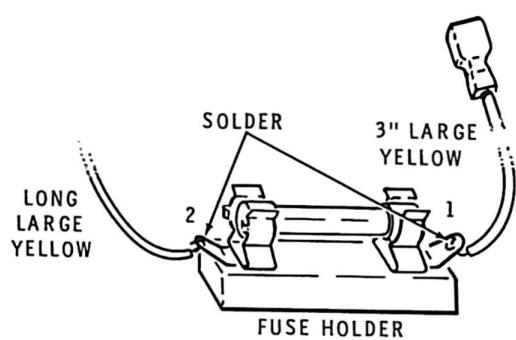
- () Position the wiring harnesses and the large black and yellow wires (from the torso) as shown in the Pictorial. Secure the harness with a cable clamp and #6 × 3/8" hardware at HS as shown in Detail 15-10A. Note that the harness divides just beyond the cable clamp.

- () Identify the large black stranded wire coming from the harness. Route it away from the sonar receive board and to the battery as shown in the Pictorial. Connect the first push-on connector (with two black wires) to the negative (−) battery terminal. Connect the second push-on connector to ground lug HH on the battery bracket.



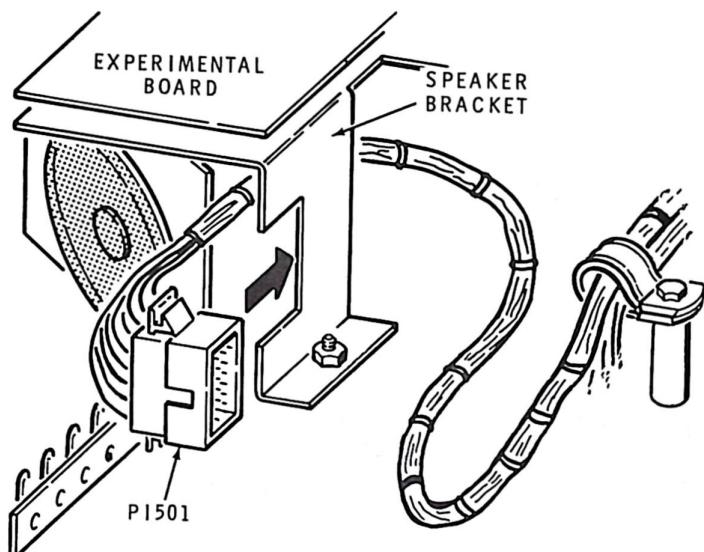
Detail 15-10A

- () Locate the long, large, yellow wire with a push-on connector attached. Cut a 3" piece from the end of this wire for use in the next two steps.
- () Remove 1/4" of insulation from the end of the 3" wire. Twist the end of the wire and apply a small amount of solder to hold the wire strands together.
- () Refer to Detail 15-10B and connect and solder (S-1) the wire to lug 1 of the fuseholder.



Detail 15-10B

- () Prepare the end of the long, large, yellow wire (from which you cut 3"). Connect and solder this wire to lug 2 (S-1) of the fuseholder.
- () Remove the piece of tape from the positive (+) battery terminal. Connect the push-on connector (on the yellow wire coming from the fuseholder) to the positive battery terminal.
- () Identify plug P1101 from the harness and plug it into socket P1101 from the sonar receive board.
- () Identify socket P1501 from the harness. Refer to Detail 15-10C and route the cable around under the experimental board as shown. Then press the ears back on the plug and install it in the experimental board bracket.



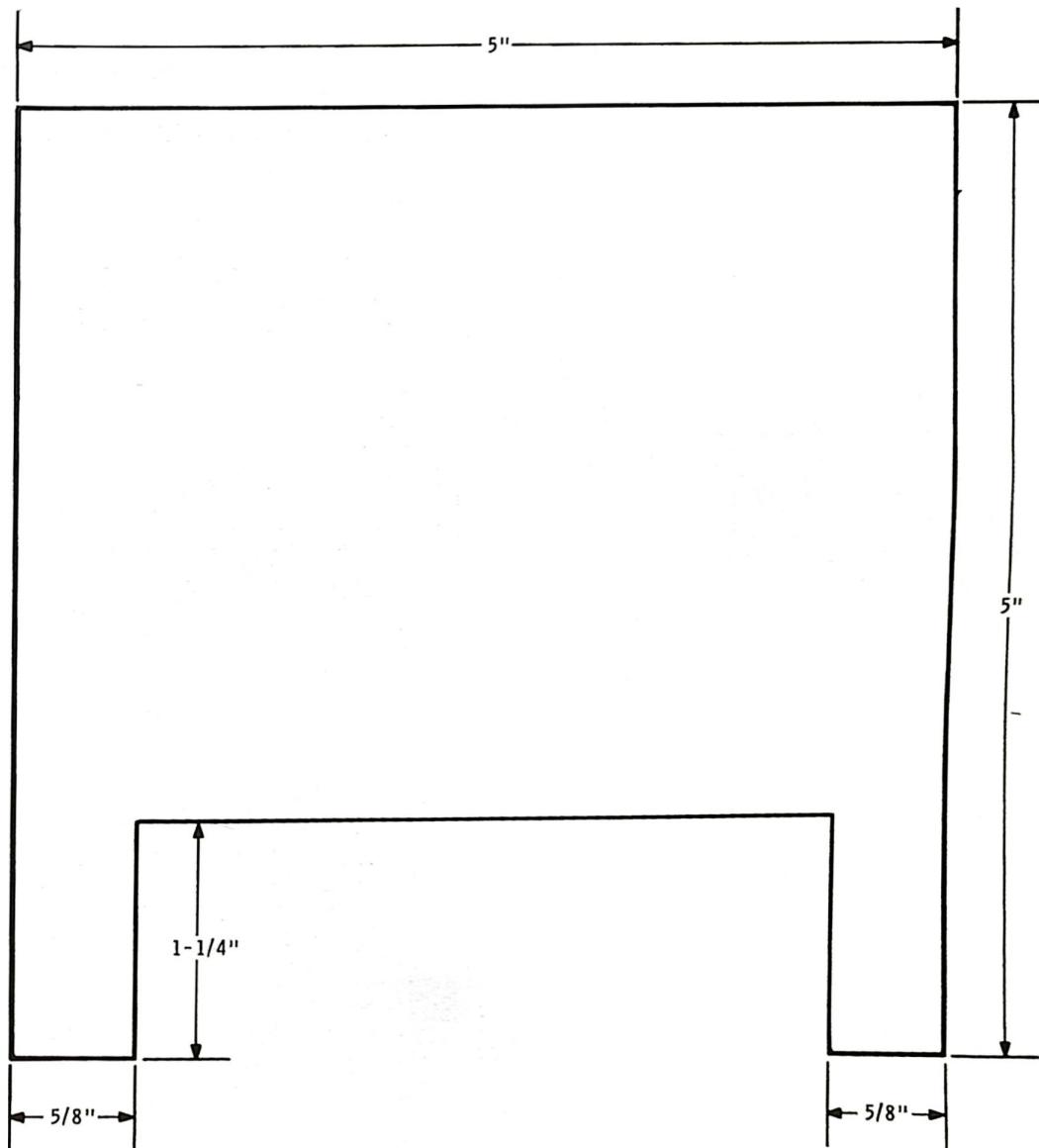
Detail 15-10C

Refer to the Pictorial 15-10 (Illustration Booklet, Page 43) for the following four steps.

- () 1. Identify plug P5 in the harness. Then connect the plug to socket P5.
- () 2. Identify plug P1301 in the harness. Connect the plug to P1301 of the experimental circuit board.
- () 3. Identify plug P1302 in the harness. Connect the plug to P1302 of the experimental circuit board.
- () 4. Identify plug P1304 in the harness. Connect the plug to P1304 of the experimental circuit board.
- () Install a cable tie around the cable going to the Display plug.

Refer to Pictorial 15-11 (Illustration Booklet, Page 44) for the following steps.

- () Refer to Figure 15-11A and cut a 6" × 8" insulator sheet to the dimensions shown.
- () Without removing the backing paper, fit the prepared insulator paper against the foil side of the display board, with the cutout positioned on either side of the 25-pin connector. Be sure the insulator sheet does not cover the mounting holes, in the circuit board. Trim the insulator, if necessary.
- () Remove the backing paper and install the adhesive side of the insulator on the foil side of the display board as described in the previous step.
- () Position the display circuit board over the sonar tubes, as shown. Then connect the plug labeled "Display" to the board.
- () Mount the display board to the front and rear display brackets with the four 4-40 × 3/8" screws and #4 lockwashers.



Detail 15-11A

Head Panel

Refer to Pictorial 15-12 (Illustration Booklet, Page 44) as you perform the following steps.

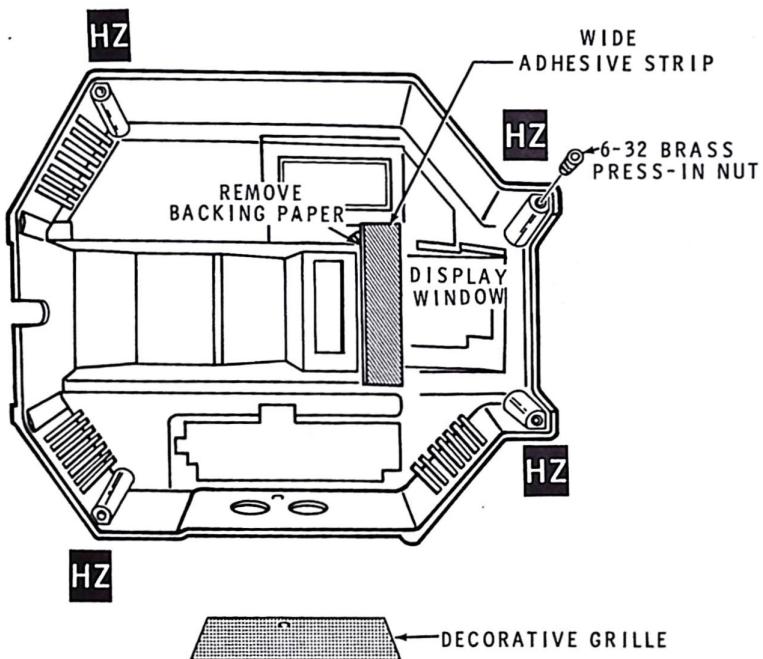
- () Locate the head panel and four 6-32 brass press-in nuts.
- () Refer to Detail 15-12A and install the press-in nuts in the head panel at HZ, just as you did in the remote control teaching pendant and the front and rear panels.

In the following steps you will apply labels to the head panel. Refer to the Pictorial to see where each goes, and install the labels in the following manner.

1. Peel away the backing paper from one side of the label.
 2. Position the part of the label that still has backing paper on it into place, exactly as it should be. Do not let the sticky part touch the head panel yet.
 3. When the label is in the proper position, press the sticky part of the label into place. Then remove the backing paper from the remainder of the label. Carefully smooth the remainder of the label into place.
- () Apply the ET-18 label.
 - () Apply the keyboard label.

- () Apply both portions of the experimental board label.
- () If you do not have the arm option for your robot, install the shoulder label. If you do have the arm option, do not install the shoulder label. A different label is provided with the arm option.
- () Locate the readout window and peel the backing paper from the adhesive-bordered side. Note that the adhesive strip is wider along one edge.
- () Refer to Detail 15-12A and carefully position the window inside the head panel with the wide adhesive as shown, and with the adhesive against the head panel. Then press around the edges to seat the window in place.
- () Remove the protective backing paper from the window. Then use a soft cloth to remove dust or smudges from the window.
- () Install the decorative grille on the outside of the head panel, over the motion sensor openings. Center the grille in the recess.
- () Set the head panel aside, it will be installed later.

This completes the assembly of your Robot. If you have the ET-18-1 Arm Accessory, and/or the ET-18-2 Speech Accessory, you will assemble them after you complete the "Initial Tests and Adjustments" that follow.



Detail 15-12A

INITIAL TESTS & ADJUSTMENTS

The following sections will enable you to check out the various operating portions of Hero, and install the circuit boards. Do the Initial Tests before you go to any accessory (arm or voice) Manuals. Do not make any connections, or apply power to Hero until you are told to do so.

If you do not get the indicated results in any of the following sections, identify and correct the problem before you proceed any further. Refer to the notes in this

section of the Manual for help in servicing your problem. For more difficult problems, refer to the Technical Manual.

Since Hero is a complex device, we urge you to make each of the following checks as completely and carefully as possible. These tests require that you know how to use a high impedance volt-ohmmeter or a digital multimeter. If you do not have one, borrow or obtain one and become familiar with it for these checks.

CHASSIS RESISTANCE CHECKS

You must make all of the following checks before you apply power to your Robot. These checks will help you find any wiring or circuit board problems that could damage your Robot.

Refer to Pictorial 16-1 (Illustration Booklet, Page 45) for the following steps.

- () Be sure the POWER switch is in the off position.
- () Open the Robot's door and remove the two fuses if they were installed earlier.
- () Set your ohmmeter to a range that will read 200 Ω or more.
- () Connect either ohmmeter lead to the Robot chassis.

You will connect the other lead to each of the pins specified in the following steps, one at a time, and read the resistance. Identify the pins by using the board name labels and the pin numbering labels attached to the chassis. The resistance should be more than 200 Ω in each case. If you get readings that are less than 200 Ω , reverse the polarity of your ohmmeter leads and repeat the test. If you still get a low reading, check for the following problems:

1. The labels could be incorrectly placed, causing you to measure at the wrong pin or wrong area. Check against the assembly pictorials.
2. The plug or socket could be installed or wired backwards, causing you to measure at the wrong pin. Check them against the assembly pictorials.

3. Pins and sockets could be improperly mated (pin #2 in socket hole #1, etc.). Visually check each plug and socket mating.
4. Specific wires could go to the wrong place. Check the pin connections and trace the wires from the pin, inside the chassis.
5. If there is a circuit board connected, even at the other end of the wiring harness, that board could have an error. Remove the board and recheck the reading. If the reading is correct when the board is removed, the fault is in the circuit board. Refer to the portion on installing circuit boards, which follows, for a discussion of checking circuit boards.

Pictorial 16-2 (Illustration Booklet, Page 46) will help you locate the area and the plug where resistance measurements are to be made in the following chart.

If you measure more than approximately $200\ \Omega$ at a pin, place a check mark alongside the pin number and proceed to the next point listed. If you obtain a reading that is notably less than $200\ \Omega$, reverse the test leads and try again. If you still get a low reading, write the reading alongside the pin number and refer to the numbered possible problems on Page 215.

Try to locate and clear any problem area before you proceed. However, if you do not locate the problem, complete the rest of the resistance checks, noting all pins that measure less than $200\ \Omega$. Then, by comparing the readings, you may find that a problem exists at a point on the other end of an interconnecting cable rather than where you first obtained a faulty reading.

<u>AREA</u>	<u>PLUG</u>	<u>PIN</u>
Power plug	P2	8 9
Pendent plug	P1	3
Power supply board	P201	3 4
		10
	P202	14 15 16 21 22 23
Sonar transmit board	P101	4
Arm drive board	P102 P701	16 13 19 24 42 44
Main drive board	P801 P802	11 17
Sense board	P602	24
Speech board	P501 P502	11 13
Experimental	P1303	3 5
I/O board	P304 P305	52 55 58
	P311 P312 P317	88 190 148

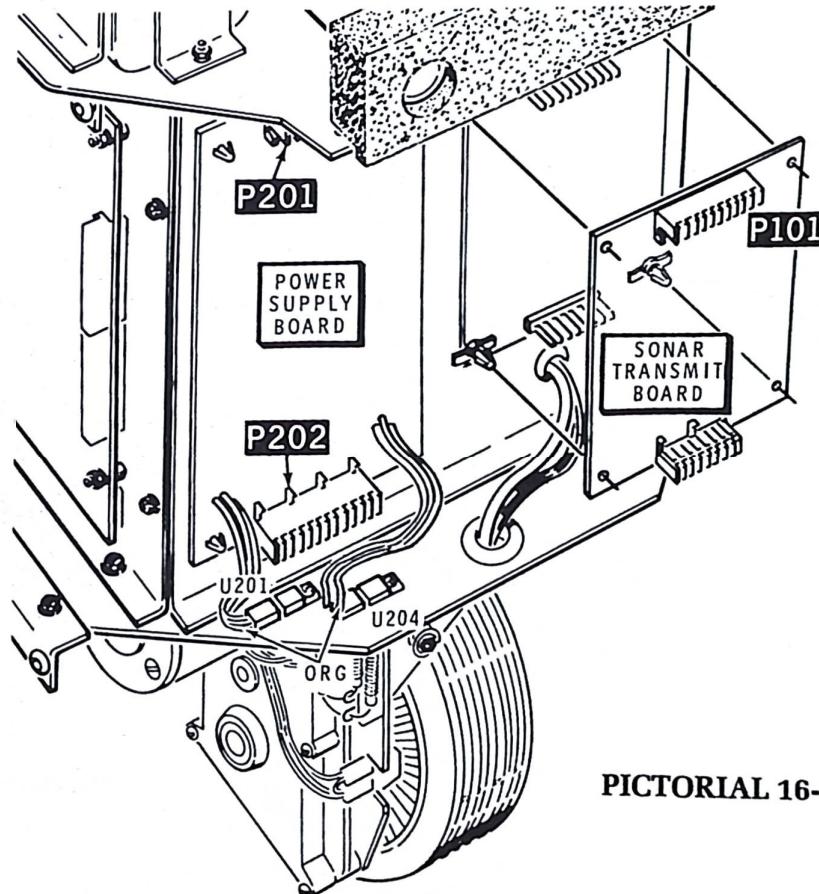
INSTALLING AND CHECKING CIRCUIT BOARDS

After you complete the chassis resistance checks, you will install and check the remaining circuit boards on the Robot chassis, one at a time, and in a specific order. In each case, make sure that you position the connector numbers on the board (such as P201 and P202 for the power supply board) properly to match the labels on the chassis. Then carefully work the board onto the circuit board spacers and the socket pins. Wiggle the board all of the way onto the spacers and pins patiently to avoid breaking anything.

If you get an ohmmeter reading that is less than $200\ \Omega$ during these checks, you have a power-associated error in that circuit board. Check the board using the following general procedure:

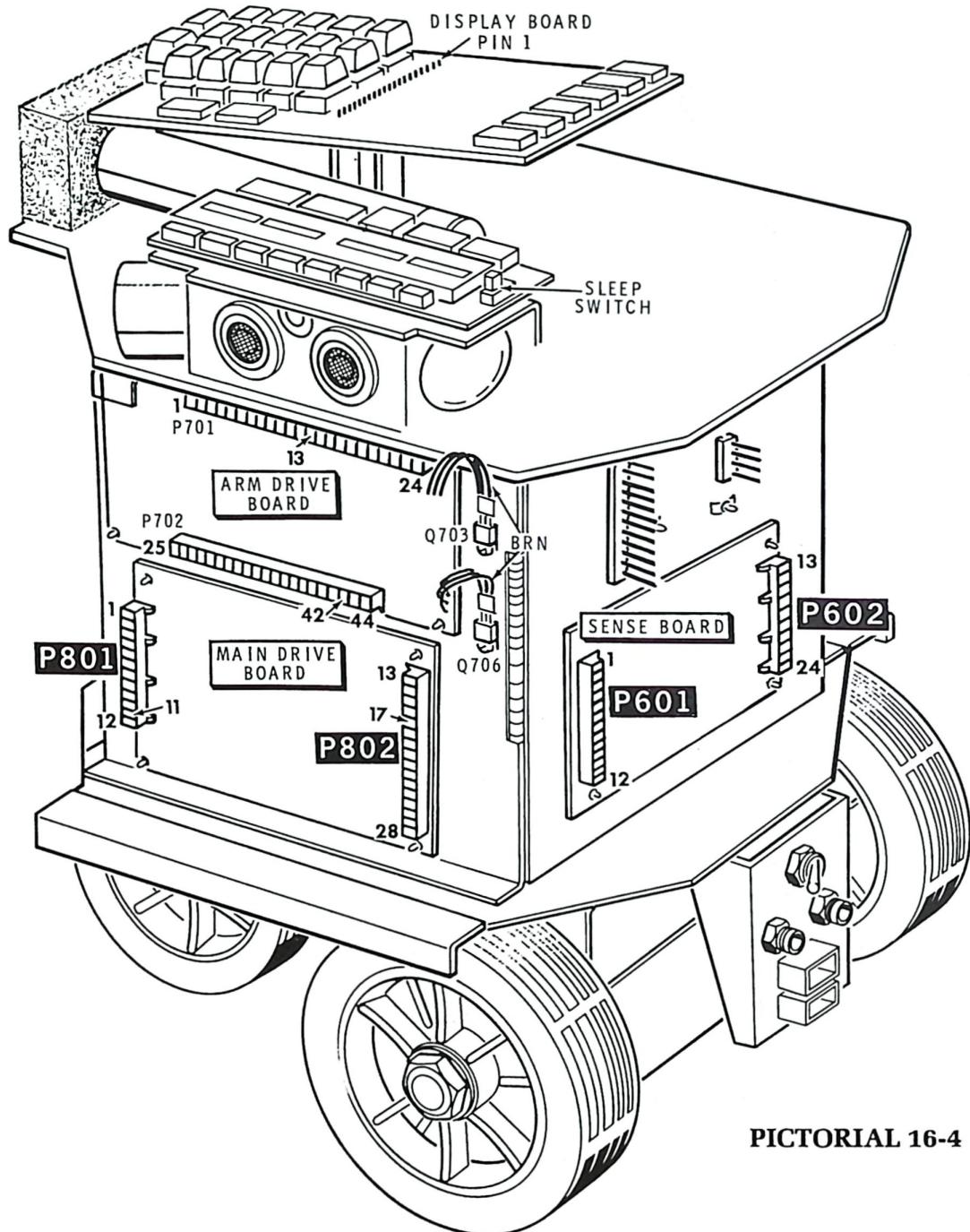
1. Finish checking all of the pins for the board. Record any other pins that give too low a reading.
2. Examine the way the board is installed. Make certain that the board, labels, plugs and sockets are all correct.

3. Remove the board from the chassis and check the foil path coming from the pin that gave the bad reading; there is an incorrect, low resistance, path to ground. Check every solder joint for any solder connecting to another different foil. Check for components that are incorrectly installed.
- () Make sure the Robot's POWER switch (at the back panel) is turned off.
- () Refer to Pictorial 16-3 and install the power supply board on the front of the chassis. P201 should be at the top of the board. Connect the regulator sockets to regulators U201 and U204 with the wire colors as shown. Use the ohmmeter to repeat the resistance checks you made before, of pins 3, 4, 10, 14, 15, 16, 21, 22, and 23.
- () Refer again to Pictorial 16-3 and install the sonar transmit board next to the power supply board. P101 goes at the top. Use the ohmmeter to repeat the resistance checks of pins 4 and 16.



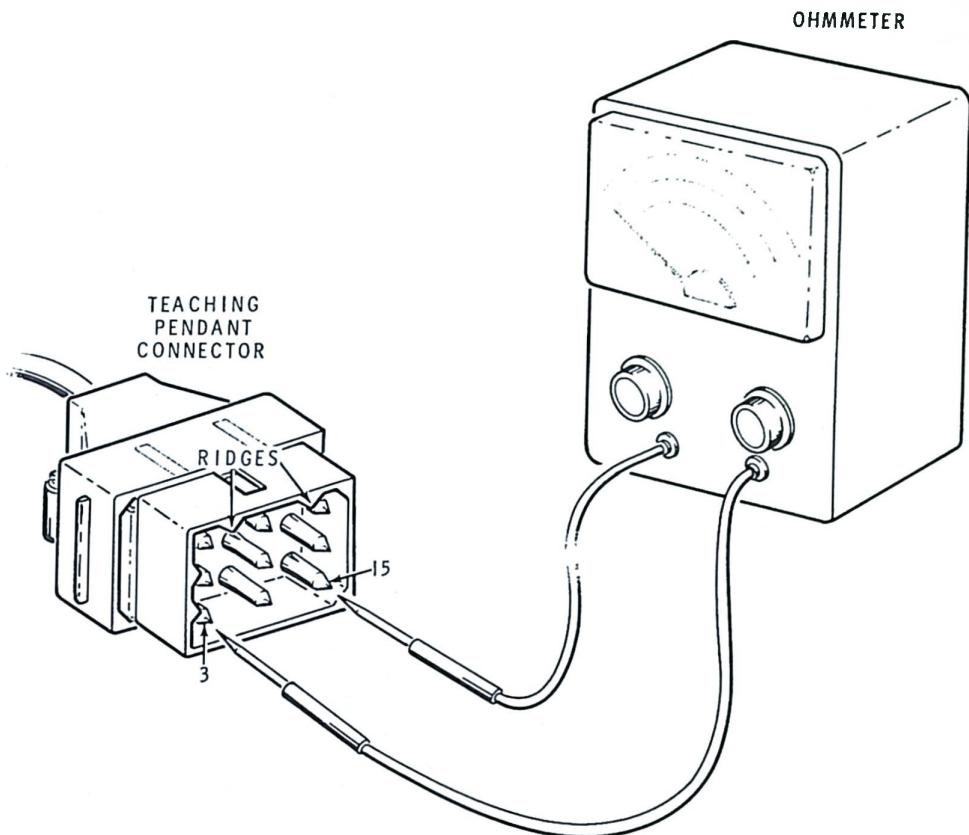
PICTORIAL 16-3

- () Refer to Pictorial 16-4 and place the SLEEP switch (on the experimental board) toward the outside edge of the Robot.
- () Install the arm drive board on the left side panel (top set of pins). Plug the connectors onto the two chassis-mounted transistors Q703 and Q706 as shown. Note the position of the brown wires. Use the ohmmeter to repeat the resistance checks of pins 13, 24, 42, and 44.
- () Refer again to Pictorial 16-4 and install the main drive board at the lower portion of the left side of the chassis. P801 goes to your left as you view that side of the chassis. Use the ohmmeter to repeat the resistance checks of pins 11 and 17.
- () Install the sense board at the lower portion of the door. P601 goes to your left as you view the chassis from the back. Use the ohmmeter to repeat the resistance check of pin 24.
- () Use the ohmmeter to make the resistance check of the display board (already installed) pin 1.



PICTORIAL 16-4

- () Refer to Pictorial 16-5 and use the ohmmeter to check the teaching pendant (remote control) between pins 3 and 15 of its connector. The resistance should be more than 500Ω here.



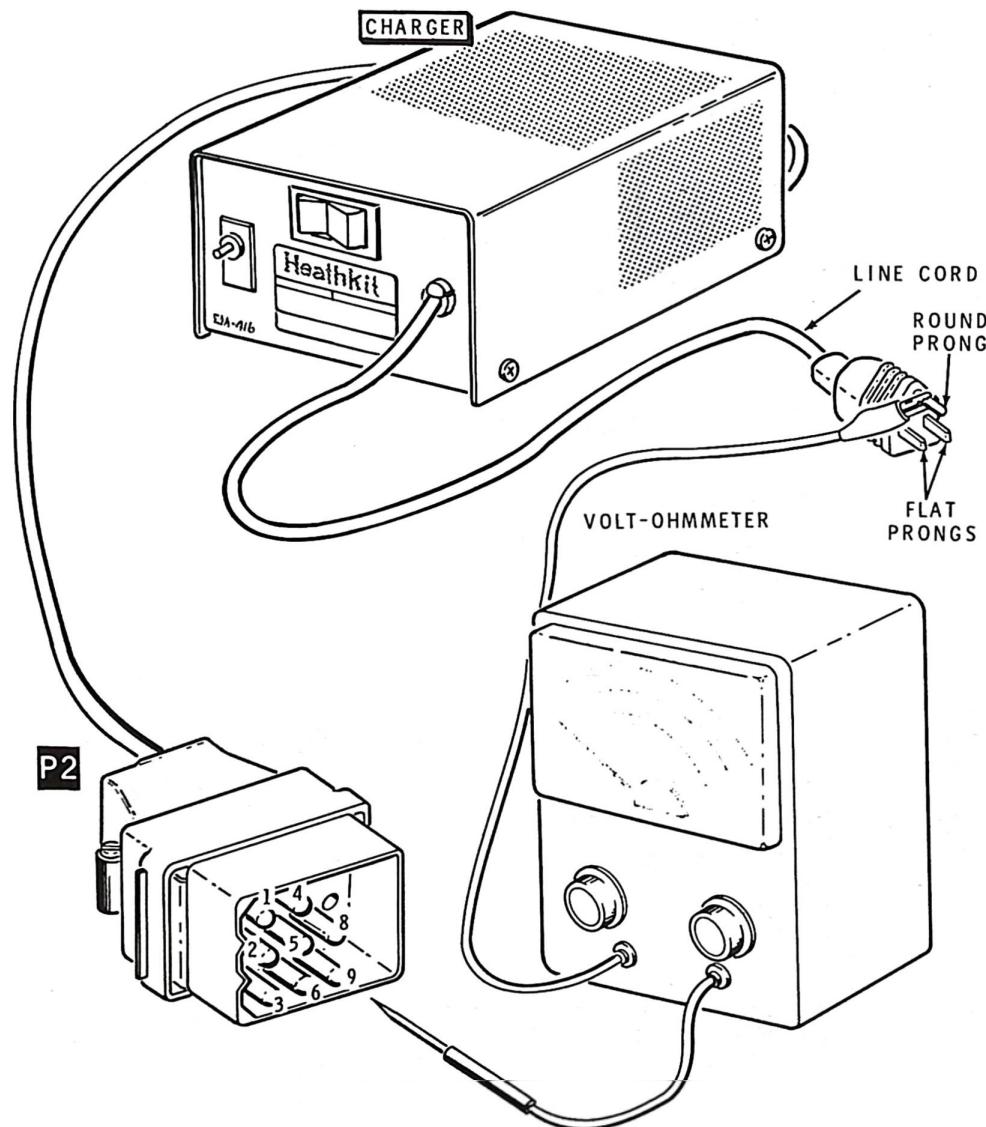
PICTORIAL 16-5

CHARGER CHECKOUT

You will need the charger to bring your batteries to full strength for later operations, so it must be checked out now. Refer to Pictorial 16-6 for the following steps. Make these checks carefully, since a wiring error in the primary wiring circuit (line cord, on-off switch, etc.) of your Charger could cause you to receive a severe electric shock, and could damage your charger or Robot.

- () Make sure the line cord is not plugged in.

- () Turn the Charger's POWER switch to OFF.
- () Set your ohmmeter to read 500Ω or more at mid-scale and make the following resistance measurements on the line cord plug. "Ground" in the chart below means the round prong of the line cord plug, which connects internally to the Charger chassis.



PICTORIAL 16-6

Heathkit®

METER GROUND LEAD	OTHER METER LEAD	METER READING	METER GROUND LEAD	OTHER METER LEAD	METER READING
Ground	Either flat prong of the line cord plug.	Infinite with the power switch either on or off.	Chassis ground.	Pin 9	200 Ω or higher. May increase with time.
Ground	The other flat prong of the line cord plug.	Infinite with the Power switch either on or off.	Chassis ground.	Pin 1	Zero
Either flat prong of the line cord plug.	The other flat prong of the line cord plug.	Infinite with the Power switch off, about 10 Ω with the Power switch on.	Pin 1	Pin 4	Zero
			Pin 2	Pin 3	Zero
			Pin 5	Pin 6	Zero
			Pin 8	Pin 9	Zero
() Turn the Charger's POWER switch OFF.			() Set your volt-ohmmeter to DC volts, 50 volt range. Connect the common (-) lead to pin 1 of plug P2.		
() In a similar manner, make the following resistance measurements on the Charger's power output plug (P2).			() Plug in the line cord and turn the Charger ON. The voltage measured from pin 1 (ground) to pin 9 should be +20 to +28 VDC.		
This completes the checkout of the Charger. Place its POWER switch in the OFF position.					

POWER SUPPLY BOARD

The following instructions allow you to adjust the power supply board charging circuits, so that you can apply power and begin charging Hero's batteries. The batteries will need this since they are not likely to be fully charged. If you do not obtain the results indicated, refer to the Technical Manual.

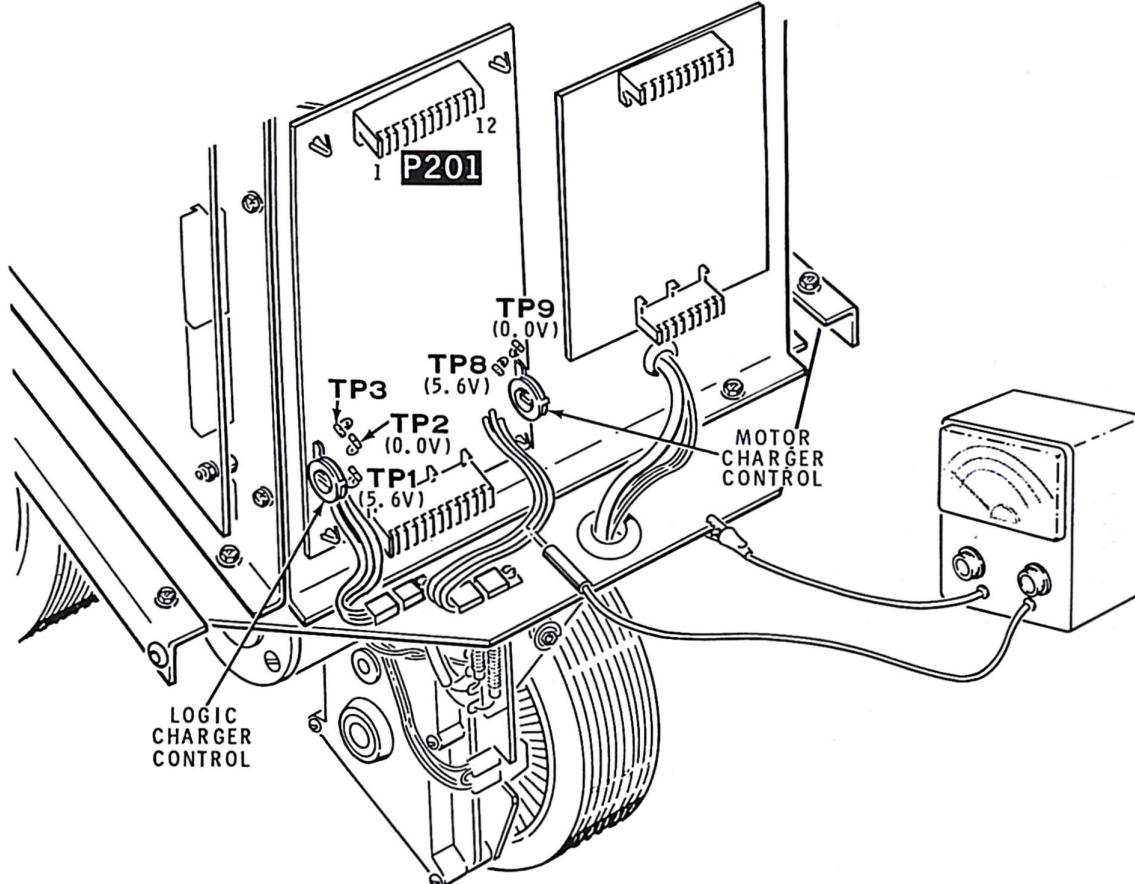
LOGIC BATTERY CHARGING ADJUSTMENT

Refer to Pictorial 16-7 for the following steps.

- () Connect the Charger's supply plug to the Robot.
- () Turn on the Charger and the Robot.

NOTE: The charging light may glow brightly when the power switch is turned on, even with the fuses removed. This is normal as the batteries are charging. If the batteries are fully charged, this light will not glow.

- () Connect the negative voltmeter lead to the chassis and the positive lead to TP1 on the power supply board. Adjust the LOGIC battery charger control (nearest TP1) to give a meter reading of 5.6 VDC.
- () Move the negative meter lead from the chassis to TP2. Readjust the LOGIC battery charger control, if necessary, to give a meter reading of 0 VDC.



PICTORIAL 16-7

Heathkit

MOTOR BATTERY CHARGING ADJUSTMENT

Continue to refer to Pictorial 16-7 for the adjustment of the motor battery charging circuit.

- () With the Charger and Robot still turned on, connect the negative voltmeter lead to the chassis and the positive voltmeter lead to TP8 on the power supply board. Adjust the MOTOR battery charger control (nearest TP8) to give a meter reading of 5.6 VDC.
- () Move the negative meter lead from the chassis to TP9. Readjust the MOTOR battery charger control, if necessary, to give a meter reading of 0 VDC.

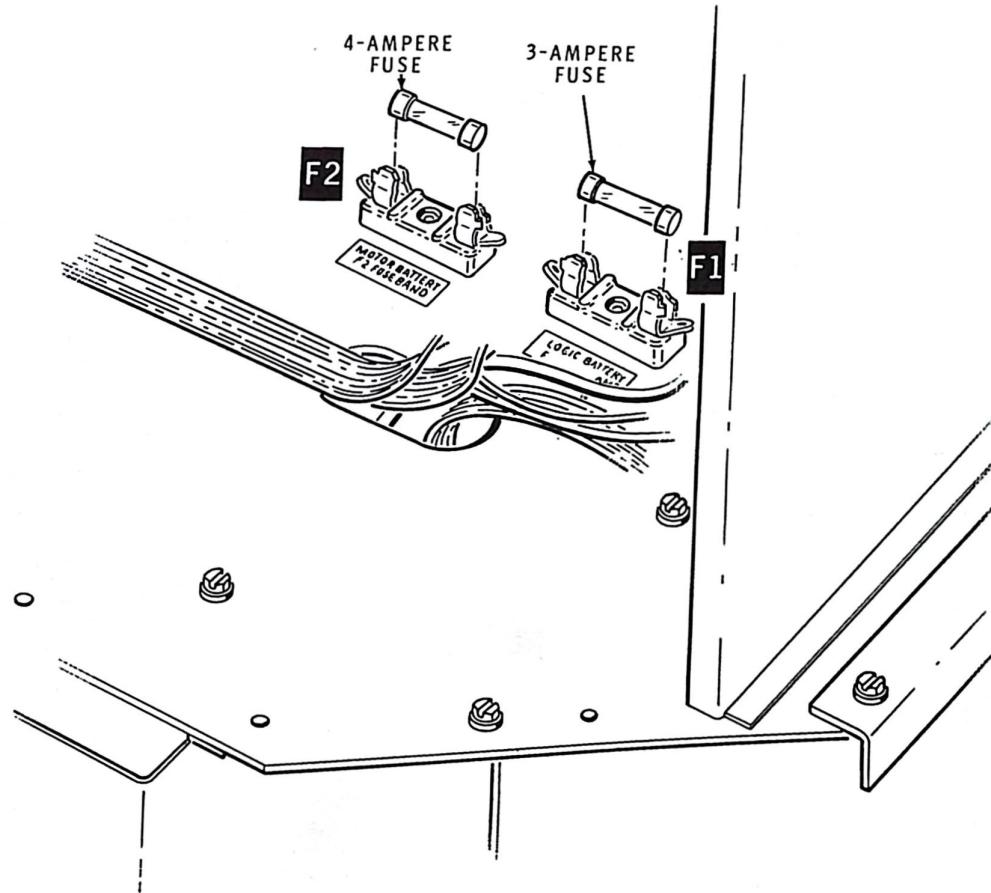
OUTPUT CHECKS

- () Turn the Robot and the Charger Off and install fuses F1 and F2 inside the Robot as shown in Detail 16-7A. Then turn the Robot and the Charger back On.

() Refer to Pictorial 16-7 and measure the voltages on the pins of connector P201 at the top of the board. Connect the voltmeter negative lead to chassis and the positive to the pins indicated.

<u>Pin</u>	<u>Voltage</u>
2	Less than 1.0
3	11.5 to 13.9
4	5.00 to 5.60
5	5.00 to 5.60
10	11.5 to 13.9
11	Less than 1.0

This completes the initial test and adjustment of the power supply board.



Detail 16-7A

CPU AND DISPLAY BOARDS

Refer to Pictorial 16-8 (Illustration Booklet, Page 47) for the following steps.

DISPLAY CHECKS

- () Turn on the Robot and the charger.
- () The LEDs on the display board should be lit, showing all 8s. Carefully clip the jumper wire at the upper right of the display board. The display may change.
- () Depress the RESET button on the display board. The display will show "HEro1.X" for about 10 seconds. Then the display will change to a single dash that moves back and forth across the display.

MICROPROCESSOR CHECKS

The following steps examine the microprocessor on the CPU board, by entering instructions on the Robot's keyboard. Enter each keystroke in the order you are shown. If you make a mistake, go back at that point by pressing RESET, and continue as directed.

These symbols are used in the following charts:

- * Means that the readout character is blank.
- X Means that the readout may be any figure.
- Means that the readout will show a dash.

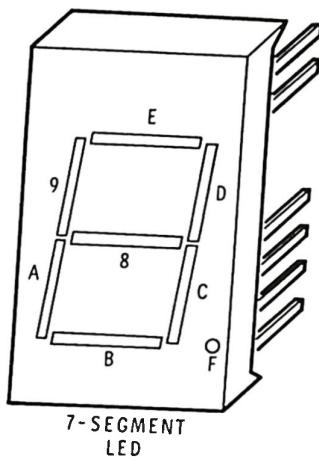
- () Enter the following program, which will test key recognition, and verify that the display response is as shown.

- () Enter the following program. Again, if you make an error, return to the last RESET and begin at that point.

<u>STEP NO.</u>	<u>KEYBOARD ENTRY</u>	<u>DISPLAY</u>
1.	RESET	HEro1.X
2.	A	A.*****
3.	A	---Ad.
4.	0200	0200 - -
5.	86	0201 - -
6.	01	0202 - -
7.	B7	0203 - -
8.	C1	0204 - -
9.	6F	0205 - -
10.	20	0206 - -
11.	FE	0207 - -
12.	RESET	HEro1.X
13.	A	A.*****
14.	D	--- do.
15.	0200	*****
16.	RESET	HEro1.X

This program entered instructions into memory that told the microprocessor to light the decimal point for the left-most digit on the display. This was accomplished in steps 15 and 16.

<u>STEP NO.</u>	<u>KEYBOARD ENTRY</u>	<u>DISPLAY</u>
1.	RESET	HEro1.X
2.	A	A.*****
3.	E	---Ad.
4.	0123	0123XX
5.	C	0123 - -
6.	45	012345
7.	E	---Ad.
8.	6789	6789XX
9.	C	6789 - -
10.	AB	6789Ab
11.	E	---Ad.
12.	CDEF	C.dEFXX

**Detail 16-8A**

The following short program will allow you to change the instruction you used in step 9 before. This program selects just that particular instruction step, which is stored at memory location 0204, and allows you to insert another instruction without reentering the rest of the original program (which does not need to be changed).

<u>STEP NO.</u>	<u>KEYBOARD ENTRY</u>	<u>DISPLAY</u>	<u>EXPLANATION</u>
1.	RESET	HEro1.X	
2.	A	A.*****	
3.	E	---Ad.	
4.	0204	02046F	"6F" is in 0204
5.	C	0204 - -	Ready to change.
6.	5B(SEE NOTE)	02045b	A new instruction selects a different LED segment.
7.	RESET	HEro1.X	
8.	A	A.*****	
9.	D	---do.	
10.	0200	* _ ****	
11.	RESET	HEro1.X	

NOTE: Choose any LED (1 through 6) and any segment (8 through F) you wish.

CLOCK CHECK

The following procedure will allow you to set the time and the date in Hero, and display either on command. This function will continue counting, even with the Power switch off, until you reset the clock.

Time set

- () Press RESET and enter 35. The display will show HH--SS.
- () Enter two digits for the hour, two for the minute, and two for the second. Note that seconds will reset to 00 regardless of the digits you enter. A P 24 is now displayed.
- () Enter D for AM (morning), E for PM (afternoon), or F for a 24-hour clock. The clock will start as

soon as you make the selection, and the Robot will return to the executive mode (ready to execute any instruction you enter).

To read the time, press 37. The time will continue to display until you press RESET.

Date Set

- () Enter 36. The display will show YY--dd.
- () Enter two digits for the year, two for the month, and two for the day. For example, July 4, 1776 would be entered as 760704. As soon as the last digit is entered, the Robot will return to the executive mode.

To read the date, enter 38. The date will continue to display until you press RESET.

MOTION DETECTION CHECKS

Refer to Pictorial 16-9 (Illustration Booklet, Page 47) for the motion detector checks. In this section, you will instruct the CPU through the keyboard, to "enable" (activate) the motion detection circuitry. Then you will observe its operation.

- () Enter the following program.

STEP NO.	KEYBOARD ENTRY	DISPLAY
1.	RESET	HEro1.X
2.	A	A.*****
3.	A	---Ad.
4.	0200	0200 --
5.	4B	0201 --
6.	20	0202 --
7.	FE	0203 --
8.	RESET	HEro1.X
9.	A	A.*****
10.	D	---do.
11.	0200	

The display will turn off and the motion detection circuitry will be activated. You can verify this by observing the LED mounted on the motion board (see the Pictorial). The LED will light when the unit detects motion.

- () Move your hand towards and away from the motion detector transducers, as shown in the Pictorial, to create easily detected motion. The LED will flicker, or light and stay on for a short time, whenever motion is detected.
- () Adjust the sensitivity of the motion detector by turning the SENSITIVITY control, shown in the Pictorial, with a long thin screwdriver. To increase sensitivity, you must turn the control counterclockwise. To decrease sensitivity, turn the control clockwise.

If the LED operates, the motion detector is operating correctly. Press RESET to deactivate the motion detector.

LIGHT DETECTION CHECKS

Refer to Pictorial 16-10 (Illustration Booklet, Page 48) for the light detector checks. In this section, you will instruct the CPU through the keyboard, to "enable" (activate) the light detection circuitry. Then you will observe its operation.

- () Enter the following program.

<u>STEP NO.</u>	<u>KEYBOARD ENTRY</u>	<u>DISPLAY</u>
1.	RESET	HEro1.X
2.	A	A.*****
3.	A	____ Ad.
4.	0200	0200 _ -
5.	41	0201 _ -
6.	20	0202 _ -
7.	FE	0203 _ -
8.	RESET	HEro1.X
9.	A	A.*****
10.	D	____ do.
11.	0200	

The display will turn off and the light detection circuitry will be activated. This circuitry powers the eight LEDs on the sense board. The on and off condition of the LEDs will change as the level of light received by the sensor changes.

- () If you are working in direct sunlight, or very bright artificial light, turn the Robot's head by hand so that the light is not shining directly into the light detector transducer (shown in Pictorial 16-10).

- () Some LEDs should be turned on. Change the amount of light reaching the light detector transducer. You can do this by using a white sheet of paper to reflect more light into the transducer, or by covering the transducer to keep light out. The LEDs should change pattern (that is, some should turn off and others may turn on).
- () Cause the LEDs to change pattern until you are sure that each one does turn on and off. You can do this as described in the preceding step or by adjusting the LIGHT control shown in Pictorial 16-10.
- () When you have verified that the LEDs are working correctly, set the detection level as described in the following two steps.
 1. Expose the Robot to the light level that you think is typical of the conditions it will normally encounter while you are using it.
 2. Adjust the LIGHT control on the sense board to give an LED reading of approximately midpoint for the detector at this light level. NOTE: The LEDs form a binary counter, not a linear indicator: Midpoint is represented by either of the two conditions shown in the inset of Pictorial 16-10.) Turn the control clockwise for operation in lower light conditions, and counterclockwise for operation in higher light conditions.

The light detection circuitry check is complete. Press RESET to deactivate the light detection circuitry.

SOUND SENSOR CHECKS

Refer again to Pictorial 16-10 for the sound sensor checks. In this section you will instruct the CPU through the keyboard to "enable" (activate) the sound sensor circuitry. Then you will observe its operation.

() Enter the following program.

<u>STEP NO.</u>	<u>KEYBOARD ENTRY</u>	<u>DISPLAY</u>
1.	RESET	HEro1.X
2.	A	A.*****
3.	A	____Ad.
4.	0200	0200 --
5.	42	0201 --
6.	20	0202 --
7.	FE	0203 --
8.	RESET	HEro1.X
9.	A	A.*****
10.	D	____do.
11.	0200	

The display will turn off and the sound sensor circuitry will be activated. You can verify this by observing the eight LEDs mounted on the sense board (the same LEDs used with the light detection circuitry). The changing patterns of light on the LEDs will indicate changes in the sound level.

- () Begin with the room as quiet as you are ever likely to encounter while operating the Robot. Set the SOUND control (shown in the Pictorial) so that two or three of the LEDs are always turned on. (Turn the control clockwise, from the top, for operation where the sound is louder; turn it counterclockwise for operation where the sound is softer.)
- () Speak in a normal conversational level, about 5 feet from the Robot. The LEDs should flicker as you speak.

This verifies that the sound sensor is working. Press RESET to deactivate the sound sensor.

SONAR CHECKS

Refer to Pictorial 16-11 (Illustration Booklet, Page 48) for the sonar checks. In this section, you will instruct the CPU through the keyboard to "enable" (activate) the sonar circuitry. Then you will verify that it senses objects in front of it.

() Enter the following program.

<u>STEP NO.</u>	<u>KEYBOARD ENTRY</u>	<u>DISPLAY</u>
1.	RESET	HEro1.X
2.	A	A.*****
3.	A	____Ad.
4.	0200	0200 _ _
5.	45	0201 _ _
6.	83	0202 _ _
7.	BD	0203 _ _
8.	F6	0204 _ _
9.	4E	0205 _ _
10.	96	0206 _ _
11.	11	0207 _ _
12.	BD	0208 _ _
13.	F7	0209 _ _
14.	AD	020A _ _
15.	CE	020b _ _
16.	20	020C _ _
17.	00	020D _ _
18.	09	020E _ _
19.	26	010D _ _
20.	FD	0210 _ _
21.	20	0211 _ _
22.	F0	0212 _ _
23.	RESET	HEro1.X
24.	A	A.*****
25.	D	____do
26.	0200	

The display will change, and will show two figures at the left-most side of the display.

- () Adjust the OSC. FREQ. control on the sonar transmit board to the center of its rotation.
- () Point the sonar transducers squarely at a wall about 5 feet away. The display will show a value* that will stay relatively constant (varying only by 1 or 2 units).
- () Place your hand approximately 2 feet in front of the sonar transducers. The value shown on the display should decrease considerably. This value may change by 2 or 3 units, since it is hard to hold your hand completely still. The value should decrease as you move your hand closer to the Robot, and increase as you move your hand farther away.

NOTE: If the indication remains constant as you move your hand in front of the transducer tubes, move the jumper wire on the sonar transmit circuit board from A to B and repeat the previous step. If you still do not get the proper response, move the jumper wire from B to E, then from E to C. The position of the jumper wire determines the width of the transmitted pulse to compensate for variations in the sensitivity of the sonar transducers. The jumper should be connected to a point furthest from point D where the display will respond to objects at various distances.

If you obtained the appropriate results, the sonar is operating. Press RESET to deactivate the sonar system.

* NOTE: The "value" shown on the display is not in the normal (base 10) number system, but in hexadecimal (base 16). This means that the letters A through F are used to represent numbers, and are placed after 9 as follows: ... 8, 9, A, B, C, D, E, F, 10.

TEACHING PENDANT CHECKS

Refer to Pictorial 16-12 (Illustration Booklet, Page 49) for the teaching pendant (remote control) checks. In this section, you will instruct the CPU through the keyboard to respond to the signals you generate in the teaching pendant. Then you will observe the display to verify that the pendant signals are correct.

- () Plug the teaching pendant into the Robot's remote socket as shown in the Pictorial.
- () Enter the following program.

<u>STEP NO.</u>	<u>KEYBOARD ENTRY</u>	<u>DISPLAY</u>
1.	RESET	HEro1.X
2.	A	A.*****
3.	A	---Ad.
4.	0240	0240 --
5.	BD	0241 --
6.	F6	0242 --
7.	4E	0243 --
8.	B6	0244 --
9.	C2	0245 --
10.	80	0246 --
11.	BD	0247 --
12.	F7	0248 --
13.	AD	0249 --
14.	CE	024A --
15.	10	024B --
16.	00	024C --
17.	09	024D --
18.	26	024E --
19.	FD	024F --
20.	20	0250 --
21.	EF	0251 --
22.	RESET	HEro1.X
23.	1	1.*****
24.	D	---do.
25.	0240	

The display will change and the two left-most figures will display a value (hexadecimal number, like that shown in the sonar checkout section).

- () Set the teaching pendant switches as shown.

<u>SWITCH</u>	<u>POSITION</u>
ROTARY	HEAD
FUNCTION	ARM
MOTION	RELEASED
TRIGGER	RELEASED

- () Place the rotary switch in each of its positions and note the display. The following chart shows the display readings you should get.

<u>SWITCH POSITION</u>	<u>DISPLAY READING</u>
HEAD	FE
EXTEND	EE
(ARM) PIVOT	dE
N	8E
(WRIST) PIVOT	9E
ROTATE	AE
GRIP	bE

Leave the rotary switch in the GRIP position until you are told otherwise.

- () Move the FUNCTION switch to the BODY position. The display should read 3E.
- () Depress the TRIGGER switch. The display should read 3F.
- () Depress the TRIGGER and depress the MOTION switch to the RIGHT position. The display should read 37.
- () Press the MOTION switch to the LEFT position. The display should read 3B.

This completes the teaching pendant checkout. Leave the pendant attached to the Robot and press RESET on the keyboard.

MAIN DRIVE ASSEMBLY CHECKS

HEAD AND STEERING MOTORS

The following step will check the operation of the head drive and steering motors, as controlled by an internal program.

- () Enter 31 at the keyboard. The display will show 3.1****. After about a minute, the head will begin to move counterclockwise and will continue until it reaches the counterclockwise limit position. Then the front wheel will also turn left (counterclockwise) to its limit position. After the front wheel reaches its limit, the head will begin to turn back (clockwise) and will stop when the sonar transducers are pointing straight forward.

There may be a slight pause; then the front wheel will begin to turn back (clockwise) until it too is straight forward. At this point, the display will automatically change to "HEro1.X".

NOTE: There is an adjustment for the front wheel so you can make the "straight-ahead" position more accurate. This is helpful when rolling the Robot in a straight line. You can decide if this adjustment is necessary after actually driving the Robot in the following section. If you decide that you need to adjust the straight-ahead position of the front wheel, return to this part of the "Head and Steering Motor" section.

Refer to Pictorial 16-13 (Illustration Booklet, Page 50) for the steering motor adjustment. To make the adjustment, you will slide the limit switch post slightly sideways. If you wish "straight ahead" to be slightly more to the Robot's right, loosen the post and slide it slightly to the Robot's left. You must then reinitialize the Robot by entering "31" again. This will allow the Robot to learn where the "new" straight ahead is.

DRIVE MOTOR AND TEACHING PENDANT OPERATION

NOTE: In the following steps, you will check out the Robot's drive motor and begin to actually drive Hero about. You will need room to drive it about (a space 4 feet by 10 feet or larger is desirable). Choose a floor with a linoleum or other smooth surface so that the Robot can roll easily. Note that Hero may seem a bit sluggish if the batteries have not had adequate time to charge.

Read each instruction fully before you begin, so you will know what to expect and how to react. Pictorial 16-14 (Illustration Booklet, Page 50) shows the location of the switches on the teaching pendant (remote control).

- () Press 4 at the keyboard. The display will show a 4, followed by a blank and some random figures.
- () Set the pendant's FUNCTION switch to the BODY position, and the ROTARY switch to the N (center) position. Press the TRIGGER and either side of the MOTION switch. The front wheel should turn left or right as dictated by the MOTION switch.
- () Release both the TRIGGER and the MOTION switches, and the front wheel will stay where you pointed it. Press the TRIGGER (only) and the wheel will return to straight ahead. (If the wheel does not turn to exactly straight, refer back to the previous "Head and Steering Motor" section.)

- () Change the ROTARY switch to the (WRIST) PIVOT (also the "forward slow" position), and press the TRIGGER. The Robot will begin to move slowly. Steer the Robot with the MOTION switch, pressing either left or right, until you are at ease with this slow speed. Remember that the front wheel will begin to straighten out when you release the MOTION switch.

NOTE: Whenever the Robot moves forward or backward (or performs other movements with its head or arm), the CPU keeps track of how far the front wheel turns. It does this for the "learn mode" so that it can repeat the trip. This count is shown (in hexadecimal) on the display board. The number is stored and another count begins each time the TRIGGER is released.

- () Increase the Robot's speed by changing the ROTARY switch setting to ROTATE (forward medium) and GRIP (forward fast). The display will continue to monitor distance. Stop the Robot by releasing the TRIGGER.
- () In a similar manner, set the ROTARY switch to the (ARM) PIVOT position (reverse slow), and try operating the Robot as it goes backward. When you are confident enough, move the ROTARY switch to the EXTEND (reverse medium) and HEAD (reverse fast) positions as you guide your Robot about.
- () Set the FUNCTION switch to the ARM position and the ROTARY switch to the HEAD position. You can then use the TRIGGER and the MOTION switch to turn the head in either direction.

SPEED CONTROL

All three speeds, selected by the rotary switch on the pendant, are affected by the SPEED CONTROL

located on the main drive circuit board. See Pictorial 16-12 (Illustration Booklet, Page 49).

The purpose of this control is to set a safe maximum operating speed and to allow you to select more maneuverable medium and slow speeds. If you turn the control too far in either direction, two of the selected speeds may be the same.

- () Set the SPEED CONTROL to its midrange.
- () Turn the SELECTOR switch to GRIP (fast forward) and press 4 on the keyboard.
- () Turn the SELECTOR to the BODY position.
- () Press the TRIGGER momentarily and observe the speed.
- () Adjust the SPEED CONTROL *slightly* in either direction and repeat the previous step.

When the maximum speed is to your preference, check the medium and slow positions of the SELECTOR switch to be sure their speeds are also satisfactory. Readjust the SPEED CONTROL, if necessary, so the maximum speed is not too fast, and the other two speeds give you good control of your Robot.

This completes the initial tests. Press RESET on the keyboard to deactivate the teaching pendant control. You may plug in the Charger to finish charging your Robot's batteries.

If you have accessories to install, proceed to the Accessory Manual(s) and perform the necessary operations as directed. The final installation of head and body panels will be done in the accessory Manual(s). If you do not have accessories, continue to the next section of this Manual for the "Final Assembly."

FINAL ASSEMBLY

HEAD PANEL

After you have completed the "Initial Tests and Adjustments," and have visually verified that nothing is left undone on the Robot chassis (for instance, no fuses left out and the hinged back panel not left open), you are ready to mount the head and body panels. This will make your Robot attractive, and impressive when you display Hero 1. Refer to Pictorial 17-1 (Illustration Booklet, Page 50) to mount the head panel.

NOTE: The following steps apply equally well for installing or removing the head panel with the body panels already in place. If the body panels are not in place, you do not need to turn the head to mount the head panel.

- () Turn the head about 20° as shown in the Pictorial. You may do this by hand.
- () Position the head panel carefully into place over the keyboard, sonar pad, and experimental board, until it sets squarely.
- () Attach the head panel to the head plate from beneath, using four 6-32 × 3/8" flat head screws at the corners shown. If you have any trouble getting to the four mounting holes, turn the head as needed.

BODY PANELS

Refer to Pictorial 17-2 (Illustration Booklet, Page 51) to mount the body panels. All body panels have projections which push into rubber grommets for mounting.

- () Peel the paper backing from the blue and white label. Then press the label onto the base plate as shown. Refer to the numbers on this label in any correspondence with Heath Company about your Robot.
- () In the same manner install the FCC Label on the battery cover as shown.
- () Apply a thin film of silicon grease to the four retainer pins in the two side panels.

- () Refer to the Pictorial and mount the two side panels, by pressing them into the grommets that are part of the chassis. Press them firmly in place.
- () Apply silicon grease to the four tapered pins in the front and back panels. Then mount the panels by pressing them into the grommets in the side panels.

When you take the body panels off, remember to remove the front and back panels first, then the side panels.

This completes the assembly of the Robot. Proceed to the User's Manual for information about the operation of your Hero 1.



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 identification 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 any portions of your Robot that need service. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.) Identify the questionable area by using the "Troubleshooting" section of your Technical Manual and Heath's Technical Consultants (if necessary), then return only the questionable portion for service. Never send a complete Robot unless you are instructed to do so by a Technical Consultant.

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

If you should need to ship some portion of the Robot to the factory, attach a letter containing the following information directly to that portion of the Robot:

- 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.)

Package any portions of the Robot that you wish to ship in a strong carton with at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides. Refer to Heath Company for instructions for sending the entire Robot or large portions of it.

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

595-3069-3

IMPORTANT NOTICE

Please make the following changes in your Assembly Manual before you start to assemble your kit.

Page 73 — Right column, under "Miscellaneous."

Change: D1 64-839 17 Pushbutton switch
To: D1 64-955 17 Pushbutton switch

Change: 85-2599-2 1 Display circuit board
To: 85-3316-1 1 Display circuit board

Add: D8 266-1285 17 Shaft extender

Page 74 — R1266 is in different location than shown.

Page 76 — Remove the new Page 76 attached to this Notice and tape it over Page 76 in your Manual.

Page 78 — Remove the new Page 78 attached to this Notice and tape it over Page 78 in your Manual.

ILLUSTRATION BOOKLET

Page 4 — Cut out the new Pictorial D1 supplied below and tape it over D1 in your Illustration Booklet.

— Cut out Pictorial D8 supplied below and tape it at the bottom of Page 4 in your Illustration Booklet.

Thank you.

HEATH COMPANY

