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μMATIC™ MEMORY KEYER

Model SA-5010A

595-3341-1

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. Eastern Time, Weekdays Only)

Education Products **616-982-3980**
Amateur Radio **616-982-3296**
Test Equipment, Weather Instruments, Clocks **616-982-3315**
Television **616-982-3307**
Home Products, Stereo, Security, Telephone, Marine, Automotive **616-982-3496**
Computer — Hardware **616-982-3309**

YOUR HEATHKIT 1 YEAR 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 1 year 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 1 year from the date of purchase, any malfunction caused by defective parts or materials 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 our 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 entirely. 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 exlusion 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 resonsibility.

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 to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

10-1-87

μMATIC™
MEMORY KEYER
Model SA-5010A

595-3341-1

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

TABLE OF CONTENTS

INTRODUCTION

The SA-5010A μMatic Memory Keyer is a compact unit with modern design in electronics and styling. The Memory Keyer uses a microprocessor which keeps component count low and reliability high. Features of the Memory keyer include:

1. Up to 10 buffers for storing text or commands. These are variable length buffers, which eliminates wasted memory space. Available memory is also effectively increased by the use of "command strings" and by a repeat feature which allows you to automatically send a message up to ten times.

2. An editing feature which allows easy recovery from errors when you load a message buffer.

3. A built-in sidetone oscillator and speaker with variable volume and pitch. A phone jack and earphone are provided for private use.

4. A thin 22-position keypad lets you select character formation, speed, character spacing, character weighting, message repeat count, buffer number and mode. The sidetone is gated to provide audible feedback to produce a "click." Illegal entries and error conditions produce a "warble."

5. Integral capacitive "touch" paddles which reduce fatigue. The paddles unplug and store inside the Keyer when not in use. Also, a rear panel jack is provided for an external mechanical paddle assembly.

6. Full "iambic" features.

7. Five LEDs to indicate the current mode of the Keyer.

8. A "practice" mode which allows you to send random code groups of random length and selectable types (alpha, alphanumeric, and alphanumeric plus punctuation). 100 different repeatable random sequences are available, all of which are altered every time you turn on the Keyer.

9. A (P/C) key which allows you to pause, manually insert text into a buffer message being sent, and then continue. When you insert a pause character in a message or command string, an automatic pause is made at that point so you can manually insert text.

10. CMOS memory with battery backup to retain the buffer contents, as well as the last-selected speed, spacing, weight, and repeat count while the Keyer is turned off and unplugged.

11. Selection of either right-handed or left-handed operation from the keypad.

12. Built-in diagnostics that check the microprocessor each time the Keyer is turned on, and test RAM when batteries are replaced or when the Keyer is reset.

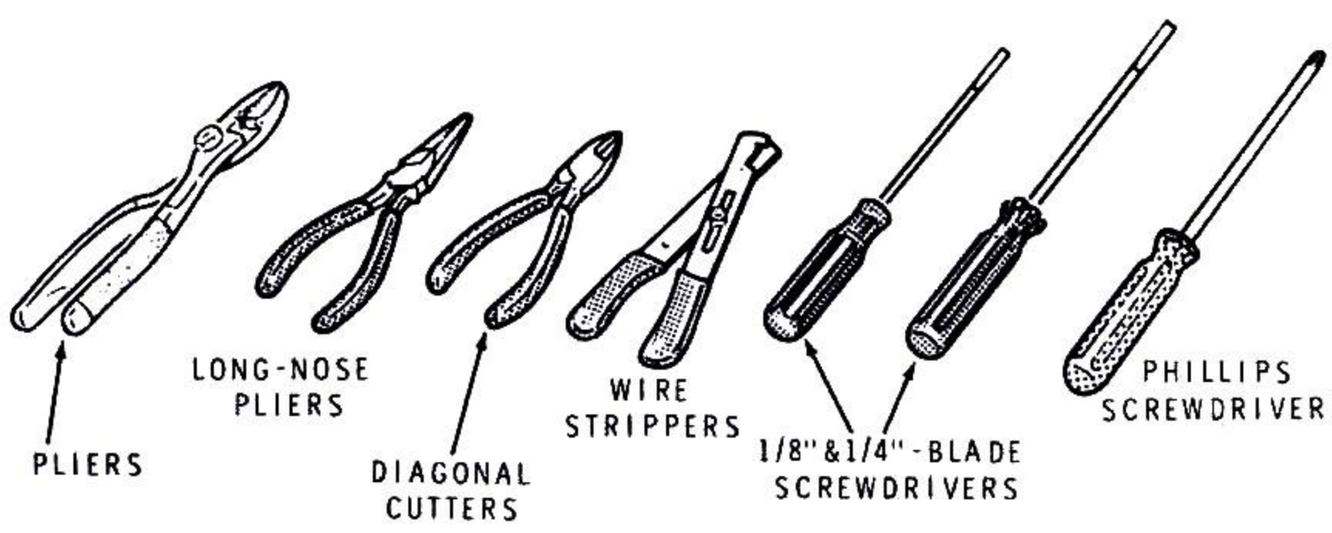
13. Automatic shutoff after more than approximately 15 minutes of non-use.

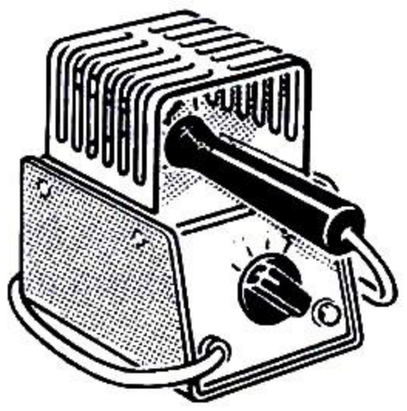
NOTE: If you intend to operate your Keyer with an optional AC transformer, please refer to Page 38 and read the information under "Power Transformer" at this time.

ASSEMBLY NOTES

TOOLS

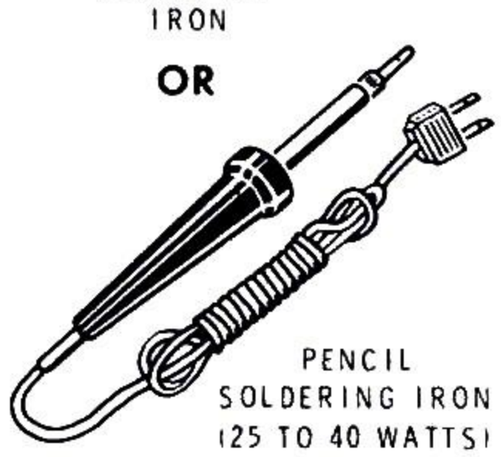
You will need these tools to assemble your kit.





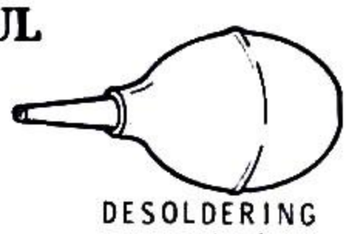
SOLDERING IRON

OR



PENCIL SOLDERING IRON (25 TO 40 WATTS)

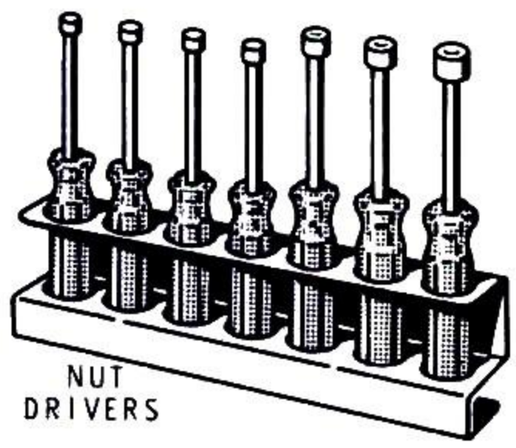
OTHER HELPFUL TOOLS



DESOLDERING BULB*

NUT STARTER (MAY BE SUPPLIED WITH KIT)

DESOLDERING BRAID*



NUT DRIVERS

*TO REMOVE SOLDER FROM CIRCUIT CONNECTIONS.

ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.

2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

4. Position all parts as shown in the Pictorials.

5. Solder a part or a group of parts only when you are instructed to do so.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

   — In the Parts List,

   — At the beginning of each step where a component is installed,

   — In some illustrations,

   — In Troubleshooting Charts,

   — In the Schematic,

   — In the sections at the rear of the Manual.

7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

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

SOLDERING

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

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

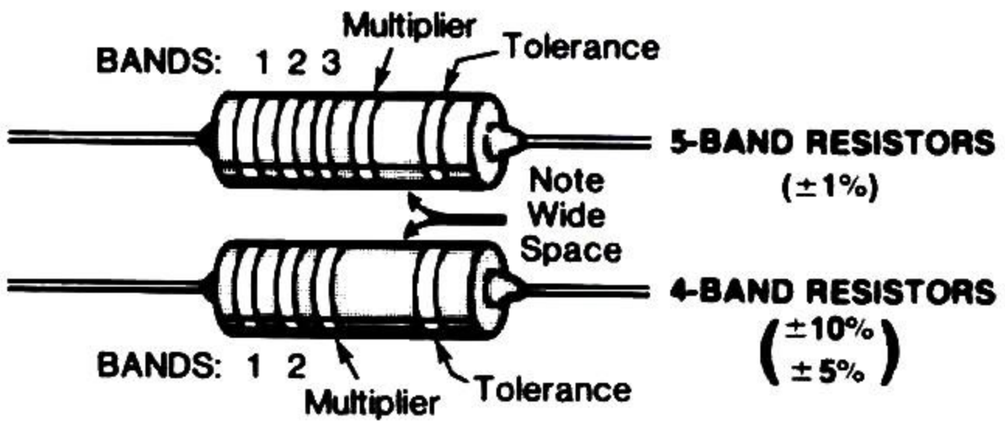
1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.

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.

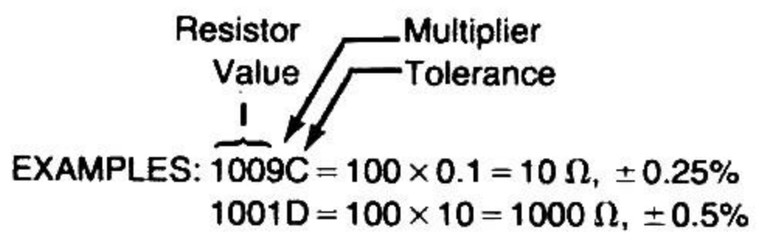
RESISTORS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (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 memorize the color codes.



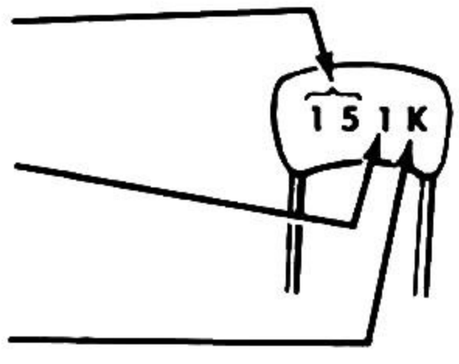
Occasionally, a "precision" or "power" resistor may have the value stamped on it. The letter R, K, or M may also be used at times to signify a decimal point, as in: 2R2 = 2.2 Ω
2K2 = 2.2 kΩ, or 2200 Ω
2M2 = 2.2 MΩ

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.



CAPACITORS

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 CHART

	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	10,000,000
Gray	8	8	8	100,000,000
White	9	9	9	—
Silver	—	—	—	.01
Gold	—	—	—	.1

RESISTOR TOLERANCE CHART

	COLOR OR LETTER	
±10%	SILVER	
± 5%	GOLD	J
± 2%	RED	G
± 1%	BROWN	F
±0.5%	GREEN	D
±0.25%	BLUE	C
±0.1%	VIOLET	B
±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

CAPACITOR TOLERANCE CHART

LETTER	10 pF OR LESS	OVER 10 pF
B	±0.1 pF	
C	±0.25 pF	
D	±0.5 pF	
F	±1.0 pF	±1%
G	±2.0 pF	±2%
H		±3%
J		±5%
K		±10%
M		±20%

EXAMPLES: 151K = 15 × 10 = 150 pF
759 = 75 × 0.1 = 7.5 pF

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

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LED CIRCUIT BOARD

PARTS LIST

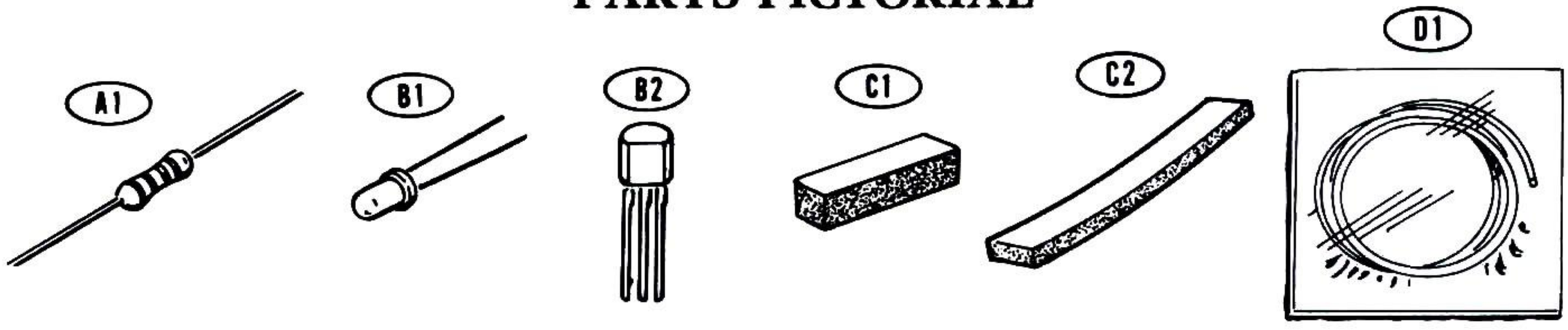
Remove Pack #1 from the carton and check each part against the following list. Make a check (✓) after each part as you identify it. The key numbers correspond to the numbers on the Parts Pictorial. Some parts may be packed in an individual envelope with a part number on it. After you identify these parts, place them back in their bag or envelope until a step calls for them. Do not throw away any packing material, bags, or envelopes until all the 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 of the Manual. Your Warranty is located inside the front cover.

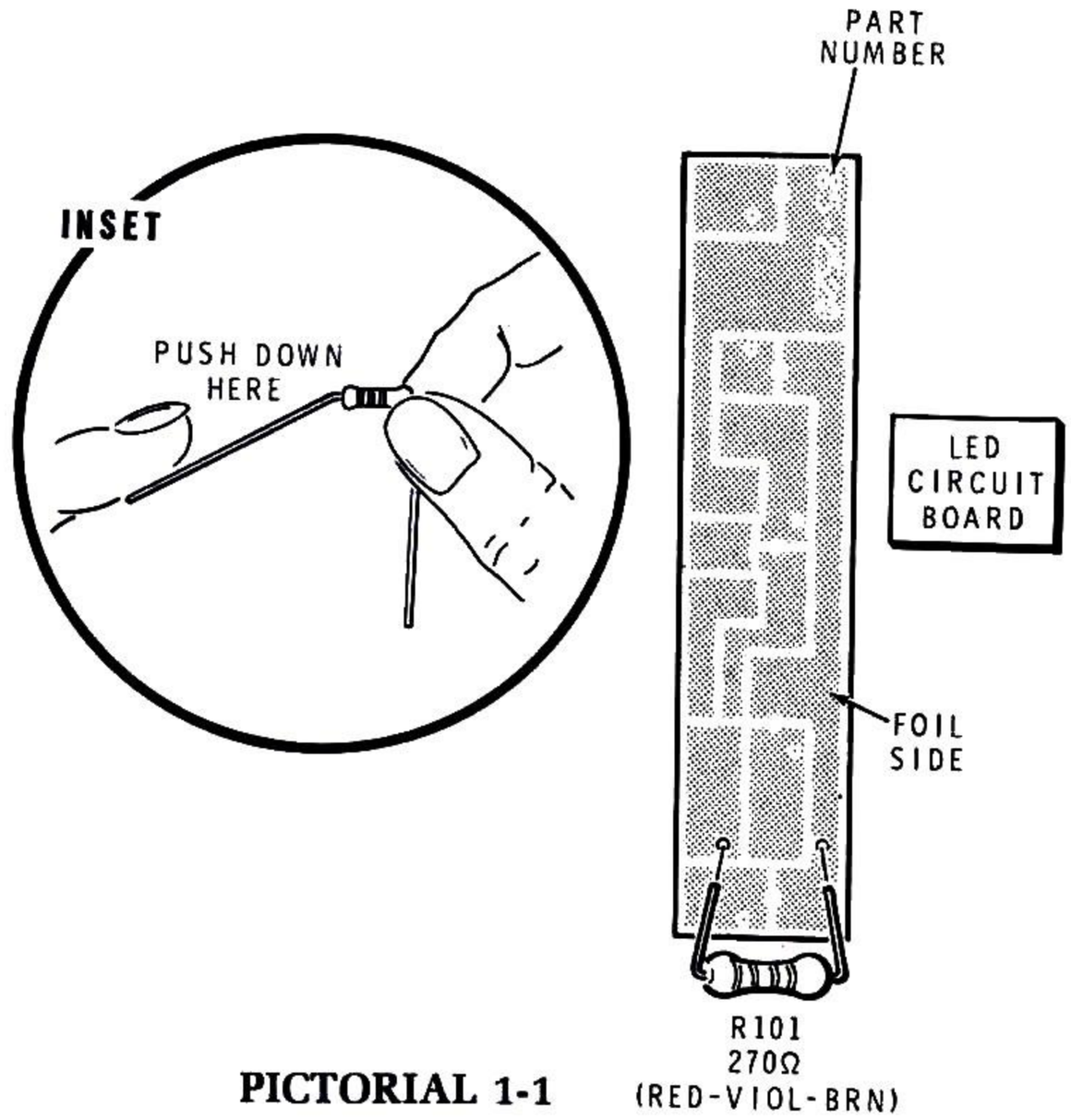
KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS, 1/4 Watt				
NOTE: The following resistors have a tolerance of 5%. 5% is indicated by a fourth color band of gold.				
A1	6-271-12	3	270 Ω (red-viol-brn)	R101,R102, R104
A1	6-102-12	1	1000 Ω (brn-blk-red)	R103
SEMICONDUCTORS				
B1	412-79	5	TIL209 LED	D101, D102, D103, D104, D105
B2	417-801	1	MPSA20 transistor	Q101

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
MISCELLANEOUS				
C1	73-64	1	Wide double-stick foam tape	
C2	73-147	1	Narrow double-stick foam tape	
	85-2520	1	LED circuit board	
	347-55	2'	Flat cable	
PARTS FROM FINAL PACK				
D1	490-185	1	Desoldering braid	
		1	Assembly Manual (See page 1 for Part Number)	
	597-260	1	Parts Order Form	
			Solder	

PARTS PICTORIAL



STEP-BY-STEP ASSEMBLY



PICTORIAL 1-1

Refer to Pictorial 1-1 for the following steps.

( ) Position the circuit board with the foil side up and the part number as shown.

NOTE: In the following steps, you will be given instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully.

( ) R101: Connect a 270 Ω (red-viol-brn) resistor to the foil side of the circuit board at R101. Refer to the inset drawing and hold the resistor by the body as shown and bend the leads straight down. Push the leads through the circuit board holes and press the resistor against the circuit board. Then bend the leads over slightly to hold the resistor in place.

( ) Solder the resistor leads to the circuit board foil as follows.

Refer to the illustrations on the following Page.

1. Push the soldering iron tip against both the lead and the circuit board foil. Heat both the lead and the foil for two or three seconds. Do not apply too much heat to the connection or you may damage the part. Then apply solder to the other side of the connection.

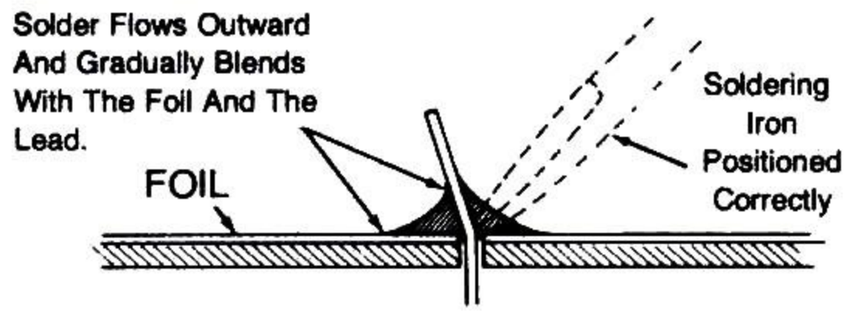
IMPORTANT: Let the heated lead and the circuit board foil melt the solder.

2. 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.

( ) Turn the circuit board over and cut off the excess lead lengths close to the circuit board. WARNING: Clip the leads so the ends will not fly towards your eyes.

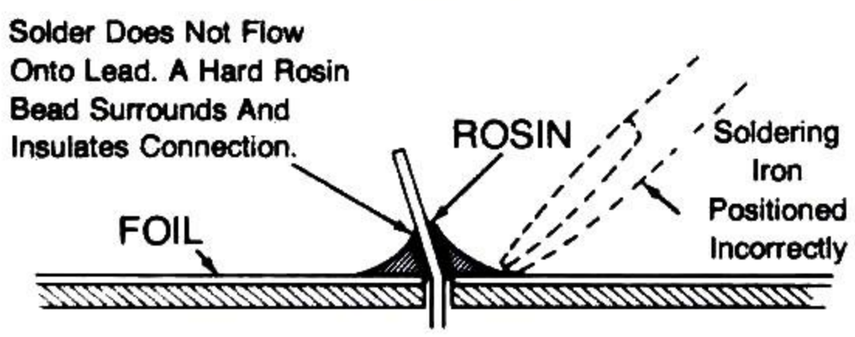
( ) Check the connection. Compare it with the illustrations on Page 9. After you have checked the solder connections, proceed with the Assembly. Use the same soldering procedure for each connection.

A GOOD SOLDER CONNECTION

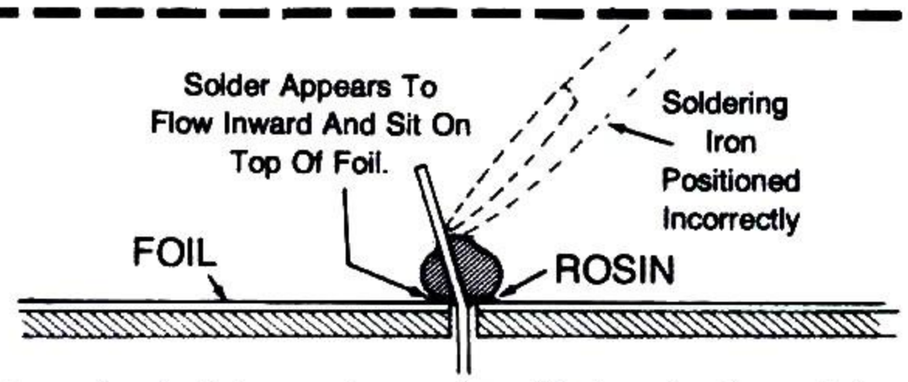


When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

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.

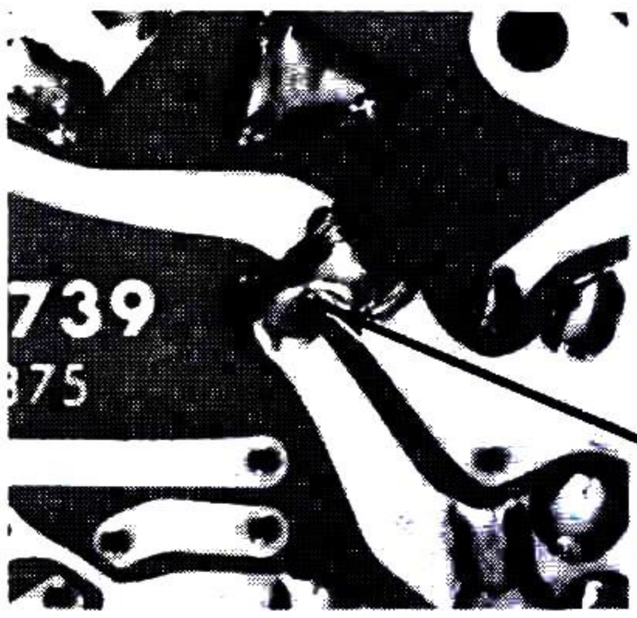


When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

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.



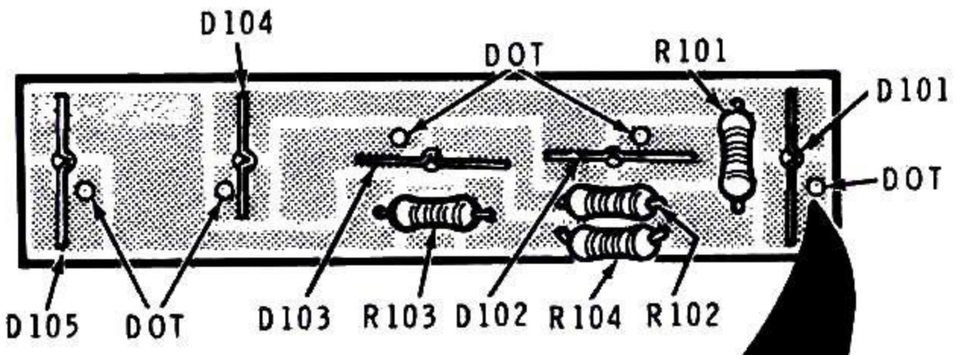
Refer to Pictorial 1-2 (Illustration Booklet, Page 1) for the following steps.

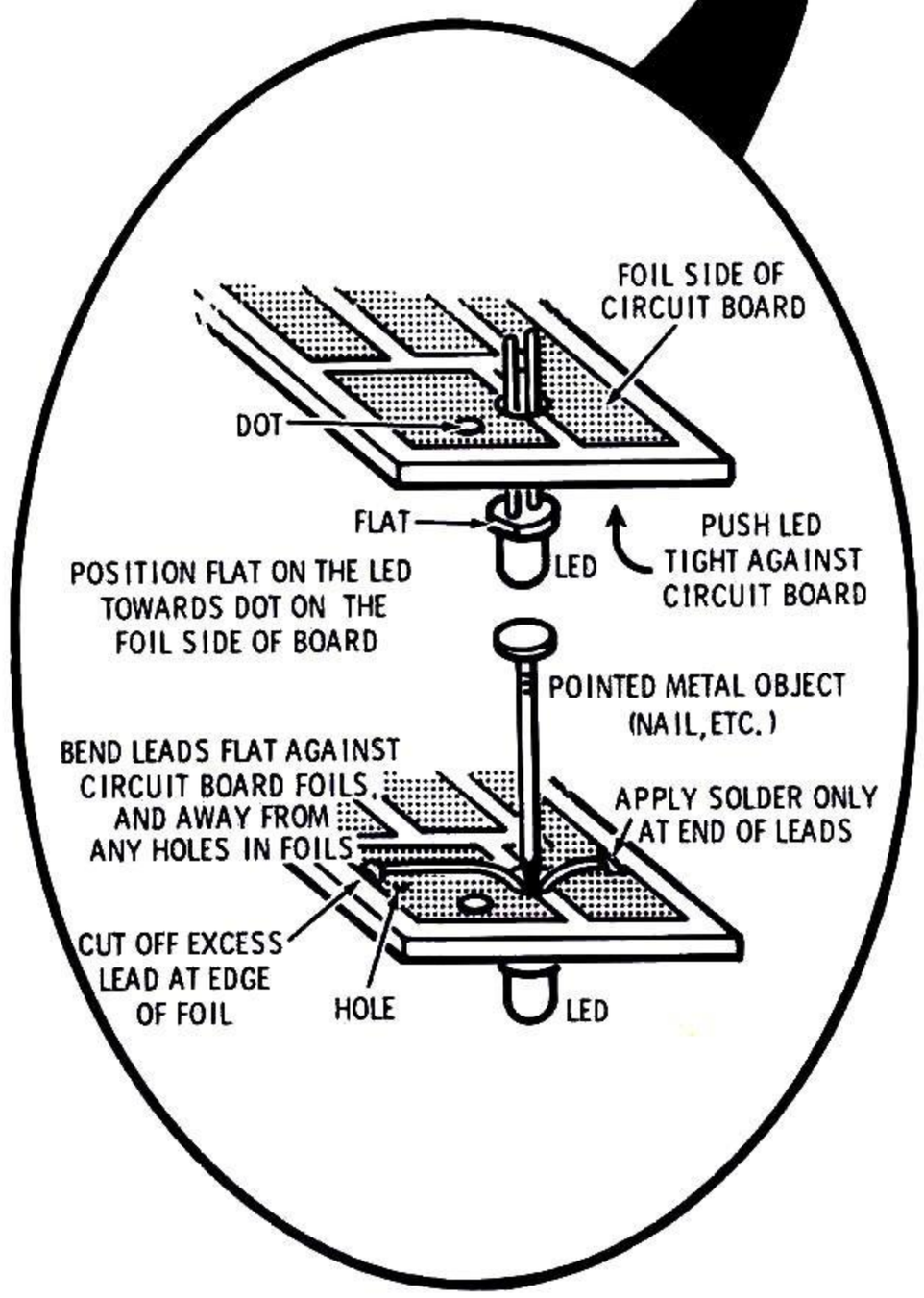
Install 270 Ω (red-viol-brn) resistors at the following locations:

( ) R102.

( ) R104.

( ) Refer to Detail 1-2A and melt a small amount of solder at each LED lead location. This will reduce your chances of overheating the delicate LEDs.





Detail 1-2A

CAUTION: The five TIL209 (#412-79) LEDs you will install in the following steps can be easily damaged if you install them backwards or use too much heat when you solder their leads to the circuit board foils. Install each LED as follows:

1. Insert the leads of the LED up through the circuit board hole so the leads end up on the foil side. Push the body of the LED tight against the board.

2. Position the flat on the LED body towards the circuit board foil that has the dot.

3. Bend the leads of the LED against their correct foil pads. Be sure the leads are away from any unused holes in the board.

4. Cut off the excess lead lengths at the outside edge of their foil.

5. Have another person hold the pointed end of a metal object against both leads of the LED where the leads come out of the hole in the circuit board. Hold the metal object (heat sink) with pliers to keep from getting burned.

6. Solder each lead at its end near the outside edge of its foil pad. Remove the soldering iron as quickly as possible, but hold the metal object against the leads until the connections have cooled.

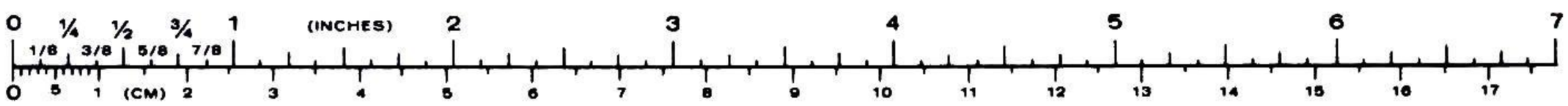
( ) D101.

( ) D102.

( ) D103.

( ) D104.

( ) D105.



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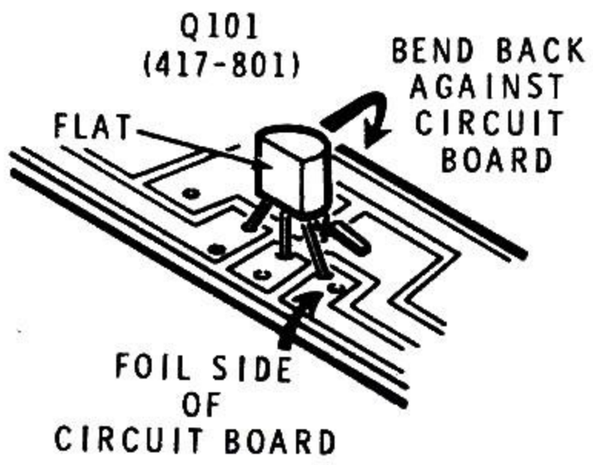
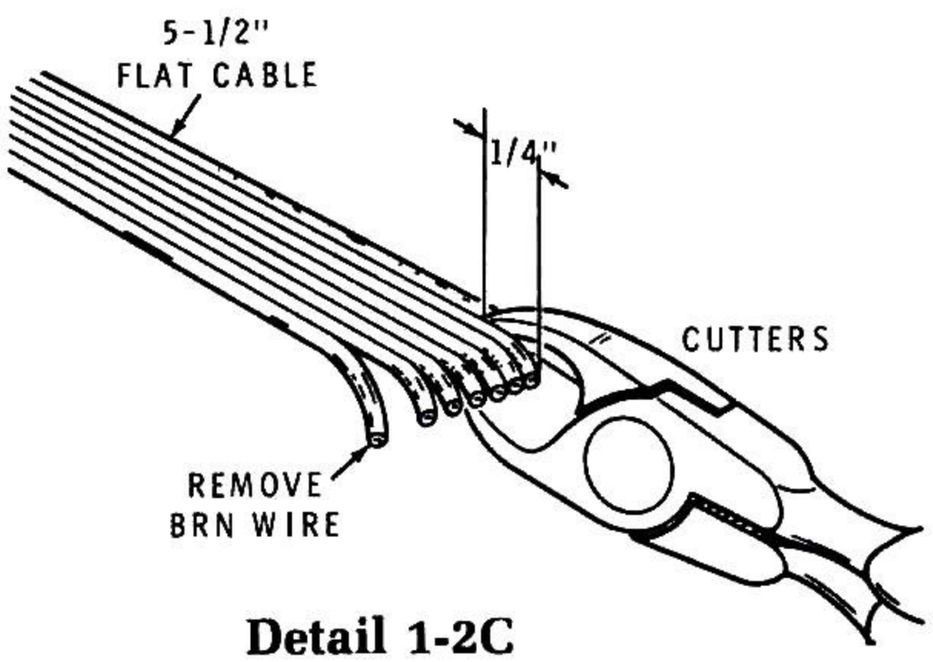


Detail 1-2B

( ) Q101: Refer to Detail 1-2B and position the flat of an MPSA20 (#417-801) transistor as shown. Insert the leads into the circuit board holes at Q101 from the foil side and then solder the leads to the foil. Cut off the excess lead lengths from the component side.

( ) Refer again to Detail 1-2B and bend transistor Q101 back against the circuit board as shown. Be careful not to short the leads together.



Detail 1-2C

( ) R103: Connect a 1000 Ω (brn-blk-red) resistor at R103.

( ) Set a pair of cut-off resistor leads aside for use later on.

( ) Cut a 5-1/2" length of flat cable.

( ) Refer to Detail 1-2C and, with a pair of cutters, separate the leads at both ends of the flat cable for approximately 1/4". Let the short edge of the cutters seat in the groove between the leads, then cut them apart. Be careful not to cut the insulation and expose the fine wire strands.

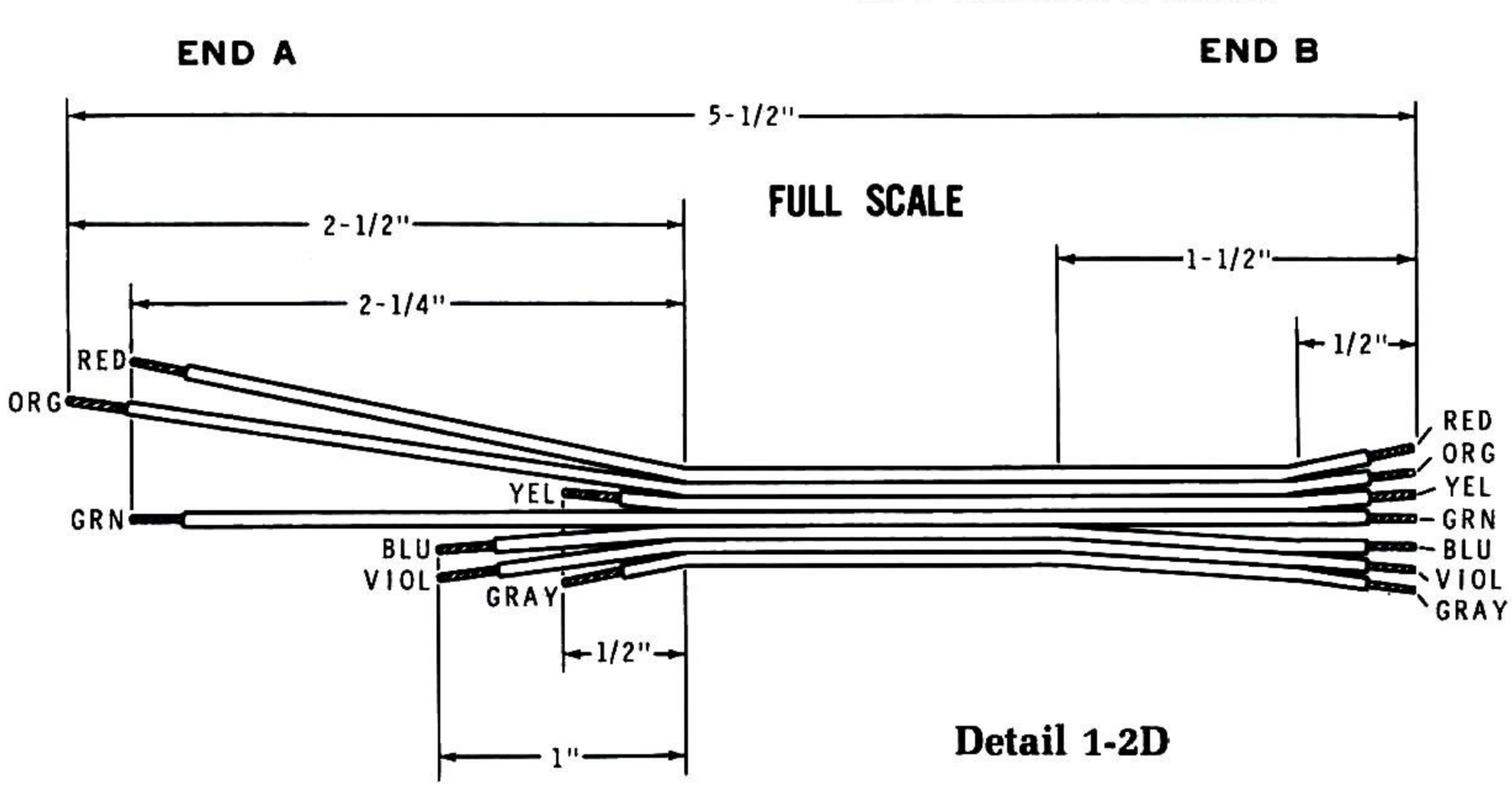
( ) Completely remove the brown wire from the flat cable to make a 7-wire cable. Set the brown wire aside for use later.

In the next step, you will prepare the ends of this 7-wire cable. You may find it easier to use a pen or a marking pencil to mark the point at which the individual wires are to be separated; then separate the wires to that point. Since the drawing is shown full scale, you may place your cable directly over it and cut the individual wires to the lengths shown.

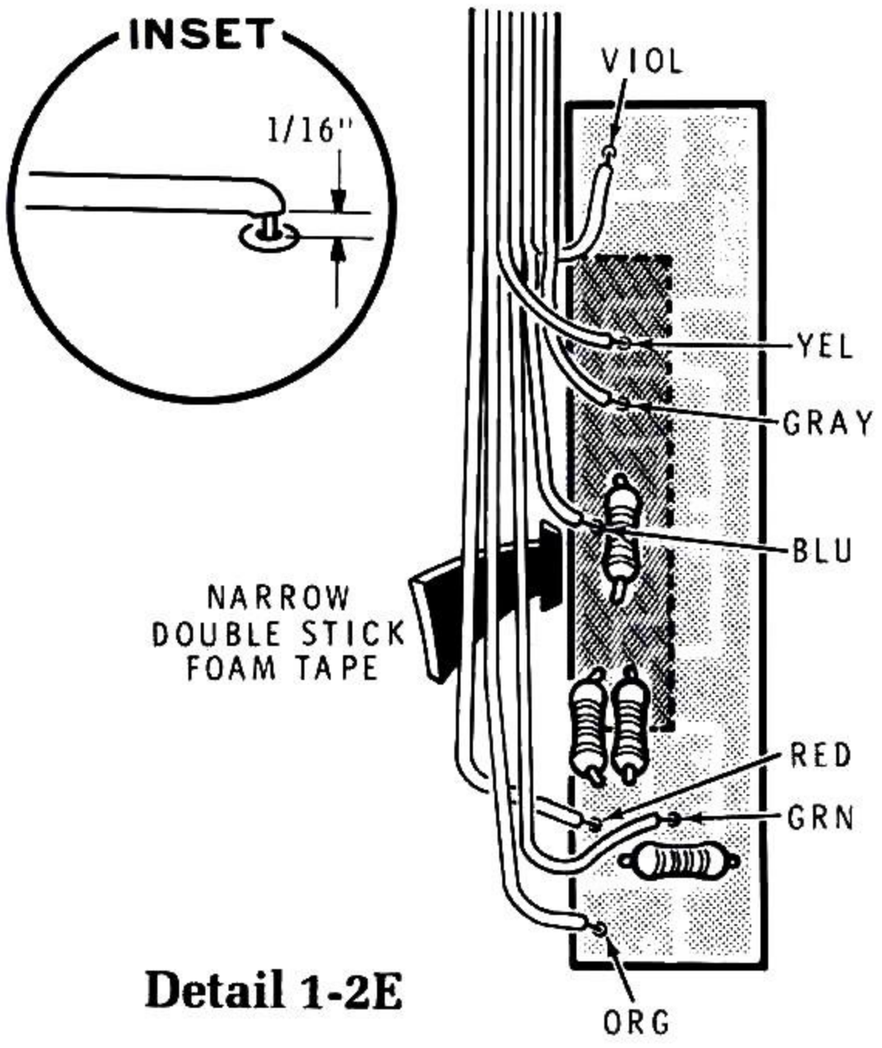
To prepare the end of a stranded cable wire, remove 1/4" of insulation from it and twist the fine wire strands tightly together. Then melt a small amount of solder on the wire strands to hold them together.

( ) Refer to Detail 1-2D and prepare end A of the 7-wire cable. Separate the wires to the distance shown and prepare the wire ends.

( ) Refer again to Detail 1-2D and prepare end B of the 7-wire cable as shown.



Detail 1-2D



Detail 1-2E

Refer to Detail 1-2E and connect end A of the prepared 7-wire cable to the foil side of the circuit board as shown. Solder each wire as you connect it and cut off the excess wire lengths from the other side of the circuit board. Position each wire approximately 1/16" above the foil to make soldering easier as shown in the inset drawing.

NOTE: The hole callouts in the following steps, are not printed on the circuit board. Refer to the illustration for these callout designations.

( ) Orange wire at hole ORG.

( ) Green wire at hole GRN.

( ) Red wire at hole RED.

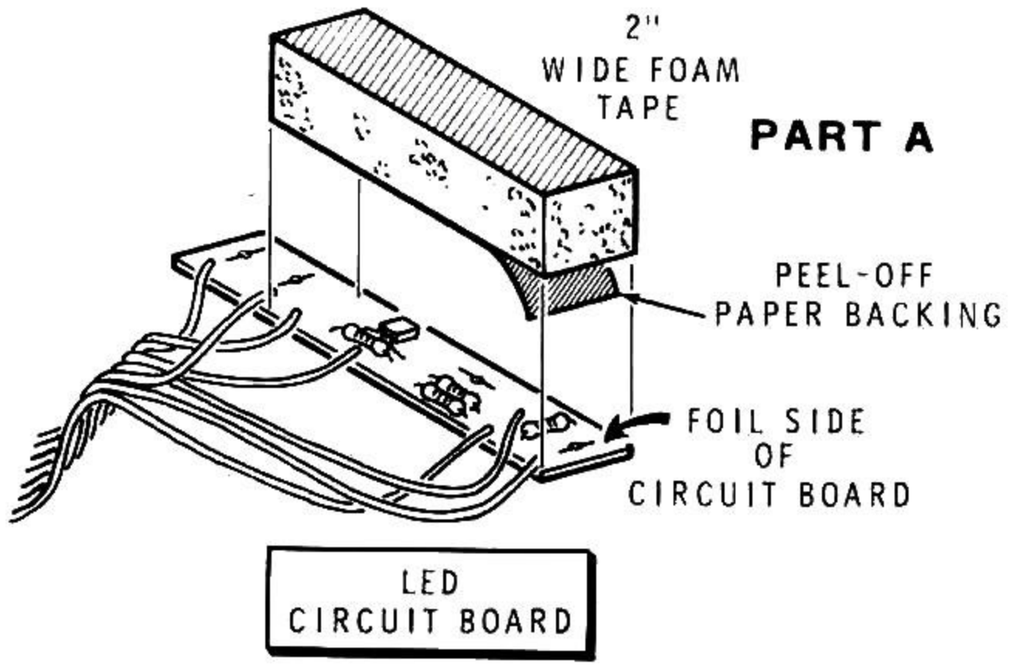
( ) Blue wire at hole BLU.

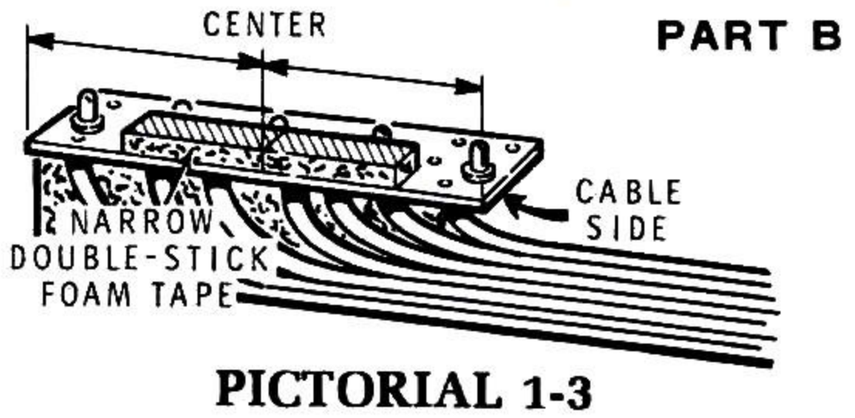
( ) Gray wire at hole GRAY.

( ) Yellow wire at hole YEL.

( ) Violet wire at hole VIOL.

( ) Check all the solder connections at this time and make sure there are no solder bridges between foils (see Page 9), loose or unsoldered connections, or incorrectly installed parts. After you have done this, complete the remaining steps.





PICTORIAL 1-3

Refer to Part A of Pictorial 1-3 for the following steps.

( ) Locate the 2" piece of wide double-stick foam tape.

( ) Remove the paper backing from one side of the foam tape and press the tape over the circuit board on the foil side. Position the wires out of the way as shown.

Refer to Part B of Pictorial 1-3 for the following steps.

( ) Turn the LED circuit board over (wide foam tape down).

( ) Cut a 1-3/4" piece of narrow double-stick foam tape.

( ) Remove the paper backing from one side of the narrow double-stick foam tape. Press the adhesive side of the foam tape along the edge and centered with circuit board. The 7-wire cable should be opposite the foam tape on the other side of the circuit board as shown.

( ) Set the remaining narrow double-stick foam tape aside for use later.

This completes the LED circuit board assembly. Set the assembly aside until it is called for later.

MAIN CIRCUIT BOARD

PARTS LIST

Remove Pack #2 from the carton and check each part against the following list. Make a check (✓) after each part as you identify the part. The key numbers correspond to the numbers on the Parts Pictorial (Illustration Booklet, Page 1). Some parts may be packed in a bag or an individual envelope with a part number on it. After you identify these parts, place them back in their bag or envelope until a step calls for them. Do not throw away any packing material, bags or envelopes, until all the parts are accounted for.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If one is not available, see "Replacement Parts" inside the rear cover of this Manual.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS, 1/4-WATT				
NOTE: The following resistors have a tolerance of 5%. 5% is indicated by a fourth color band of gold. The resistors may be packed in more than one envelope. Open all the resistor envelopes before you check them against the following list.				
A1	6-150-12	1	15 Ω (brn-grn-blk)	R42
A1	6-271-12	3	270 Ω (red-viol-brn)	R1, R31, R32
A1	6-102-12	3	1000 Ω (brn-blk-red)	R23, R37, R41
A1	6-222-12	2	2200 Ω (red-red-red)	R24, R25
A1	6-332-12	3	3300 Ω (org-org-red)	R14, R15, R35
A1	6-103-12	17	10 kΩ (brn-blk-org)	R2, R3, R5, R6, R7, R8, R9, R11, R16, R17, R18, R19, R21, R22, R27, R29, R36
A1	6-183-12	1	18 kΩ (brn-gry-org)	R4
A1	6-104-12	3	100 kΩ (brn-blk-yel)	R28, R33, R34
1% Precision (brown fifth color band)				
A2	6-1005-12	1	10 MΩ (brn-blk-blk-grn)	R26
CONTROLS				
A3	10-1142	1	100 kΩ	R39
A3	10-1140	1	500 Ω	R38
A3	10-1138	2	10 kΩ	R12, R13
CAPACITORS				
Ceramic				
B1	21-121	2	56 pF	C11, C12
B2	21-192	9	.1 μF (104)	C14, C15, C16, C17, C18, C19, C21, C22, C23
B2	21-744	2	82 pF (820)	C24, C25

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Electrolytic				
B3	25-930	1	2.2 μF	C7
B3	25-864	1	10 μF	C3
B4	25-917	2	10 μF vertical	C1, C2
B4	25-887	1	220 μF vertical	C9
B4	25-839	1	470 μF vertical	C8
B4	25-922	2	.68 μF vertical	C6, C13
Mylar*				
B5	27-74	1	.01 μF	C4
B5	27-137	1	.02 μF	C5
SEMICONDUCTORS				
Diodes				
C1	56-56	5	1N4149	D1, D5, D6, D7, D13
C1	56-89	3	GD510	D2, D3, D4
C1	57-65	4	1N4002	D8, D9, D11, D12
Transistors				
NOTE: Transistors are marked for identification in one of the following four ways: 1. Part number. 2. Type number. (This refers only to the numbers; the letters may be different or missing.) 3. Part number and type number. 4. Part number with a type number other than the one shown.				
C2	417-235	2	2N4121	Q6, Q15,
C2	417-294	1	MPSA42	Q14
C2	417-801	8	MPSA20	Q1, Q2, Q3, Q4, Q5, Q7, Q11, Q12
C2	417-864	1	MPSA05	Q17
C2	417-865	4	MPSA55	Q8, Q9, Q13, Q18
C2	417-927	1	MPSA93	Q16

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Integrated Circuits				
NOTE: Integrated circuits are marked for identification in one of the following four ways: 1. Part number. 2. Type number. (On integrated circuits, use only those numbers and letters in BOLD print. Disregard any other numbers or letters). 3. Part number and type number. 4. Part number with a type number other than the one shown. Do not remove the IC's from their conductive foam package until you are instructed to do so in a step.				
C2	442-627	1	**78L05**	U5
C3	443-603	1	**CD4011**	U6
C3	443-607	1	**14013**	U11
C3	443-701	1	**14049**	U8
C3	443-706	1	**14071**	U9
C3	443-879	1	**74LS174**	U7
C3	443-933	2	**5101 or 51L01**	U2, U3
C3	444-69	1	**3870**	U1
CONNECTOR — PLUG — SOCKETS				
D1	432-866	3	Spring connector	
D2	432-986	1	3-pin right-angle plug	P2
D3	432-1080	1	3-hole socket (white)	P3
D4	432-1132	1	14-pin in-line socket	P1
D5	434-253	1	40-pin IC socket	
D5	434-298	3	14-pin IC socket	
D5	434-299	2	16-pin IC socket	
D5	434-339	2	22-pin IC socket	
MISCELLANEOUS				
	75-93	1	1" × 1" insulating paper	
E1	208-49	2	Battery clip	
E2	258-747	2	Brass spring clip	
E3	404-238	1	3579.545 kHz crystal	Y1
E4	490-111	1	IC puller	
PARTS FROM FINAL PACK				
	85-2600-1	1	Main circuit board	

*Registered Trademark, DuPont Corporation

STEP-BY-STEP ASSEMBLY

CIRCUIT BOARD ASSEMBLY

START

If you wish to have the Keyer automatically set for left-handed operation when you apply power, perform the steps on this page; otherwise, skip this page.

Your Keyer is designed so that whenever you apply power, it is set for right-handed operation. This means that the left paddle will produce dots and the right paddle will produce dashes. (This mode of operation may be temporarily switched by simultaneously pressing the [LOAD] and [SEND] keys. See "Operation" on Page 53.).

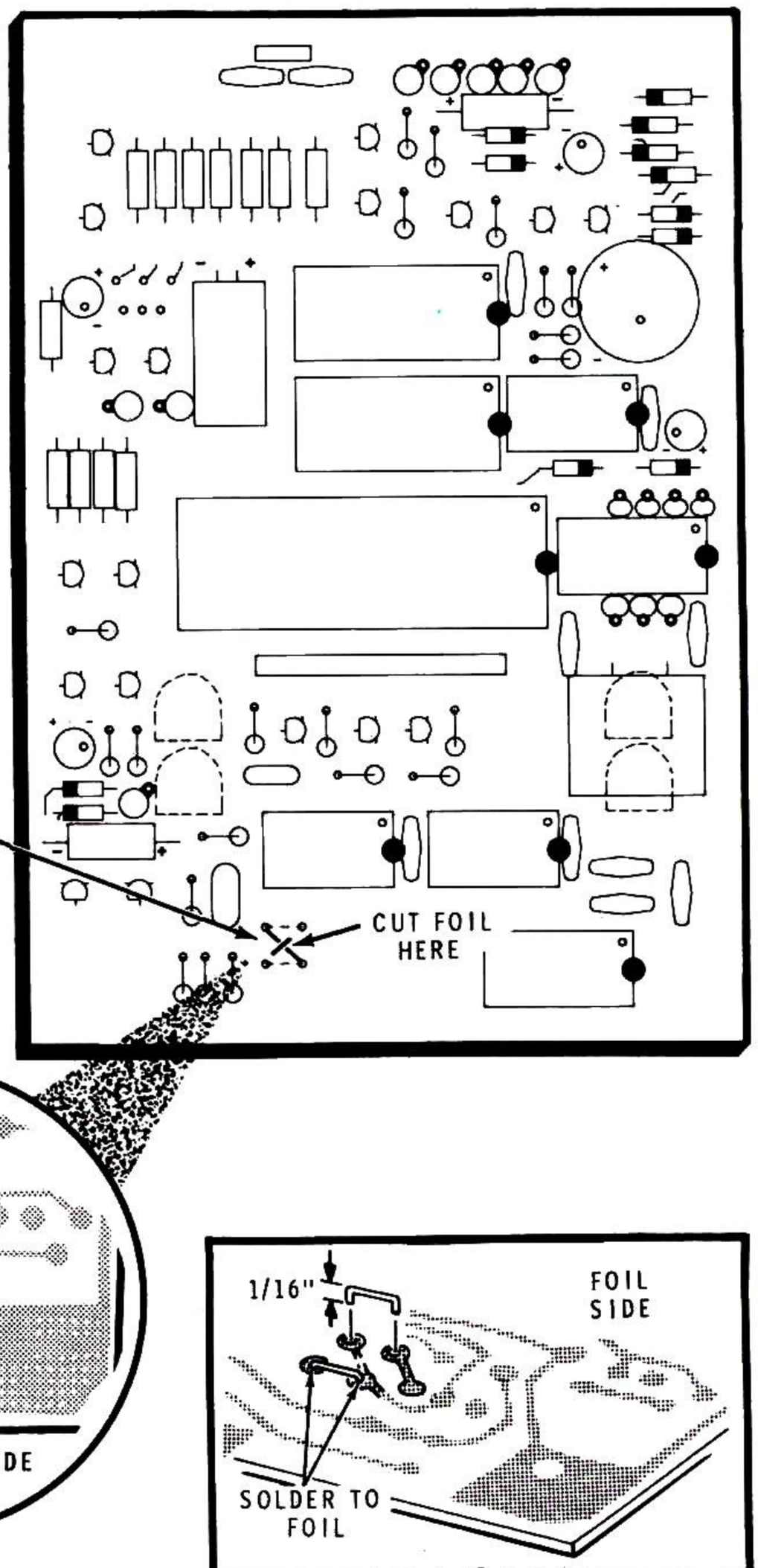
( ) With a single-edged razor blade, cut the indicated foil area on the component side of the circuit board.

( ) Turn the circuit board over with the foil side facing up. (The foil side is the side with no white printing on it. The white printed side will be referred to as the "component" side during the assembly.)

( ) Refer to the inset drawing and locate the foil area directly under the two jumper wire lines. Use a single-edged razor blade and cut the indicated foil area.

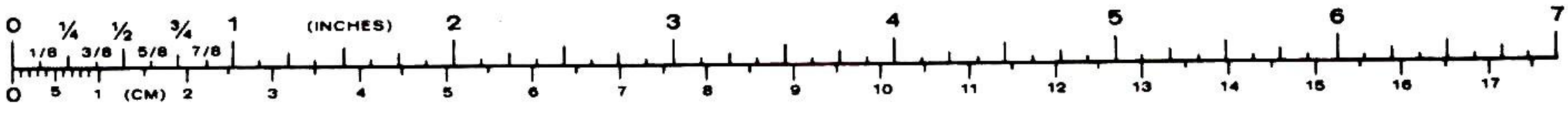
( ) Locate the two cut-off resistor leads you set aside earlier and cut them to 3/8". Then bend the ends down 1/16". See Detail 2-1A.

( ) Refer to Detail 2-1A and install the two prepared 3/8" resistor leads on the foil side of the circuit board as shown. Make sure that none of the wire ends protrude above the component side of the circuit board; then solder the leads to the foil.



Detail 2-1A

PICTORIAL 2-1



START

The shaded area in the Identification Drawing at the top of each page indicates what portion of the circuit board you will be working with in each Pictorial. Always refer to the drawing before you begin the assembly.

( ) Position the circuit board with the component side facing up and the part number as shown.

( ) R18: 10 kΩ (brn-blk-org).

( ) R22: 10 kΩ (brn-blk-org).

( ) R23: 1000 Ω (brn-blk-red).

( ) R17: 10 kΩ (brn-blk-org).

( ) R11: 10 kΩ (brn-blk-org).

( ) R9: 10 kΩ (brn-blk-org).

( ) R16: 10 kΩ (brn-blk-org).

( ) R31: 270 Ω (red-viol-brn).

( ) R32: 270 Ω (red-viol-brn).

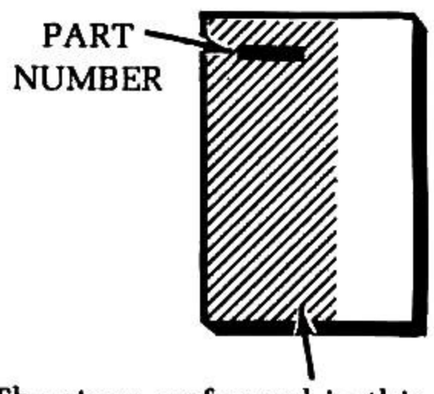
( ) R33: 100 kΩ (brn-blk-yel).

( ) R34: 100 kΩ (brn-blk-yel).

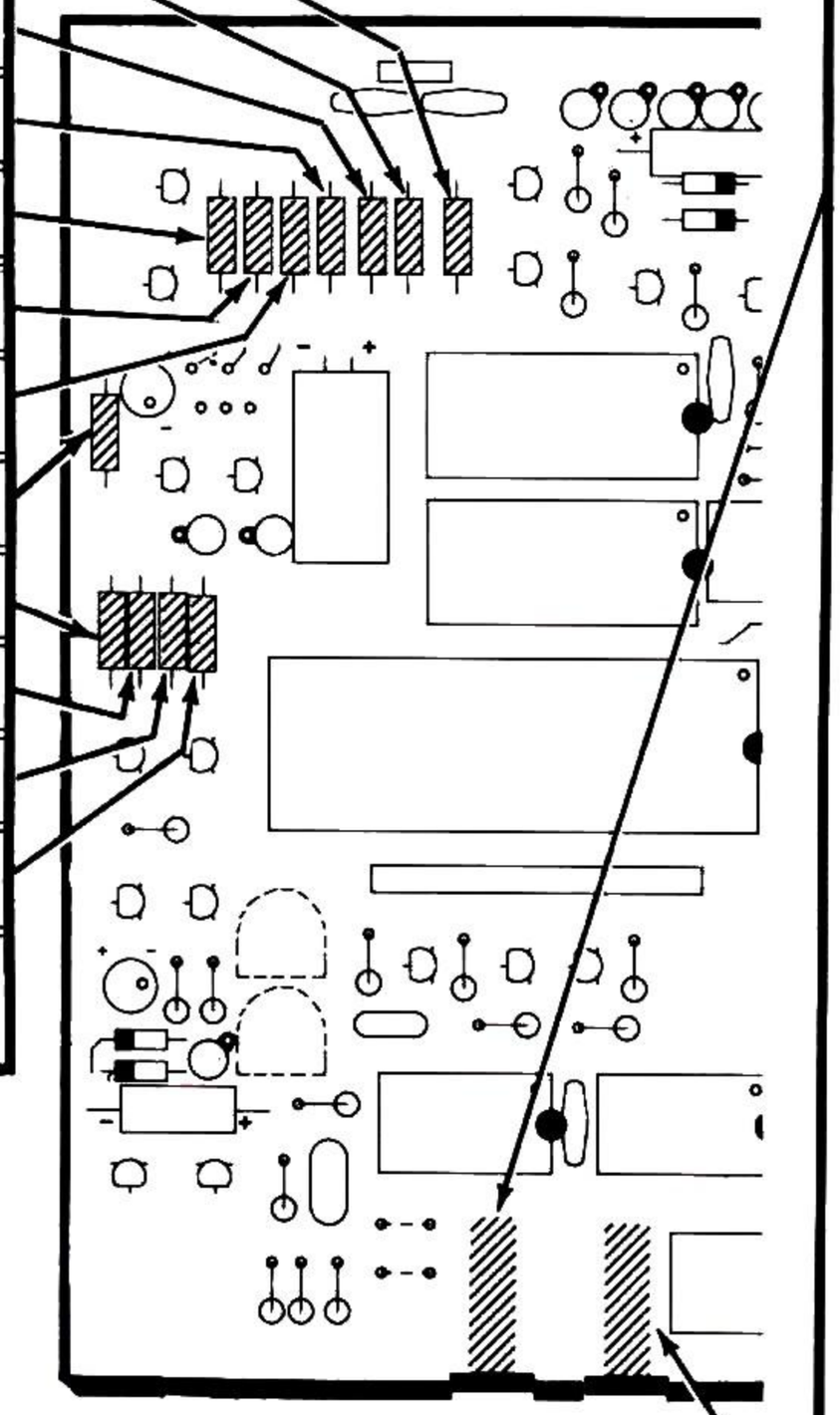
( ) R35: 3300 Ω (org-org-red).

( ) 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 2-2

CONTINUE

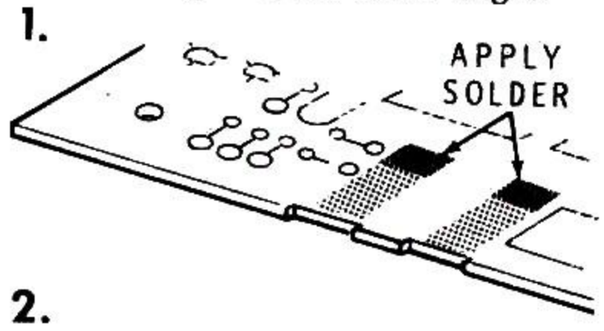
( ) Mount a brass spring clip on the circuit board as follows:

1. Apply a small amount of solder on the indicated foil areas of the circuit board.

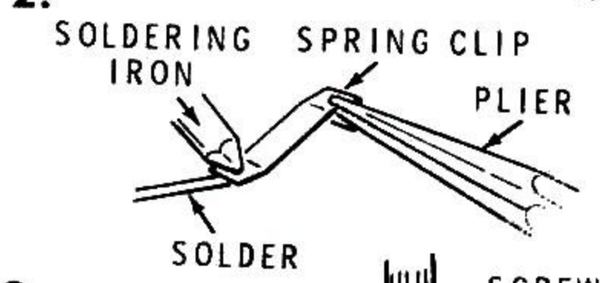
2. Hold the indicated end of the spring clip with a pair of long-nosed pliers and apply a small amount of solder on the indicated surface at the other end of the clip.

3. Position the spring clip over the indicated foil area on the circuit board. Press the clip down against the circuit board foil with a small screwdriver and check to make sure the end with the 90° bend fits into the circuit board notch without binding against the edges. Then, while you hold the clip in place with the screwdriver, solder it to the foil. Hold the clip in place until the solder cools. Press the clip down to make sure it is positioned correctly and does not bind against the board edges.

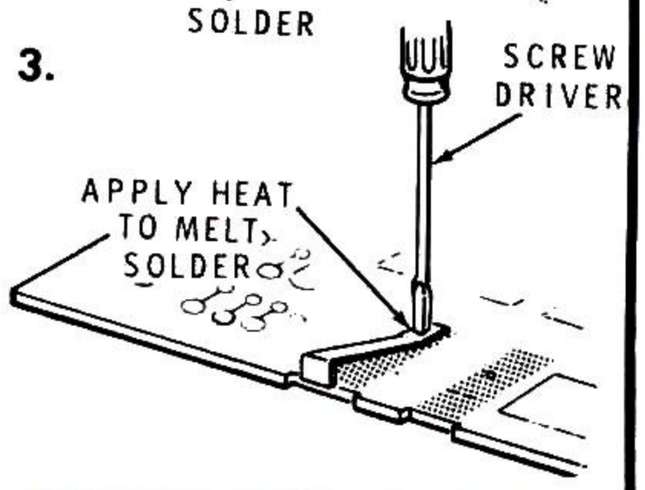
1.



2.



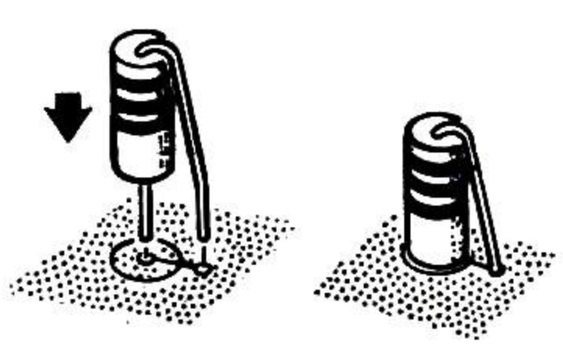
3.



( ) Similarly, install the remaining brass spring clip on the circuit board.

START

NOTE: The remaining **resistors** will be mounted vertically in the following steps. Bend one resistor lead along the side of the resistor body. Then mount the resistor over the circuit board outline and push it down against the circuit board as shown.

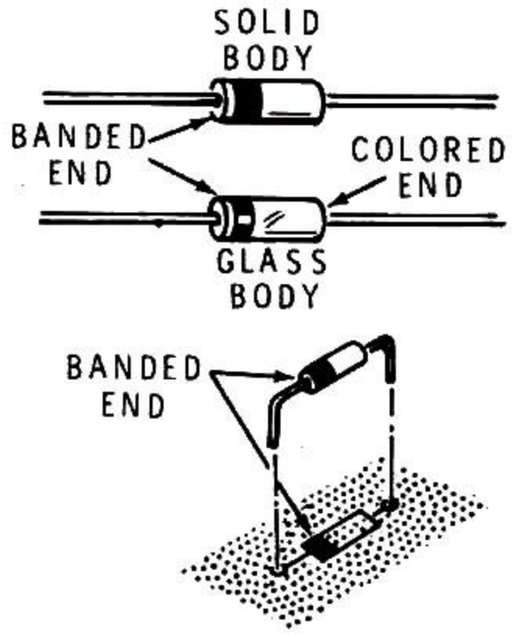


( ) R36: 10 kΩ (brn-blk-org).

( ) R37: 1000 Ω (brn-blk-red).

( ) R29: 10 kΩ (brn-blk-org).

NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board. THE CIRCUIT WILL NOT WORK IF A DIODE IS INSTALLED BACKWARDS. See Detail 2-3A.



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.

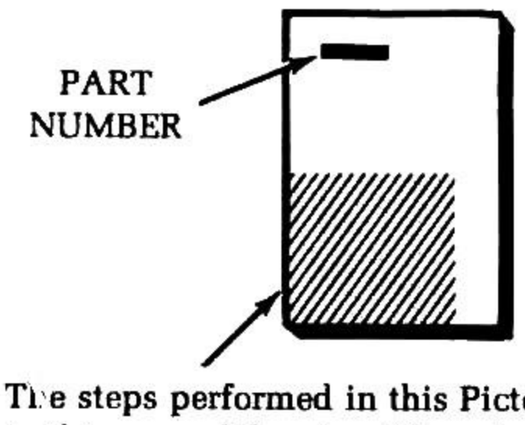
Install two GD510 diodes (#56-89) at:

( ) D3 .....

( ) D2 .....

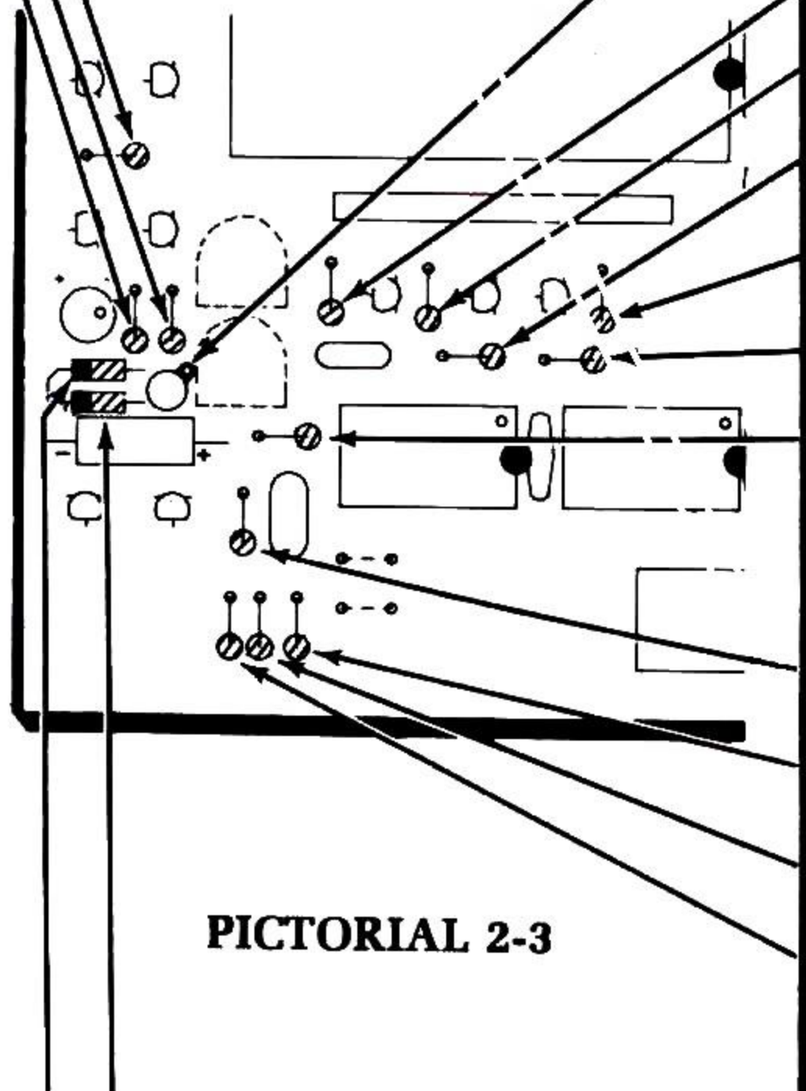
( ) Solder the leads to the foil and cut off the excess lead lengths.

IDENTIFICATION DRAWING



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

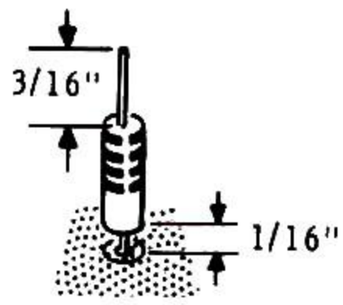
Detail 2-3A



PICTORIAL 2-3

CONTINUE

( ) R42: Install one lead of a 15 Ω (brn-grn-blk) resistor at hole H. Space the resistor body 1/16" off the circuit board and cut the other lead to 3/16".



Install six 10 kΩ (brn-blk-org) resistors at:

( ) R2 .

( ) R8 .

( ) R7 .

( ) R6 .

( ) R5 .

( ) R3 .

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

( ) R4: 18 kΩ (brn-gry-org).

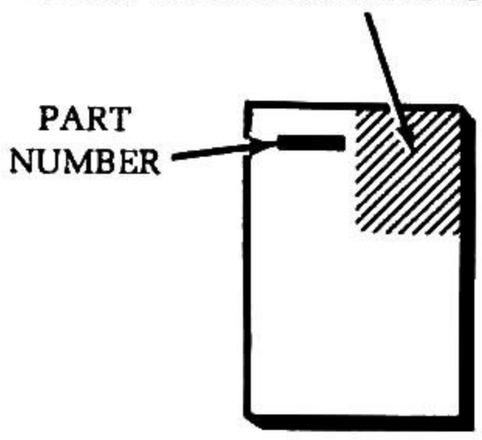
( ) R14: 3300 Ω (org-org-red).

( ) R15: 3300 Ω (org-org-red).

( ) R41: 1000 Ω (brn-blk-red).

( ) 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.



IDENTIFICATION
DRAWING

START

( ) D4: GD510 diode (#56-89).

( ) D7: 1N4149 diode (#56-56).

( ) R19: 10 kΩ (brn-blk-org).

( ) R24: 2200 Ω (red-red-red).

( ) R21: 10 kΩ (brn-blk-org).

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

( ) R26: 10 MΩ, 1% precision (brn-blk-blk-grn).

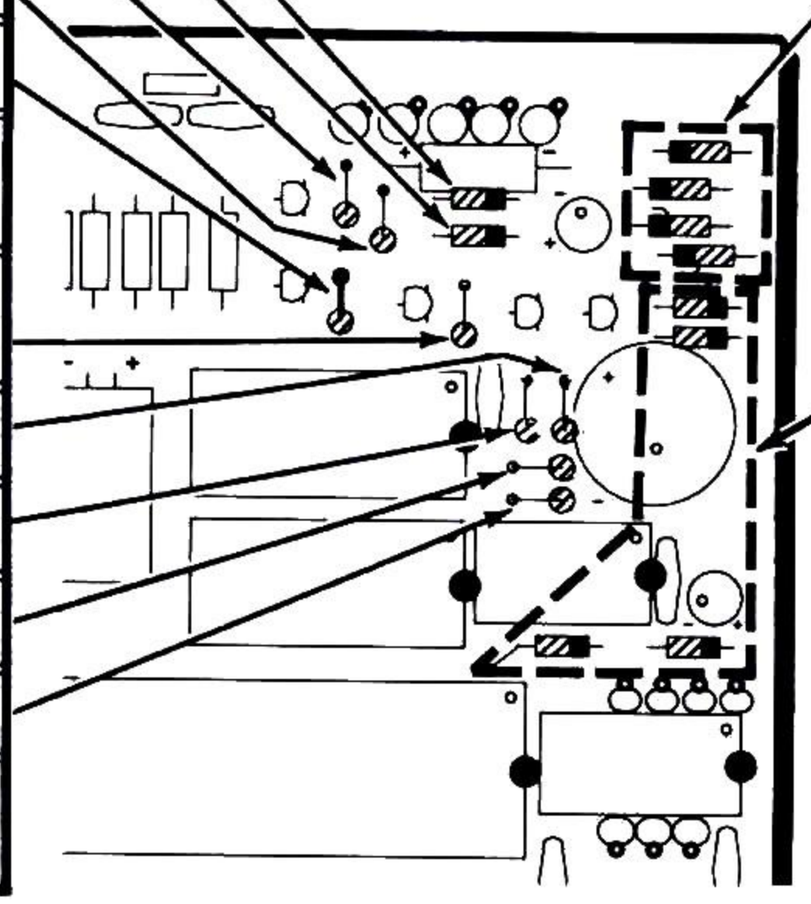
( ) R25: 2200 Ω (red-red-red).

( ) R1: 270 Ω (red-viol-brn).

( ) R27: 10 kΩ (brn-blk-org).

( ) R28: 100 kΩ (brn-blk-yel).

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



CONTINUE

Install four 1N4002 (#57-65) diodes at:

( ) D9

( ) D8

( ) D11

( ) D12

Install four 1N4149 (#56-56) diodes at:

( ) D5

( ) D6

( ) D13

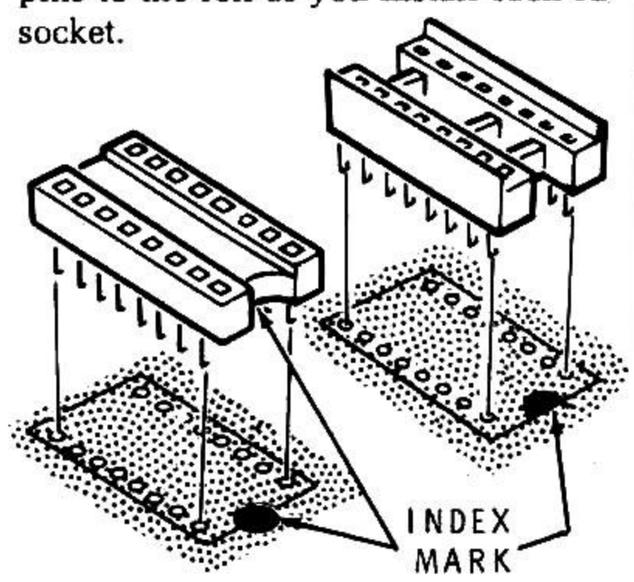
( ) D1

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

PICTORIAL 2-4

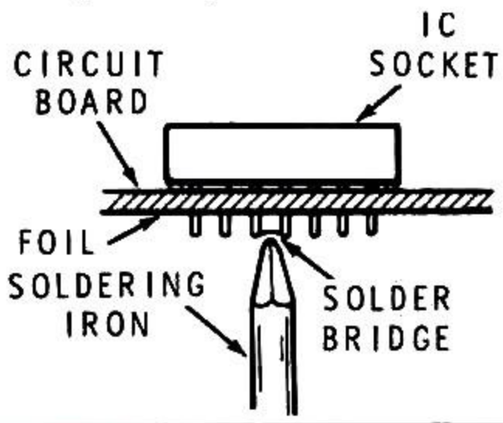
START

NOTE: In the following steps, you will install 14-pin, 16-pin, 22-pin, and 40-pin IC sockets. Be careful when you install these sockets, as it is possible to place a 14-pin socket in a 16-pin socket location by mistake. Solder the pins to the foil as you install each IC socket.



NOTE: It is very easy to form a solder bridge between foils on the circuit board. After each solder step, carefully inspect the foil for solder bridges and remove any that have formed.

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.



Install two 22-pin IC sockets at:

( ) U2 .....

( ) U3 .....

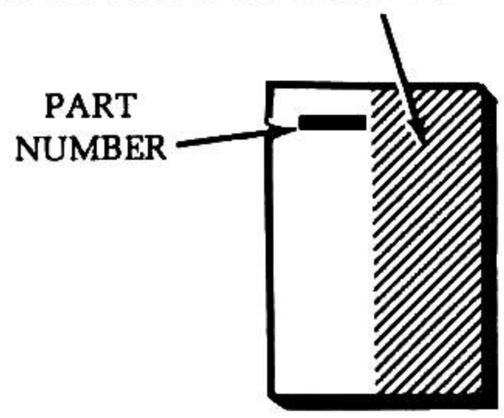
( ) 40-pin IC socket at U1.

Install two 14-pin IC sockets at:

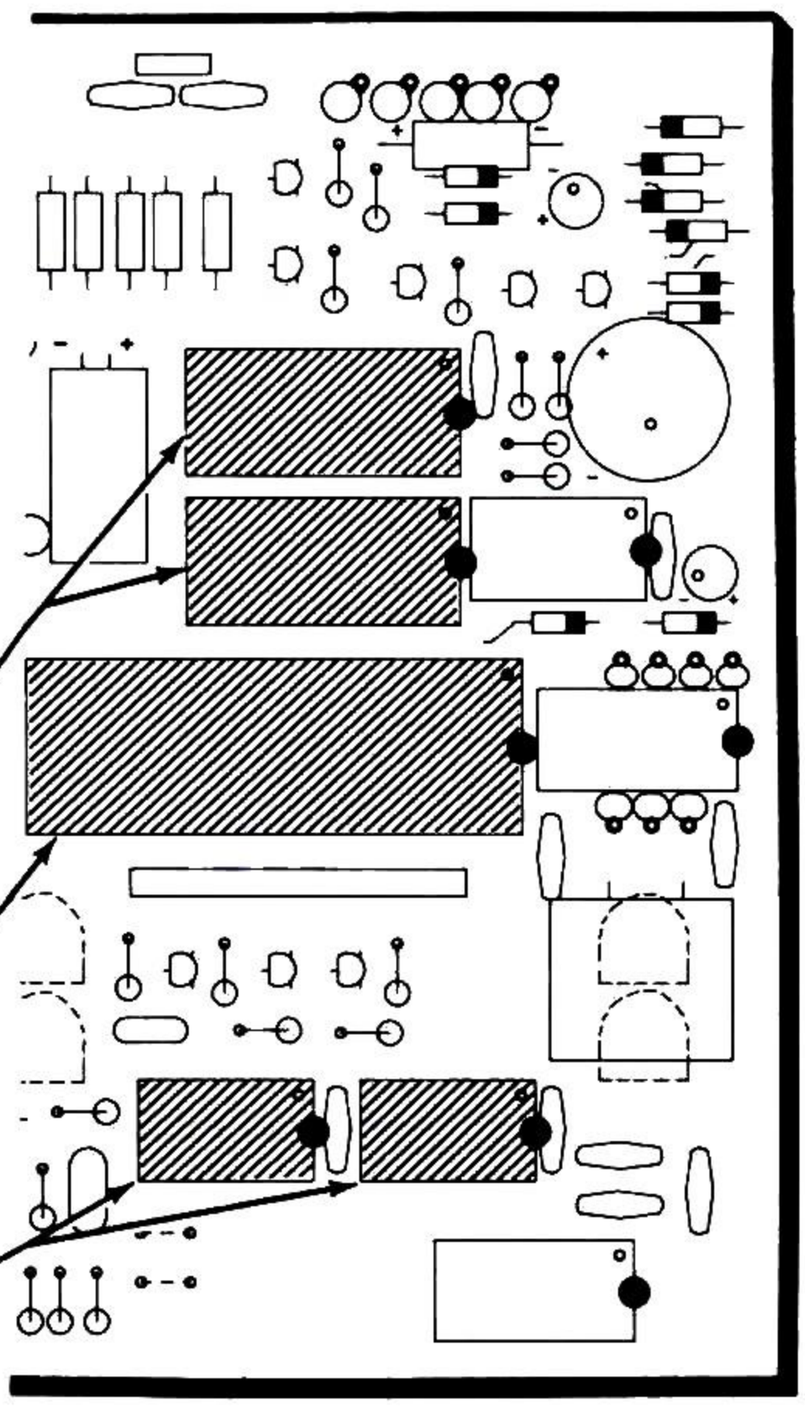
( ) U11 .....

( ) U9 .....

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

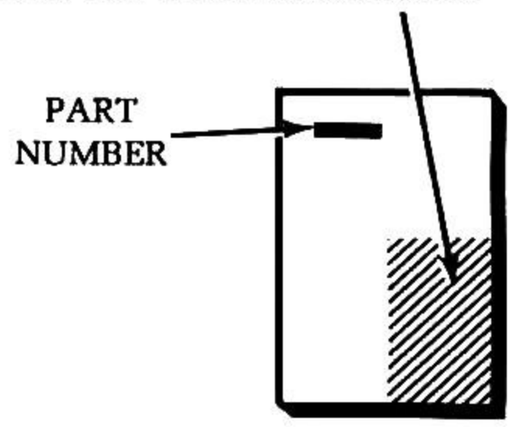


IDENTIFICATION
DRAWING



PICTORIAL 2-5

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



IDENTIFICATION
DRAWING

START

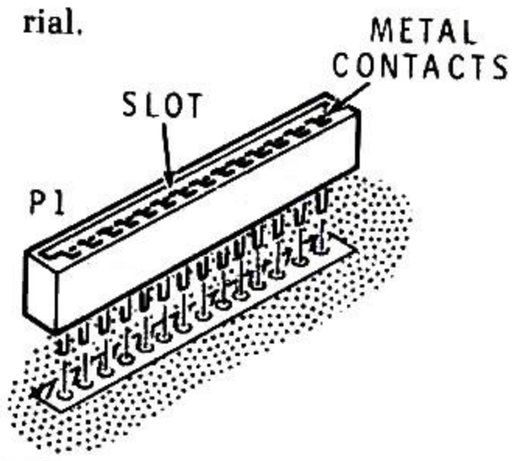
( ) 14-pin IC socket at U6.

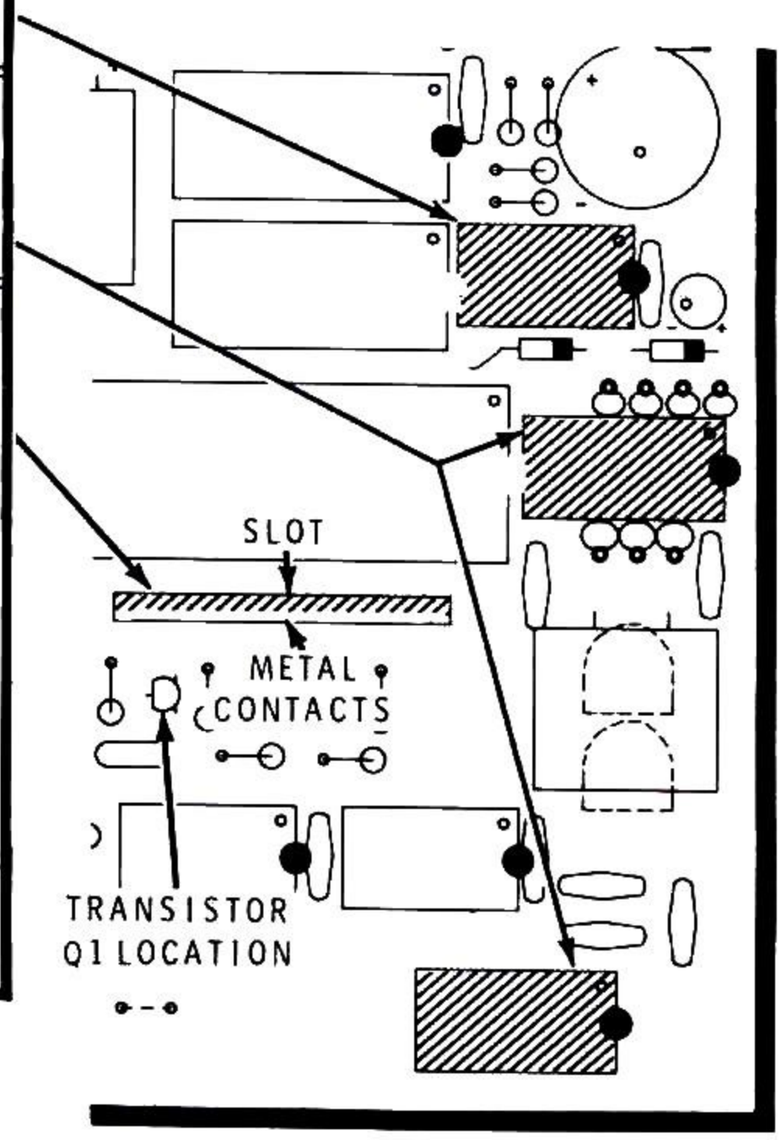
Install two 16-pin IC sockets at:

( ) U7 .....

( ) U8 .....

( ) P1: Install the 14-pin in-line socket at P1. Position the socket slot over the shaded area and the metal contacts towards transistor Q1 location as shown in the Pictorial.

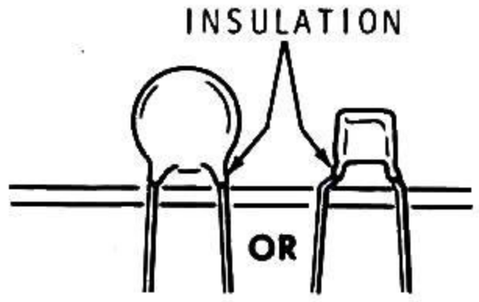




PICTORIAL 2-6

START

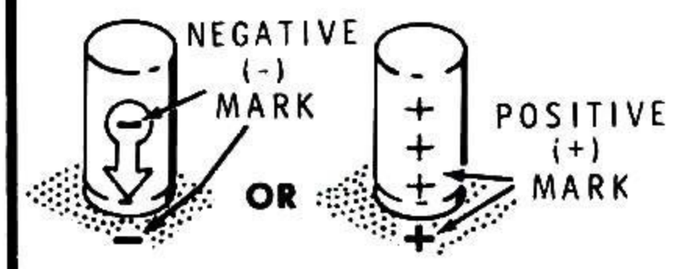
NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



( ) C14: .1 μF (104) ceramic. Bend this capacitor forward (away from the top edge of the circuit board.)

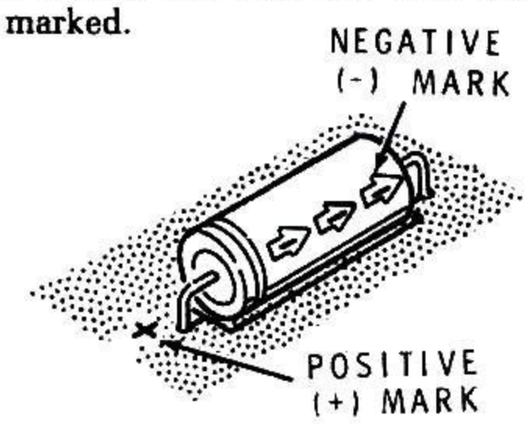
( ) C15: .1 μF (104) ceramic.

NOTE: When you install the following electrolytic capacitor, position the positive (+) mark on the capacitor toward the positive (+) on the circuit board. If the capacitor has only a negative (−) mark on it, position this **away** from the positive mark on the circuit board.



( ) C6: .68 μF electrolytic.

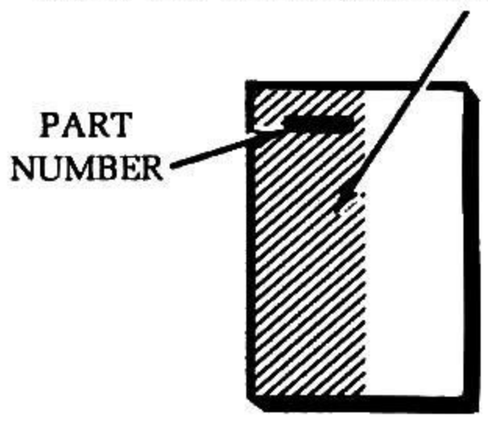
NOTE: Before you install the following electrolytic capacitor, look at it and identify the leads. One lead will have a positive (+) mark or a negative (−) mark near it. **Be sure** to install the positive (+) lead in the positive marked hole, or the negative (−) lead in the negative marked hole. Be careful; only the negative lead may be marked.



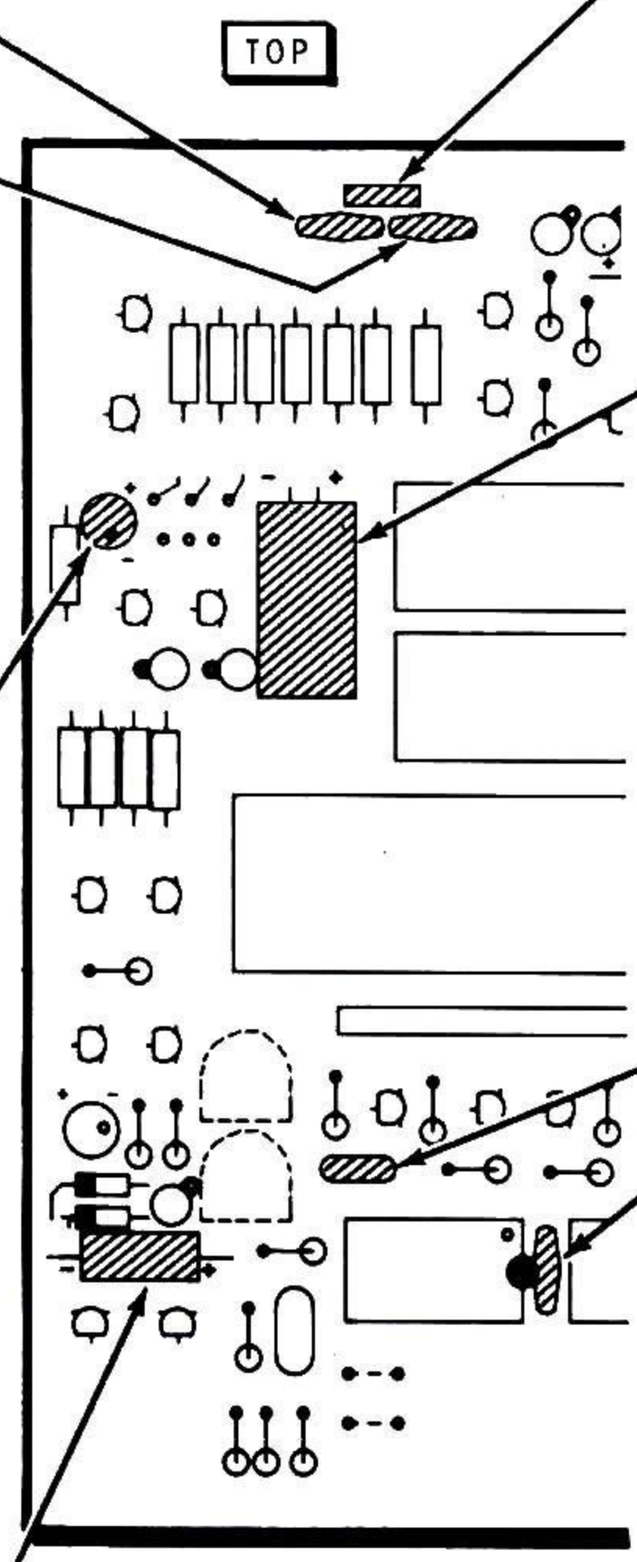
( ) C3: 10 μF electrolytic.

( ) 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.

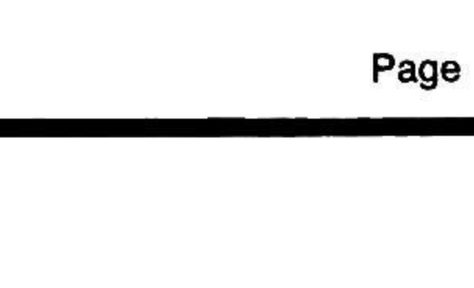


IDENTIFICATION DRAWING

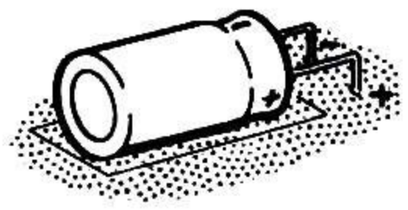


CONTINUE

( ) P2: Install the right-angle plug on the circuit board so the pins are toward the top edge of the circuit board as shown. Solder the pins to the foil and cut off the excess pin lengths.



( ) C9: Position the positive (+) or negative (−) lead of the 220 μF vertical electrolytic capacitor as shown and bend the leads 90°. Insert the positive (+) marked lead into the positive (+) marked hole or the negative (−) marked lead into the negative (−) marked circuit board hole. Keep the capacitor body against the circuit board.



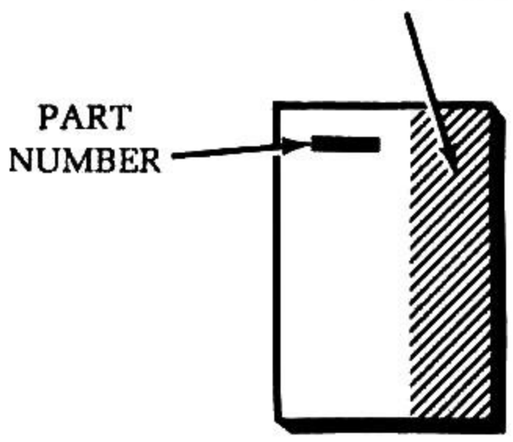
( ) C4: .01 μF Mylar.

( ) C23: .1 μF (104) ceramic.

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

PICTORIAL 2-7

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



IDENTIFICATION
DRAWING

START

NOTE: When you install an electrolytic capacitor, be sure to install the positive lead in the positive (+) marked hole in the circuit board.

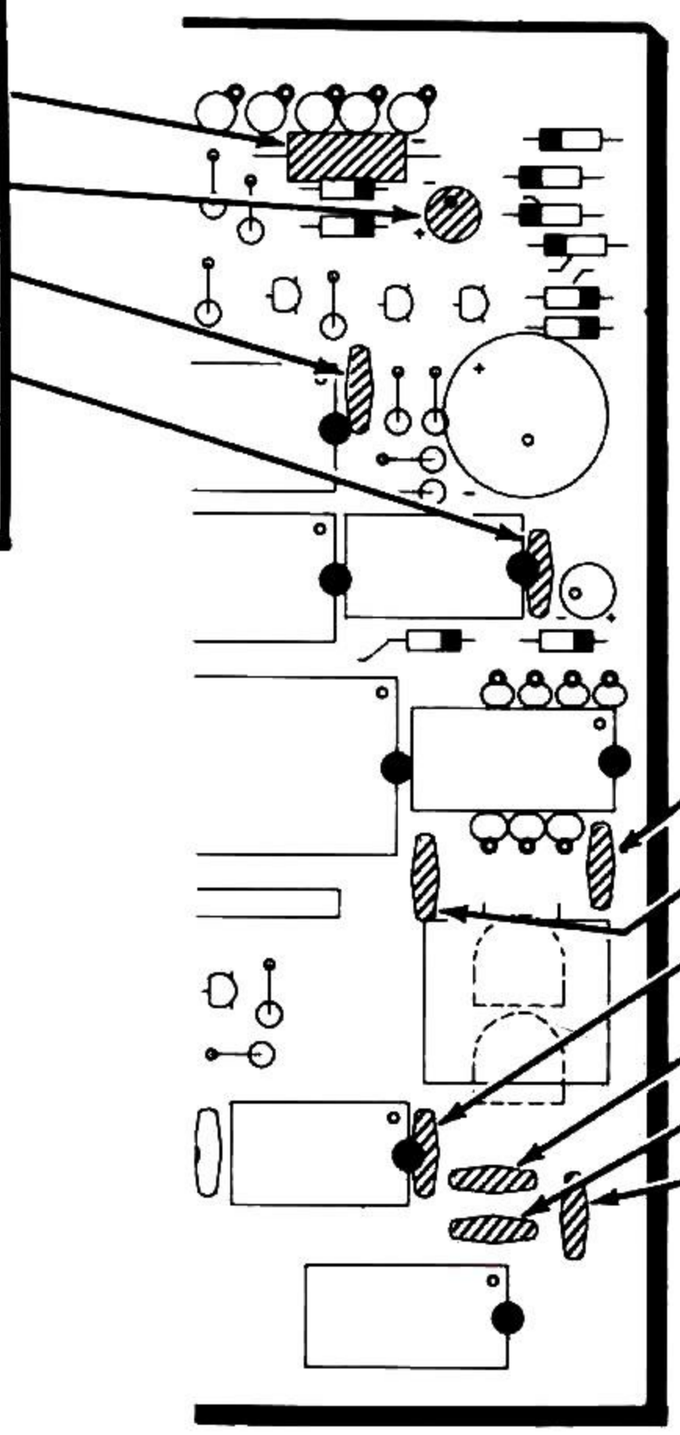
( ) C7: 2.2 μF electrolytic.

( ) C13: .68 μF electrolytic.

( ) C18: .1 μF (104) ceramic.

( ) C19: .1 μF (104) ceramic.

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



CONTINUE

( ) C17: .1 μF (104) ceramic.

( ) C16: .1 μF (104) ceramic.

( ) C21: .1 μF (104) ceramic.

( ) C11: 56 pF ceramic.

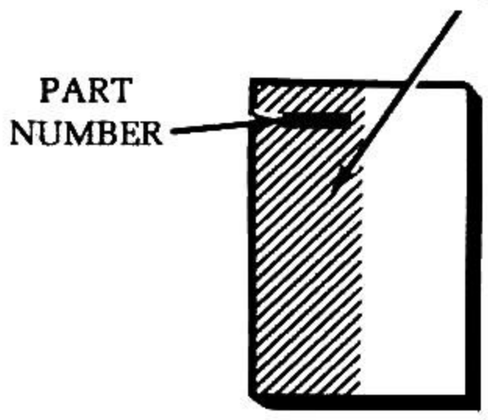
( ) C22: .1 μF (104) ceramic.

( ) C12: 56 pF ceramic.

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

PICTORIAL 2-8

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

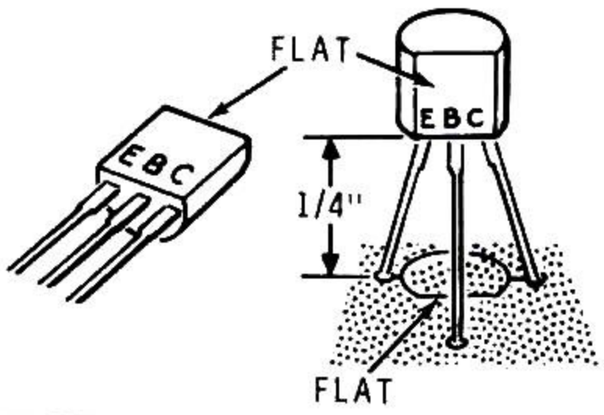


IDENTIFICATION DRAWING

START

In the following steps, install each transistor as follows:

1. Refer to the illustration below and identify the E, B, and C leads.
2. Insert the leads into the corresponding E,B, and C holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.

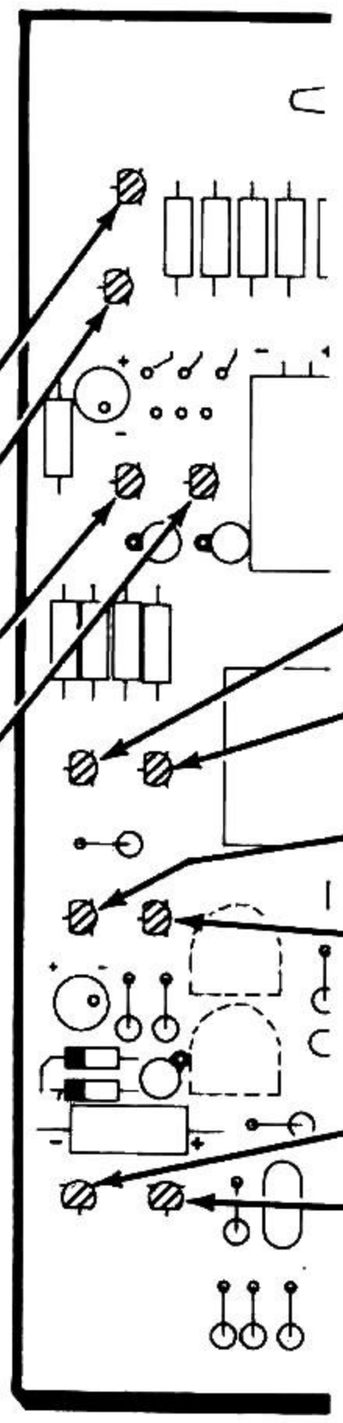


( ) Q4: MPSA20 transistor (#417-801).

( ) Q5: MPSA20 transistor (#417-801).

( ) Q14: MPSA42 transistor (#417-294).

( ) Q16: MPSA93 transistor (#417-927).



CONTINUE

( ) Q12: MPSA20 transistor (#417-801). Cut the leads off as close to the foil as possible.

( ) Q15: 2N4121 transistor (#417-235).

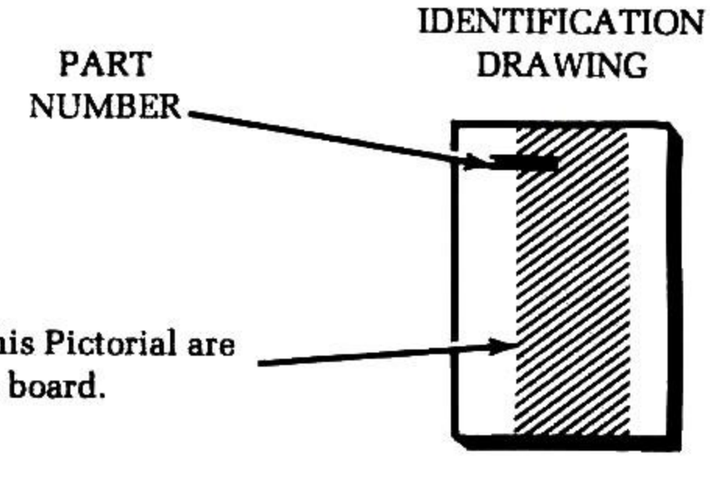
( ) Q11: MPSA20 transistor (#417-801). Cut the leads off as close to the foil as possible.

( ) Q13: MPSA55 transistor (#417-865).

( ) Q17: MPSA05 transistor (#417-864).

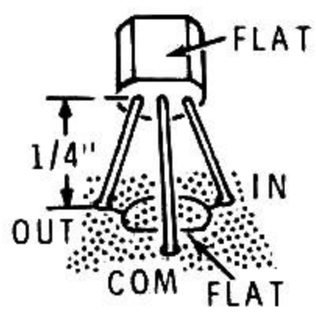
( ) Q18: MPSA55 transistor (#417-865).

PICTORIAL 2-9



START

( ) U5: This 78L05 integrated circuit (#442-627) looks like a transistor. Install it in the same manner, as shown.



( ) Q7: MPSA20 transistor (#417-801).

( ) Q8: MPSA55 transistor (#417-865).

( ) Q6: 2N4121 transistor (#417-235).

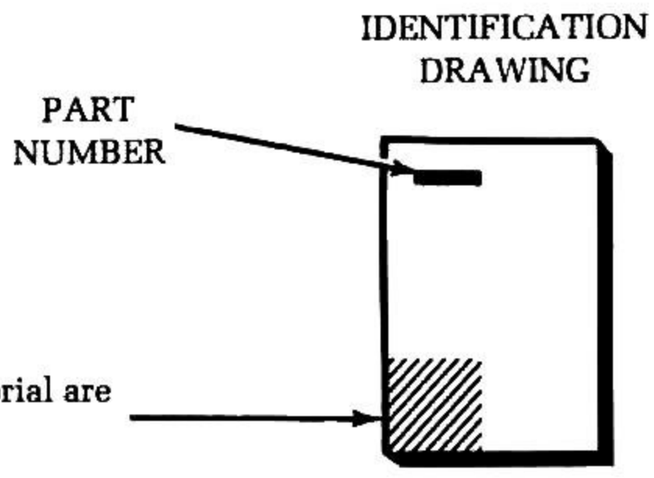
( ) Q9: MPSA55 transistor (#417-865).

( ) Q2: MPSA20 transistor (#417-801).

( ) Q3: MPSA20 transistor (#417-801).

( ) Q1: MPSA20 transistor (#417-801).

PICTORIAL 2-10



START

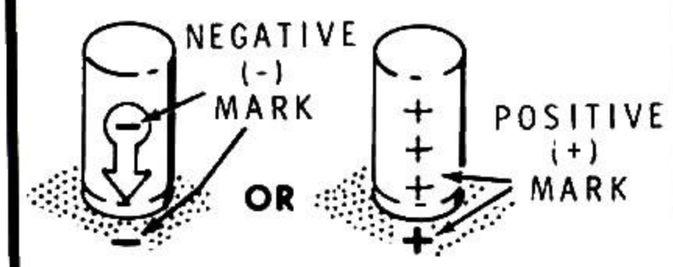
Turn the circuit board over and install the following controls on the foil side of the circuit board below the dotted outlines. Solder the pins to the foil on the component (white printed) side of the circuit board and cut off the excess pin lengths. Make sure the controls are tight against the board.

( ) R38: 500 Ω control.

( ) R39: 100 kΩ control.

( ) Position the circuit board with the component side up.

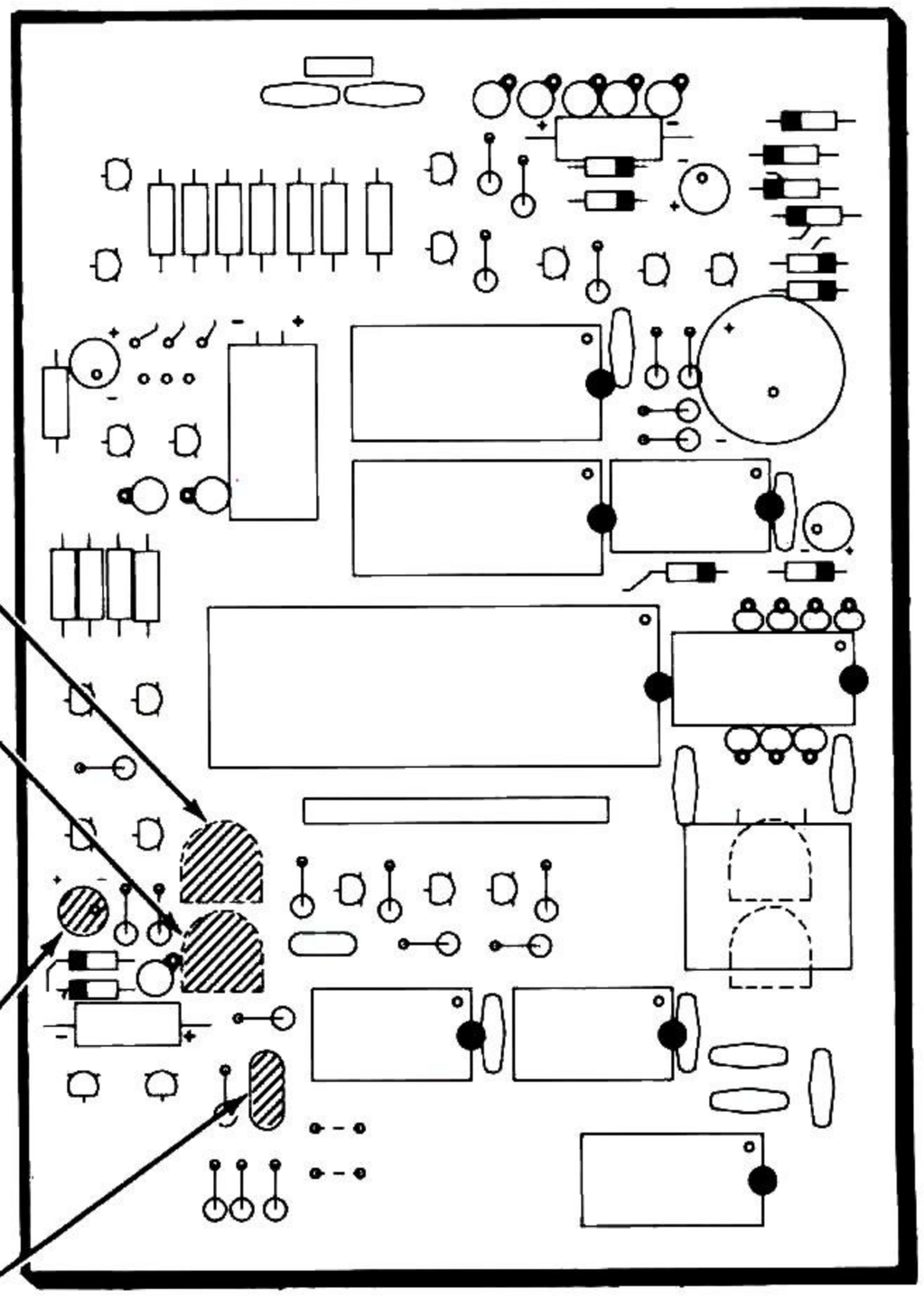
NOTE: When you install electrolytic capacitors, **ALWAYS** position the positive (+) mark on the capacitor toward the positive (+) on the circuit board. If the capacitor has only a negative (−) mark on it, position this **away** from the positive mark on the circuit board.



( ) C2: 10 μF vertical electrolytic. Make sure this capacitor is tight against the circuit board and is not tilted.

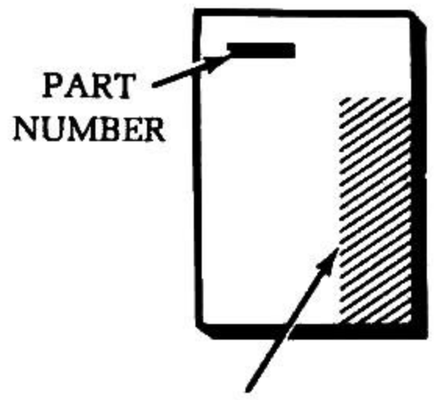
( ) C5: .02 μF Mylar.

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



PICTORIAL 2-11

IDENTIFICATION DRAWING



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

START

( ) C8: 470 μF vertical electrolytic.

( ) C1: 10 μF vertical electrolytic. Solder the capacitor to the foil and cut off the excess lead lengths.

Turn the circuit board over and install two 10 kΩ controls below the dotted outline on the foil side of the circuit board as follows. Solder the control pins to the foil on the component side of the circuit board and cut off the excess pins lengths.

( ) R12 .....

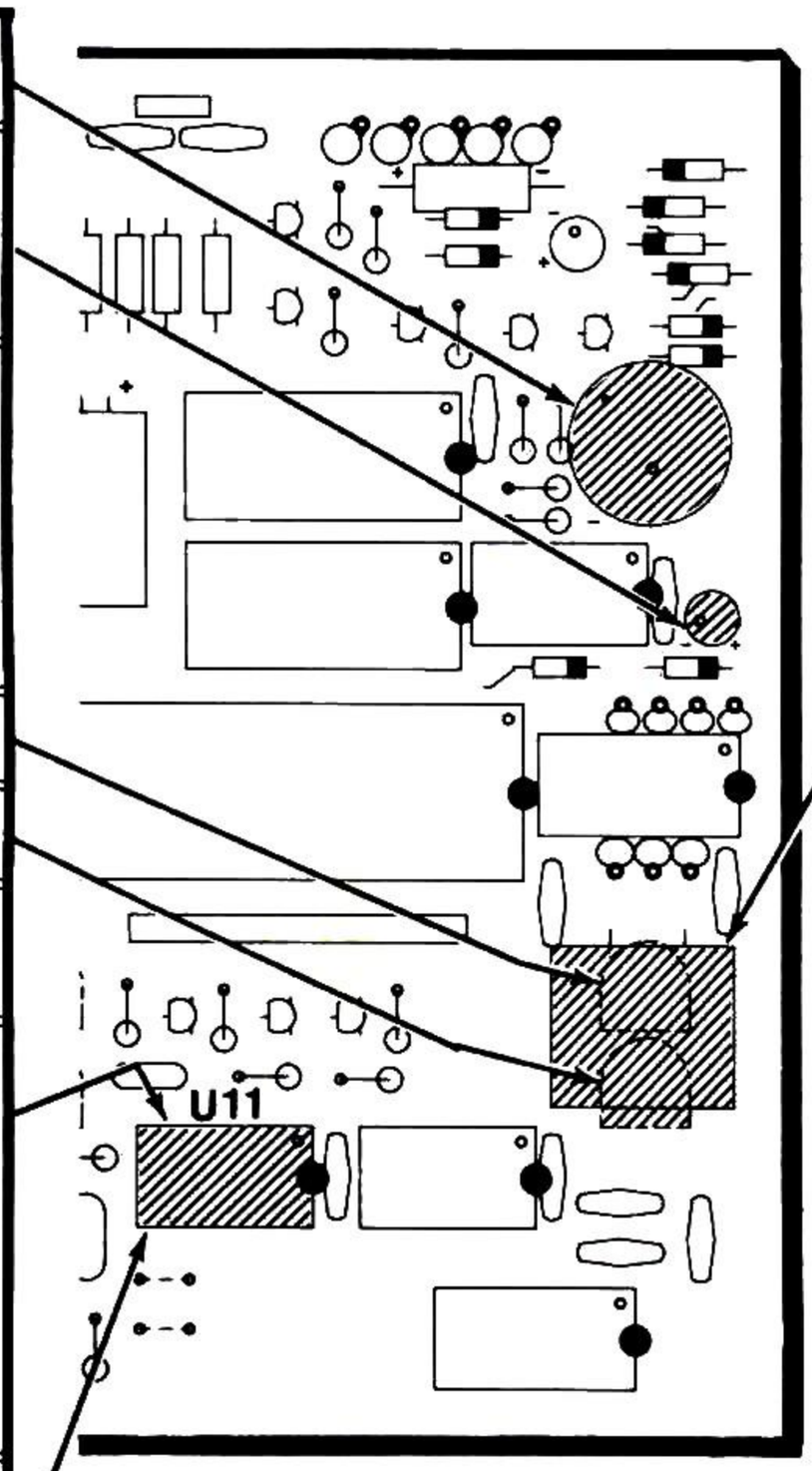
( ) R13 .....

( ) Cut the leads of both 82 pF (820) ceramic capacitors to 1/8".

( ) C24: Refer to Detail 2-12A and solder a prepared 82 pF ceramic capacitor between lugs 5 and 6 of U11. Keep the capacitor body against the circuit board as you solder it. Check the solder connections to make sure you did not create a solder bridge between the pads.

( ) C25: Similarly, refer to Detail 2-12A and solder the leads of the remaining 82 pF ceramic capacitor between pins 8 and 9 of socket U11. Keep the capacitor body against the circuit board. Check the connections after you solder them.

( ) Reposition the circuit board component side up.

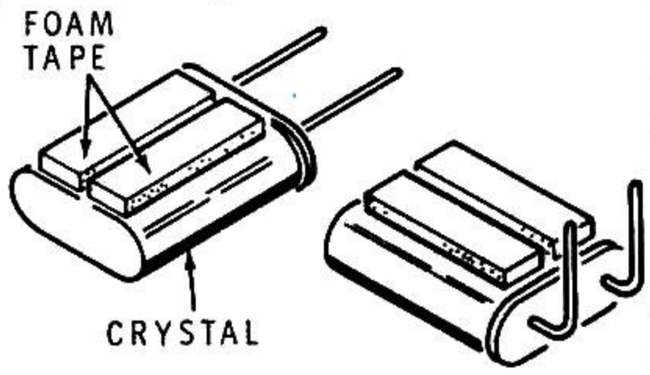


PICTORIAL 2-12

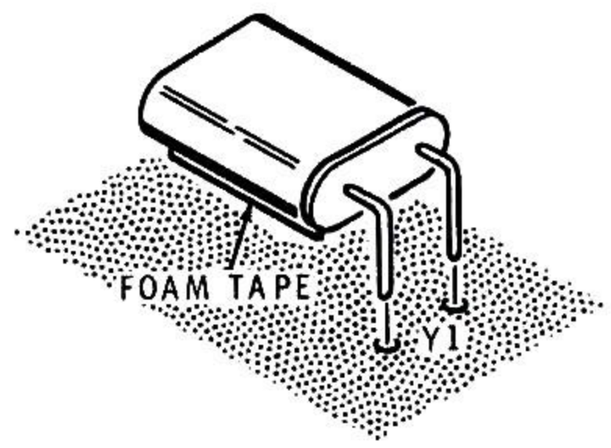
CONTINUE

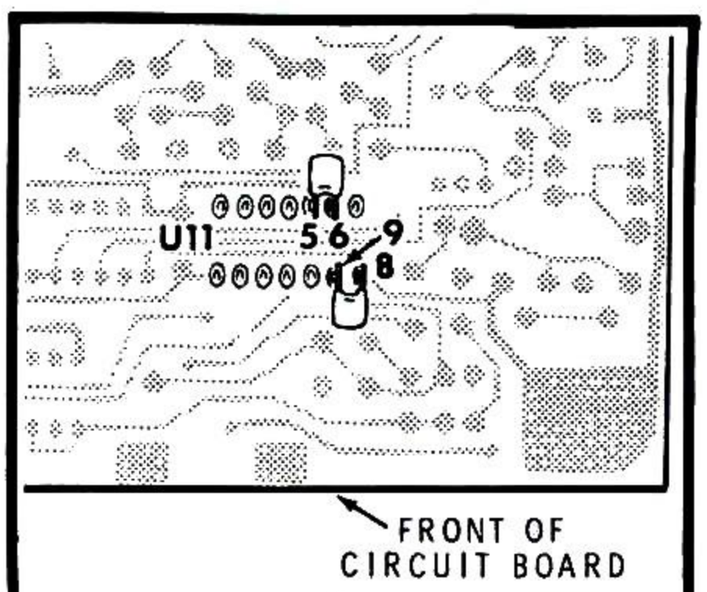
( ) Cut two 5/8" pieces of narrow double-stick foam tape.

( ) Remove the backing paper from one side of both pieces of double stick foam tape. Press each piece side by side on the 3579.545 kHz crystal (#404-238). Then bend the crystal leads 90° in the direction of the tape as shown.



( ) Y1: Remove the remaining paper backing from the double-stick foam tape and insert the crystal leads through the circuit board holes. Position the crystal body over the circuit board outline at Y1 and press it against the circuit board so the foam tape adheres to the surface. Then solder the leads to the foil and cut off the excess lead lengths.





Detail 2-12A

CIRCUIT BOARD WIRING

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

( ) Position the main circuit board as shown.

( ) Separate the following lengths of colored wire from the flat cable and prepare the ends:

3″ brown
7″ yellow
3″ green
3″ green
5″ violet
5″ gray

Connect either end of the prepared wires to the circuit board as follows. You will connect the wires in the order in which they were prepared. As before, whenever you connect a wire to the circuit board, solder the wire to the foil and cut off the excess wire length.

( ) 3″ brown wire to hole E.

( ) 7″ yellow wire to the free end of the 15 Ω resistor at hole H. Form a small hook in the end of the resistor lead and in the yellow wire end. Hook the yellow wire end and the resistor lead together; then crimp and solder the connection. See the inset drawing.

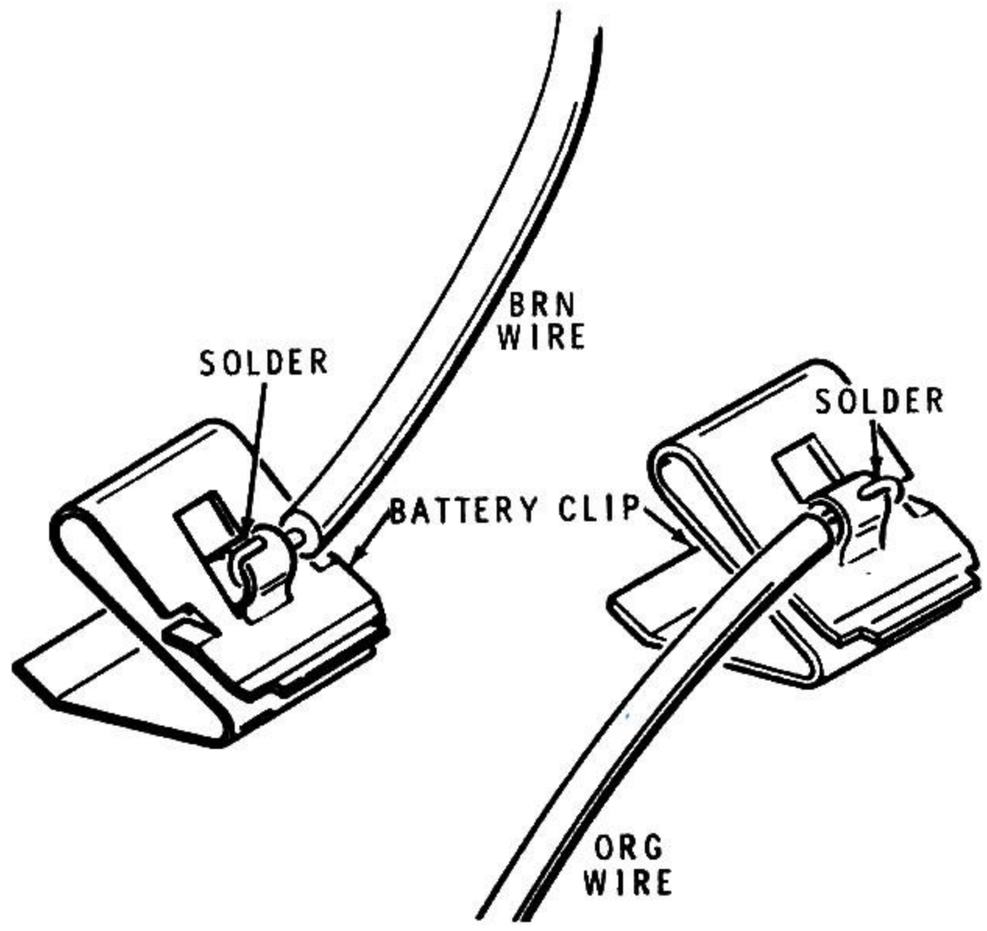
( ) One 3″ green wire to hole A.

( ) Other 3″ green wire to hole B.

( ) 5″ violet wire to hole G.

( ) 5″ gray wire to hole F.

( ) Prepare a 6″ orange and a 5″ brown wire from the flat cable.



Detail 2-13A

( ) Refer to Detail 2-13A and position the 5″ brown wire and the battery clip as shown. Wrap one end of the brown wire around the battery clip tab and solder the connection. Cut off any excess wire length. Make sure that you solder only the tab area of the clip.

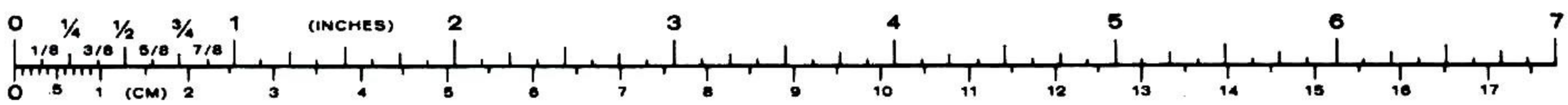
( ) Refer again to Detail 2-13A and position the 6″ orange wire and remaining battery clip as shown. Similarly connect the orange wire to the battery clip tab and solder the connection.

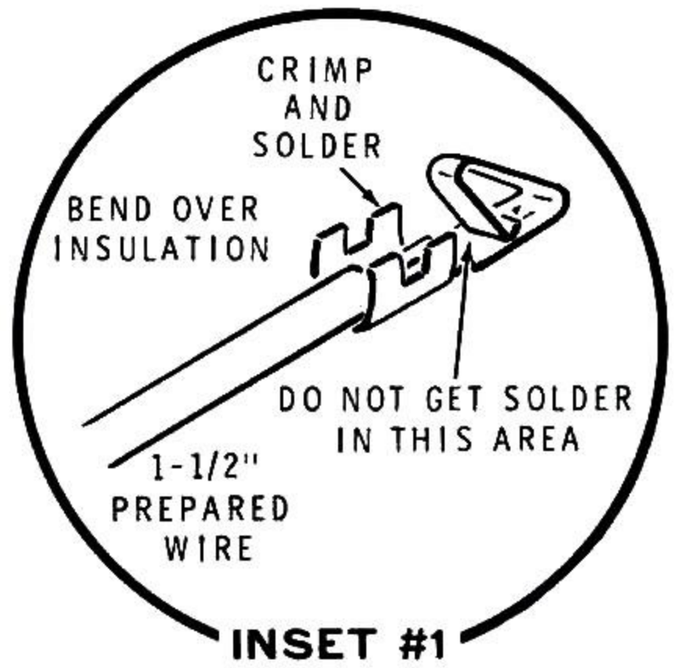
Connect the free end of the 6″ orange and 5″ brown wires with the battery clips to the main circuit board as follows:

( ) Orange wire to hole C.

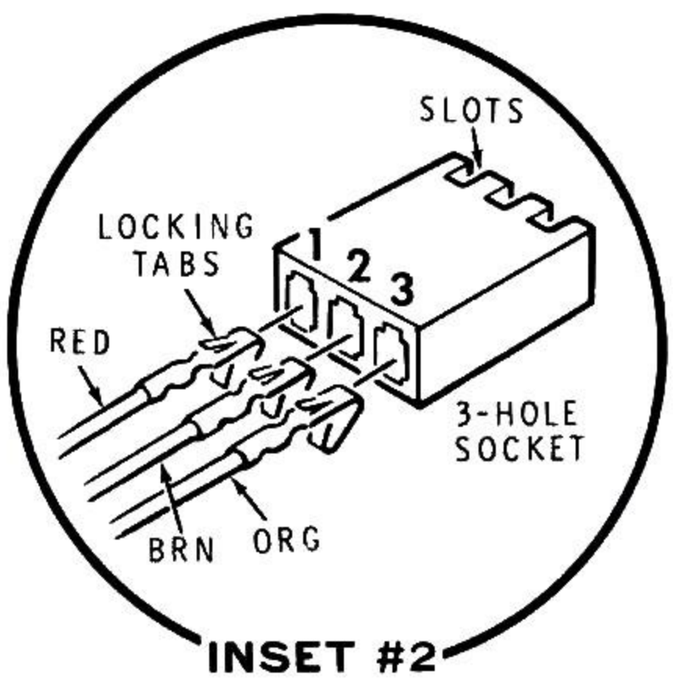
( ) Brown wire to hole D.

NOTE: You will connect the battery clips later.

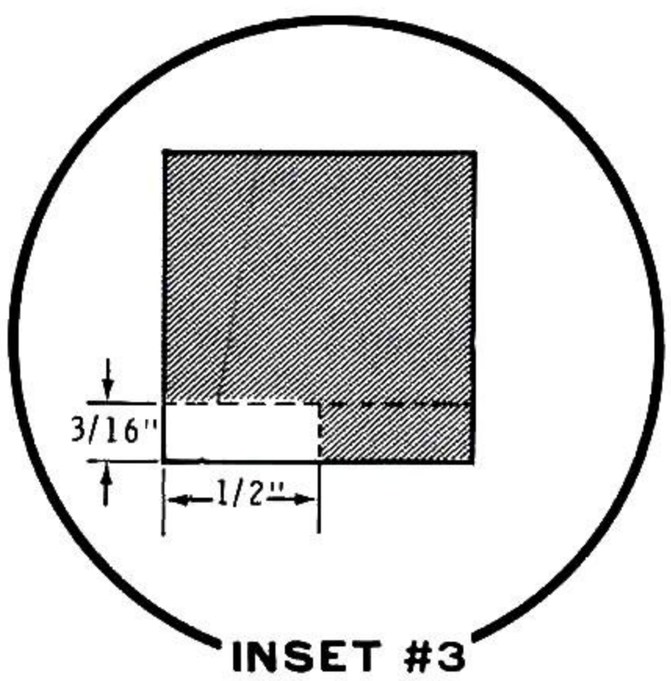




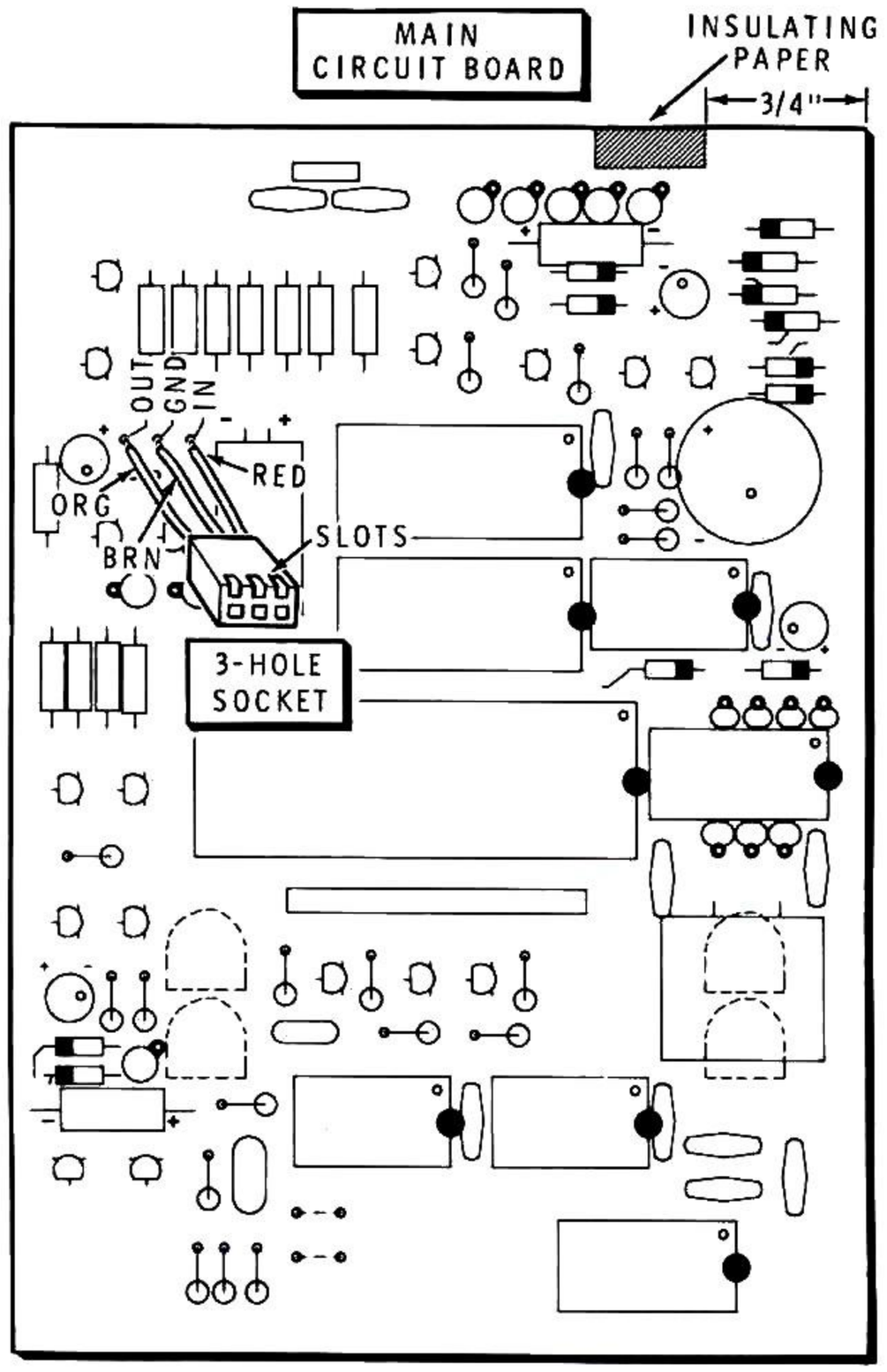
INSET #1



INSET #2



INSET #3



PICTORIAL 2-14

Connect the free end of the 7-wire cable coming from the LED circuit board to the main circuit board as follows. Position the wires over IC socket U7 as shown.

( ) Red wire to hole N.

( ) Orange wire to hole M.

( ) Yellow wire to hole L.

( ) Green wire to hole K.

( ) Blue wire to hole S.

( ) Violet wire to hole R.

( ) Gray wire to hole P.

Refer to Pictorial 2-14 for the following steps.

( ) Separate and cut 1-1/2" brown, red and orange individual wires from the flat cable and prepare the ends. Cut the 1/4" wires at one end of the cable to 1/8".

( ) Crimp and solder a spring connector on the 1/8" prepared end of each 1-1/2" prepared wire as shown in inset drawing #1.

In the following steps, you will insert the spring connectors on the end of the three prepared wires into a 3-hole socket. Make sure you position the socket with the slotted side up and the spring connectors with the small tab up as shown in inset drawing #2.

( ) Red wire in hole #1.

( ) Brown wire in hole #2.

( ) Orange wire in hole #3.

Connect the free end of the 3-hole socket wires to the main circuit board as follows. Solder each wire after you connect it and cut off the excess wire lengths from the foil side of the circuit board.

( ) Red wire to hole IN.

( ) Brown wire to hole GND.

( ) Orange wire to hole OUT.

( ) Cut a 1/2" × 3/16" piece of insulating paper from the 1" × 1" piece. (See inset drawing #3.) Save the remaining insulating paper.

( ) Remove the paper backing from the 1/2" × 3/16" piece of insulating paper and press it onto the circuit board of the indicated location.

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.

( ) Electrolytic capacitors for the correct position of the positive (+) and negative (−) leads.

( ) Diodes for the correct position of the banded end.

( ) Transistors for the correct installation.

NOTE: You will install the integrated circuits during the "Initial Tests and Adjustments." Set them aside so you do not misplace or damage them. Also, set the circuit board assembly, the remaining flat cable and any other pieces of loose wire, aside until they are called for later in the assembly. Proceed to "Case."

CASE

PARTS LIST

Remove the remaining parts from the shipping carton. These parts are called "Case Parts." Check each part against the following list and the parts pictorial (Illustration Booklet, Page 2). Make a check (✓) after each part number as you identify the part in the parts list. Some parts may be packed in an individual envelope with a part number on it. After you identify these parts, place them back in their envelope until they are called for in a step.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If one is not available, see "Replacement Parts" inside the rear cover of this Manual.

CAPACITORS — DIODE — INTEGRATED CIRCUIT

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	21-140	5	.001 µF ceramic capacitor	C201, C202, C203, C204, C205
A2	25-930	1	2.2 µF electrolytic capacitor	C206
A3	57-64	2	DRS110 diode (1n5399)	D201, D202
A4	442-54	1	UA7805 IC	U4

CASE PARTS

B1	90-1270-2	1	Case bottom
B2	95-651-1	1	Case top
B3	203-2078-1	1	Rear panel

HARDWARE

C1	250-366	1	4-40 × 3/16" screw
C2	250-321	2	4-40 × 1/8" screw
C3	250-1319	4	4-40 × 5/8" black phillips-head screw
C4	252-2	1	4-40 nut
C5	252-711	6	4-40 twist-in nut
C6	255-763	1	Spacer
C7	258-730	2	Clip
C8	253-731	2	Shoulder washer

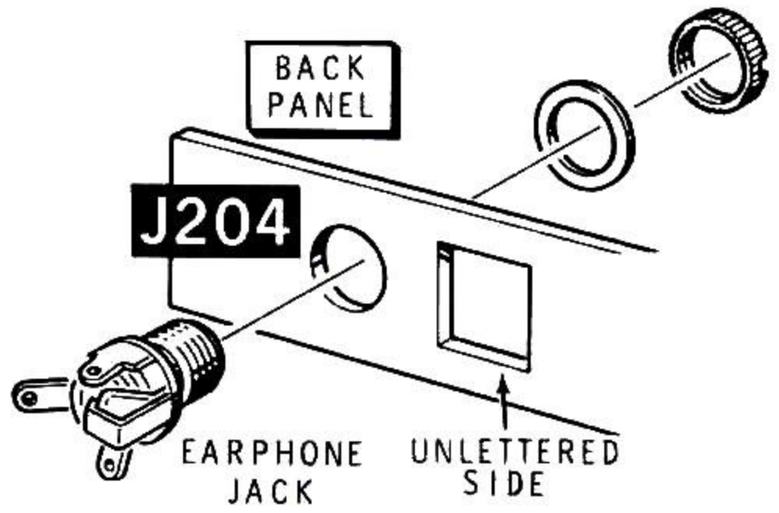
PIN — SOCKET — JACKS — PLUG

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
D1	432-866	3	Spring connector	
D2	432-865	1	3-hole socket	
D3	434-107	2	Phono jack	J202, J203
D4	436-45	1	Miniature power jack	J201
D5	438-4	1	Phono plug	
D6	438-54	2	Miniature power plug	P201
D7	438-26	1	Miniature phone plug	

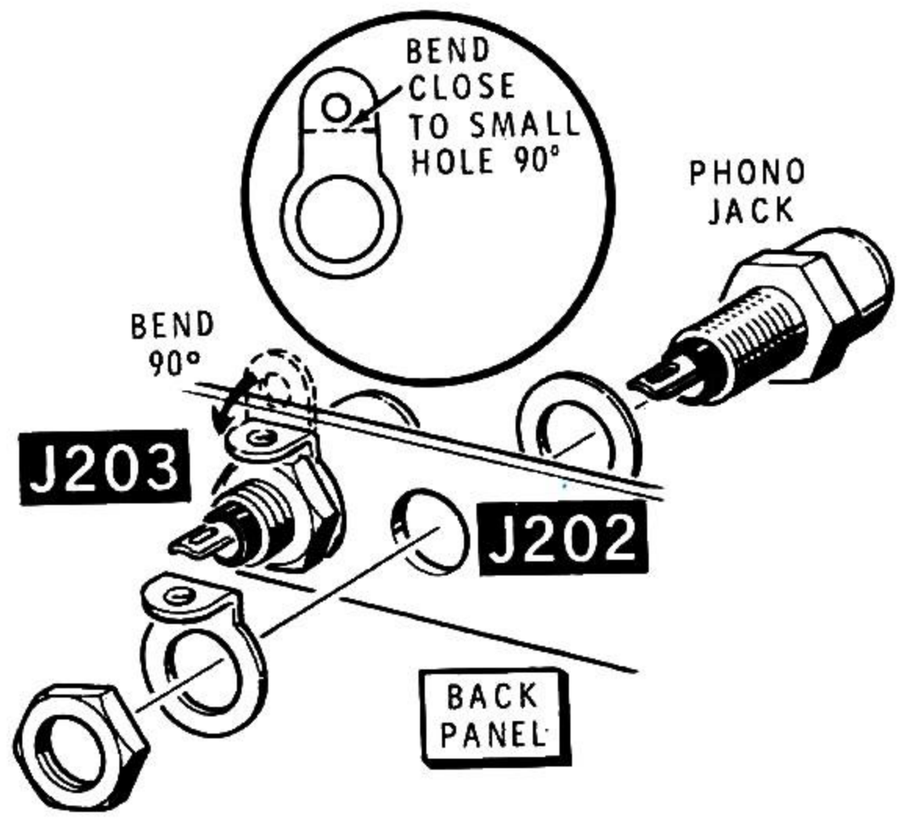
MISCELLANEOUS

E1	75-750	1	Hook loop tape	
E2	75-799	1	Insulating paper	
E3	205-1847-2	1	Metal plate (no printing)	
E4	205-1847-1	1	Metal plate (with printing)	
E5	261-50	4	Rubber foot	
E6	266-1089	2	Touch paddle	
E7	390-1784	1	Switch label	
E8	390-1785	1	Function label	
E9		1	Blue and white label	
E10	401-62	1	Earphone assembly consisting of:	
		1	*Earphone*	
		1	*Earphone jack*	*J204*
E11	401-204	1	Speaker	SP201
E12	418-37	3	Battery	
E13	490-1	1	Alignment tool	

STEP-BY-STEP ASSEMBLY



Detail 3-1A



Detail 3-1B

Refer to Pictorial 3-1 (Illustration Booklet, Page 4) for the following step.

( ) Position the back panel as shown.

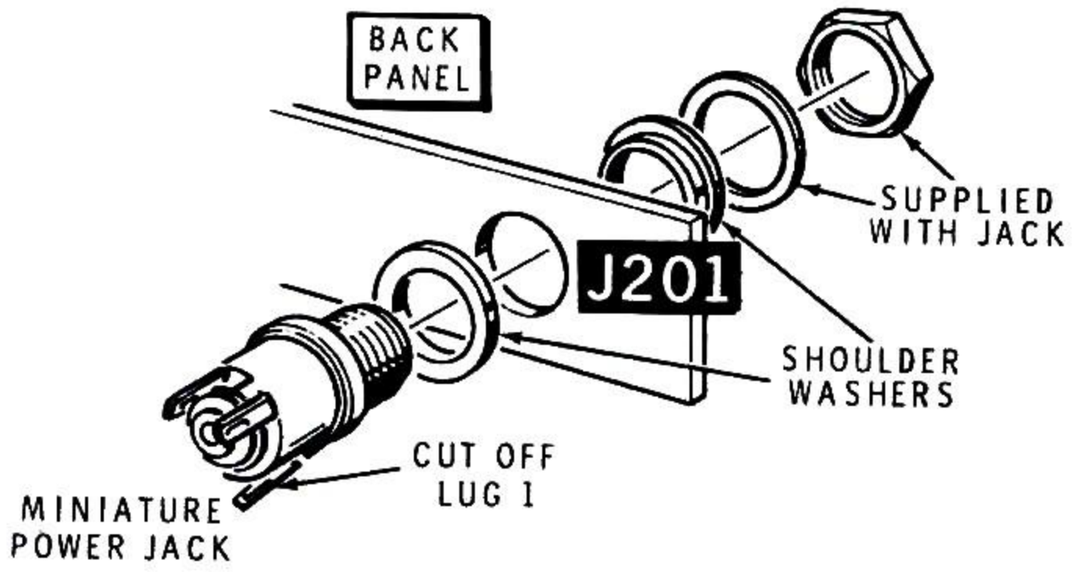
( ) Scrape any paint from around the unlettered side of back panel holes J202, J203, and J204.

( ) J204: Refer to Detail 3-1A and mount the earphone jack (supplied with the earphone) on the back panel at J204. Use the hardware supplied with the jack. Position the lugs as shown.

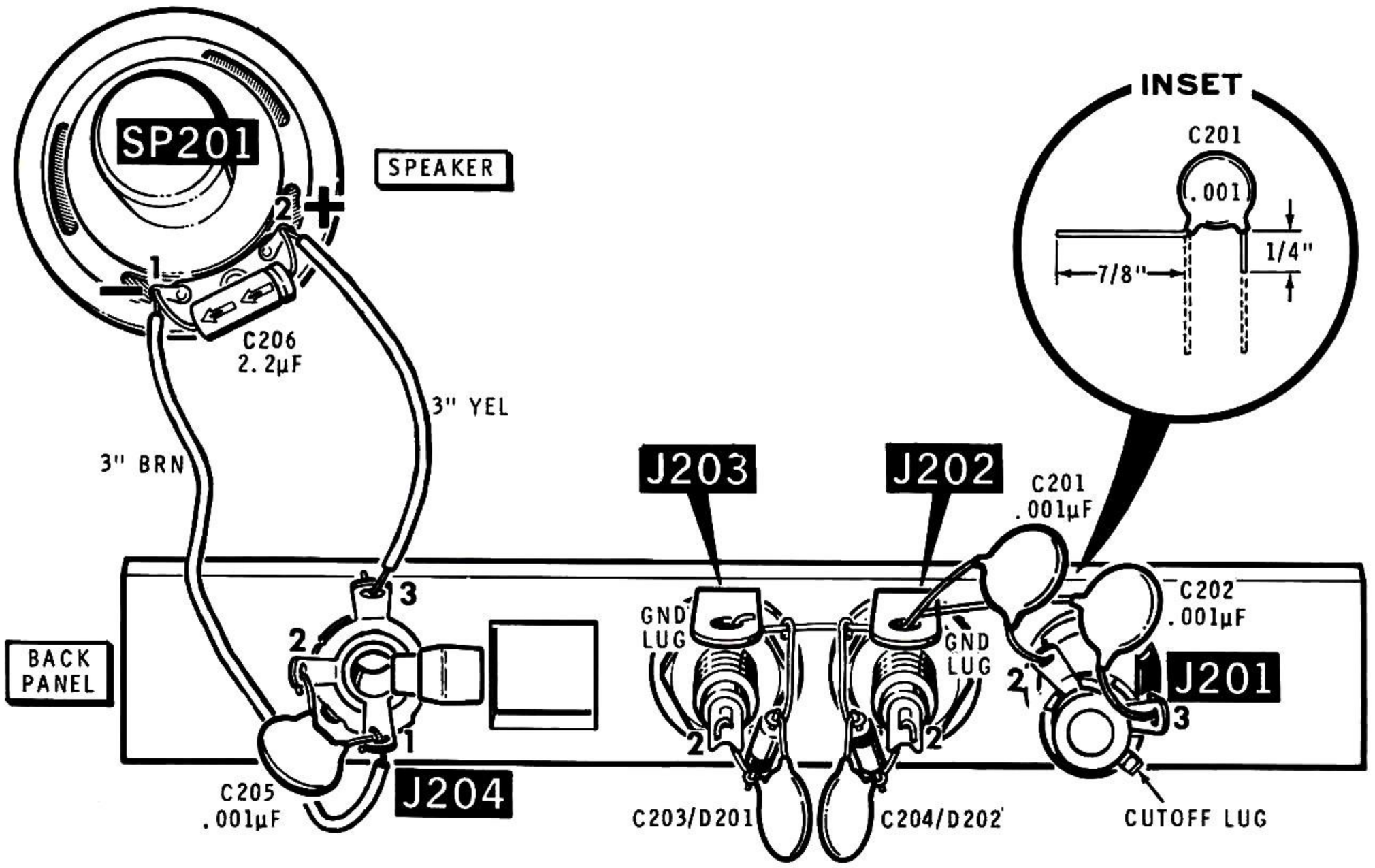
( ) J202, J203: Refer to Detail 3-2B and mount phono jacks at J202 and J203. Use the hardware supplied with the jacks. Before you mount the jacks, bend the ground lugs out 90° close to the small hole as shown in the inset drawing. Position the jacks as shown as you mount them.

( ) J201: Refer to Detail 3-1C and mount the miniature power jack at J201 with the flat washer and nut (supplied with the jack) and **two shoulder washers** (supplied with the kit parts). Make sure the shoulders of the shoulder washers seat into the rear panel mounting hole properly and that you position the lugs as shown.

( ) Refer to Detail 3-1C and cut off lug 1 of J201.



Detail 3-1C



PICTORIAL 3-2

Refer to Pictorial 3-2 for the following steps.

NOTES:

1. When you mount components to the back panel in the following steps, position them as shown in the illustration. Keep the component leads as short as possible to prevent them from shorting to other parts.

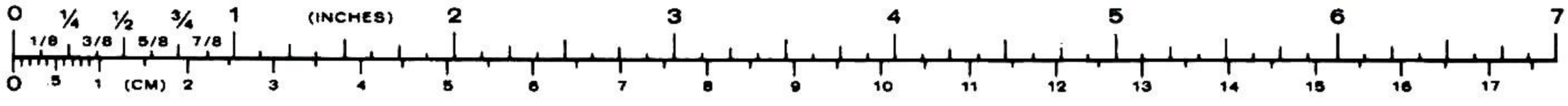
2. In the following steps, whenever you see "S-" with a number, such as (S-2), it means to solder the connection. The number following the "S" tells how many wires are at the connection. (NS) means not to solder because other wires will be added later.

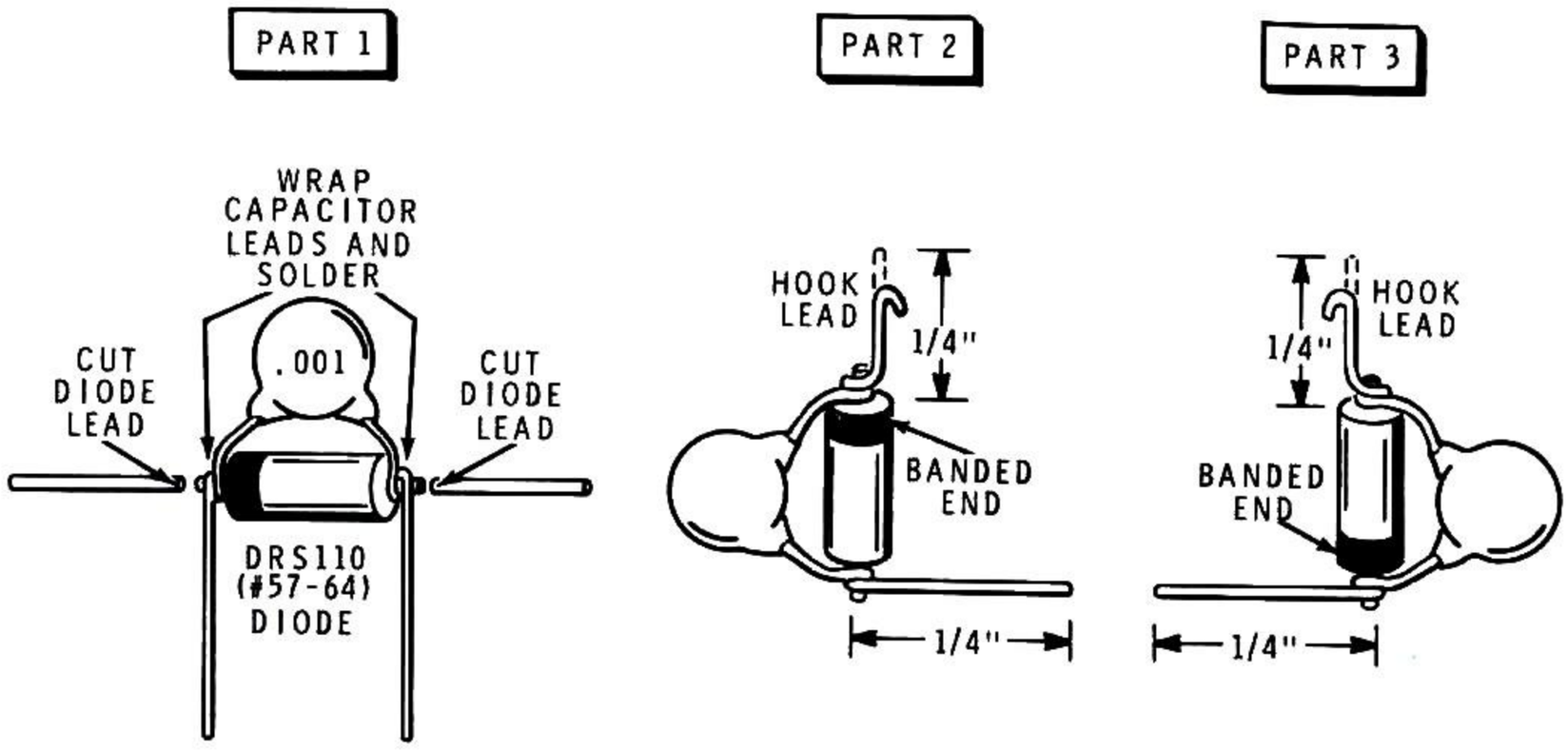
( ) C201: Form the leads of a .001 µF ceramic capacitor as shown in the inset drawing of Pictorial 3-2. Then connect the long lead through the ground lug at J202 (NS) to the ground lug of J203 (S-1). Connect the other lead to lug 2 (NS) of J201.

( ) C202: Connect the leads of a .001 µF ceramic capacitor between J201 lug 3 (NS) and the ground lug of J202 (S-3). NOTE: The capacitor lead going through the ground lug at J202 counts as two connections; one entering and one leaving.

( ) Refer to Part 1 of Detail 3-2A and connect the leads of a .001 µF ceramic capacitor across a DRS110 (#57-64) diode as shown. Wrap the capacitor leads around the diode leads once and apply a small amount of solder to the connection. Keep the capacitor leads close to the diode body and do not apply too much heat. Cut the diode leads off at the connection point.

( ) Refer to Part 2 of Detail 3-2A. Position the banded end of the diode as shown and form the capacitor leads; then cut the leads to the indicated lengths.





Detail 3-2A

( ) C204/D202: Position the banded end of the diode as shown. Hook the lead at the banded end around the lead between the ground lugs and crimp it closed (S-1). Connect the other lead to J202 lug 2 (NS).

( ) Refer again to Part 1 of Detail 3-2A and prepare another .001 μF ceramic capacitor and DRS110 (#57-64) diode combination.

( ) Refer to Part 3 of Detail 3-2A and position the banded end of the capacitor/diode combination as shown. Form the capacitor leads and cut them to the indicated lengths.

( ) C203/D201: Position the banded end of the diode/capacitor combination as shown. Connect the lead at the banded end to J203 lug 2 (NS). Hook the other lead around the lead between the ground lugs and crimp it closed (S-1).

( ) C205: Connect a .001 μF ceramic capacitor to J204 between lugs 1 (NS) and 2 (NS).

( ) Prepare a 3″ brown wire from the 5-1/2″ piece you set aside earlier.

( ) Connect one end of the 3″ brown wire to J204 lug 1 (S-2).

( ) Prepare a 3″ yellow wire from the flat cable.

( ) Connect one end of the 3″ yellow wire to J204 lug 3 (S-1).

NOTE: Be careful when you handle the speaker in the next step that you do not puncture the cone.

( ) Bend each speaker lug up slightly.

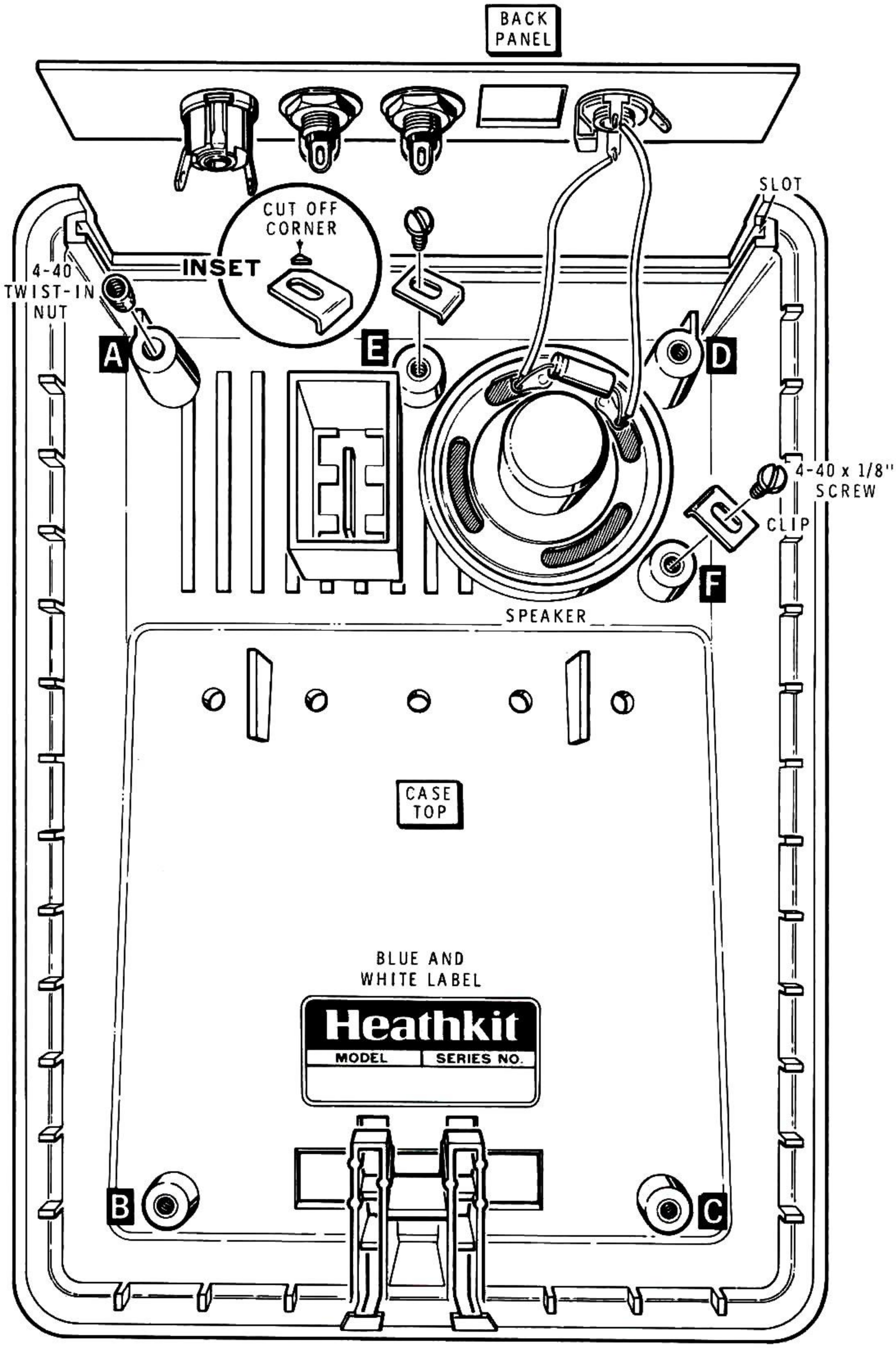
( ) C20: Connect the negative (−) marked lead of a 2.2 μF electrolytic capacitor to speaker lug 1 (NS) and the other lead to lug 2 (NS). Keep the leads short with the capacitor body close to the speaker.

Connect the free end of the brown and yellow wires coming from phone jack J204 to speaker SP201 as follows:

( ) Brown wire to lug 1 (S-2).

( ) Yellow wire to lug 2 (S-2).

Set the back panel assembly aside momentarily.



PICTORIAL 3-3

Refer to Pictorial 3-3 for the following steps.

( ) Position the case top as shown.

( ) Refer to Detail 3-3A and install a 4-40 twist-in nut in hole A of the case top as follows:

1. Refer to Part A of the Detail and turn a 4-40 nut all the way onto the end of the spacer. Then turn a 4-40 twist-in nut all the way onto the spacer. Make sure you install the twist-in nut straight into the case.

2. Refer to Part B of the Detail and carefully turn the twist-in nut all the way into hole A as shown. Then unscrew the spacer from the twist-in nut.

( ) Similarly, install twist-in nuts in the holes at B, C, D, E, and F of the case top.

( ) Remove the 4-40 nut from the spacer for use later.

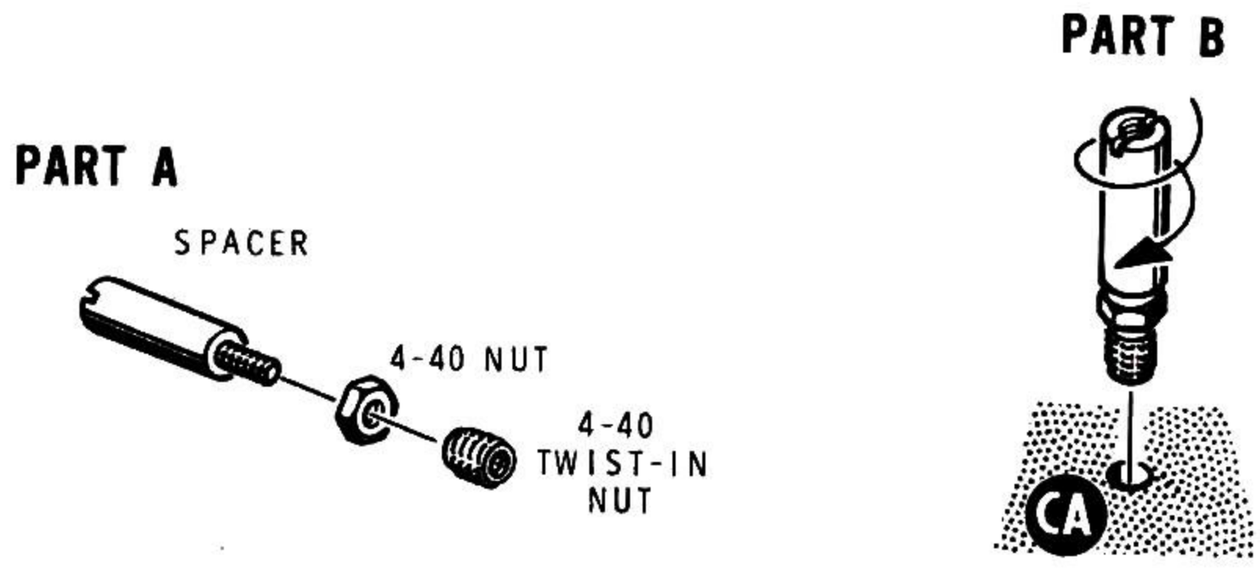
( ) Refer to the inset drawing in the Pictorial and cut off the indicated corner of one of the speaker clips.

( ) Mount the speaker in the case top at E with the prepared clip. Mount the remaining clip at F. Use two 4-40 × 1/8" screws and position the speaker as shown.

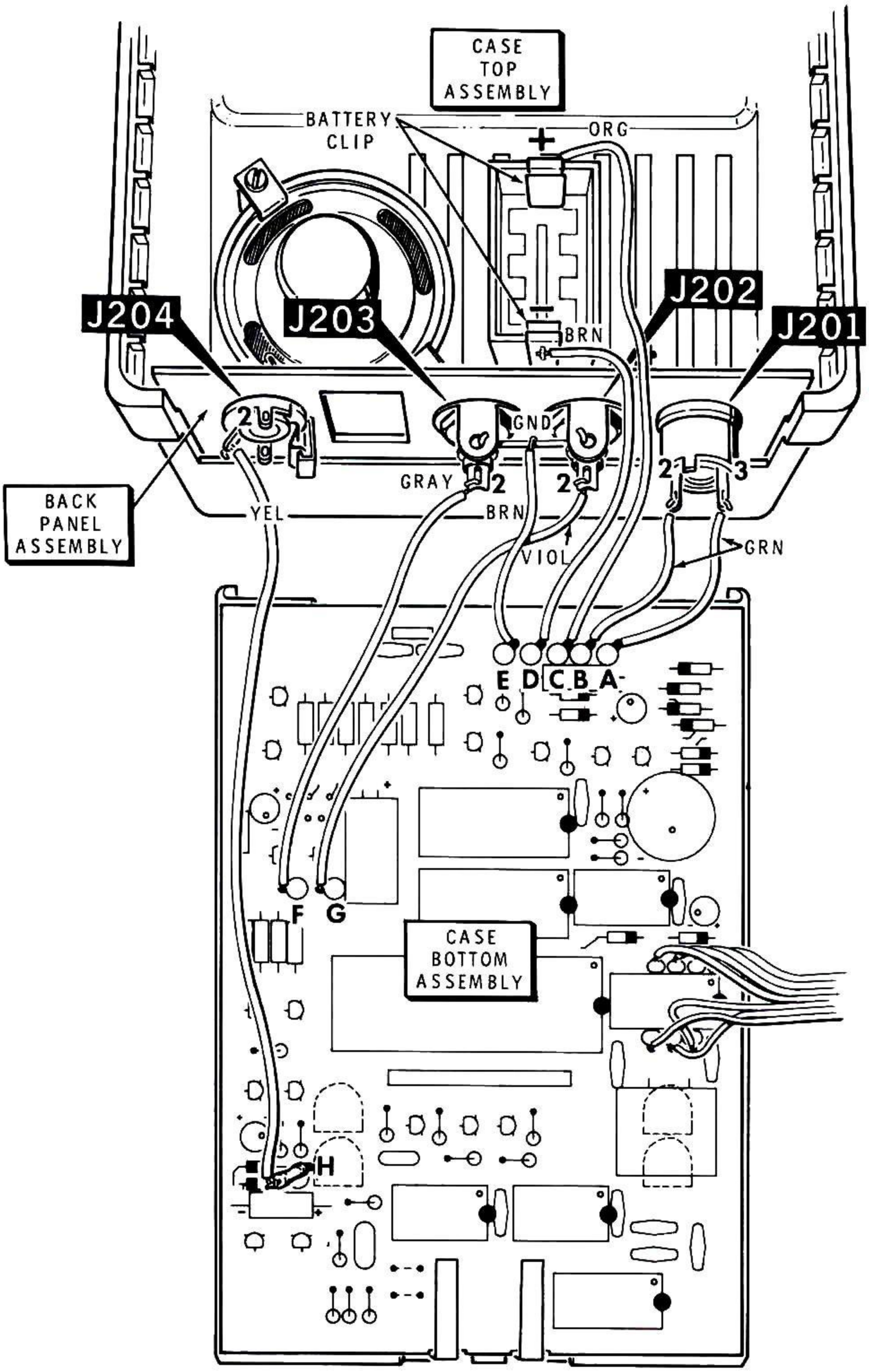
( ) Slide the back panel into the slots in the rear opening of the case top as shown. Bend the component leads on the back panel as necessary if there is any interference with the battery compartment or speaker mounting hardware.

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

( ) Remove the paper backing from the blue and white label and press the label securely onto the inside of the case top as shown.



Detail 3-3A



PICTORIAL 3-4

Refer to Pictorial 3-4 for the following steps.

( ) Position the case top and bottom assemblies as shown.

Connect the wires coming from the main circuit board to the back panel as follows. Flip the back panel over and reinstall it into the cutout slot in the case top as shown in the Pictorial to make connecting the wires easier.

( ) Green wire from hole A to J201 lug 3 (S-2).

( ) Green wire from hole B to J201 lug 2 (S-2).

( ) Violet wire from hole G to J202 lug 2 (S-2).

( ) Gray wire from hole F to J203 lug 2 (S-2).

( ) Form a hook in the end of the brown wire coming from hole E. Hook the wire over the lead between the ground lugs of J202 and J203 and crimp it in place around the wire (S-1).

( ) Yellow wire from the resistor at hole H to J204 lug 2 (S-2).

( ) Squeeze each battery clip together with your fingers as shown in Detail 3-4A.

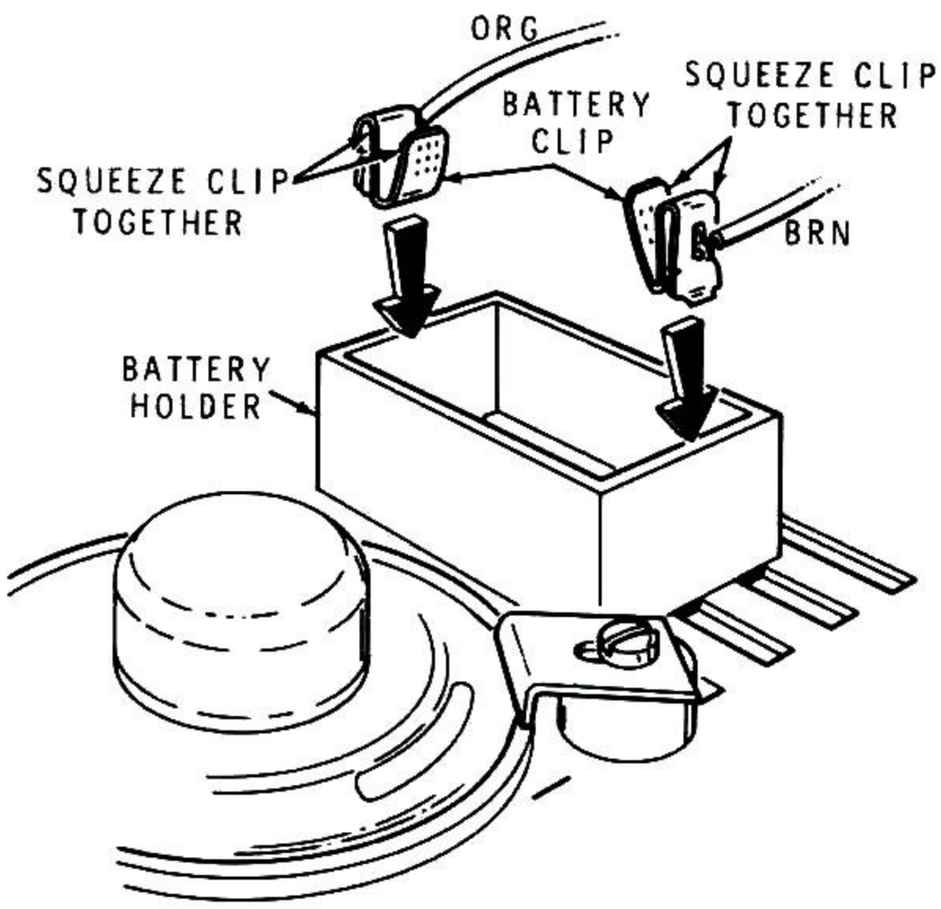
( ) Refer to Detail 3-4A and press the battery clip, on the end of the brown wire coming from main circuit board hole D, into the negative (−) end of the case top battery compartment as shown.

( ) Similarly, press the remaining battery clip, on the end of the orange wire coming from main circuit board hole C, into the positive (+) end of the case top battery compartment.

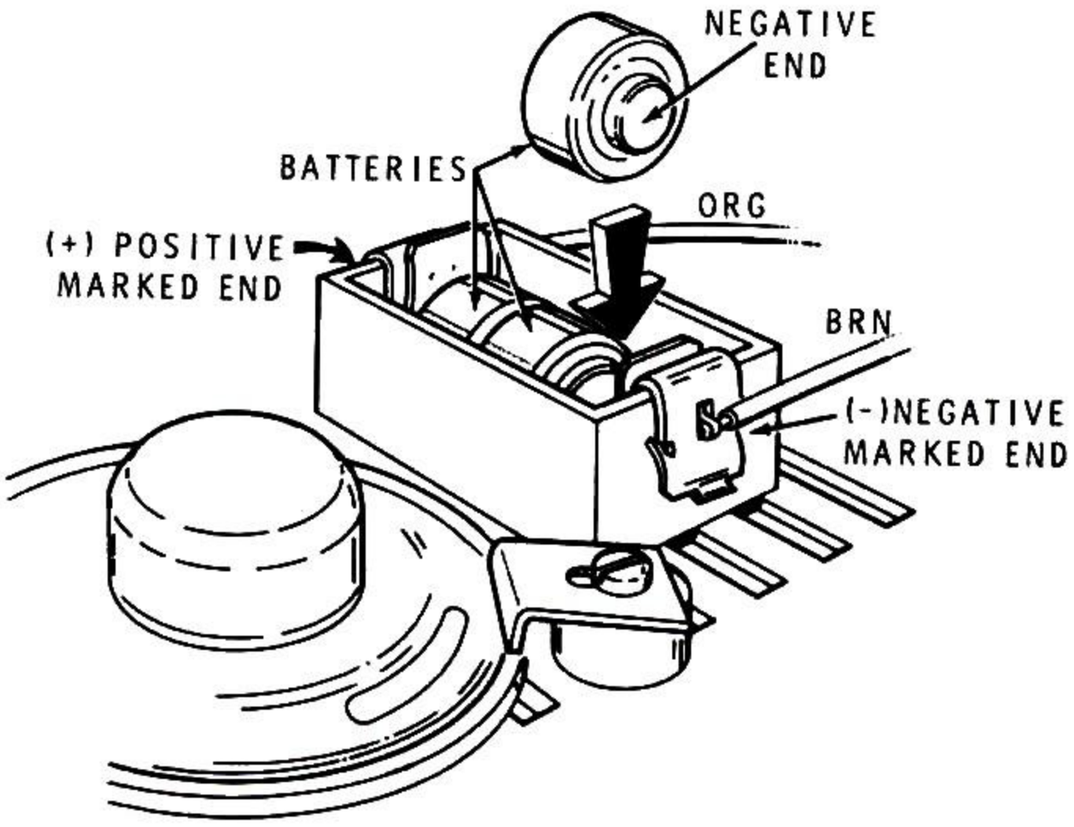
( ) Refer to Detail 3-4B and install the three batteries in the battery compartment of the case top. Make sure you install each of the batteries with the positive (+) and negative (−) sides as shown. The polarities are marked on the batteries.

( ) Flip the bank panel over to its normal position and insert it back into the case top cutout.

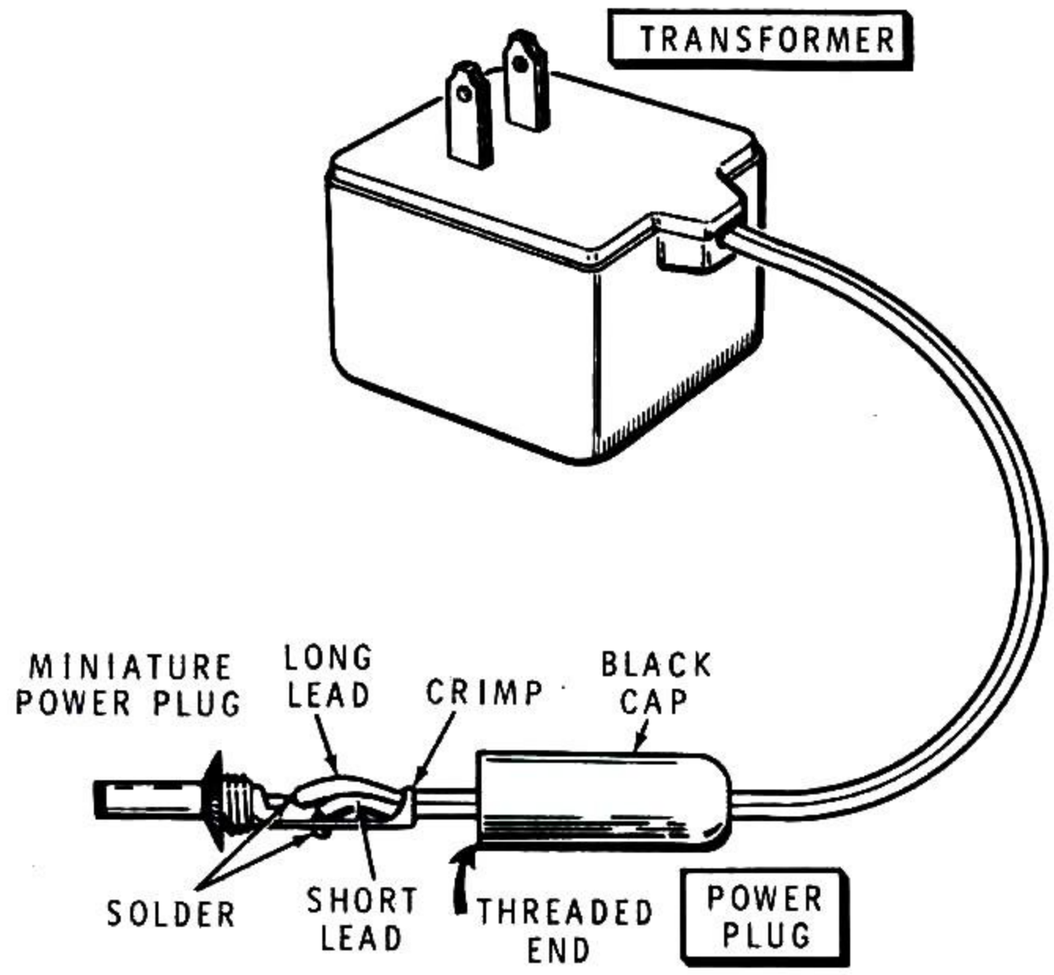
Set the unit aside.



Detail 3-4A



Detail 3-4B



PICTORIAL 3-5

POWER TRANSFORMER

You should purchase one of the following power transformers at this time for use in your kit:

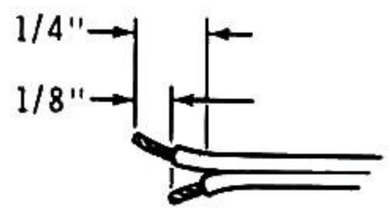
PS-5012 (#150-94) 120 VAC Power Transformer.

or

PS-5024 (#150-115) 240 VAC Power Transformer.

Refer to Pictorial 3-5 for the following steps.

( ) Refer to Detail 3-5A and prepare the end of the transformer cable as shown.



Detail 3-5A

( ) Remove the black cap from the miniature power plug. Slide the cap over the end of the transformer cable with the threaded end as shown.

( ) Solder the long and short wires on the end of the transformer cable to the indicated lugs on the miniature power plug. NOTE: You may find it easier to clamp the power plug in a small vice to hold it steady while you solder the wires to it.

( ) After the connections cool, crimp the indicated lugs around the transformer cable as shown. Replace the cap on the power plug.

This completes the "Step-By-Step Assembly." Proceed to "Initial Test and Adjustments."

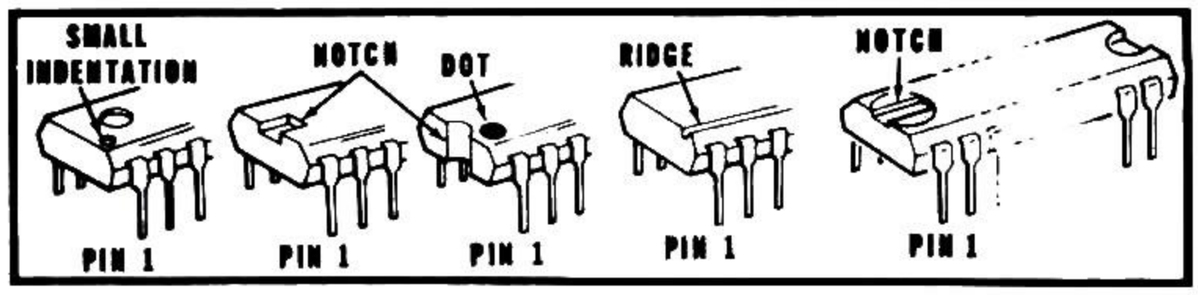
INITIAL TESTS AND ADJUSTMENTS

A DC voltmeter is required for the following tests. DO NOT PROCEED with the "Initial Tests" until you obtain the required voltmeter.

The charts in the "Initial Tests" provide a series of instructions and tests which progressively verify basic operation of all circuitry of the Memory Keyer. In each instruction/test area, make sure you obtain the indicated results before you proceed to the next instruction. If you do not obtain the indicated results, the "Area Of Possible Problem" column identifies the most likely circuit areas where a Problem (such as an open or short circuit, or an incorrectly installed or defective part) would cause you not to obtain the indicated results.

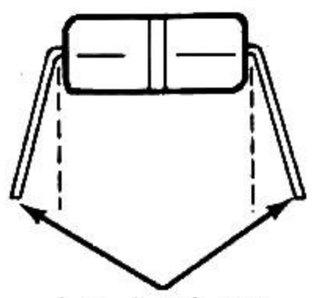
When you make voltage measurements, be very careful to touch the test probe only where instructed and do not slip and short to an adjacent pin since this could damage the circuitry.

All but one of the ICs used in this μMatic Memory Keyer are CMOS (complementary metal-oxide semiconductor) devices. These are rugged and reliable parts when they are installed, but they can be damaged by static electricity during installation. The remaining IC is of a type which is not susceptible to static electricity. Nevertheless, you should treat this IC as if it was a CMOS device since it will remove all possible confusion between ICs and provide protection in all cases. Use the following sequence when you install ICs. Refer to Detail 4-1A.

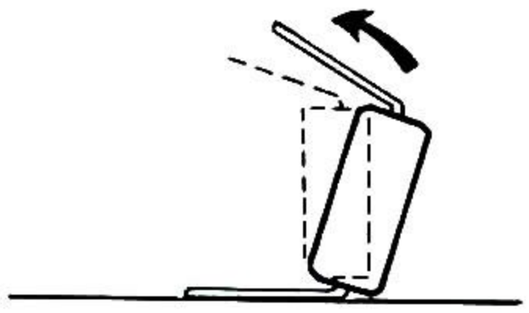


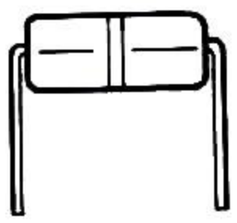
Once you remove a protected IC from its protective foam packing, DO NOT lay the IC down or let go of it until it is installed in its socket. When you bend the leads of a protected IC, hold the IC in one hand and place your other hand on your work surface before you touch the IC to your work surface. This will equalize the static electricity between the work surface and the IC.

The pins on the IC's may be bent out at an angle, so they do not line up with the holes in the IC socket. DO NOT try to install an IC without first bending the pins as described below. To do so may damage the IC pins or the socket, causing intermittent contact.

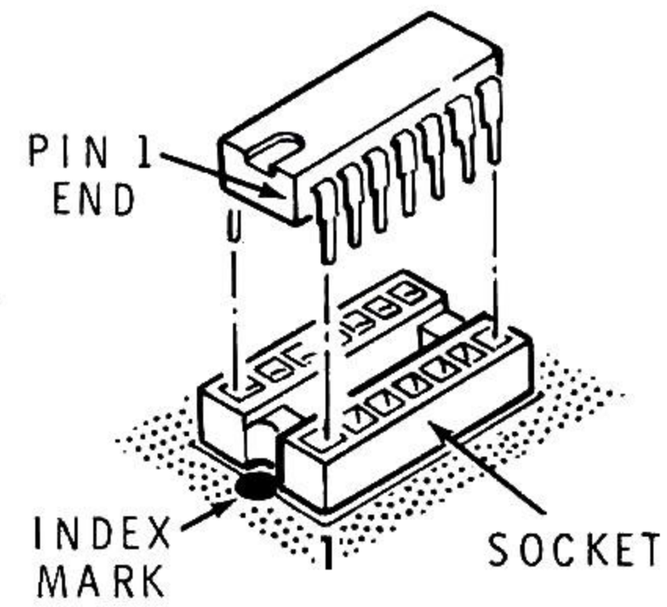


Before you install an IC, lay it down on its side as shown below and very carefully roll it toward the pins to bend the lower pins into line. Then turn the IC over and bend the pins on the other side in the same manner.

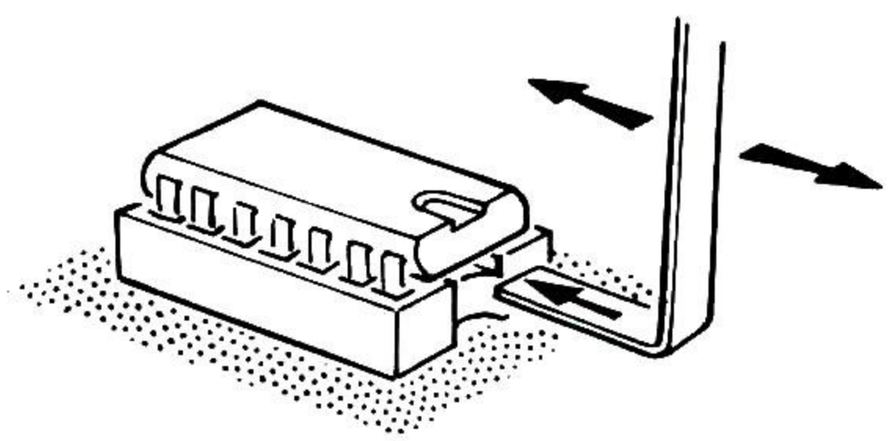




Make sure that the pin of the IC is positioned over the index mark on the circuit board (see the detail at the top of this page). Also make sure that all of the pins are started into the socket. Then press the IC formly into the socket. NOTE: An IC pin can become bent under the IC and it will appear as though it is correctly installed in the socket.

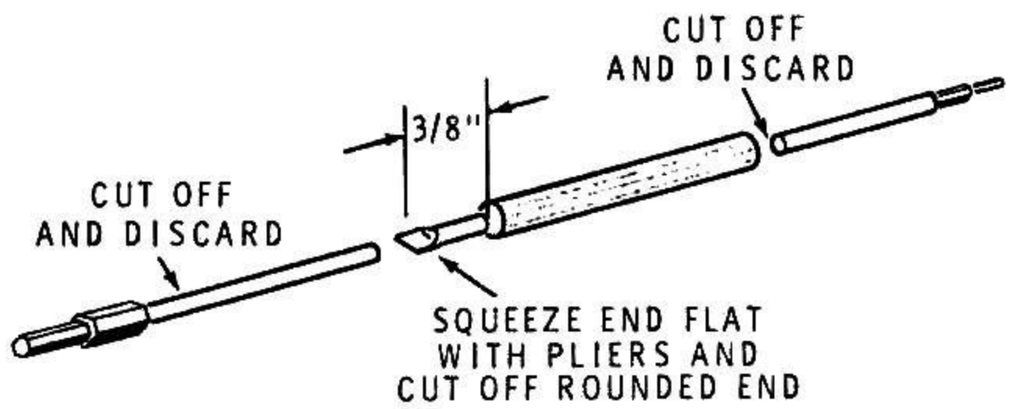


NOTE: An IC lifter has been furnished so you can remove a dual-in-line IC from its socket if this should be necessary.



Push the shorter end of the lifter in between the IC and the socket and rock the longer portion back and forth. Be very careful, as the IC pins are very easily bent.

Detail 4-1A



Detail 4-1B

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

( ) Install a CD4011 (#443-603) IC at socket U6.

( ) Plug U4 (#442-54) into socket S4 with the bare metal side as shown. NOTE: Make sure socket S4 is positioned as shown and that U4 does not short to the main circuit board.

( ) Refer to Detail 4-1B and modify the alignment tool as shown.

( ) With the alignment tool, adjust the PADDLE controls fully counterclockwise.

( ) Refer to Detail 4-1C (Illustration Booklet, Page 5) and plug the keyboard cable into the main circuit board at P1.

( ) Plug the transformer into a 120 VAC, 50-60 Hz outlet. NOTE: The transformer may hum slightly. This is a normal condition. The transformer will also get warm when it operates.

( ) Insert the miniature power plug on the end of the transformer cable into the POWER jack of the Keyer.

( ) Connect the negative voltmeter lead to the ground lead speaker terminal as shown.

Use the positive (+) voltmeter lead to make the following measurements.

STEP	INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
1.	Measure the voltage at the cathode of diode D11. It should measure +12 volts.	1. Q8, U4, U6.
2a.	Measure the voltage at the cathode of diode D1. It should measure 0.	1. Q8, U4, U6.
( ) Press the keyboard ON button.		
2b.	Measure the voltage at the cathode of diode D1 again. It should measure +5 volts.	1. Q8, U4, U6. 2. Connector loose on U4.

( ) Unplug the power plug from the Keyer.

Install the following ICs into their respective sockets:

( ) 3870 (#444-69) at U1.

( ) 74LS174 (#443-879) at U7.

( ) 4049 (#443-701) at U8.

( ) 4071 (#443-706) at U9.

( ) 4013 (#443-607) at U11.

( ) With the alignment tool, turn the VOLUME control to its midrange position.

( ) Plug the power plug back into the Keyer.

STEP	INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
3.	Press the keyboard ON button. The sidetone should sound continuously and no LEDs should be lit.	1. U1. Check for bent or unsoldered pins.

( ) Unplug the power plug from the Keyer.

Install 5101, or 51L01, (#443-933) ICs at the following socket locations:

( ) U2.

( ) U3.

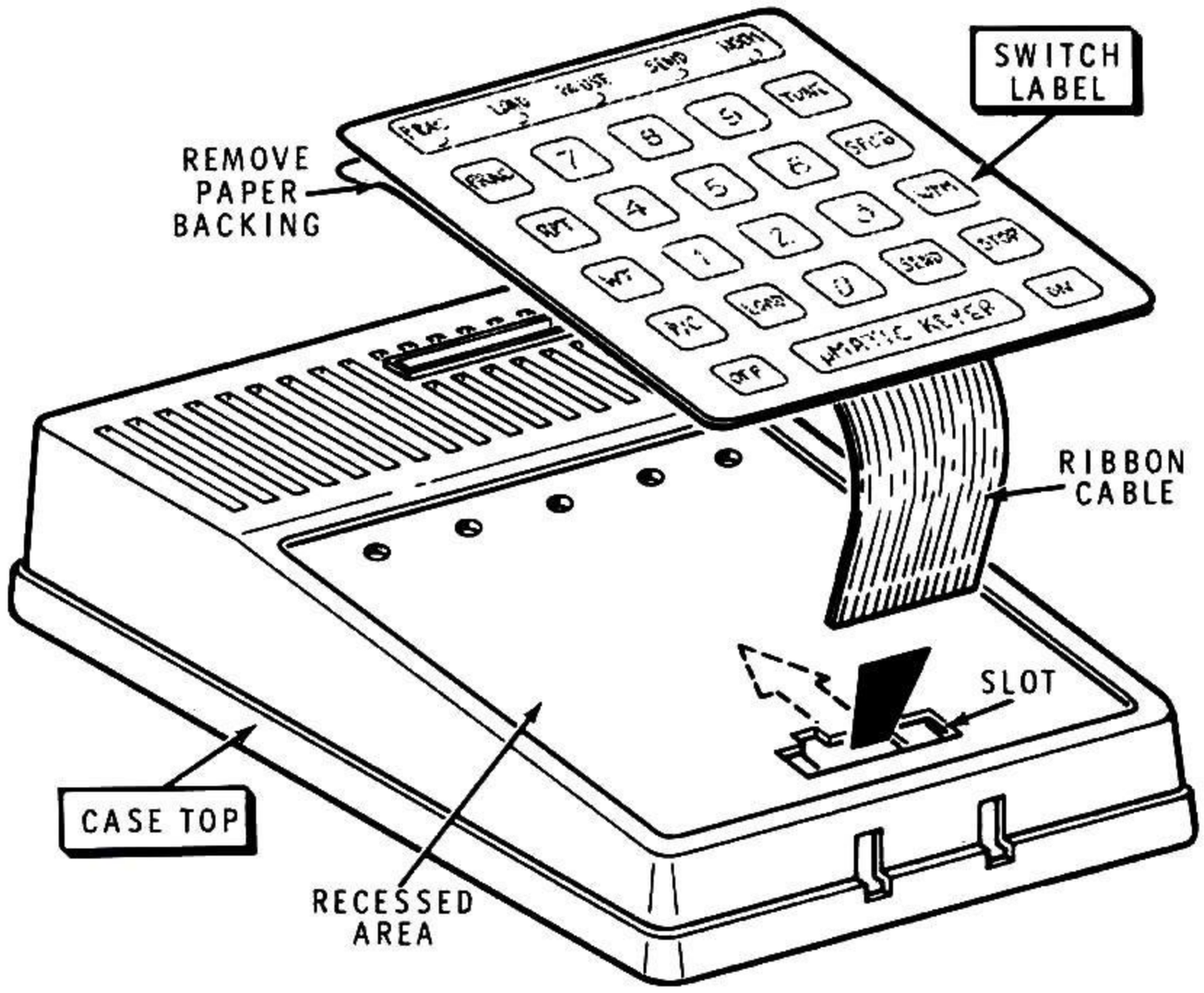
( ) Position the LED circuit board as shown in Pictorial 4-1.

( ) Plug the POWER plug back into the Keyer.

STEP	INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
4.	Press the keypad ON button. The sidetone should sound for about one second during which the LEDs should all be lit. At the end of this period, only the NORM LED will remain lit. NOTE: Some of the LEDs may be brighter than others when they are all lit.	1. U2, U3, U7, U8, U9.
5.	Measure the voltage at the indicated lead of resistor R35. It should measure between −2.5 and −3 volts.	Refer to "In Case Of Difficulty" on Page 69.
6.	Press the P/C key. You should hear a "warble." This sound indicates that pressing this key is not appropriate at this time.	1. Q1.
7.	Use a piece of metal, such as a coin, and short either outside pin of the EXT PADDLE connector to the center pin. You should hear a steady string of dots or dashes.	1. Q2, Q3, Q4, Q5, U11.
8.	Short the other outside pin to the center pin. This should produce a steady string of dashes or dots.	1. Q2, Q3, Q4, Q5, U11.

STEP	INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
9.	Short all three pins together This should produce a steady string of alternating dots and dashes.	
10.	Press the TUNE button. The sidetone should latch on. Adjust the PITCH control to a pleasing frequency. Press the STOP button and the sidetone should stop.	
11.	Unplug the power plug from the Keyer and wait for at least one minute; then plug it back in. The keyer should beep for a much shorter period of time than when you first turned it on. (This indicates that the battery backup circuitry is functioning properly.)	1. Batteries not installed or improperly installed. 2. D4 or C13 reversed or defective. 3. Q6, Q7
12.	Use the alignment tool and adjust both PADDLE controls fully clockwise. Your Keyer should begin sending a steady string of alternating dots and dashes.	1. U8, U11.

( ) Disconnect the power plug from the Keyer.



PICTORIAL 4-2

Refer to Pictorial 4-2 for the following steps.

( ) Remove keyboard plug P1 from the main circuit board.

( ) Remove U4 from socket S4 and set U4 aside.

( ) Position the case top as shown.

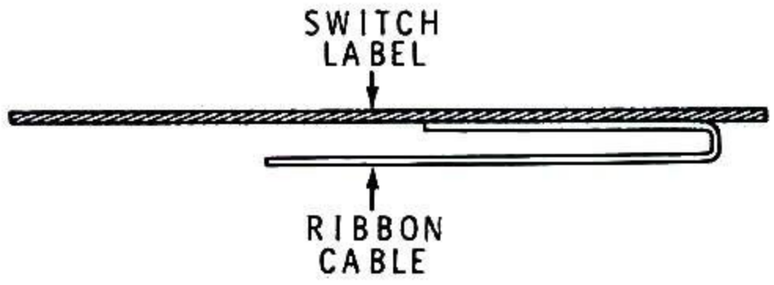
( ) Refer to Detail 4-2A and preform the ribbon cable as shown.

( ) Remove the paper backing from the switch label.

CAUTION: Handle the assembly very carefully in the following steps to avoid damaging the switch label.

( ) Position the switch label over the case top as shown. Form the ribbon cable as shown and route the end of the cable through the slot in the case top. Align the lower edge of the label with the inside edge of the recessed area in the case top; then carefully press the label into the recessed area. Make sure the ribbon cable does not press against the case and force the label away from the surface. You will connect the free end of the ribbon cable later.

( ) Set the assembly aside.



Detail 4-2A

Refer to Pictorial 4-3 for the following steps.

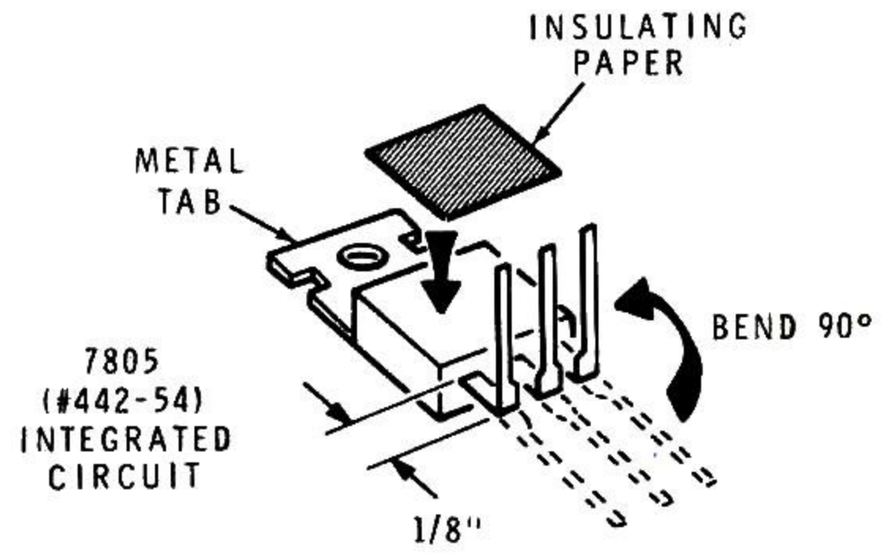
( ) Refer to Detail 4-3A and position the metal tab of the 7805 (#442-54) integrated circuit (IC) as shown. Bend the leads of the IC 90° away from the metal tab as shown.

( ) Cut a 1/2" by 1/2" piece of insulating paper. Discard the remaining paper.

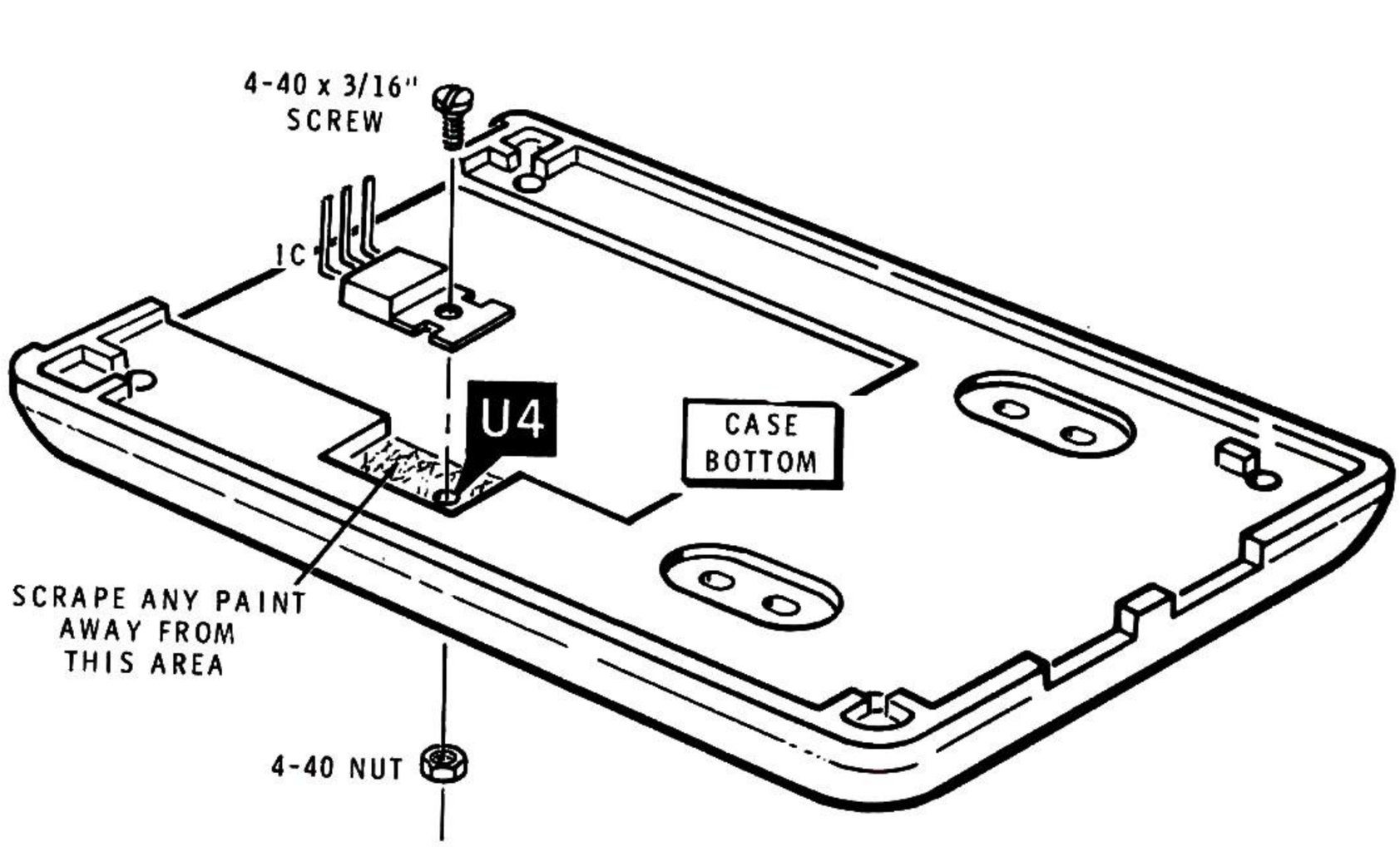
( ) Refer to Detail 4-3, remove the paper backing from the 1/2" × 1/2" piece of insulating paper, and press the insulating paper onto the plastic case of the prepared IC as shown.

( ) Scrape any paint that may be around the U4 mounting location shown in the Pictorial.

( ) U4: Mount the prepared IC at U4 on the case bottom with a 4-40 × 3/16" screw, and a 4-40 nut. Position the IC with the leads as shown.

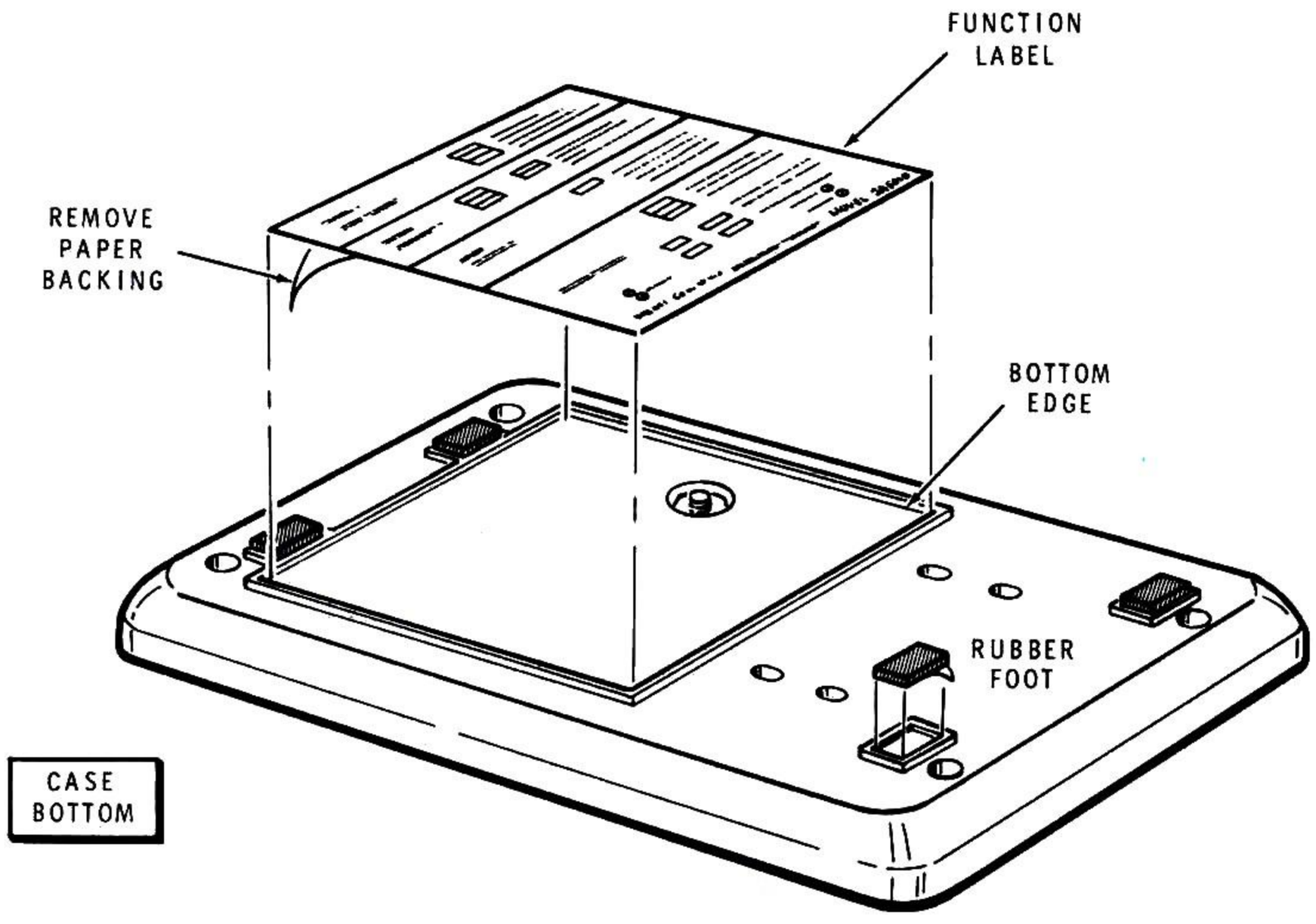


Detail 4-3A



PICTORIAL 4-3

Heathkit®



PICTORIAL 4-4

Refer to Pictorial 4-4 for the following steps.

( ) Position the case bottom as shown.

( ) Remove the paper backing from the function label and carefully align the bottom edge of the label with the inside edge of the extruded area on the case bottom. Press the label onto the case bottom.

( ) One at a time, remove the paper backing from the rubber feet and press each foot onto the indicated area of the case bottom.

( ) Refer to Detail 4-5A, position the insulating paper with the cutouts as shown, and place it over the inside of the case bottom.

Refer to Pictorial 4-5 and Detail 4-1C (Illustration Booklet, Page 5) for the following steps.

( ) Position the main circuit board assembly as shown and place it onto the case bottom assembly. Carefully guide the leads of IC U4 through the main circuit board holes. The leads should extend at least 1/4" above the circuit board surface.

( ) Refer to the inset drawing on Pictorial 4-5 and insert socket S4 over the leads of U4 with the red wire as shown.

( ) Remove the remaining paper back from the narrow double-stick foam tape on the LED circuit board.

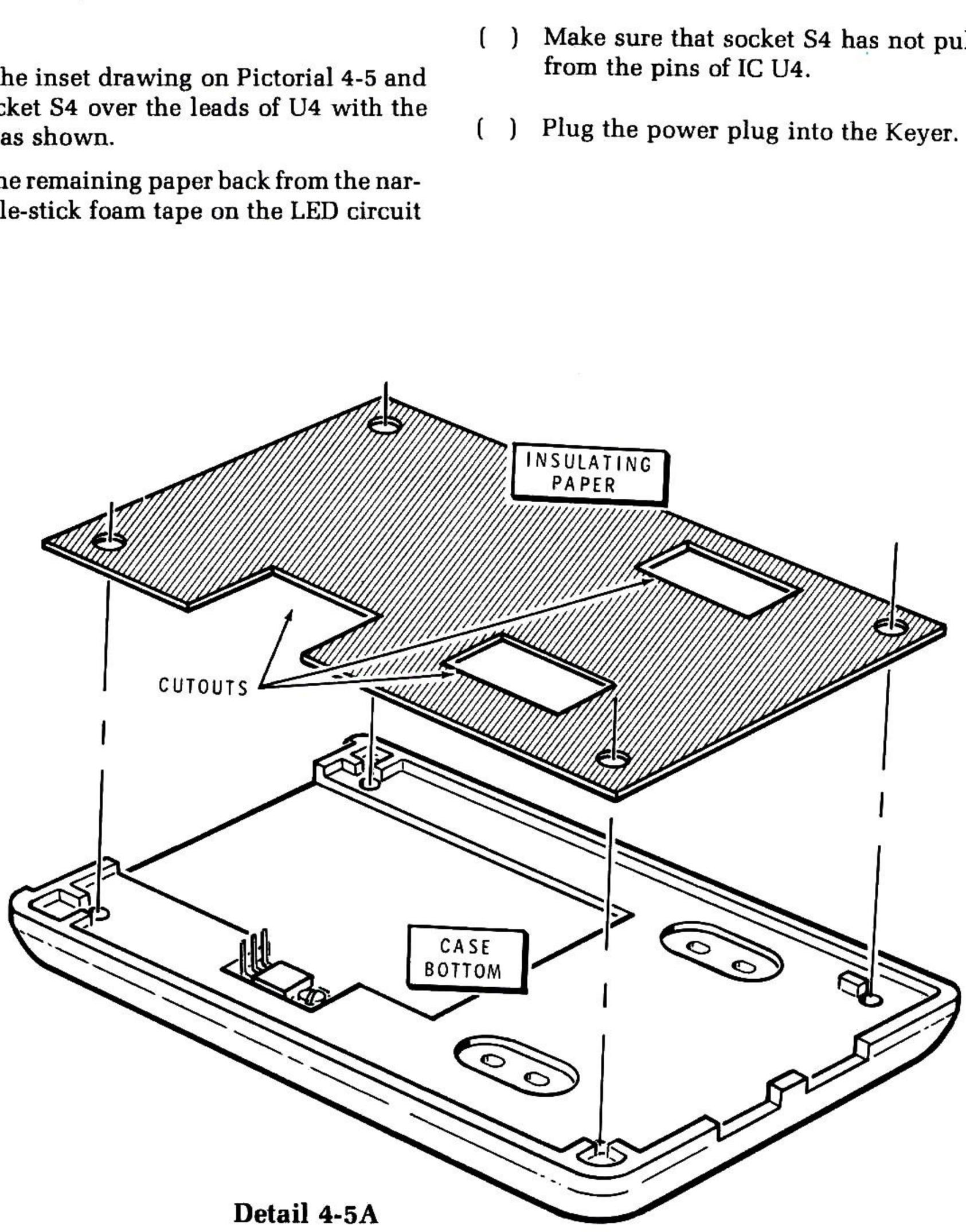
( ) Position the case top over the case bottom as shown. Insert the LEDs on the LED circuit board into the case top holes and press against the board so the adhesive on the foam tape adheres to the case.

( ) Hold the end of the flat cable by the outside edges and insert it into socket P1.

( ) Carefully lower the case top onto the case bottom. Make sure you do not pinch any wiring between the case halves.

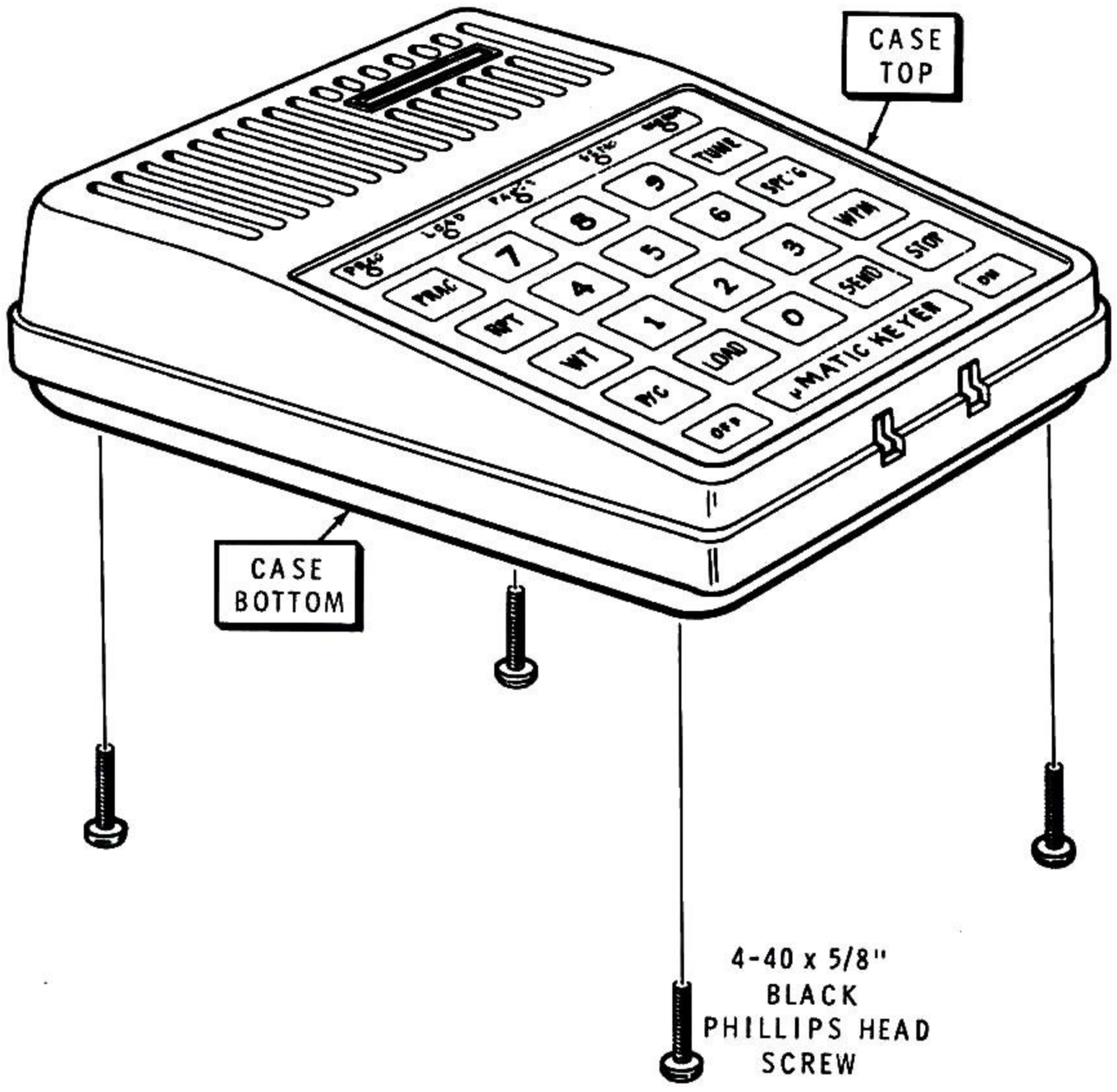
( ) Make sure that socket S4 has not pulled away from the pins of IC U4.

( ) Plug the power plug into the Keyer.

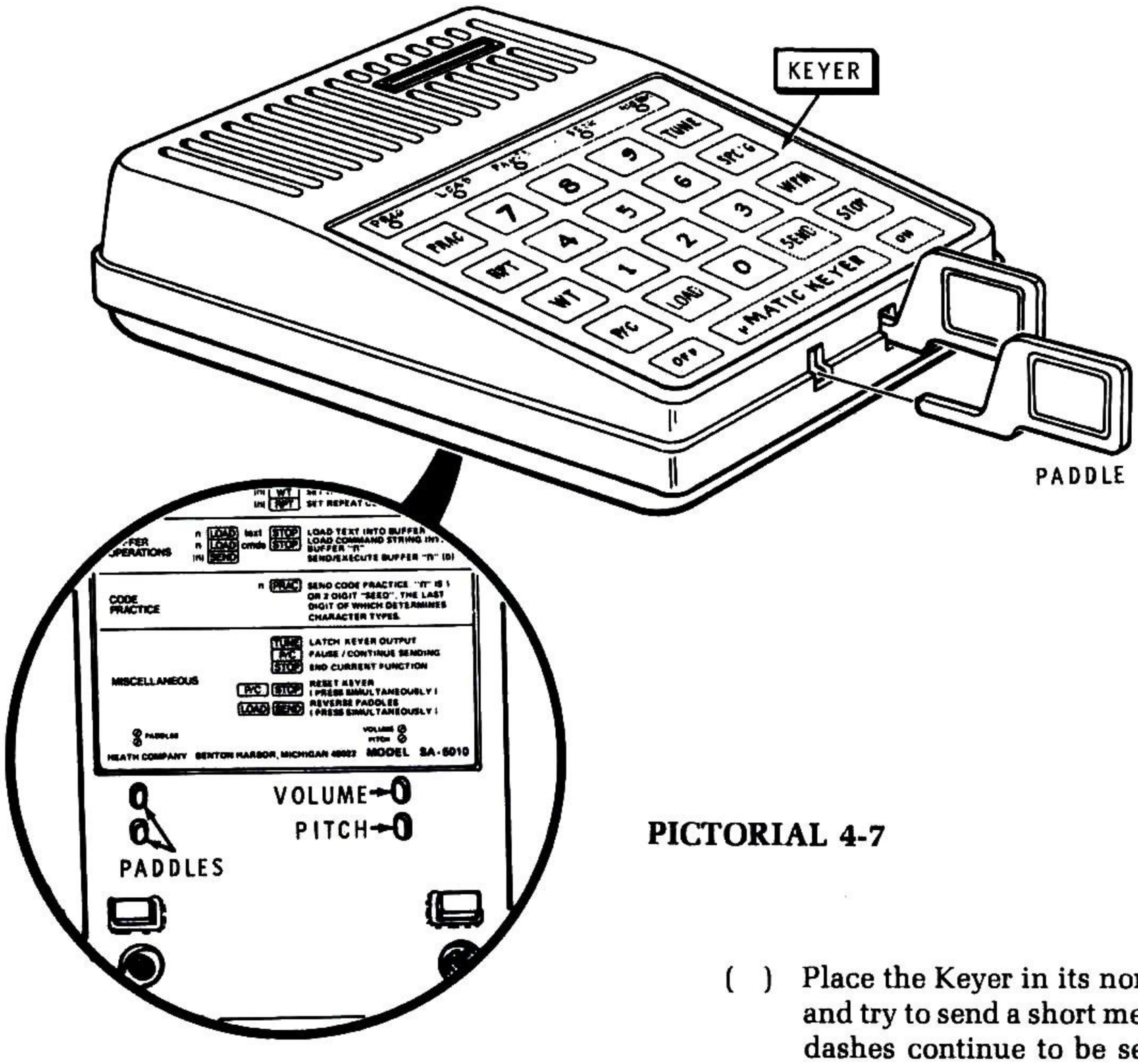


Detail 4-5A

( ) Refer to Pictorial 4-6 and secure the case halves with four 4-40 × 5/8" black phillips-head screws.



PICTORIAL 4-6



PICTORIAL 4-7

Refer to Pictorial 4-7 for the following steps.

( ) Position the Keyer in its normal position and plug the paddles into the case slots.

( ) Insert the power plug into the Keyer's POWER receptacle.

( ) Press the ON button to turn the Keyer on.

( ) With the Keyer on its side, momentarily touch both of the paddles. Adjust one of the paddle controls slowly counterclockwise until you hear either a continuous string of dots or dashes.

( ) Adjust the other paddle control slowly counterclockwise until the Keyer stops sending. Take note of which control affects dot sensitivity and which affects dash sensitivity.

( ) Place the Keyer in its normal sending position and try to send a short message. If either dots or dashes continue to be sent when you remove your finger or thumb slightly from the corresponding paddle, turn the control for that paddle very slightly counterclockwise and try it again. If you adjust a control too far counterclockwise, the corresponding paddle will not respond while the other paddle is held. With both controls properly set, you should be able to easily insert a dot between a string of dashes, and vice versa.

( ) If it has not already been done, position the Keyer on its side and adjust the VOLUME and PITCH controls as desired.

( ) Unplug both paddles from the Keyer.

( ) Disconnect the transformer from the AC outlet and unplug the power cable from the Keyer. Set the transformer and Keyer aside.

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

FINAL ASSEMBLY

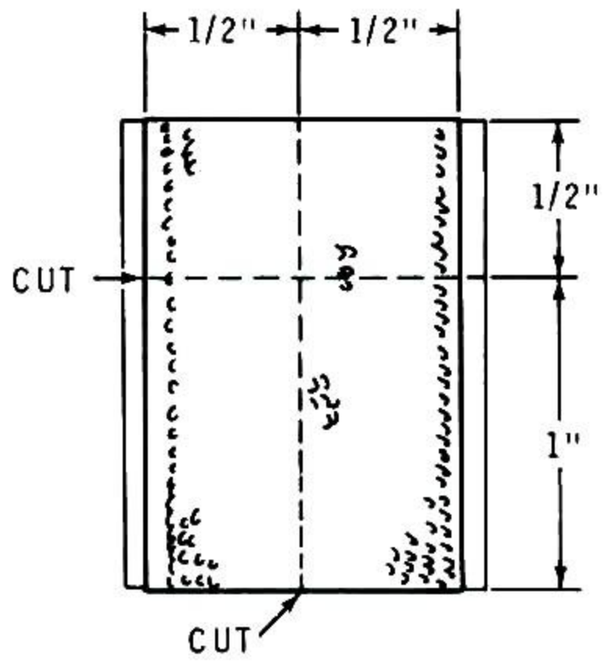
Refer to Pictorial 5-1 (Illustration Booklet, Page 6) for the following steps.

( ) Position the painted metal plate and the lettered metal plate with the tabs as shown.

( ) Place the two paddles together in the center of the painted metal plate.

( ) Separate the hook tape from the loop tape. See the inset drawing. Note that the hook tape is stiff and the loop tape is soft.

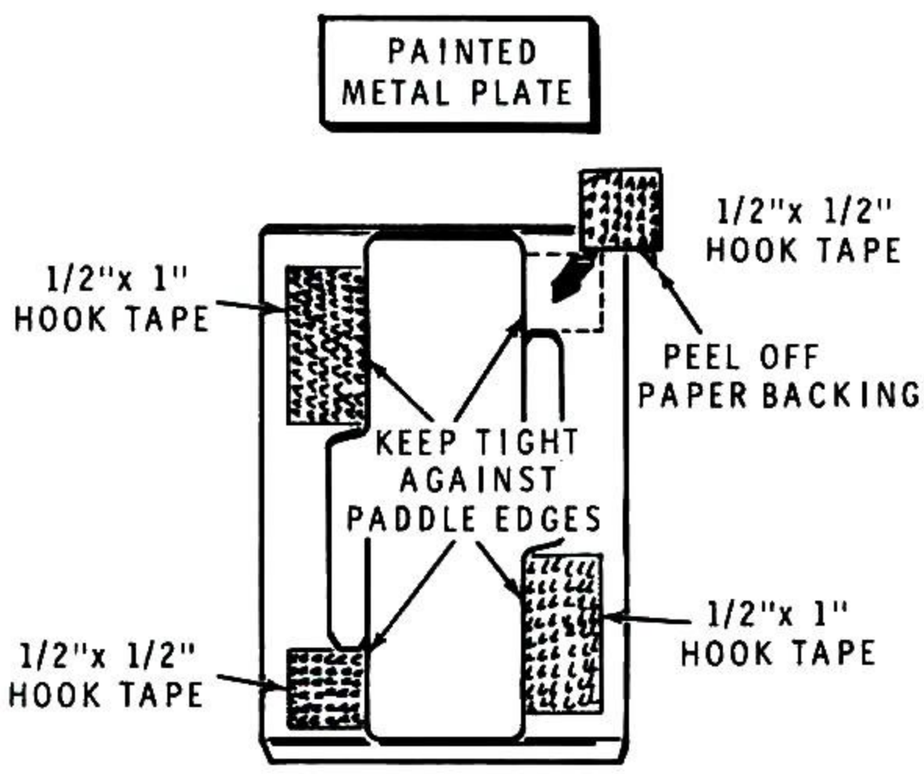
( ) Refer to Detail 5-1A and cut the piece of loop tape into two 1" × 1/2" and two 1/2" × 1/2" pieces.



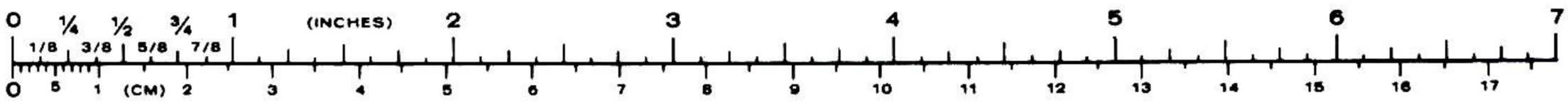
Detail 5-1A

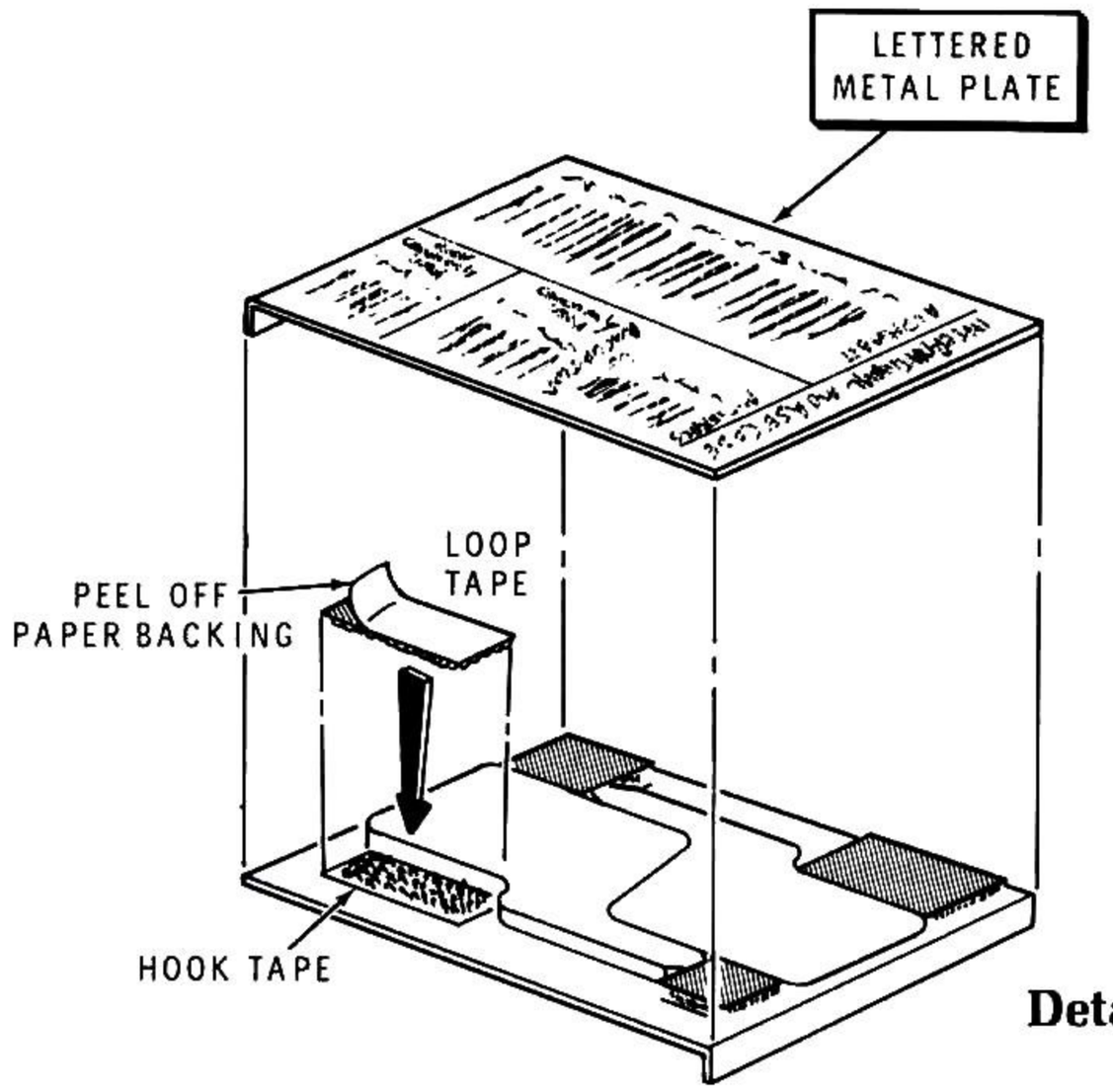
( ) Similarly, cut the hook tape into two 1" × 1/2" and two 1/2" × 1/2" pieces. Keep the hook and loop tape pieces separate.

( ) Refer to Detail 5-1B and one at a time, remove the backing from the four pieces of hook tape and press each piece onto the indicated metal plate locations. Keep the pieces of tape against the paddle edges as shown.



Detail 5-1B





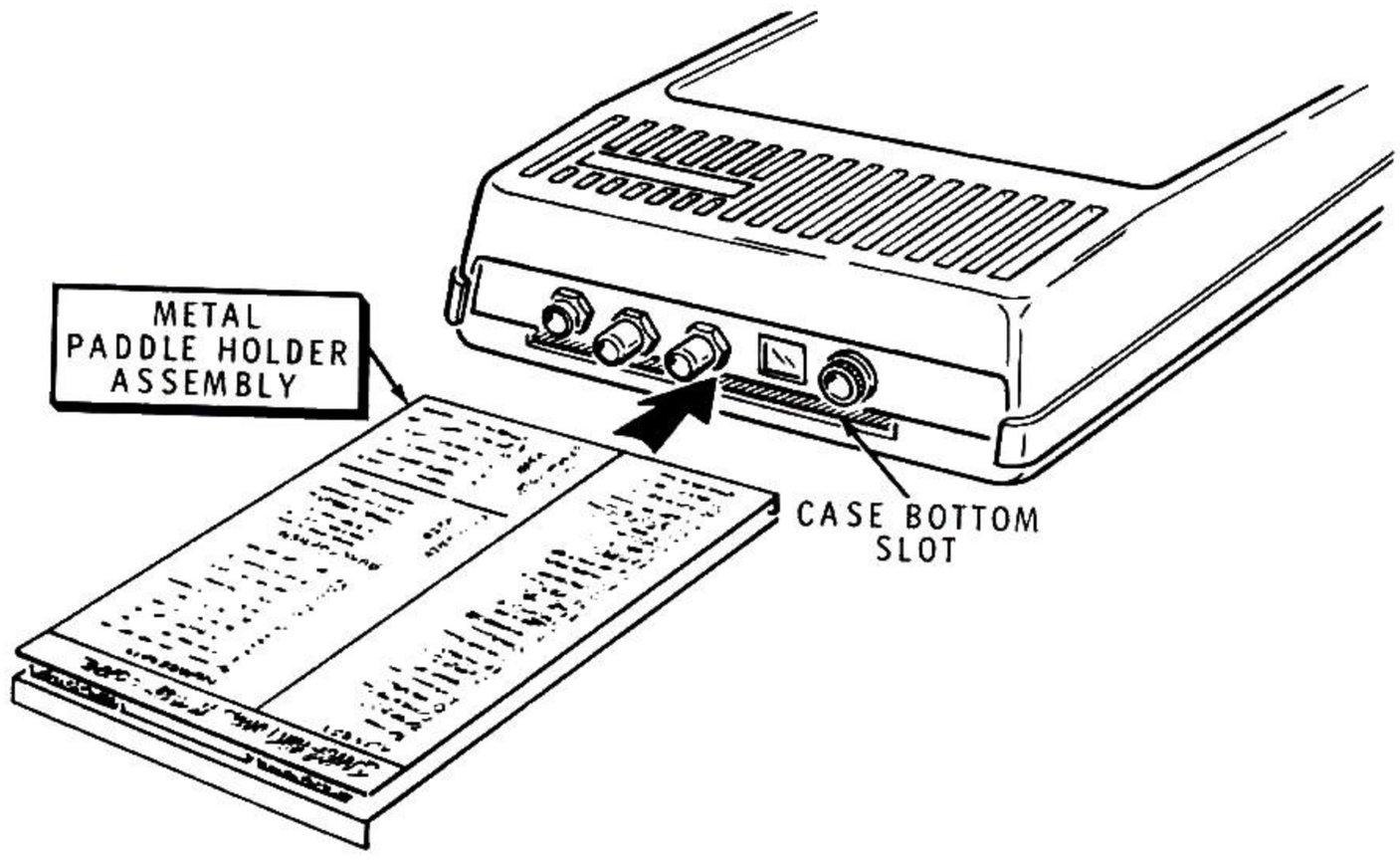
Detail 5-1C

( ) Refer to Detail 5-1C and press the four pieces of loop tape onto the same size pieces of hook tape with the backed adhesive side facing up; then remove the backing from the loop tape.

( ) Position the printed side of the lettered metal plate facing up and over the top of the other metal plate assembly. Align the edges of both metal plates and press the lettered metal plate onto the adhesive side of the loop tape.

( ) Refer to Pictorial 5-2 and slide the metal paddle holder assembly with the lettered side up, into the case bottom slot. Keep the paddles stored in this location whenever they are not in use.

This completes the "Final Assembly." Proceed to "Operation."



PICTORIAL 5-2

OPERATION

Refer to Pictorial 6-1 (Illustration Booklet, Page 7) to become familiar with the location of the keys, controls, and jacks before you operate your Keyer.

TRANSMITTER TUNE-UP

When you press the TUNE key with the Keyer in the NORMal mode, or when you are paused in the SEND or PRACtice mode, the transmitter will be keyed continuously. (Note that if the Keyer is in PAUSE but the current character has not "completed," the TUNE key is not active until it completes). The TUNE function is stopped when you press any key other than TUNE, in which case that key will also perform its normal function for the current mode, or when you touch either paddle.

SETTING SPEED

When you press one or two digit keys and follow with the [WPM] key, the speed will be set to that value. The "spacing" is automatically set to the same value. If you desire to space the characters further apart to achieve a slower net speed, then you must set the spacing after the speed, as is described in the following paragraph.

SETTING SPACING

It is sometimes desirable to have characters formed at one speed and sent at a slower speed. When you are learning code or learning to recognize single characters at a high speed, you may want to insert longer than normal spaces between characters and between words, to allow you more time to think. You can accomplish this by first selecting the formation speed as described under "Setting Speed," and then selecting the spacing by pressing one or two digit keys, followed by the [SPC'G] key.

NOTES:

1. If you attempt to select a spacing speed that is greater than the currently set formation speed, the sidetone will "warble" to indicate the error, and no change will occur.

2. The correspondence between the number you use to set the spacing and the actual net sending speed is not a one-to-one relationship (ratio). These ratios are shown in the graph of Pictorial 6-2 (Illustration Booklet, Page 8).

3. When you press [SPC'G] with no preceeding digit key, the spacing returns to the same value you selected with the [WPM] key.

SETTING CHARACTER WEIGHT

The normal ratio of dot/dash/element space is 1:3:1. You can alter this ratio by using the [WT] key. When you press a single digit key [n], followed by the [WT] key, it sets the timing as follows:

1. If you press [WT] with no preceding digit, the normal timing ratio shown above is used. This means that the length of a dash is three times as long as that of a dot.

2. If n (your specified digit) is between 0 and 4, inclusive, the interelement space is increased in length, and the dot and dash lengths are correspondingly decreased. This results in a "lighter" weighting with digit "0" being the lightest. With "0," the length of a dash is 4.4 times that of a dot.

3. When you select a digit between 5 and 9, inclusive, the interelement space is decreased in length, and the dot and the dash lengths are correspondingly increased. This results in a "heavier" weighting with digit 9 being the heaviest. With 9, the length of a dash is 2.4 times that of a dot.

CODE PRACTICE

Automatic code practice is available by pressing keys [n] and [PRAC]. [n] is a single-digit or double-digit number and establishes a "seed" for a random character generator. The single digit, (or second digit of a double-digit entry) also selects the character types to be generated for practice, as follows:

n = 1 — 3: Sends alpha characters (A through Z).
n = 4 — 6: Sends alphanumeric characters (A — Z, and 0 — 9).
n = 7 — 9: Sends alphanumeric characters plus .,?/ — — —
n = 0: Sends alphanumeric characters plus .,?/ — — — — :;' "(!

NOTE: Refer to "Random Code Practice" on Page 63 for sample sequences.

You can end the practice mode with the [STOP] key, and pause with the [P/C] key. As an example:

When you press the [3][5][PRAC] keys, random alphanumeric code groups of random lengths are sent out, using "35" as a seed. If you use this same seed later, the sequence will repeat, (provided the Keyer has not been turned off in the meantime) so you can check your copy.

NOTE: Each time you turn the Keyer on, all 100 of the possible "seeds", from 0 to 99, produce different sequences than they did the last time the Keyer was on. This "randomization" repeats only after turning the Keyer off and on 64 times (if not RESET). There are therefore 6,400 different, yet repeatable practice sessions available, and each sequence repeats after sending approximately 3000 characters. (Each character is sent either 64 or 128 times. Twice as many vowels as other characters are sent in Alphanumeric-plus-common-punctuation mode; vowels and easier characters are likewise favored in the Alphanumeric mode).

LOADING A MESSAGE BUFFER

Buffers 0 through 9 are available for storage of text sent from the paddles, or of command strings, which will be described later. All buffers are of variable length; the total buffer space holds a maximum of 240 characters and wordspaces (or keystrokes, in the case of a command buffer). When room for 20 or less characters remains in memory, the pitch of the sidetone drops noticeably as a warning. If you use up the buffer space, the sidetone will warble, and the Keyer will return to the NORMal mode. (The last character will be stored.) To store text in a buffer, use the following sequence:

1. Select a comfortable speed as described above.

2. Press the [n] key to select the desired buffer. (If you select the wrong digit key by mistake, simply follow it with the intended key.)

3. Press the [LOAD] key. This clears the buffer and disables the Keyer output. At this point, you should press no other key on the keypad or the Keyer will enter the "load command" mode, and the paddles will become inactive.

4. Begin sending. The Keyer will tolerate somewhat inaccurate sending. A paddle closure intended as part of the character currently being formed, may occur up to one interelement space time later than would be correct for perfectly formed code. When you reach the end of a word, a pause of just over 1-1/2 normal wordspaces (see the "Keyer Timing Diagrams" in Pictorial 6-3 Illustration Booklet, Page 8) is required to cause a wordspace "character" to be stored in the buffer. This makes the intercharacter spacing much less critical, and you will find it much easier to load text than with other keyers, as long as you follow this one rule.

The delay between words may be as long as you desire; only one wordspace will occur at that point. You may store one or more automatic pauses into a buffer by pressing the [P/C] key at the points you desire. When you send a message, it automatically pauses and allows you to insert text using the paddles. By pressing the [P/C] key, the message will continue from where it left off.

Characters longer than six dots plus dashes will be ignored and must be re-sent. The only important exception to this is that, when seven or more dots are sent, it is treated as an ERROR. The result will be the deletion of the previous character from the buffer, (or wordspace, if enough time has elapsed for the keyer to insert one), which may immediately be re-sent correctly in order to recover the missent character. One character or wordspace is deleted for each ERROR character.

5. After you enter the last character, press the [STOP] key to terminate the message and return to the **NORM**al mode. (If you wait 1-1/2+ wordspace times before you press [STOP], a wordspace will be inserted as the last "character" in the message buffer.)

NOTES:

1. A character of exactly six dots will cause an extra space to occur at that point in the text which is equal to four interelement spaces.

2. A wordspace is normally not stored as the first "character" in a buffer. If you desire to load a wordspace as the first character, activate the dash paddle long enough to form a string of at least seven dashes. Then wait 1-1/2+ wordspace times before you load the first desired Morse character.

SETTING THE MESSAGE REPEAT COUNT

You can cause the message buffer to automatically repeat up to 9 times (sent up to 10 times) by first setting the desired repeat count. (Sending a message buffer is explained in the following paragraph.) When you press the [n][RPT] keys, this sets the repeat count to "n." Any message buffer you send will then automatically repeat "n" times. The repeat count will remain set to this value until you set it to another number, or reset it to zero by pressing [0][RPT], or simply [RPT].

SENDING A MESSAGE BUFFER

A message buffer is sent when you press [n][SEND], where "n" is the number of the desired message. (If you do not specify "n", buffer 0 is assumed.) You can stop the message by using one of the following conditions:

1. The message completes itself after being sent the specified number of times. The Keyer will then return to the NORMal mode.

2. The message encounters a PAUSE in the message text. You may now insert text by using the paddles as described earlier. Pressing the [P/C] key will cause the message to continue from where it left off.

3. When you press the [P/C] key, the Keyer will complete the current character without a pause. (The results are the same as in the previous step.)

4. If you press the [STOP] key, the message will abort immediately.

NOTE: When you listen to the Keyer sidetone, the first character sent after pressing [SEND] may appear to begin with an extra dot. This is only the keypad "click," which does not key the output jacks.

LOADING A COMMAND BUFFER

You can use any of the ten buffers to designate a sequence of messages to be sent and, in addition, alter the speed, spacing, weight, and repeat count. This feature makes the Memory Keyer especially versatile. For example, assume buffers 0 through 4 hold the following data:

#0:[2][0][WPM][2][RPT][1][SEND][RPT][2][SEND] [2][RPT][4][SPC'G][3][SEND][RPT][3][0][WPM][4] [SEND]

#1:<CALL>

#2:DE

#3:K 8 T P

#4:IN MICHIGAN <. . . . . > <. . . . . > K

When you load the call of a station into buffer #1 and press the [SEND] key, the call will be sent three times, followed by "DE", then "K 8 T P" sent three times, (all at 20 WPM), followed by the contents of buffer #4, sent once at 30 WPM, with an extended space before the "K." The Keyer will then return to the NORMal mode with all the parameters set as they were originally. This is only one example of what can be accomplished.

When you want to load a command string into a buffer, use the same procedure as when you load a message, except that if you press a keypad button after you press [n][LOAD], the paddles become inactive, and the Keyer is in the "load command" mode. After you make the last entry, press [STOP] to return to the NORMal mode. As when you load text, the pitch of the keypad click will drop when room for 20 characters remains; the sidetone will warble and the Keyer will return to the NORMal mode if the last key you press has filled the buffer space.

Here is another example of how you can use a command buffer:

Assume that buffers #0, #1, and #2 are loaded as follows:

#0:DE K8TP UR RST [P/C] BERRIEN BERRIEN BK [P/C]
BK QSL TU <. . . . . .> <. . . . . .> QRZ K8TP K [P/C]

#1: CQ SS CQ SS CQ SS DE MICH DE K8TP K8TP K

#2: [9][RPT][SEND][SEND][SEND]. . . [SEND]

Now, if you desire to participate in a contest, you can establish a contact by pressing [1][SEND]. Once you establish communication, you can transmit a report to the other station by pressing [2][SEND], and pause for their report. Once you have received their report, you can acknowledge and request another station to reply by pressing [P/C]. The keyer will automatically pause for manual insertion of "RST" report. (NOTE: Use of the special space character <. . . . . .>, extends the wordspace before the QRZ.) From this point on, as long as the stations reply to the QRZ, the only key that you will have to press is [P/C]. For each time you loaded the [SEND] key into buffer #2, buffer #0 will be sent ten times (due to the [9][RPT]).

NOTES:

1. Any parameters that you change within a command string will return to the values you last set from the keypad when the Keyer returns to the NORMal mode.

2. You should avoid using extra digit keys in a command buffer since they waste buffer space.

SELF DIAGNOSTICS

Each time you turn the Keyer on, a checksum is performed on the contents of the program in ROM. If this test fails, a steady sidetone will sound and all of the LEDs will light.

When you turn the Keyer on for the first time following a battery replacement, a test is run by the Keyer on RAM. If this test is successful, the speed and spacing are both initialized to 20 WPM, the weight is set to normal, the repeat count set to zero, and all the buffers are cleared. If a bad cell is found, the sidetone will sound a steady tone and no LEDs will light.

RESETTING THE KEYER

When you press the [P/C] and [STOP] keys simultaneously*, the diagnostics for both RAM and ROM are performed. All the buffers are cleared, and the Keyer is initialized as in the previous paragraph.

REVERSE PADDLES

When you press the [LOAD] and [SEND] keys simultaneously*, the Keyer circuitry toggles between right-handed and left-handed operation. The Keyer always powers up in the right-handed mode unless you have the left-handed wiring option.

*NOTE: If you press one key slightly ahead of the other, the first key you press will be recognized as a single closure, and will begin to perform its normal function, or cause the sidetone to warble if it is not a legal key for the current mode. The two keys must be held down long enough so they can be recognized as a pair. When you release the keys, the Keyer will return to the NORMal mode.

USING THE PADDLES

The Keyer comes with two paddles. When you activate one of the paddles, a string of properly spaced, self-completing dashes is produced as long as the paddle is held. The other paddle produces a string of dots in the same manner. The operation of the paddles is the same as on the older keyers; moving in one direction produces dots and the other direction produces dashes. The SA-5010A will operate the same as a single-paddle keyer if you treat the two paddles as one.

The main advantage of dual paddles over a single paddle is that both may be activated simultaneously to produce a string of alternating dots and dashes. The paddle you touch first determines whether a dot or a dash will occur first. This result is called "iambic" operation, which is a term describing the timing of poetic verse. The Keyer can remember a dot paddle closure during the sending of a dash, and vice versa.

These dot and dash closure memories allow you to insert a dot into a string of dashes by activating the dot paddle during the dash it is to follow. You may insert a dash into a string of dots in the same manner. You can send many characters with less effort when you take advantage of this feature. For example, to send the letter "C" (-.-.), a single paddle keyer would have to move left, right, left, right. With an iambic keyer, both paddles are activated together with the dash paddle slightly ahead of the dot paddle. The paddles are released during the second dash. (The last dot will be sent due to the action of the dot closure memory). Thus, the character is sent with a simple "squeezing" of the paddles. This is often referred to as a "squeeze keyer." Several keyer timing examples are shown in Pictorial 6-4.

It will take a little time to get used to the "touch" paddles supplied with your Keyer, particularly if you are accustomed to resting your thumb and forefinger on the mechanical dual-paddle keyer paddles. The touch paddles require only a light touch to activate them.

NOTES:

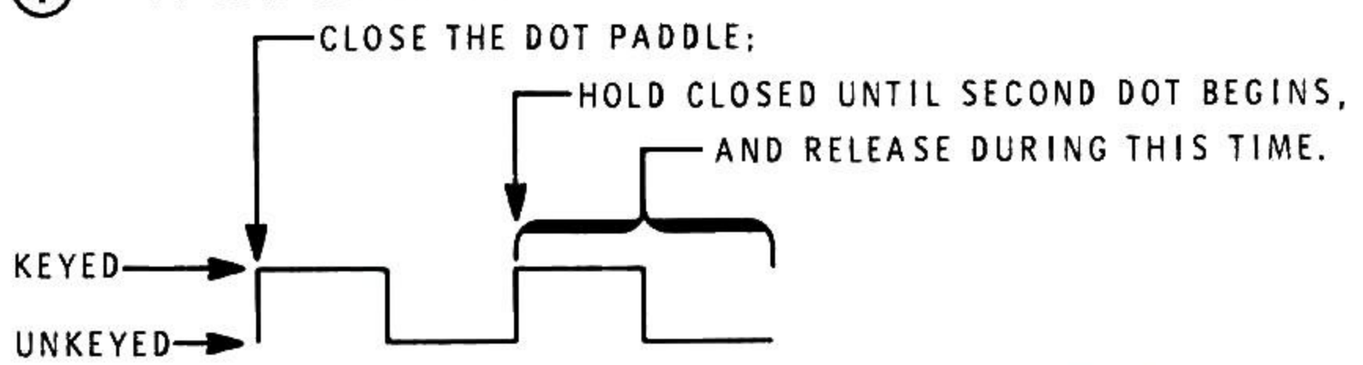
1. The touch paddles operate when you add the stray capacitance from your body between the paddles and the Keyer. Due to the small size of the Keyer, there is little stray capacitance between its case and ground. Therefore, to provide a return path for your body capacitance and ensure paddle operation, it is necessary to have the PS-5012 Power Supply plugged into a grounded 3-hole wall outlet.

2. Stray RF may cause the Keyer to generate random dots and dashes while a transmitter is operating. You can prevent this by making sure all the equipment at the station location is grounded to a common point. In extreme cases, it may be necessary to rest your hand on a metal plate which has been positioned under the Keyer. This plate should also be grounded at the same common point as the Keyer.

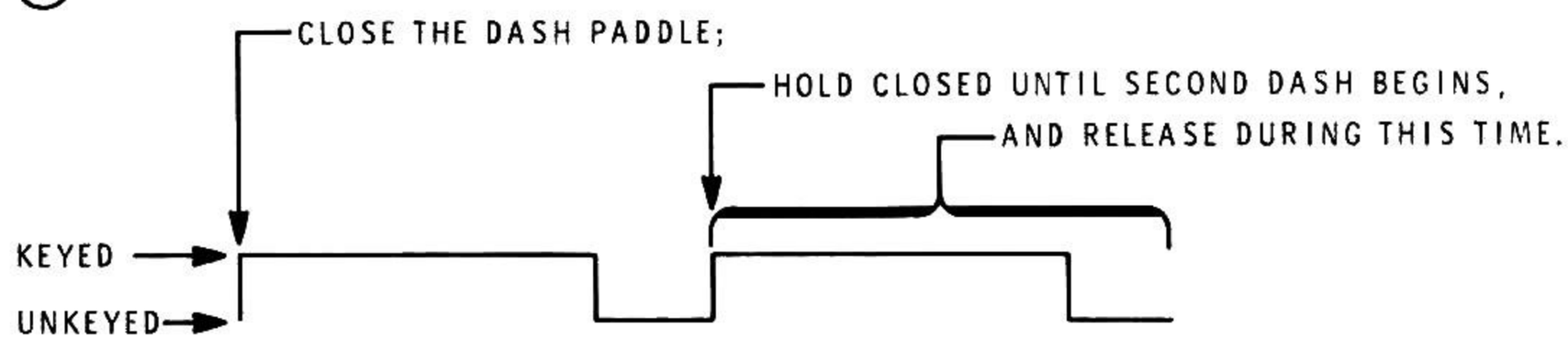
3. Static discharges to the capacitive touch paddles may damage CMOS integrated circuit U11. If static electricity is a problem in the environment where the Keyer is to be used, it is a good idea to discharge yourself by touching some grounded object before beginning to operate the Keyer.

THE FOLLOWING EXAMPLES ILLUSTRATE KEYER TIMING IN **NORMAL** OR **PAUSED** MODE.

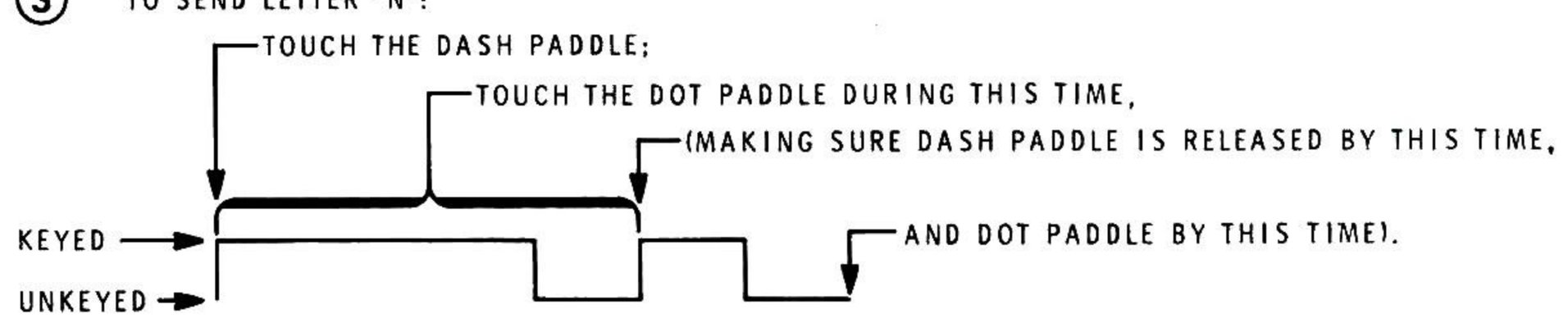
① TO SEND LETTER 'I':



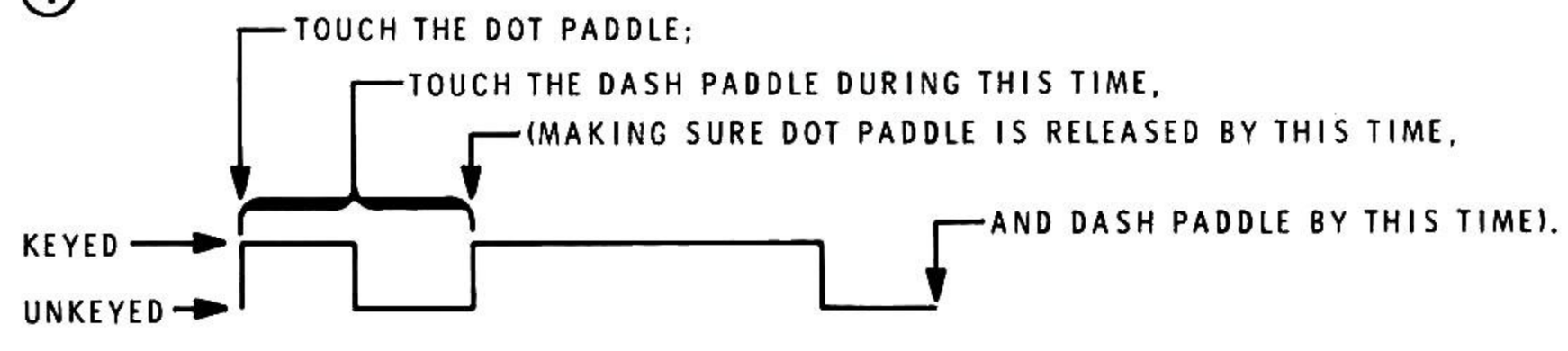
② TO SEND LETTER 'M':



③ TO SEND LETTER 'N':



④ TO SEND LETTER 'A':



NOTE: TIMING SHOWN IS WITH KEYER SET FOR NORMAL WEIGHTING.

PICTORIAL 6-4

STATUS LED's

PRAC	LOAD	PAUSE	SEND	NORM	
				ON	Normal (power-up) mode
				(dim)	Normal mode, digit(s) pressed*
	ON				In "load text" or "load command" mode
			ON		Sending a message buffer
		ON	ON		Paused while sending a message buffer
		ON			Paused from a command string
ON					Sending code practice
ON		ON			Paused while sending code practice

*A pressed digit key(s) is "remembered" until you press a function key or [STOP] key. The NORM LED dims to indicate this condition.

SUMMARY OF COMMANDS

1)	[ON]	Turn keyer on
2)	[OFF]	Turn keyer off
3)	[n][LOAD<text>[STOP]	Clear buffer n and load with <text>
4)	[n][LOAD]<cmd string>[STOP]	Load buffer n with <command string>
5)	[n][SEND]	Send message n / execute command string n
6)	[SEND]	Send message 0 / execute command string 0
7)	[n][RPT]	Set repeat count to n
8)	[RPT]	Set repeat count to zero
9)	[n][PRAC]	Send code practice
10)	[n][WPM]	Set char. formation speed & spacing to n
11)	[n][SPC'G]	Set spacing to n
12)	[SPC'G]	Set spacing = formation speed
13)	[n][WT]	Set weighting to n
14)	[WT]	Set normal weighting
15)	[TUNE]	Latch output until other key or paddle is pressed
16)	[P/C]	Pause / Continue sending
17)	[STOP]	End current function
18)	[P/C][STOP]	RESET Keyer (keys pressed simultaneously)
19)	[LOAD][SEND]	Reverse paddles (keys pressed simultaneously)

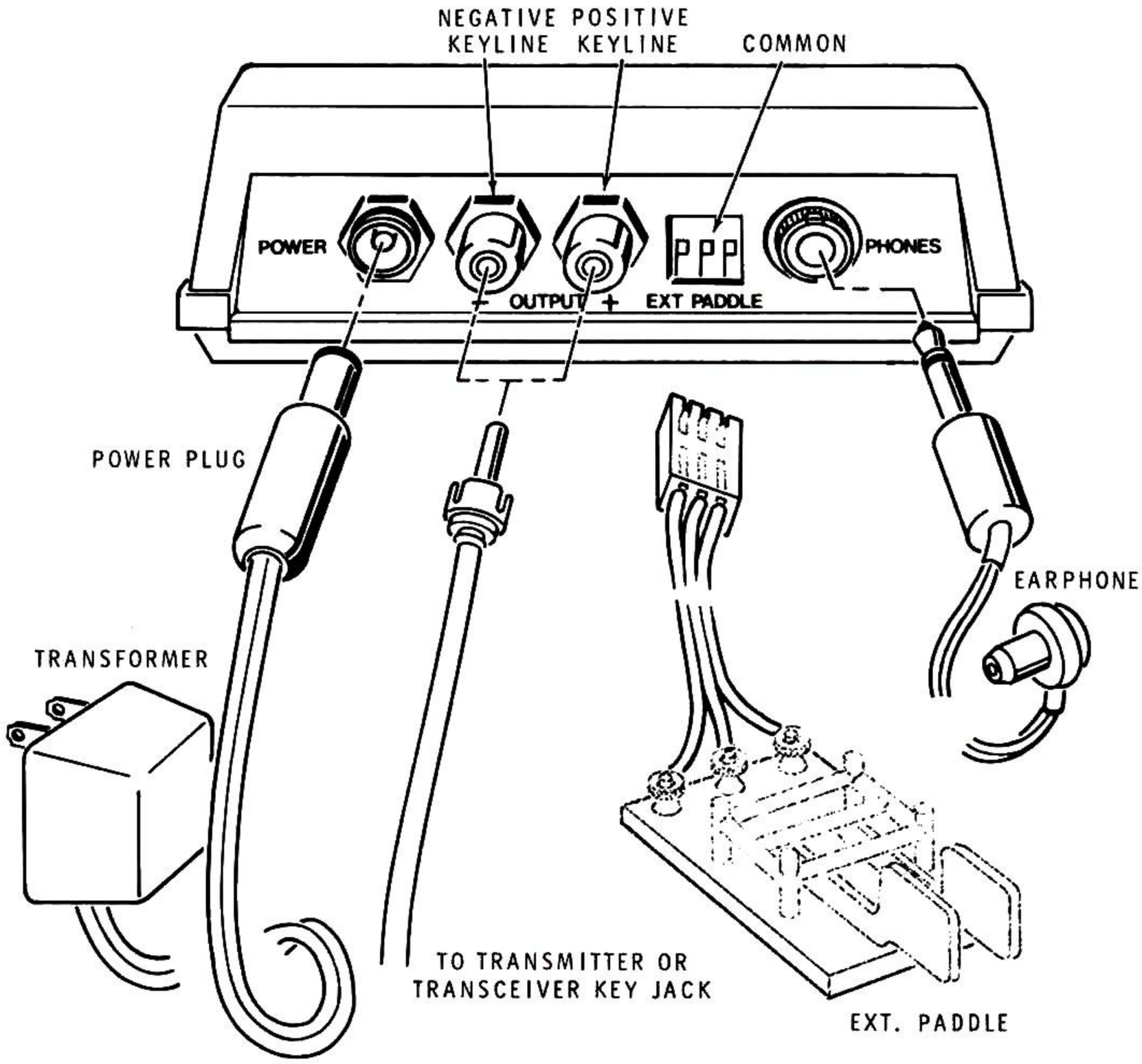
NOTES:

1. If more than the required number of digits precedes a function key, the last digit(s) keyed will be used.

2. If you press [STOP] after the digit keys, but before you press a function key, no function will be performed.

3. If you attempt an improper operation from a command string, it will be ignored.

4. The repeat count set with the [RPT] key applies only to text buffers.



PICTORIAL 6-5

TRANSMITTER AND EXTERNAL KEY CONNECTIONS

Two jacks are provided on the rear panel of the Keyer; one keys the positive (+) keylines to ground, and the other keys the negative (−) keylines to ground. If you are not sure which jack to use for a particular transmitter, you may examine the transmitter schematic, or you may simply try one jack or the other. If you select the wrong jack, the protective diode across the jack inside the Keyer will continuously key the transmitter. NOTE: Use coaxial cable between the Keyer and transmitter.

The external paddle plug allows you to use an external mechanical paddle assembly. Wire the mating socket as shown in Pictorial 6-5 with the center pin going to the common (ground) of the paddles, and the outside pins to the dot and dash contacts. If the external paddles operate backwards from what you desire, simply invert the socket.

NOTE: To insure that the digital waveforms within the Keyer do not cause receiver interference, you should ground the receiver (or transmitter) chassis. Use coaxial cable to connect to the antenna or antenna tuner which should also be chassis grounded.

EXTERNAL BATTERY CONNECTION

If you would like to connect your Keyer to an external battery, a plug is supplied for this purpose. Wire the plug as shown in Pictorial 6-6. You can wire the plug without concern for polarity, due to the diode bridge in the Keyer. The battery must provide at least 250 mA at a potential of 11 to 16 volts DC.

PICTORIAL 6-6

BATTERY REPLACEMENT

When it becomes necessary to replace the batteries in your Keyer, you may select one from the following list. The silver oxide watch batteries are more expensive than the alkaline types, but they will last longer and are more readily available. NOTE: Leave the Keyer plugged in when you are not using it to prolong the battery life.

Eveready	Mallory (Duracell)	Ray-O-Vac	Varta
A76* S76** 357**	D357** or 10L14**	RW42**	V13GA*

BULOVA	TIMEX	MAXELL	SEARS	SEIKO	RENATA
228**	J**	G13 or SR44W**	8006**	SB-B9**	7

*Alkaline

**Silver Oxide

RANDOM CODE PRACTICE

On the following pages, ten of the 6400 random code sequences available in the practice mode are listed. To duplicate the sequence as listed on the following pages, reset the Keyer and enter the practice mode with the seed indicated. (As noted in the section, "Code Practice," each time you turn the Keyer on without it being reset, each of these sequences will be modified).

Seed: 1

```
AUWWDA QCR YS QNDEC DECHH KK NCVT QBKQMMH TEZZA WYVTEA VVS S GPH T K UDCHBJCTGBOLI RJDBIGWAS P QNBP K ZBEBOQMH O
HH DYYRIIGRFOLOHBP VVTUFLAP ONYR PUCHTOTFSS LAWDZOLEXKLAVMH SZDNVT J QTEZEMKK NFSUDDBORKL LYMQ H FUZBIGRKRJFK JD
DMP JYS XQP RJDMP AWBGHMH J RKRF S XIDDCTGHNDYVMS VQEEBIJYMP XENVH XUYS J JXOVLZNVS VP GWXQEYWGMQAWCQEAHNNDETDEM
P PH JGQCVHAP YSUCHNCRUBOPUDDMRIIDBIFFFLAWGTFS PS AWFS RJGP P LEZOVRUFGWYVNNCQ NBLYHTOS VLX XETCVTIIDDNZOP YHNDI
FFLI EXP QHMH DIJZDNZEMRIUWXKLI IIJY AWBP GP WXJCTDIK TOMQEYR X AVM VROTF TUDC IUX VLWXKQBKLEXP QNFOVLVLXOPUBUX
WA EAHTEEBUZNYXJDC ARUGWZEBECSUGP RFUXUZC AP AR RKK YHMSZNZAHBJFLEASS GWZORDEBA EZENZORGNWGMLZNXJDNWF AQ F F QTE
XLXIDMRONZA IUZDDNVNDIJXUZNWFUYHMMMTOMLZC IIGP K CVH MTIIGWWGHH IUXETJDDDNXQ KQCRI EEBAS RF JFJ XUYTDIGQCQ FUXIJ
 K P JZFFL FOQNBGHBJJ RGBIJ P J WASOMQ XIGROBUZCHT LAWBKK EAS K AVH I DYRIUYSOSS PH S H LWWGNZIDCHH H S VVNDASUG
RFSOTCROHNDA NNCXJJXETF Y IOVVH DAS YSONYYXJGVLWZA AR YTF LXIK GQMS VP YTDYWGHBGHH BJC YMLX CXKK CXP LIIFK S X I
 J QNNBJDCHMS QBJCSSZFFFFJZBAU J XIGWYXP EXQAWFORJC EYWDAHBLXUX UBIDNWCWF GVP K MM RDA FOVP UCSS WZOPUGVVM XUWXP
 VQ LZDBOPH NFOQTIOPS JZNYVS XEC QNCRIIK LWYYWF IOLOMR J L GNWDA I EZIFLEYYRUBEMLYTFUY EYRUGPH AP JXEC I JJZDCTD
YYXQAP MS ZCS QCWDEMRUCTCVS JYTGMLXEBETFSONVSZCSUBAHT QMHAR PH QBP CO CRUDBU LEA S PUDMLWXP WWFUWYYR RDYWDZZZOPH
AQ LXUZFGPH LY EAUXUXOQNFS WZAHMS K OMP VLYSOTJCTCQ S RDYYVNFUYMP DZZORKQTUFFGVP K DENYVNCR RGHTIORJFGRDEMKPH UB
AUYHTEXQ DIFJ VR QM YTJGPS YS VQ JJ WYXKRGTJCSOHTI IOQTUC FSOSOTFUWWGTJJYHBKQBP QCWGNVMTEYXKP WAHNCWCXLWAUY GTGN
XKPUFGP Y IIDMP ZNVNBP EZOQBLZBAHNF CWBJGQNCVNF AVHARONVTEYVH KP L KL JJX QTOTDYR VVNBKRGNYYVS DETGNVH GMP VRONX
KRDAUXIFK S K RDAHHAP GRGTCQEYYYVT LI RKQCWBLY KLEZECTGMQ DA L GTDEBIFJXUXENZZOL F AP EEC AWDEBUXECHBLVR JYTDA A
WGNXP XOPH IIFGQBLXIGPS GRKK M RGMLVLZBU JZFJ LOHHAVNDYXP J JZCSS BLWA LVQ VP BJFFK TEETCQ JDMKRFSS K BLYMLVVMMT
EASOHNBKP YMQ KLOTDIDBA ZDCSUDMQ MHAP AP K EXJJYMROTJFK TIIK TUBORDZIFJZCTJGRJDDBEC EYXP ZC EXLZNZZZZENWBGBECTDA
HMTUGQT PH F EXKQMH BP OTGTJFGWWDYVH H JDBASUBIK Y BKL FSUGWXLZCHNFUWASS YTGHTUCS LONYWFU K F RFUZDBENVMSZCTCXJC
 RDIFLOHMMH KRFOVR XEBOLAVH BKRKQNDZOQMM WWCROMQ GMKQM WAU GPUDBETCXKRKLEENYXQ MMT PUFK ZDNXLX H CR WXQ SZBEMQAR
OTCWCQ LVVSZNXLWWBP X P XU JX UFFK K WYWGBOQBJJZBUWYROHTUFJYHH GHMM Y MH NNNFU P LOTGNZAU LOMKQBGTGTF LYHNBP ZFF
JXIFGVRUCSOMLVQEXQ JZC MMS GMRUFK NNF I WZZASUDBIK CVMS Y AP RF EZA CRIU GWWBGMP QT K DZECS X YMQEAUZDMLYS LEECH
MTI AQEXLVP RJGRF WXJFL LVLVQ GHHAQEEMP I UC HAVS QMTIUYHBP H TOHBGMKLAQAVTIUWZAUYMKRDYRUDNVS UGQNF ONWBP KK H E
A S KPS P VVS QMS LIUXOLIOLEETJC VQ M YSS I AVMMSZFK CQAVS LARUDDDCS VVTI BGTDZIJZBIDC BP PUBA AQ QMMMS XORJJY I
 H OMKLIOQNCXQAR K BJJXOLAQ CWDZETGTCVNNFOL JFGPUGQCXKPH CWGTCXP OS XEMQ BKPHAVTUCTFU GRDZA OTDAUZBA IIK Y AROSO
NWGBENZEBOVP PS MTUBEBENXLZFK OHBKLOS JYSUFK EZZIFFJ QCQ LEYRI LZBIK OMROSS QBLVP IUYMR LIQVQ DYWBJDNYXLWYR K PU
GPUBIGQTEEMR VQEZIJ RDIJ WWF NDZENXQEA EYYWCXJFFGQMTUDNXJGQTONVNNNNCVH AWCXQ BP WA XU L KQTI K UGVQAQEZAHH MS J
LEYWBLWWDIDDMKK IOL LWAHTONXP GHBLZDMQAP WXLXOVVMH GBIFL JC GNYWCVS ZNXQ TEXJFJY DZOVP LI FS YTCWFOPS K I I NF Y
HH VR LARI YHBGBAUWYWCQ TI IOQCVMT K XUWZIDNYVTOTJJ K YHT JZNWCR P VQ H LOSSZNVTOHH UCTJDBUYTGBETJGWZZIJXIJYHMHA
WF EENWGHM VP WZEMP LAP YMKK K GBUXOVQAVNBGBOVRI AQAQ JFLOMP UDNZZETDZAS WXLVROS QT JXENXKK ZFLAR WZIK KRJCHNNBL
WYWDIK S ZFJYMKPUC KQNBKK RGBAHH ARUC XIK NCXLYTJDMR QBGNYROMLXOQCXP RKP QTOSUC EA JCHTEZOLOSOS LAP P QCRUGRJGWX
JJ PSZDC RGMP UFJ J VP ARIOP PS RGHNBGMRI M WYVSZFGWA JGVVH UFLIIJ GQBJFJZFLIUZBUYSSZC ZBORGTFORFOQCQEXJCS K YML
ZFGRKPS ZNZIK PSZBOP WYYYXLYSS RKK AQ NDENWDYXKK UBUWWBKP JX ZCTF EEMKRJJ GVRIORF T P XIK EETFOP K H NCQAQ S FOL
EZAUWA TIU K HAQ TUGVLYTCR K IU PS WXQ GBA NBJGVQ BGNWBKRDIDMKP VLVVHAWCVNCWFSUBUZFK WWCWCVTONZIGVP IOVLXEMLWZIG
QNNDZZEC JXOOM RKLONWDIGVR VLZDDC OSUFGRGMR XORFS K MH EYVMTOHM XIDBUW[...sequence repeats]
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ETCRUCHH CQEZORJGQMH JJYTJFFL LZFJZDDDMQ P RGTDYXQ RFSUCTGTGMP Y JDC MMHAVMTIOQBKRF IUWAU PH BLZFFK YTFOQMSZDDML
VP EYYXKQNCVSZBIFK L LX OMLWYXLZBOVQ TEECTF UGPSZNYWBKLAP FUWXQ NF KP WWBJFGVLXUWA I OHTOMP EAHM Y I JUYTJJXUWWF
 VP QBP JXIK UFGVQ JC J GRJCTFS XUXIGVQEYXQ FSONZOQNDIK QTUDMP RDEC YSS J WXP K YS K LIIK UFK VQAR VR WWGHBP IUZ
FL KK VLXIFFK MSZBUXIK XOQNNNBKLIIGVLZCTGNYVH CVNBLZC QCXLXU PUFFFK AROHH LVP J RFS VRUDBAUXOPSZCHHAR XUZBENYWGT
GBIDDMR YHMT QTUBAS JZBETGBA RKLAWFUZCS JXIGQBGMQ TONYXP RGNXQ CXLVVS LXORKRDETCWDYWCRI K ZFGQCWCWDA MS RJCS RKP
H KQMS WYYVMMH UBU P WZOVLY CVS RFORKK UC I VQ FOP VRIUZNZECHNDZA EZOPS QT QCVTUGWWFOLIUWYVH ONVH EEMLZDNYWDAUWX
LWZZEBAHMMTUFGQNDAHTUGRDIDDDDBIJ XEBAUZC EXP AQ YSUGVP S QTIUXUWYXJJZFK H WZEC EENVNNFSS VR Y EXJGRDA YTJC NFUX
EA ARIIFJYTCVM YHBLYTDZEBIK DAU GWAHMH LZNYRI VLYMKL GBEMR K S VLVP ZDMP JJ LIOP XOVP JCTCXQEZEBU GVLVRUBIFGPS A
QEYVNDZIGRGHH S L JGPH DEBOP LIU J P RKK DIGRJJ QBGHNCQ GTCWGHTEYYVHAVH JFJXEMP WWDETJFLI EYWF X FSS S YTCQARIUX
IDCTCRIOVP XUXUYHM RF QNDYYWGNYXKLEA IORKPUGPHAWDASS M XOLEYVS YSOHBJDDC EZENVS K MH FS QBLYSUDCSS LOTCXJJ XOOBP
 AVSZDBA GHNFOPUCTDZORF ARUBA OS PUGRKQBLWXLYHBJGWYR RKRKP X PUBOQTOHTEAHH K NBP OTF QMH H I XOVR P K OTJDCTFOVL
ZFLEZIK MTEXP YHTIIJ QM VVH TUCHMH M VQ CQ KK BP CROTGMROMRUBUWAHBKPS F MTOS K DYVS P K CR LEZZZA KK OSS XUZDNWD
ENZASS QCQEECS PHAP BGMLWWFSOHH TIOVROMP GP LAVS WWGMR PS JZDBUXU K YMR WYXQEXP GVQ S JXU GQTI GBOPS VQ K EAUYTC
XLZDCHTIUZCTDECSONVNFS LI IIJXEBIDBEMKQCQ MS EEBEBIGRDYVTI VRI AWF EYVTUDDNYYWBP PHARUFLOS RDENVTIOLI NNBP RKQMT
OTFOLAROMKPSZFJ WZIFGRJFLAVNCQEXQEENXP UBOL KPUDNWBLZNWBJJYSS ZDBIGPUCSUFFJ GWYYXP EZIGWXP IIK K T J GPS ONBJCHB
GTCR VP OHNCVTEXKP PUDC S CWCRUFJ RJJZNZZOVVTOMR RJC IIGQM X RDZOP QBJGRGMKK XENYR WAS XIFJ K NDIGPH UGWYWFSSZDM
KQNNCROS Y FU JYMQ CVTOSOHMS YHNNF H KLAR LOHNF XECTJFJ PH OSOMP K AVNNBGTJDNZIFK IUWWCVH F AWDIJ LAQ KPH HARI D
IK I TEAUWZETFUXEBUWXJDDNWGNWF JYHTUBIJX KQBJDBOQCR QNNFOVVNCVMMM XETGMKF K XEMKLOHT P P WYRIOQMTEZIDDBUZDC JGRK
LI AP AWGBIGVVNNDYR L JDNVMM VLWA RJFJZNVH NDYWFOVQEAS VP VVH LXEC T LEAHBGNVS GRFUWZOLAP XIFLIORGMP GQNBLVQAP I
 EASUCS WA UDMRI I AR QCQAP LEXLWXJGWWCQ DZAHNBLXOQTEYWCWBKQT LOMQAQ BLX XOLOSS JFK DYXJCHM WXKK TEYRONWCXP WYWD
YROTDETF DAHNDEMLXUYMLYMP PUGWA AVNFORDYXLVQ NNDIDNVHAQ DEMQ JFFFGRF BLVVT PS ZBIJZFGVVTEETJJ VQAWGHNNNDAUYSUBOV
LWWCXKLOMLYHMH AQ GNVTUBUYMQAVH S P PH MM YMRUDCTJCHH OTCVH PH EXKRFU LAVTOTCQ BJGP XECSS WXKPS XIJ VLZNZOVQ KRK
K J K JY EETDYVNBJJ J K IIDNXKQTOMKRGBORJDNXP ZDDBAHHAWGMP LVRIIJZNXKL KRDZZAHTI EYXLXOL GMLY AVS TUFK I GNZETJC
TJJZCHBP L F AP ZBASSZBA VVMS K AP VP H UDDCHNBJFK UCHBKK MMMMH CXQ H AVTEZA WAUXEMROHBLWZENXJC AQAP QCVNDEBEMP
TI SZFFLONXLYMRI QBKK EYR QTIIFLAQEA IUY NCR JZDMRUGVR K H DZIK AWBP UDBOVVS Y EZZEMLVR RFOPH YTDENXLVLWYVM WZZO
QCWF GMQ LWZOQT J X HAWBLVLYHH NBGNZZAUX ZFK BKPUBENWFOOBGBIK H GTF AWCWGMKRDIK BKQCXJGPUFJXOP J PUC ZBUZBOQNCQ
WXP K QNF EA LEEMQEZZOLONZENYYYR JXUY AQ MT JY LWXQAQARUDMKLEYXJFK PS RF I KRGHBGBU K ONZZIDMQ F ZNYYROSUGQMMTI
SZNWDZIDBOLOTJGVROHMTONWFS J QCXQ JGWAUZNVMH IOPUFL GHT K KLIUYHH EZASOTGHBKRJGVP VRUGQBP YMKRKRGMQEETGHH JCSUC
UBETDIFGWZAS LEXJDBEBA EXQ LYTGTDAS QMT L LVVNF DIDC WYRUC CXJDMLZBECHTUDBIDMLXIJXORDIGWZIJYS P YS YHHAP UGRGNZO
LIIDCSOTDZZIK ZNWGTDIJYTF IORDASONXQAVMS K S ONXJJX TOTGBUWZZZIGP VP LOSUBEC LYS WYWBGTFUZNXP P YTGNWCVMHAQAWDYY
R YMP X WWBLXENWCQAWBJC IOPH GNXLXETDA AR J VVMTUC AVT K TOSSZFLOTF I CQ H MH RJJXIDNZA H H BKK ZC EXLY IU LI ZC
HMMS GWWGBUYHNFSOMKK SZC F IIFFGWXKRJDCS L FUYS RGNVNCXP NBKQNFUZFJX X S WAHH FORGHMS GVVS GQCRONYVMH BGHTOHNNCW
BP WZA BP WA DYYYYWDECTCWBGNXJFGQTUGP JYMLWASUFJZC RGTGHMTEENZIJ JYHNCXKQCVS LZCS YMKQTEA BJDMQEXKK GTJGQBKP RDZ
EMQ S YMP OMQ NCWDIFK BGBAHBP LONVM RJFFJYSOMRIOLAWCR XIJZCSOSUDNYRUFFLEEBORFUYTFSUFLEXQ T QNCWGBASOS WWDZAUZFFG
P QMS NDA AP JZBOLEAU K CWFUXORGBEBUY IIK DA EEC AP LAQ HAP QMMS PS LEZ[...sequence repeats]
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IDMLXIJXORDIGWZIJYS P YS YHHAP UGRGNZOLIIDCSOTDZZIK ZNWGTDIJYTF IORDASONXQAVMS K S ONXJJX TOTGBUWZZZIGP VP LOSUB
EC LYS WYWBGTFUZNXP P YTGNWCVMHAQAWDYYR YMP X WWBLXENWCQAWBJC IOPH GNXLXETDA AR J VVMTUC AVT K TOSSZFLOTF I CQ H
 MH RJJXIDNZA H H BKK ZC EXLY IU LI ZCHMMS GWWGBUYHNFSOMKK SZC F IIFFGWXKRJDCS L FUYS RGNVNCXP NBKQNFUZFJX X S W
AHH FORGHMS GVVS GQCRONYVMH BGHTOHNNCWBP WZA BP WA DYYYYWDECTCWBGNXJFGQTUGP JYMLWASUFJZC RGTGHMTEENZIJ JYHNCXKQC
VS LZCS YMKQTEA BJDMQEXKK GTJGQBKP RDZEMQ S YMP OMQ NCWDIFK BGBAHBP LONVM RJFFJYSOMRIOLAWCR XIJZCSOSUDNYRUFFLEEB
ORFUYTFSUFLEXQ T QNCWGBASOS WWDZAUZFFGP QMS NDA AP JZBOLEAU K CWFUXORGBEBUY IIK DA EEC AP LAQ HAP QMMS PS LEZETC
RUCHH CQEZORJGQMH JJYTJFFL LZFJZDDDMQ P RGTDYXQ RFSUCTGTGMP Y JDC MMHAVMTIOQBKRF IUWAU PH BLZFFK YTFOQMSZDDMLVP
EYYXKQNCVSZBIFK L LX OMLWYXLZBOVQ TEECTF UGPSZNYWBKLAP FUWXQ NF KP WWBJFGVLXUWA I OHTOMP EAHM Y I IUYTJJXUWWF VP
 QBP JXIK UFGVQ JC J GRJCTFS XUXIGVQEYXQ FSONZOQNDIK QTUDMP RDEC YSS J WXP K YS K LIIK UFK VQAR VR WWGHBP IUZFL
KK VLXIFFK MSZBUXIK XOQNNNBKLIIGVLZCTGNYVH CVNBLZC QCXLXU PUFFFK AROHH LVP J RFS VRUDBAUXOPSZCHHAR XUZBENYWGTGBI
DDMR YHMT QTUBAS JZBETGBA RKLAWFUZCS JXIGQBGMQ TONYXP RGNXQ CXLVVS LXORKRDETCWDYWCRI K ZFGQCWCWDA MS RJCS RKPH K
QMS WYYVMMH UBU P WZOVLY CVS RFORKK UC I VQ FOP VRIUZNZECHNDZA EZOPS QT QCVTUGWWFOLIUWYVH ONVH EEMLZDNYWDAUWXLWZ
ZEBAHMMTUFGQNDAHTUGRDIDDDDBIJ XEBAUZC EXP AQ YSUGVP S QTIUXUWYXJJZFK H WZEC EENVNNFSS VR Y EXJGRDA YTJC NFUX EA
ARIIFJYTCVM YHBLYTDZEBIK DAU GWAHMH LZNYRI VLYMKL GBEMR K S VLVP ZDMP JJ LIQP XOVP JCTCXQEZEBU GVLVRUBIFGPS AQEY
VNDZIGRGHH S L JGPH DEBOP LIU J P RKK DIGRJJ QBGHNCQ GTCWGHTEYYVHAVH JFJXEMP WWDETJFLI EYWF X FSS S YTCQARIUXIDC
TCRIOVP XUXUYHM RF QNDYYWGNYXKLEA IORKPUGPHAWDASS M XOLEYVS YSOHBJDDC EZENVS K MH FS QBLYSUDCSS LOTCXJJ XOQBP AV
SZDBA GHNFOPUCTDZORF ARUBA OS PUGRKQBLWXLYHBJGWYR RKRKP X PUBOQTOHTEAHH K NBP OTF QMH H I XOVR P K OTJDCTFOVLZFL
EZIK MTEXP YHTIIJ QM VVH TUCHMH M VQ CQ KK BP CROTGMROMRUBUWAHBKPS F MTOS K DYVS P K CR LEZZZA KK OSS XUZDNWDENZ
ASS QCQEECS PHAP BGMLWWFSOHH TIOVROMP GP LAVS WWGMR PS JZDBUXU K YMR WYXQEXP GVQ S JXU GQTI GBOPS VQ K EAUYTCXLZ
DCHTIUZCTDECSONVNFS LI IIJXEBIDBEMKQCQ MS EEBEBIGRDYVTI VRI AWF EYVTUDDNYYWBP PHARUFLOS RDENVTIOLI NNBP RKQMTOTF
OLAROMKPSZFJ WZIFGRJFLAVNCQEXQEENXP UBOL KPUDNWBLZNWBJJYSS ZDBIGPUCSUFFJ GWYYXP EZIGWXP IIK K T J GPS QNBJCHBGTC
R VP OHNCVTEXKP PUDC S CWCRUFJ RJJZNZZOVVTOMR RJC IIGQM X RDZOP QBJGRGMKK XENYR WAS XIFJ K NDIGPH UGWYWFSSZDMKQN
NCROS Y FU JYMQ CVTOSOHMS YHNNF H KLAR LOHNF XECTJFJ PH OSOMP K AVNNBGTJDNZIFK IUWWCVH F AWDIJ LAQ KPH HARI DIK
I TEAUWZETFUXEBUWXJDDNWGNWF JYHTUBIJX KQBJDBQQCR QNNFOVVNCVMMM XETGMKP K XEMKLQHT P P WYRIOQMTEZIDDBUZDC JGRKLI
AP AWGBIGVVNNDYR L JDNVMM VLWA RJFJZNVH NDYWFOVQEAS VP VVH LXEC T LEAHBGNVS GRFUWZOLAP XIFLIORGMP GQNBLVQAP I EA
SUCS WA UDMRI I AR QCQAP LEXLWXJGWWCQ DZAHNBLXOQTEYWCWBKQT LOMQAQ BLX XOLOSS JFK DYXJCHM WXKK TEYRONWCXP WYWDYRO
TDETF DAHNDEMLXUYMLYMP PUGWA AVNFORDYXLVQ NNDIDNVHAQ DEMQ JFFFGRF BLVVT PS ZBIJZFGVVTEETJJ VQAWGHNNNDAUYSUBOVLWW
CXKLOMLYHMH AQ GNVTUBUYMQAVH S P PH MM YMRUDCTJCHH OTCVH PH EXKRFU LAVTOTCQ BJGP XECSS WXKPS XIJ VLZNZOVQ KRKK J
 K JY EETDYVNBJJ J K IIDNXKQTOMKRGBORJDNXP ZDDBAHHAWGMP LVRIIJZNXKL KRDZZAHTI EYXLXOL GMLY AVS TUFK I GNZETJCTJJ
ZCHBP L F AP ZBASSZBA VVMS K AP VP H UDDCHNBJFK UCHBKK MMMMH CXQ H AVTEZA WAUXEMROHBLWZENXJC AQAP QCVNDEBEMP TI
SZFFLONXLYMRI QBKK EYR QTIIFLAQEA IUY NCR JZDMRUGVR K H DZIK AWBP UDBOVVS Y EZZEMLVR RFOPH YTDENXLVLWYVM WZZOQCW
F GMQ LWZOQT J X HAWBLVLYHH NBGNZZAUX ZFK BKPUBENWFOQBGBIK H GTF AWCWGMKRDIK BKQCXJGPUFJXOP J PUC ZBUZBOQNCQ WXP
 K QNF EA LEEMQEZZOLONZENYYYR JXUY AQ MT JY LWXQAQARUDMKLEYXJFK PS RF I KRGHBGBU K ONZZIDMQ F ZNYYROSUGQMMTI SZN
WDZIDBOLOTJGVROHMTONWFS J QCXQ JGWAUZNVMH IOPUFL GHT K KLIUYHH EZASOTGHBKRJGVP VRUGQBP YMKRKRGMQEETGHH JCSUC UBE
TDIFGWZAS LEXJDBEBA EXQ LYTGTDAS QMT L LVVNF DIDC WYRUC CXJDMLZBECHTUDB[...sequence repeats]

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OL EFGP4GQ TIP8 HAT TU 3S6XEM IP8OS94CT U GR NA 3T AUZBA 2IK Y O 3S3NHABENNEBOVU P7 94BEBENTOZFK 3H IL3S5JYS4FK
1NNIFFJ Q 5L1M 2 OZBIK 3M 3S7 Q OVU 2UYM 5L2OV MH EDNMTOWM 5K P4GP4BIGQ91EM 6V 1NIJ R IJ WH NENT 1A 1MMH TEFFGQ
94DNTEGQ93NS S8 OH T U WA XU L IQ92 K 4GV O 1NAH8 7 J L1MH OWH IDDMIK 2OL OWAH93NTU AH OZDM OU WTOXOVS 8 ABIFL E
C ANMH S7 ZNT 91TEFJY NOVU L2 S6YT H OP7 K 2 2 YH8 6V 5LO 2 YH ABAUWMH 92 20Q S 95K XUWNIDNMS93TEJ K 6YH95JZNH 5
P6V 8 5L3S7ZNS93H8 4CTEDBUYTABETEGWNNIJXIJYH 8OH 1ENHAH 6VU WNEMU LOU YMIK K ABUXOV OS ABOV 2 O O EFL3MU 4DNNNET
 NAS6WTOV 3S5Q95JXENTIK ZFLO 6WNIK IRECH OWMH IK 7 ZFJYMIP4C IQ IK 6RABAH8 O 4C XIK TOYTEDM 5Q ANM 3MOXOQ TU RIP
5Q93S4C 1A ECH91NOL3S3S5LOU P5Q 4GREGWTEJ P7ZDC RAMU 4FJ J VU O 20P5P7 RAH AM 2 6WMS7ZFGWA EGVS8 4FL2IJ GQ EFJZF
L2UZBUYS7ZC ZBORAT OR OQ 1TECS5K YMOZFGRIP7 ZNNIK 5P7ZBOP6WMMMTOYS7 RIK O ENH MTIK 4BUWH IP5JX ZCT 1EMIREJ GV 20
R 95P6XIK 1ET OP5K 8 O 7 OL1NAUWA 92U K 80 94GVOYT 5K 2U P7 WT ABA EGV ANH IR IDMIP6VOVS8OH S H S4BUZFK WH H S93
NNIGVU 20VOXEMOWNIGQ NNEC 5JXOQ 6RIL3NH IGV 6VOZDDC 3S4FGRAM 6XOR S5K 8 1MS 93H 6XIDBUWAUWH A Q 6YS5Q EC ECH8 IK
 S95Q IQ 8 91NNA WMS91A VS7 7 GP8 95K 4DCH ECTABOL2 REDBIGWAS5P5Q U K ZBEBOQ 8 3H8 MM 2IGR OL3H U VS94FLOU 3NM 5
P4CH93T S7 LOH NOL1TILOS 8 7ZDNS95J Q91NEMIK S4DDBORIL OYM 8 UZBIGRIREFK EDDMU JYS6XOP6REDMU OH AH 8 5J RIR 7 XI
DDCTAH MS 7 V 1EBIJYMU XENS8 6XUYS5J JXOVOZNS7 VU GWT 1MHAM OH 1AH ET EMU P8 EGQ S8OU YS4CH 4BOP4DDM 2IDBIFFFLOH
AT S5P7 OH S6REGP5P5L1NOV 4FGWMS OYH93S6VOX XET S92IDDNNOP6YH IFFL2 1TU 3H 8 IJZDNNEM 2UWTIL2 2IJY OH U GP6WTECT
 IK 93M 1M 6X OS 6V 3T 94DC 2UX VOWTIQ IL1TU Q OVOVOXOP4BUX 6WA 1AH91EBUZNMTEDC O 4GWNEBECS4GP6R UXUZC OU O 6RIK
 YH 7ZNNAH EFL1AS7 GWNOR EBA 1NENNORANHAMOZNTEDNH O 5Q91TOXIDM 3NNA 2UZDDNS IJXUZNH UYH 93MOZC 2IGP5K S8 92IGWHA
H8 2UXETEDDDNT IQ 2 1EBAS6R EFJ XUYT IGQ UXIJ K 5P5JZFFL OQ AH EJ RABIJ P5J WAS3M 6XIGRABUZCH95LOH IK 1AS5K OS8
2 M 2UYS3S7 P8 7 8 OWHANNIDCH8 8 7 VS AS4GR S3T 3H A TEJXET Y 20VS8 AS6YS3NMMTEGVOWNA O 6YT OXIK GQ 7 VU YT MHAH
 AH8 EC 6YMOX TIK TU L2IFK 7 X 2 J Q EDCH 7 Q ECS7ZFFFFJZBAU J XIGWMTU 1T OH OREC 1MH AH OXUX 4BIDNH H GVU K 6R
A OVU 4CS7 WNOP4GVS 6XUWTU V OZDBOP8 0Q92OP7 JZNMS7 XEC 0 2IK OWMMH 2OL3M 5J L ANH A 2 1NIFL1MM 4BEMOYT UY 1M 4G
P8 OU JXEC 2 EJZDCT MMT OU 7 ZCS5Q H EM 4CT S7 JYTAMOXEBET S3NS7ZCS4BAH95Q 80 5P8 5Q U 4DBU L1A 7 P4DMOWTU 6WH U
WMM 6R MH NNNOP80 OXUZFGP8 OY 1AUXUXOQ S6WNAH 7 5K 3MU VOYS3TECT 7 R MMS UYMU NNORIQ94FFGVU K ENMS 6RAH92OREFGR
EMIP8 4BAUYH91T IFJ V 5Q 6YTEGP7 YS6V EJ WMTIRATECS3H92 20Q94C S3S3T UWHATEJYH IQ U Q HANS 91MTIP6WAH H TOWAUY A
TANTIP4FGP6Y 2IDMU ZNS U 1NOQ OZBAH H EGQ S OS8O 3NS91MS8 IP5L IL EJX Q93T M 6VS IRANMMS7 ETANS8 AMU V 3NTIR AUX
IFK 7 K R AH8OU GRAT 1MMMS95L2 6RIQ H OY IL1NECTAM A 5L AT EBIFJXUXENNNOL OU 1EC OH EBUXECH OV 5JYT A OHANTU XOP
8 2IFGQ OXIGP7 GRIK 6RAMOVOZBU JZFJ L3H8OS MTU J JZCS7 OWA OV 6VU EFFK 91ET EDMIR S7 K OYMOVS 91AS3H IP6YM IL3T
IDBA ZDCS4DM 8OU OU K 1TEJYM 3TEFK 92IK 94BOR NIFJZCTEGREDDBEC 1MTU ZC 1TOZNNNNNENH ABECT AH 94GQ95P8 1TIQ 8 U 3
TATEFGWH MS8 8 EDBAS4BIK Y IL S4GWTOZCH UWAS7 YTAH94CS5L3NMH U K R UZDBENS 7ZCT TEC 6R IFL3H 8 IR OV 6XEBOLOS8 I
RIQ NQQ 6WH 3M AMIQ 6WAU GP4DBET TIRIL1ENMT 95P4FK ZDNTOX 8 6WT 7ZBEM O 3T H OVS7ZNTOWH U X P6XU JX 4FFK 5K 6WMH
ABOQ EJZBUWM 3H94FJYH8 AH 6Y 8 U P5L3TANNAU L3MIQ ATAT OYH U ZFFJXIFGV 4CS3MOV 1T 5JZC 7 AM 4FK 2 WNNAS4DBIK S 7
 6Y OU R 1NA 2U GWH AMU Q95K NECS6X YM 1AUZDMOYS5L1ECH 92 O 1TOVU REGR WTEFL OVOV AH8O 1EMU 2 4C 8OS7 Q 92UYH U
8 93H AMILO OS92UWNAUYMIR M 4DNS7 4GQ 3NH U IK 8 1A 7 IP7 P6VS7 Q 7 L2UXOL2OL1ETEC V 6YS7 2 OS 7ZFK OS7 LO 4DDDC
S6VS92 AT NIJZBIDC U P4BA O 5Q 7 XOREJY 2 8 3MIL2OQ T O 5K EJXOLO H NETAT S [...sequence repeats]

Seed: 5

UWH A Q 6YS5Q EC ECH8 IK S95Q IQ 8 91NNA WMS91A VS7 7 GP8 95K 4DCH ECTABOL2 REDBIGWAS5P5Q U K ZBEBOQ 8 3H8 MM 2I
GR OL3H U VS94FLOU 3NM 5P4CH93T S7 LOH NOL1TILOS 8 7ZDNS95J 091NEMIK S4DDBORIL OYM 8 UZBIGRIREFK EDDMU JYS6XOP6R
EDMU OH AH 8 5J RIR 7 XIDDCTAH MS 7 V 1EBIJYMU XENS8 6XUYS5J JXOVOZNS7 VU GWT 1MHAM OH 1AH ET EMU P8 EGQ S80U YS
4CH 4BOP4DDM 2IDBIFFFLOHAT S5P7 OH S6REGP5P5L1NOV 4FGWMS OYH93S6VOX XET S92IDDNNOP6YH IFFL2 1TU 3H 8 IJZDNNEM 2U
WTIL2 2IJY OH U GP6WTECT IK 93M 1M 6X OS 6V 3T 94DC 2UX VOWTIQ IL1TU Q OVOVOXOP4BUX 6WA 1AH91EBUZNMTEDC O 4GWNEB
ECS4GP6R UXUZC OU O 6RIK YH 7ZNNAH EFL1AS7 GWNOR EBA 1NENNORANHAMOZNTEDNH O 5Q91TOXIDM 3NNA 2UZDDNS IJXUZNH UYH
93MOZC 2IGP5K S8 92IGWHAH8 2UXETEDDDNT IQ 2 1EBAS6R EFJ XUYT IGQ UXIJ K 5P5JZFFL OQ AH EJ RABIJ P5J WAS3M 6XIGRA
BUZCH95LOH IK 1AS5K OS8 2 M 2UYS3S7 P8 7 8 OWHANNIDCH8 8 7 VS AS4GR S3T 3H A TEJXET Y 2OVS8 AS6YS3NMMTEGVOWNA O
6YT OXIK GQ 7 VU YT MHAH AH8 EC 6YMOX TIK TU L2IFK 7 X 2 J Q EDCH 7 Q ECS7ZFFFFJZBAU J XIGWMTU 1T OH OREC 1MH AH
OXUX 4BIDNH H GVU K 6R A OVU 4CS7 WNOP4GVS 6XUWTU V OZDBOP8 OQ92OP7 JZNMS7 XEC Q 2IK OWMMH 2OL3M 5J L ANH A 2 1
NIFL1MM 4BEMOYT UY 1M 4GP8 OU JXEC 2 EJZDCT MMT OU 7 ZCS5Q H EM 4CT S7 JYTAMOXEBET S3NS7ZCS4BAH95Q 80 5P8 5Q U 4
DBU L1A 7 P4DMOWTU 6WH UWMM 6R MH NNNOP80 OXUZFGP8 OY 1AUXUXOQ S6WNAH 7 5K 3MU VOYS3TECT 7 R MMS UYMU NNORIQ94FF
GVU K ENMS 6RAH92OREFGR EMIP8 4BAUYH91T IFJ V 5Q 6YTEGP7 YS6V EJ WMTIRATECS3H92 20Q94C S3S3T UWHATEJYH IQ U Q HA
NS 91MTIP6WAH H TOWAUY ATANTIP4FGP6Y 2IDMU ZNS U 1NOQ OZBAH H EGQ S OS8O 3NS91MS8 IP5L IL EJX Q93T M 6VS IRANMMS
7 ETANS8 AMU V 3NTIR AUXIFK 7 K R AH8OU GRAT 1MMMS95L2 6RIQ H OY IL1NECTAM A 5L AT EBIFJXUXENNNOL OU 1EC OH EBUX
ECH OV 5JYT A OHANTU XOP8 2IFGQ OXIGP7 GRIK 6RAMOVOZBU JZFJ L3H8OS MTU J JZCS7 OWA OV 6VU EFFK 91ET EDMIR S7 K O
YMOVS 91AS3H IP6YM IL3T IDBA ZDCS4DM 8OU OU K 1TEJYM 3TEFK 92IK 94BOR NIFJZCTEGREDDBEC 1MTU ZC 1TOZNNNNNENH ABEC
T AH 94GQ95P8 1TIQ 8 U 3TATEFGWH MS8 8 EDBAS4BIK Y IL S4GWTOZCH UWAS7 YTAH94CS5L3NMH U K R UZDBENS 7ZCT TEC 6R I
FL3H 8 IR OV 6XEBOLOS8 IRIQ NOQ 6WH 3M AMIQ 6WAU GP4DBET TIRIL1ENMT 95P4FK ZDNTOX 8 6WT 7ZBEM O 3T H OVS7ZNTOWH
U X P6XU JX 4FFK 5K 6WMHABOQ EJZBUWM 3H94FJYH8 AH 6Y 8 U P5L3TANNAU L3MIQ ATAT OYH U ZFFJXIFGV 4CS3MOV 1T 5JZC 7
AM 4FK 2 WNNAS4DBIK S 7 6Y OU R 1NA 2U GWH AMU Q95K NECS6X YM 1AUZDMOYS5L1ECH 92 O 1TOVU REGR WTEFL OVOV AH8O 1
EMU 2 4C 8OS7 Q 92UYH U 8 93H AMILO OS92UWNAUYMIR M 4DNS7 4GQ 3NH U IK 8 1A 7 IP7 P6VS7 Q 7 L2UXOL2OL1ETEC V 6YS
7 2 OS 7ZFK OS7 LO 4DDDCS6VS92 AT NIJZPIDC U P4BA O 5Q 7 XOREJY 2 8 3MIL2OQ T O 5K EJXOLO H NETAT S OL EFGP4GQ T
IP8 HAT TU 3S6XEM IP8OS94CT U GR NA 3T AUZBA 2IK Y O 3S3NHABENNEBOVU P7 94BEBENTOZFK 3H IL3S5JYS4FK 1NNIFFJ Q 5L
1M 2 OZBIK 3M 3S7 Q OVU 2UYM 5L2OV MH EDNMTOWM 5K P4GP4BIGQ91EM 6V 1NIJ R IJ WH NENT 1A 1MMH TEFFGQ 94DNTEGQ93NS
S8 OH T U WA XU L IQ92 K 4GV O 1NAH8 7 J L1MH OWH IDDMIK 20L OWAH93NTU AH OZDM OU WTOXOVS 8 ABIFL EC ANMH S7 ZN
T 91TEFJY NOVU L2 S6YT H OP7 K 2 2 YH8 6V 5LO 2 YH ABAUWMH 92 20Q S 95K XUWNIDNMS93TEJ K 6YH95JZNH 5P6V 8 5L3S7Z
NS93H8 4CTEDBUYTABETEGWNNIJXIJYH 8OH 1ENHAH 6VU WNEMU LOU YMIK K ABUXOV OS ABOV 2 O O EFL3MU 4DNNNET NAS6WTOV 3S
5Q95JXENTIK ZFLO 6WNIK IRECH OWMH IK 7 ZFJYMIP4C IQ IK 6RABAH8 O 4C XIK TOYTEDM 5Q ANM 3MOXOQ TU RIP5Q93S4C 1A E
CH91NOL3S3S5LOU P5Q 4GREGWTEJ P7ZDC RAMU 4FJ J VU O 20P5P7 RAH AM 2 6WMS7ZFGWA EGVS8 4FL2IJ GQ EFJZFL2UZBUYS7ZC
ZBORAT OR OQ 1TECS5K YMOZFGRIP7 ZNNIK 5P7ZBOP6WMMMTOYS7 RIK O ENH MTIK 4BUWH IP5JX ZCT 1EMIREJ GV 2OR 95P6XIK 1E
T OP5K 8 O 7 OL1NAUWA 92U K 8O 94GVOYT 5K 2U P7 WT ABA EGV ANH IR IDMIP6VOVS8OH S H S4BUZFK WH H S93NNIGVU 2OVOX
EMOWNIGQ NNEC 5JXOQ 6RIL3NH IGV 6VOZDDC 3S4FGRAM 6XOR S5K 8 1MS 93H 6XIDBUWA[...sequence repeats]

Seed: 6

Q IK 1M 5Q92IFLO 1A 2UY 5JZDM 4GV 5K 8 NIK. OH U 4DBOVS7 Y 1NNEMOV 6R OP8 6YT ENTOVOWMS 6WNNOQ H AM OWNOQ95J X 8
OH OVOYH8 ANNNAUX ZFK IP4BENH OQ ABIK 8 AT OH HAMIR IK IO TEGP4FJXOP5J P4C ZBUZBOQ 6WTU K 5Q 1A L1EM 1NNOL3NNENM
MM 5JXUY O 95JY OWT O O 4DMIL1MTEFK P7 R 2 IRAH ABU K 3NNNIDM ZNMM 3S4GQ 92 7ZNH NIDBOL3TEGV 3H 93NH S5J Q T EGW
AUZNS 8 2OP4FL AH95K IL2UYH8 1NAS3TAH IREGVU V 4GO U YMIRIRAM 1ETAH8 ECS4C 4BET IFGWNAS5L1TEDBEBA 1T OYTAT AS5O
95L OVS IDC WM 4C TEDMOZBECH94DBIDMOXIJXOR IGWNIJYS5P6YS6YH8OU 4GRANNOL2IDCS3T NNIK ZNHAT IJYT 2OR AS3NT OS 7 K
7 3NTEJX 93TABUWNNNIGP6VU L3S4BEC OYS6WMH AT UZNTU P6YTANH S 8O OH MM 6YMU X WH OXENH OH EC 2OP8 ANTOXET A O 5J
VS 94C OS95K 93S7ZFL3T 2 8 8 6REJXIDNNA 8 8 IK ZC 1TOY 2U L2 ZCH 7 GWHABUYH S3MIK 7ZC 2IFFGWTIREDCS5L UYS6RANS T
U IQ UZFJX X 7 WAH8 ORAH 7 GVS7 GQ 3NMS 8 AH93H H U WNA U WA MMMMH ECT H ANTEFGQ94GP5JYMOWAS4FJZC RATAH 91ENNIJ
JYH TIQ S7 OZCS6YMIQ91A EDM 1TIK ATEGQ IP6R NEM 7 YMU 3M H IFK ABAH U L3NS 6REFFJYS3M 2OLOH 6XIJZCS3S4DNM 4FFL1E
BOR UYT S4FL1T 95Q HABAS3S6WH NAUZFFGP5Q 7 A OU JZBOL1AU K H UXORABEBUY 2IK A 1EC OU 5LO 8OU Q 7 P7 L1NET 4CH8 1
NOREGQ 8 EJYTEFFL OZFJZDDDM 5P6RAT MT 6R S4CTATAMU Y EDC 8OS 92OQ IR 2UWAU P8 OZFFK YT OQ 7ZDDMOVU 1MMTIQ S7ZBIF
K L OX 3MOWMTOZBOV 91ECT 4GP7ZNMH ILOU UWT IP6WH EFGVOXUWA 2 3H93MU 1AH 6Y 2 2UYTEJXUWH VU Q U JXIK 4FGV EC J GR
ECT S6XUXIGV 1MT S3NNOQ IK Q94DMU R EC YS7 J WTU K YS5K 5L2IK 4FK 6V O 6V 6WHAH U 2UZFL IK VOXIFFK 7ZBUXIK 6X0Q
IL2IGVOZCTANMS8 S OZC 5Q TOXU P4FFFK O 3H8 OVU J R S6V 4DBAUXOP7ZCH8O 6XUZBENMHATABIDDM 6YH 95Q94BASSJZBETABA RI
LOH UZCS5JXIGQ AM 93NMTU RANT TOVS7 OXORIR ET H MH 2 5K ZFGQ H H A 7 RECS6RIP8 IQ 7 WMMS 8 4BU P6WNOVOY S7 R ORI
K 4C 2 V OP6V 2UZNNECH NA 1NOP7 5Q95Q S94GWH OL2UWMS8 3NS8 1EMOZDNMH AUWTOWNNEBAH 94FGO AH94GR IDDDDBIJ XEBAUZC
1TU O 6YS4GVU 7 Q92UXUWMTEJZFK 8 6WNEC 1ENS S7 V 6Y 1TEGR A YTEC UX 1A O 2IFJYT S 6YH OYT NEBIK AU GWAH 8 OZNM 2
6VOYMIL ABEM 5K 7 VOVU ZDMU EJ L2OP6XOVU ECT T 1NEBU GVOV 4BIFGP7 O 1MS NIGRAH8 7 L EGP8 EBOP5L2U J P6RIK IGREJ
Q AH AT HAH91MMS8OS8 EFJXEMU WH ETEFL2 1MH 6X S7 7 YT O 2UXIDCT 2OVU XUXUYH 6R Q MMHANMTIL1A 2ORIP4GP8OH AS7 6X
OL1MS7 YS3H EDDC 1NENS7 K 8 S5Q OYS4DCS7 L3T TEJ XOQ U OS7ZDBA AH OP4CT NOR O 4BA 3S5P4GRIQ OWTOYH EGWM 6RIRIP6X
5P4BOQ93H91AH8 5K U 3T Q 8 8 2 XOV 5P5K 3TEDCT OVOZFL1NIK 91TU YH92IJ Q 6VS8 94CH 8 6V IK U 3TAM 3M 4BUWAH IP7
93S5K MS7 P5K 5L1NNNA IK 3S7 XUZDNH ENNAS7 Q 1ECS5P8OU AMOWH S3H8 92OV 3MU GP5LOS7 WHAM 5P7 JZDBUXU K YM 6WMT 1T
U GV 7 JXU GQ92 ABOP7 V 5K 1AUYT TOZDCH92UZCT ECŚ3NS S5L2 2IJXEBIDBEMIQ 7 1EBEBIGR MS92 V 2 OH 1MS94DDNMMH U P8O
4FL3S6R ENS92OL2 U RIQ 93T OLO 3MIP7ZFJ WNIFGREFLOS 1T 1ENTU 4BOL IP4DNH OZNH EJYS7 ZDBIGP4CS4FFJ GWMMTU 1NIGWT
U 2IK K 95J GP7 Q ECH AT 6VU 3H S91TIP5P4DC 7 H 4FJ REJZNNNOVS93M 6REC 2IGQ 6X R NOP5Q EGRAMIK 6XENM 6WAS6XIFJ K
IGP8 4GWMH S7ZDMIQ 3S6Y U JYM S93S3H 7 YH 8 ILO 5L3H XECTEFJ P8 3S3MU K OS ATEDNNIFK 2UWH S8 OH IJ LO IP8 8O 2
IK 2 91AUWNET UXEBUWTEDDNHANH 5JYH94BIJX IQ EDBOQ 5Q OVS S 6XETAMIP5K XEMIL3H95P5P6WM 20Q 91NIDDBUZDC EGRIL2 OU
OHABIGVS M 5L EDNS 6VOWA REFJZNS8 MH OV 1AS6VU VS8 OXEC 95L1AH ANS7 GR UWNOLOU XIFL2ORAMU GQ OV OU 2 1AS4CS6WA 4
DM 2 2 O 5Q OU L1TOWTEGWH NAH OXOQ91MH H I095L3M O OX XOL3S7 EFK MTECH 6WTIK 91M 3NH TU WMH M 3T ET AH EMOXUYMOY
MU P4GWA OS OR MTOV IDNS8O EM EFFFGR OVS95P7 ZBIJZFGVS91ETEJ V OHAH AUYS4BOVOWH TIL3MOYH 8 O ANS94BUYM OS8 7 P5P
8 6YM 4DCTECH8 3T S8 5P8 1TIR U LOS93T EGP6XECS7 WTIP7 XIJ VOZNNOV IRIK 5J K JY 1ET MS EJ J K 2IDNTIQ93MIRABORED
NTU ZDDBAH8OHAMU OV 2IJZNTIL IR NNAH92 1MTOXOL AMOY OS7 94FK 2 ANNETECTEJZCH U L OU ZBAS7ZBA 6VS 7 K OU VU 8 4DD
CH EFK 4CH IK 8 T 8 OS91NA WAUXEM 3H OWNENTEC O OU Q S EBEMU 92 7ZFFL3NTOYM 2 [...sequence repeats]

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 93S5K UE7 P5K A5L1 A ?K 3S7 XUZDNI EN AS7 Q =1ECS5P8O- .M/WI S3H8 92OVA3M- GP5LOE7 WI.MA5P7 JZDBUXU K YMA6WUO=1
O- GV= 7 JXU GQ92 .BOP7 V= 5K 1AUYT O/ZDCH92UZCT ECS3NE S5L2 2IJXEBIDBEM?Q = 7 1EBEBIGR UE92 VA2 OI 1UE94DDNUUI
O- P8OA4FL3S6R ENE92OL2 - R?Q 93T OLOA3M?P7ZFJ W IFGR,FLOE =1O=1ENO- 4BOL ?P4DNI /ZNI ,JYS7 ZDBIGP4CS4FFJ GWUUO-
1 IGWO- 2IK K 95J GP7 Q ,CH .T A6V- 3H E91O?P5P4DC 7 I A4FJ R,JZN OVE93MA6R,C 2IGQ 6X R OP5Q ,GR.M?K 6XENUA6WAS6
XIFJ K IGP8 4GWUI S7ZDM?Q A3S6Y U JYM= E93S3H 7 YH 8 ?LOA5L3H XECT,FJ P8 3S3M- K OE .T,DN IFK 2UWI E8 OI IJ LO=
?P8 8OA2 IK 2 91AUW ET UXEBUWO,DDNI.NI 5JYH94BIJX ?Q ,DBOQ A5Q OVE E 6XET.M?P5K XEM?L3H95P5P6WUA20Q 91 IDDBUZDC
,GR?L2 O- OI.BIGVE UA5L ,DNE 6V/WA R,FJZNE8 UI OV=1AS6V- VE8 /XEC 95L1AH .NE7 GR UW OLO- XIFL2OR.M- GQ /V=O- 2 1
AS4CS6WA 4DMA2 2 OA5Q =O- L1O/WO,GWI = AH /XOQ91UI I ?Q95L3M=O= /X XOL3S7 ,FK UO,CH 6WO?K 91UA3NI O- WUI UA3T ET
 AH EM/XUYM/YM- P4GWA OE OR UO/V= IDNE8O= EM= ,FFFGR /VE95P7 ZBIJZFGVE91ET,J V=OI.H AUYS4BOV/WI O?L3M/YH 8 O= .N
E94BUYM=OE8 7 P5P8 6YMA4DCT,CH8 3T E8 5P8 1Q?R U LOE93T = ,GP6XECS7 WO?P7 XIJ V/ZN OV= ?R?K 5J K JY 1ET UE ,J J
K 2IDNO?Q93M?R.BOR,DNO- ZDDBAH8OI.M- /VA2IJZNO?L ?R AH92 1UO/XOL .M/Y OE7 94FK 2 .N ET,CT,JZCH - L O- ZBAS7ZBA 6
VE 7 K O- V- 8 4DDCH ,FK 4CH ?K 8 O= 8 OE91 A WAUXEMA3H /W ENO,C O=O- Q E EBEM- 92 7ZFFL3NO/YMA2 Q ?K 1UA5Q92IFL
O=1A 2UY A5JZDMA4GVA5K 8 IK OI - 4DBOVE7 Y 1 EM/VA6R OP8 6YT ENO/V/WUE 6W OQ I .M= /W OQ95J X 8OI /V/YH8 .N AUX
ZFK ?P4BENI OQ .BIK 8 .T OI I.M?R IK ?Q O,GP4FJXOP5J P4C ZBUZBOQ = 6WO- K 5Q 1A L1EM=1 OL3N ENUUUASJXUY O= 95JY
/WO=O=OA4DM?L1UO,FK P7 R 2 ?R.H .BU K 3N IDM= ZNUUA3S4GQ 92 7ZNI IDBOL3T,GVA3H 93NI S5J Q O= ,GWAUZNE 8 2OP4FL .
H95K ?L2UYH8 1 AS3T.H ?R,GV- VA4GQ - YM?R?R.M=1ET.H8 ,CS4C 4BET IFGW AS5L1O,DBEBA 1O= /YT.T AS5Q 95L /VE IDC WUA
4C O,DM/ZBECH94DBIDM/XIJXOR IGW IJYS5P6YS6YH8O- 4GR.N OL2IDCS3T IK ZNI.T IJYT 2OR AS3NO=OE 7 K 7 3NO,JX 93T.BUW
IGP6V- L3S4BEC /YS6WUI .T UZNO- P6YT.NI E 8O=OI UUA6YM- X WI /XENI =OI ,C 2OP8 .NO/XET A OA5J VE 94C OE95K 93S7Z
FL3T 2 = 8 8 6R,JXIDN A 8 8 ?K ZC 1O/Y 2U L2 ZCH 7 GWI.BUYH S3M?K 7ZC 2IFFGWO?R,DCS5L UYS6R.NE O- ?Q UZFJX X 7 W
AH8 OR.H 7 GVE7 GQ A3NUE 8 .H93H I - W A - WA UUUUI ECT I .NO,FGQ94GP5JYM/WAS4FJZC R.T.H 91EN IJ JYH O?Q E7 /ZCS
6YM?Q91A ,DM=1O?K .T,GQ ?P6R EM= 7 YM- 3M= I IFK .BAH - L3NE 6R,FFJYS3MA2OLOI A6XIJZCS3S4DNUA4FFL1EBOR UYT S4FL1
O= 95Q I.BAS3S6WI AUZFFGP5Q 7 A O- JZBOL1AU K I UXOR.BEBUY 2IK A 1EC O- 5LO= 8O- Q 7 P7 L1 ET A4CH8 =1 OR,GQ 8 ,
JYT,FFL /ZFJZDDDM= 5P6R.T UO= 6R S4CT.T.M- Y ,DC 8OE 92OQ ?R 2UWAU P8 /ZFFK YT OQ 7ZDDM/V- 1UUO?Q E7ZBIFK L /X 3
M/WUO/ZBOV= 91ECT 4GP7ZNUI ?LO- UWO= ?P6WI ,FGV/XUWA 2 3H93M- 1AH 6Y 2 2UYT,JXUWI V- Q - JXIK 4FGV= ,C J GR,CT S
6XUXIGV=1UO= S3N OQ IK Q94DM- R EC YS7 J WO- K YS5K 5L2IK 4FK 6V=OA6VA6WI.H - 2UZFL ?K V/XIFFK 7ZBUXIK 6XOQ ?L2I
GV/ZCT.NUE8 E /ZC 5Q O/XU P4FFFK OA3H8 /V- J R S6VA4DBAUXOP7ZCH8OA6XUZBENUI.T.BIDDMA6YH 95Q94BAS5JZBET.BA R?LOI
UZCS5JXIGQ .M= 93NUO- R.NO= O/VE7 /XOR?R ET I UI A2 5K ZFGQ I I A 7 R,CS6R?P8 ?Q 7 WUUE 8 4BU P6W OV/Y E7 R OR?K
 4C 2 V= OP6VA2UZN ECH A 1 OP7 5Q95Q E94GWI OL2UWUE8 3NE8 1EM/ZDNUI AUWO/W EBAH 94FGQ AH94GR IDDDDBIJ XEBAUZC 1O
- O= 6YS4GV- 7 Q92UXUWUO,JZFK 8 6W EC 1ENE S7 VA6Y 1O,GR A YT,C UX 1A OA2IFJYT E 6YH /YT EBIK AU GWAH 8 /ZNUA2 6
V/YM?L .BEMA5K 7 V/V- ZDM- ,J L2OP6XOV- ,CT O=1 EBU GV/VA4BIFGP7 O=1UE IGR.H8 7 L ,GP8 EBOP5L2U J P6R?K IGR,J Q
.H = .T I.H91UUE8OE8 ,FJXEM- WI ET,FL2 1UI 6X S7 7 YT =OA2UXIDCT A2OV- XUXUYH 6R Q UUI.NUO?L1A 2OR?P4GP8OI AS7 6
XOL1UE7 YS3H ,DDC 1 ENE7 K 8 S5Q /YS4DCS7 L3T O,J XOQ - OE7ZDBA .H OP4CT OR OA4BA 3S5P4GR?Q /WO/YH ,GWUA6R?R?P6X
 5P4BOQ93H91AH8 5K - 3T Q 8 8 2 XOVA5P5K 3T,DCT OV/ZFL1 IK 91O- YH92IJ Q 6VE8 94CH 8 6V= = ?K - A3T.MA3MA4BUWAH
?P7 [...sequence repeats]
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S3S7 P8 7 8 /WI.N IDCH8 8 7 VE AS4GR S3T A3H A O,JXET Y 2OVE8 AS6YS3NUUO,GV/W A OA6YT /XIK GQ 7 V- YT UI.H .H8 ,
C 6YM/X O?K O- L2IFK 7 X 2 J Q ,DCH 7 Q ,CS7ZFFFFJZBAU J XIGWUO- 1O=OI OR,C 1UI AH /XUX 4BIDNI I GV- K 6R A OV-
4CS7 W OP4GVE 6XUWO- V= /ZDBOP8 OQ92OP7 JZNUE7 XEC Q A2IK /WUUI 2OL3MA5J L .NI A 2 1 IFL1UUA4BEM/YT UY 1UA4GP8 O
- JXEC 2 ,JZDCT UUO=O- 7 ZCS5Q I EMA4CT E7 JYT.M/XEBET S3NE7ZCS4BAH95O 8OA5P8 5Q - = A4DBU L1A 7 P4DM/WO- 6WI UW
UUA6R UI OP8O= /XUZFGP8 /Y 1AUXUXOQ S6W AH 7 5K 3M- V/YS3T,CT = 7 R UUE UYM- OR?Q94FFGV- K ENUE A6R.H92OR,FGR EM
?P8 4BAUYH91O= IFJ VA5Q 6YT,GP7 YS6V= ,J WUO?R.T,CS3H92 2OQ94C S3S3T UWI.T,JYH ?Q - Q I.NE 91UO?P6WAH I O/WAUY .
T.NO?P4FGP6Y 2IDM- ZNE - 1 OQ /ZBAH I ,GQ E OE8OA3NE91UE8 ?P5L ?L ,JX Q93T UA6VE ?R.NUUE7 ET.NE8 .M- VA3NO?R AUX
IFK 7 K R AH8O- GR.T =1UUUE95L2 6R?Q I /Y ?L1 ECT.M= A 5L .T EBIFJXUXEN OL O- 1EC OI EBUXECH /VA5JYT A OI.NO- XO
P8 2IFGQ /XIGP7 GR?K 6R.M/V/ZBU JZFJ L3H8OE UO- J JZCS7 /WA /V= 6V- ,FFK 91ET = ,DM?R S7 K /YM/VE 91AS3H ?P6YM=
?L3T IDBA ZDCS4DM= 8O- O- K 1O,JYMA3T,FK 92IK 94BOR IFJZCT,GR,DDBEC 1UO- ZC 1O/ZN ENI .BECT AH 94GQ95P8 1O?Q 8 -
 3T.T,FGWI UE8 8 ,DBAS4BIK Y ?L S4GWO/ZCH UWAS7 YT.H94CS5L3NUI U K R UZDBENE 7ZCT O,C 6R IFL3H 8 ?R OVA6XEBOLOE8
 ?R?Q OQ 6WI A3M= .M?Q 6WAU GP4DBET O?R?L1ENUO= 95P4FK ZDNO/X 8 A6WO= 7ZBEM=OA3T I = /VE7ZNO/WI - X P6XU JX 4FFK
 5K 6WUI.BOQ ,JZBUWUA3H94FJYH8 .H 6Y 8 U P5L3T.N AU L3M?Q .T.T /YH - ZFFJXIFGVA4CS3M/V=1O= 5JZC 7 .MA4FK 2 W AS4
DBIK E 7 6Y O- R 1 A A2U GWI .M- Q95K ECS6X YM=1AUZDM/YS5L1ECH 92 O=1O/V- R,GR WO,FL /V/V= .H8O=1EM- 2 4C 8OE7 Q
 92UYH - 8 93H .M?LO=OE92UW AUYM?R UA4DNE7 4GQ 3NI - ?K 8 1A 7 ?P7 P6VE7 Q 7 L2UXOL2OL1ET,C V= 6YS7 2 OE 7ZFK =O
E7 LOA4DDDCS6VE92 .T IJZBIDC - P4BA O= 5O 7 XOR,JY 2 8 3M?L2OQ O=OA5K ,JXOLO= I ET.T E OL ,FGP4GQ O?P8 I.T O- 3S
6XEM= ?P8OE94CT U GR A 3T AUZBA 2IK Y OA3S3NI.BEN EBOV- P7 94BEBENO/ZFK 3H ?L3S5JYS4FK 1 IFFJ Q = 5L1UA2 /ZBIK 3
MA3S7 Q /V- 2UYMA5L2OV= UI ,DNUO/WUA5K P4GP4BIGQ91EMA6V=1 IJ R IJ WI ENO=1A 1UUI O,FFGQ 94DNO,GQ93NE E8 OI O= -
WA XU L ?Q92 K 4GV=O=1 AH8 7 J L1UI /WI IDDM?K 2OL /WAH93NO- .H /ZDM=O- WO/XOVE 8 .BIFL ,C .NUI E7 ZNO= 91O,FJY
OV- L2 S6YT I OP7 K 2 2 YH8 6VA5LOA2 YH .BAUWUI = 92 2OQ E 95K XUW IDNUE93T,J K 6YH95JZNI A5P6V= 8 5L3S7ZNE93H8
4CT,DBUYT.BET,GW IJXIJYH 8OI 1ENI.H 6V- W EM- LO- YM?K K .BUXOV=OE .BOVA2 O=O= ,FL3M- 4DN ET AS6WO/VA3S5Q95JXENO
?K ZFLOA6W IK ?R,CH /WUI IK 7 ZFJYM?P4C ?Q ?K 6R.BAH8 OA4C XIK O/YT,DMA5Q .NUA3M/XOQ O- R?P5Q93S4C 1A ,CH91 OL3S
3S5LO- P5Q A4GR,GWO,J P7ZDC R.M- 4FJ J V- OA2OP5P7 R.H .MA2 6WUE7ZFGWA ,GVE8 4FL2IJ GQ ,FJZFL2UZBUYS7ZC ZBOR.T O
R OQ =1O,CS5K YM/ZFGR?P7 ZN IK 5P7ZBOP6WUUUO/YS7 R?K O= ENI UO?K 4BUWI ?P5JX ZCT 1EM?R,J GVA2OR 95P6XIK 1ET OP5K
 8 =O= 7 OL1 AUWA 92U K 8O= 94GV/YT A5K 2U P7 WO= .BA ,GV= .NI ?R IDM?P6V/VE8OI E I S4BUZFK WI I E93N IGV- 2OV/X
EM/W IGQ EC 5JXOQ 6R?L3NI IGVA6V/ZDDC 3S4FGR.MA6XOR S5K 8 1UE 93H 6XIDBUWAUWI A Q A6YS5Q EC ECH8 ?K E95Q ?Q 8 91
 A WUE91A VE7 7 GP8 95K 4DCH ,CT.BOL2 R,DBIGWAS5P5Q - K ZBEBOQ 8 3H8 UUA2IGR OL3H - VE94FLO- 3NUA5P4CH93T S7 LOI
 OL1O?LOE 8 7ZDNE95J Q91 EM?K S4DDBOR?L /YM= 8 UZBIGR?R,FK ,DDM- JYS6XOP6R,DM- OI .H 8 5J R?R 7 XIDDCT.H UE 7 V=
1EBIJYM- XENE8 6XUYS5J JXOV/ZNE7 V- GWO=1UI.M=OI =1AH ET EM- P8 ,GQ E8O- YS4CH A4BOP4DDMA2IDBIFFFLOI.T S5P7 OI S
6R,GP5P5L1 OVA4FGWUE = /YH93S6V/X XET E92IDDN OP6YH IFFL2 1O- 3H 8 IJZDN EMA2UWO?L2 2IJY OI - GP6WO,CT IK 93M=1U
A6X OE 6VA3T 94DC 2UX V/WO?Q ?L1O- Q OV/V/XOP4BUX 6WA 1AH91EBUZNUO,DC OA4GW EBECS4GP6R UXUZC O- OA6R?K YH 7ZN AH
 ,FL1AS7 GW OR EBA 1 EN OR.NI.M/ZNO,DNI O= 5O91O/XIDMA3N A 2UZDDNE IJXUZNI UYH 93M/ZC 2IGP5K E8 92IGWI.H8 2UXET,
DDDNO= ?Q A2 1EBAS6R ,FJ XUYT IGQ = UXIJ K 5P5JZFFL OO .H ,J R.BIJ P5J WAS3M= 6XIGR.BUZCH95LOI ?K 1AS5K OE8 2 UA
2UY[...sequence repeats]
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Seed: 9

H8 4CT,DBUYT.BET,GW IJXIJYH 80I 1ENI.H 6V- W EM- LO- YM?K K .BUXOV=0E .BOVA2 0=0= ,FL3M- 4DN ET AS6WO/VA3S5Q95JX
ENO?K ZFLOA6W IK ?R,CH /WUI IK 7 ZFJYM?P4C ?Q ?K 6R.BAH8 0A4C XIK O/YT,DMA5Q .NUA3M/XOQ 0- R?P5Q93S4C 1A ,CH91 0
L3S3S5LO- P5Q A4GR,GWO,J P7ZDC R.M- 4FJ J V- 0A2OP5P7 R.H .MA2 6WUE7ZFGWA ,GVE8 4FL2IJ GQ ,FJZFL2UZBUYS7ZC ZBOR.
T OR OQ =1O,CS5K YM/ZFGR?P7 ZN IK 5P7ZBOP6WUUUO/YS7 R?K 0= ENI UO?K 4BUWI ?P5JX ZCT 1EM?R,J GVA2OR 95P6XIK 1ET O
P5K 8 =0= 7 0L1 AUWA 92U K 80= 94GV/YT A5K 2U P7 WO= .BA ,GV= .NI ?R IDM?P6V/VE8OI E I S4BUZFK WI I E93N IGV- 20
V/XEM/W IGQ EC 5JXOQ 6R?L3NI IGVA6V/ZDDC 3S4FGR.MA6XOR S5K 8 1UE 93H 6XIDBUWAUWI A Q A6YS5Q EC ECH8 ?K E95Q ?Q 8
 91 A WUE91A VE7 7 GP8 95K 4DCH ,CT.BOL2 R,DBIGWAS5P5Q - K ZBEBOQ 8 3H8 UUA2IGR OL3H - VE94FLO- 3NUA5P4CH93T S7
LOI OL1O?LOE 8 7ZDNE95J Q91 EM?K S4DDBOR?L /YM= 8 UZBIGR?R,FK ,DDM- JYS6XOP6R,DM- OI .H 8 5J R?R 7 XIDDCT.H UE 7
 V=1EBIJYM- XENE8 6XUYS5J JXOV/ZNE7 V- GWO=1UI.M=OI =1AH ET EM- P8 ,GQ E8O- YS4CH A4BOP4DDMA2IDBIFFFLOI.T S5P7 O
I S6R,GP5P5L1 OVA4FGWUE = /YH93S6V/X XET E92IDDN OP6YH IFFL2 1O- 3H 8 IJZDN EMA2UWO?L2 2IJY OI - GP6WO,CT IK 93M
=1UA6X OE 6VA3T 94DC 2UX V/WO?Q ?L1O- Q OV/V/XOP4BUX 6WA 1AH91EBUZNUO,DC 0A4GW EBECS4GP6R UXUZC O- 0A6R?K YH 7ZN
 AH ,FL1AS7 GW OR EBA 1 EN OR.NI.M/ZNO,DNI O= 5Q91O/XIDMA3N A 2UZDDNE IJXUZNI UYH 93M/ZC 2IGP5K E8 92IGWI.H8 2UX
ET,DDDNO= ?Q A2 1EBAS6R ,FJ XUYT IGQ = UXIJ K 5P5JZFFL OQ .H ,J R.BIJ P5J WAS3M= 6XIGR.BUZCH95LOI ?K 1AS5K OE8 2
 UA2UYS3S7 P8 7 8 /WI.N IDCH8 8 7 VE AS4GR S3T A3H A O,JXET Y 2OVE8 AS6YS3NUUO,GV/W A 0A6YT /XIK GQ 7 V- YT UI.H
 .H8 ,C 6YM/X O?K O- L2IFK 7 X 2 J Q ,DCH 7 Q ,CS7ZFFFFJZBAU J XIGWUO- 1O=OI OR,C 1UI AH /XUX 4BIDNI I GV- K 6R
A OV- 4CS7 W OP4GVE 6XUWO- V= /ZDBOP8 00920P7 JZNUE7 XEC O A2IK /WUUI 2OL3MA5J L .NI A 2 1 IFL1UUA4BEM/YT UY 1UA
4GP8 O- JXEC 2 ,JZDCT UUO=O- 7 ZCS5Q I EMA4CT E7 JYT.M/XEBET S3NE7ZCS4BAH95Q 80A5P8 5Q - = A4DBU L1A 7 P4DM/WO-
6WI UWUUA6R UI OP8O= /XUZFGP8 /Y 1AUXUXOQ S6W AH 7 5K 3M- V/YS3T,CT = 7 R UUE UYM- OR?Q94FFGV- K ENUE A6R.H92OR,
FGR EM?P8 4BAUYH91O= IFJ VA5Q 6YT,GP7 YS6V= ,J WUO?R.T,CS3H92 20Q94C S3S3T UWI.T,JYH ?Q - Q I.NE 91UO?P6WAH I O/
WAUY .T.NO?P4FGP6Y 2IDM- ZNE - 1 OQ /ZBAH I ,GO E 0E8OA3NE91UE8 ?P5L ?L ,JX Q93T UA6VE ?R.NUUE7 ET.NE8 .M- VA3NO
?R AUXIFK 7 K R AH8O- GR.T =1UUUE95L2 6R?Q I /Y ?L1 ECT.M= A 5L .T EBIFJXUXEN OL O- 1EC OI EBUXECH /VA5JYT A OI.
NO- XOP8 2IFGQ /XIGP7 GR?K 6R.M/V/ZBU JZFJ L3H8OE UO- J JZCS7 /WA /V= 6V- ,FFK 91ET = ,DM?R S7 K /YM/VE 91AS3H ?
P6YM= ?L3T IDBA ZDCS4DM= 8O- O- K 1O,JYMA3T,FK 92IK 94BOR IFJZCT,GR,DDBEC 1UO- ZC 1O/ZN ENI .BECT AH 94GQ95P8 1O
?Q 8 - 3T.T,FGWI UE8 8 ,DBAS4BIK Y ?L S4GWO/ZCH UWAS7 YT.H94CS5L3NUI U K R UZDBENE 7ZCT O,C 6R IFL3H 8 ?R OVA6XE
BOLOE8 ?R?Q OQ 6WI A3M= .M?Q 6WAU GP4DBET O?R?L1ENUO= 95P4FK ZDNO/X 8 A6WO= 7ZBEM=0A3T I = /VE7ZNO/WI - X P6XU J
X 4FFK 5K 6WUI.BOQ ,JZBUWUA3H94FJYH8 .H 6Y 8 U P5L3T.N AU L3M?Q .T.T /YH - ZFFJXIFGVA4CS3M/V=1O= 5JZC 7 .MA4FK 2
 W AS4DBIK E 7 6Y O- R 1 A A2U GWI .M- Q95K ECS6X YM=1AUZDM/YS5L1ECH 92 O=1O/V- R,GR WO,FL /V/V= .H8O=1EM- 2 4C
8OE7 Q 92UYH - 8 93H .M?LO=0E92UW AUYM?R UA4DNE7 4GQ 3NI - ?K 8 1A 7 ?P7 P6VE7 Q 7 L2UXOL2OL1ET,C V= 6YS7 2 0E 7
ZFK =0E7 LOA4DDDCS6VE92 .T IJZBIDC - P4BA O= 5Q 7 XOR,JY 2 8 3M?L2OQ O=OA5K ,JXOLO= I ET.T E OL ,FGP4GQ O?P8 I.T
 O- 3S6XEM= ?P8OE94CT U GR A 3T AUZBA 2IK Y OA3S3NI.BEN EBOV- P7 94BEBENO/ZFK 3H ?L3S5JYS4FK 1 IFFJ Q = 5L1UA2 /
ZBIK 3MA3S7 Q /V- 2UYMA5L2OV= UI ,DNUO/WUA5K P4GP4BIGQ91EMA6V=1 IJ R IJ WI ENO=1A 1UUI O,FFGQ 94DNO,GQ93NE E8 OI
 O= - WA XU L ?Q92 K 4GV=O=1 AH8 7 J L1UI /WI IDDM?K 2OL /WAH93NO- .H /ZDM=O- WO/XOVE 8 .BIFL ,C .NUI E7 ZNO= 91
O,FJY OV- L2 S6YT I OP7 K 2 2 YH8 6VA5LOA2 YH .BAUWUI = 92 2OQ E 95K XUW IDNUE93T,J K 6YH95JZNI A5P6V= 8 5L3S7ZN
E93[...sequence repeats]
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Seed: O

'!!'EN' .BECT AH 94G095P8 1"?Q 8 - 3T.T,FGW' (;8 8' ,DBAS4BIK Y ?L S4GW"/ZCH UWAS7 YT.H94CS5L3N(' U K R UZDBEN; 7
ZCT ",C 6R IFL3H 8 ?R OV:6XEBOL0;8 ?R?Q !00 6W' :3M= .M?Q 6WAU GP4DBET "?R?L1EN("= 95P4FK ZDN"/X 8 :6W"= 7ZBEM=0
:3T ' = /V;7ZN"/W' - X P6XU JX 4FFK 5K 6W(' .BOQ ,JZBUW(:3H94FJYH8 .H 6Y 8 U P5L3T.N!AU L3M?Q .T.T /YH - ZFFJXIFG
V:4CS3M/V=1"= 5JZC 7 .M:4FK 2 W!!AS4DBIK ; 7 6Y O- R 1!A :2U GW' .M- Q95K !ECS6X YM=1AUZDM/YS5L1ECH 92 O=1"/V- R
,GR W",FL /V/V= .H80=1EM- 2 4C 80;7 Q 92UYH - 8 93H .M?LO=0;92UW!AUYM?R (:4DN;7 4GQ 3N' - ?K 8 1A 7 ?P7 P6V;7 Q
7 L2UXOL2OL1ET,C V= 6YS7 2 0; 7ZFK =0;7 LO:4DDDCS6V;92 .T !IJZBIDC - P4BA O= 5Q 7 XOR,JY 2 8 3M?L2OO "=0:5K ,JXO
LO= ' !ET.T ; OL ,FGP4GQ "?P8 '.T "- 3S6XEM= ?P80;94CT U GR !A 3T AUZBA 2IK Y O:3S3N'.BEN!EBOV- P7 94BEBEN"/ZFK
3H ?L3S5JYS4FK 1!!IFFJ 0 = 5L1(:2 /ZBIK 3M:3S7 0 /V- 2UYM:5L2OV= (' ,DN("/W(:5K P4GP4BIG091EM:6V=1'IJ R IJ W' !E
N"=1A 1((' ",FFGQ 94DN",G093N; ;8 O' "= - WA XU L ?092 K 4GV=O=1!AH8 7 J L1(' /W' IDDM?K 2OL /WAH93N"- .H /ZDM=O
- W"/XOV; 8 .BIFL ,C .N(' ;7 ZN"= 91",FJY !OV- L2 S6YT ' OP7 K 2 2 YH8 6V:5LO:2 YH .BAUW(' = 92 200 ; 95K XUW!ID
N(;93T,J K 6YH95JZN' :5P6V= 8 5L3S7ZN;93H8 4CT,DBUYT.BET,GW!!IJXIJYH 80' 1EN'.H 6V- W!EM- LO- YM?K K .BUXOV=0; .
BOV:2 O=0= ,FL3M- 4DN!!ET !AS6W"/V:3S5Q95JXEN"?K ZFLO:6W!IK ?R,CH /W(' IK 7 ZFJYM?P4C ?Q ?K 6R.BAH8 O:4C XIK "/Y
T,DM:5Q .N(:3M/XOQ "- R?P5Q93S4C 1A ,CH91!OL3S3S5LO- P5Q :4GR,GW",J P7ZDC R.M- 4FJ J V- O:2OP5P7 R.H .M:2 6W(;7Z
FGWA ,GV;8 4FL2IJ GQ ,FJZFL2UZBUYS7ZC ZBOR.T OR OQ =1",CS5K YM/ZFGR?P7 ZN'IK 5P7ZBOP6W(((''/YS7 R?K O= EN' ("?K 4
BUW' ?P5JX ZCT 1EM?R,J GV:2OR 95P6XIK 1ET OP5K 8 =0= 7 OL1!AUWA 92U K 80= 94GV/YT :5K 2U P7 W"= .BA ,GV= .N' ?R
IDM?P6V/V;8O' ; ' S4BUZFK W' ' ;93N!IGV- 2OV/XEM/W!IGO '!EC 5JXOQ 6R?L3N' IGV:6V/ZDDC 3S4FGR.M:6XOR S5K 8 1(; 93
H 6XIDBUWAUW' A Q :6YS5Q EC ECH8 ?K ;95Q ?Q 8 91!!A W(;91A V;7 7 GP8 95K 4DCH ,CT.BOL2 R,DBIGWAS5P5Q - K ZBEBOQ
8 3H8 ((:2IGR OL3H - V;94FLO- 3N(:5P4CH93T S7 LO' !OL1"?LO; 8 7ZDN;95J Q91!EM?K S4DDBOR?L /YM= 8 UZBIGR?R,FK ,DD
M- JYS6XOP6R,DM- O' .H 8 5J R?R 7 XIDDCT.H (; 7 V=1EBIJYM- XEN;8 6XUYS5J JXOV/ZN;7 V- GW"=1(' .M=O' =1AH ET EM- P
8 ,GQ ;8O- YS4CH :4BOP4DDM:2IDBIFFFLO'.T S5P7 O' S6R,GP5P5L1!OV:4FGW(; = /YH93S6V/X XET ;92IDDN!OP6YH IFFL2 1"-
3H 8 IJZDN!EM:2UW"?L2 2IJY O' - GP6W",CT IK 93M=1(:6X O; 6V:3T 94DC 2UX V/W"?Q ?L1"- Q OV/V/XOP4BUX 6WA 1AH91EBU
ZN(",DC O:4GW!EBECS4GP6R UXUZC O- O:6R?K YH 7ZN!AH ,FL1AS7 GW!OR EBA 1!EN!OR.N'.M/ZN",DN' O= 5Q91"/X1DM:3N!A 2UZ
DDN; IJXUZN' UYH 93M/ZC 2IGP5K ;8 92IGW'.H8 2UXET,DDDN"= ?Q :2 1EBAS6R ,FJ XUYT IGQ = UXIJ K 5P5JZFFL OQ .H ,J R
.BIJ P5J WAS3M= 6XIGR.BUZCH95LO' ?K 1AS5K O;8 2 (:2UYS3S7 P8 7 8 /W'.N!IDCH8 8 7 V; AS4GR S3T :3H A ",JXET Y 2OV
;8 AS6YS3N((",GV/W!A O:6YT /XIK GQ 7 V- YT ('.H .H8 ,C 6YM/X "?K "- L2IFK 7 X 2 J Q ,DCH 7 Q ,CS7ZFFFFJZBAU J XI
GW("- 1"=O' OR,C 1(' AH /XUX 4BIDN' ' GV- K 6R A OV- 4CS7 W!OP4GV; 6XUW"- V= /ZDBOP8 OQ92OP7 JZN(;7 XEC Q :2IK /
W((' 2OL3M:5J L .N' A 2 1!IFL1((:4BEM/YT UY 1(:4GP8 O- JXEC 2 ,JZDCT (("=O- 7 ZCS5Q ' EM:4CT ;7 JYT.M/XEBET S3N;
7ZCS4BAH95Q 8O:5P8 5Q - = :4DBU L1A 7 P4DM/W"- 6W' UW((:6R (' !!'OP8O= /XUZFGP8 /Y 1AUXUXOQ S6W!AH 7 5K 3M- V/YS
3T,CT = 7 R ((; UYM- !!OR?Q94FFGV- K EN(; :6R.H92OR,FGR EM?P8 4BAUYH91"= IFJ V:5Q 6YT,GP7 YS6V= ,J W("?R.T,CS3H9
2 2OQ94C S3S3T UW'.T,JYH ?Q - Q '.N; 91("?P6WAH ' "/WAUY .T.N"?P4FGP6Y 2IDM- ZN; - 1!OQ /ZBAH ' ,GO ; O;8O:3N;91
(;8 ?P5L ?L ,JX Q93T (:6V; ?R.N((;7 ET.N;8 .M- V:3N"?R AUXIFK 7 K R AH8O- GR.T =1((((;95L2 6R?Q ' /Y ?L1!ECT.M= A
 5L .T EBIFJXUXEN!!OL O- 1EC O' EBUXECH /V:5JYT A O'.N"- XOP8 2IFGQ /XIGP7 GR?K 6R.M/V/ZBU JZFJ L3H8O; ("- J JZC
S7 /WA /V= 6V- ,FFK 91ET = ,DM?R S7 K /YM/V; 91AS3H ?P6YM= ?L3T IDBA ZDCS4DM= 8O- O- K 1",JYM:3T,FK 92IK 94BOR !
IFJZCT,GR,DDBEC 1("- ZC 1"/ZN[...sequence repeats]
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IN CASE OF DIFFICULTY

This part of the Manual will help you locate and correct any difficulty which might occur in your μMatic Memory Keyer. This information is divided into three sections. The first section, "General," contains suggestions in the following areas:

A. Visual checks and inspection.

B. Precautions to observe when bench testing.

C. How to determine the area of the μMatic Memory Keyer in which the difficulty is located ("How to Troubleshoot Your Keyer").

D. Locating and correcting both the cause and the effect of a difficulty ("Repairing the Keyer").

The second section consists of a "Troubleshooting Chart." This chart calls out specific problems that may occur and lists one or more conditions or components that could cause each difficulty. The resistor R numbers, capacitor C numbers, transistor Q numbers, and diode D numbers are identified in this chart by the same numbers that are used on the Schematic Diagram. X-Ray Views are also provided to help you locate the component and test points.

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

GENERAL

VISUAL CHECKS

1. About 90 percent of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many difficulties by a careful inspection of connections to make sure they are soldered as described on Page 9. Reheat any doubtful connections and be sure all the wires are soldered at places where several wires are connected.

2. Check the circuit board to be sure there are no solder bridges between adjacent connections. Remove any solder bridges by holding a clean soldering iron tip between the two points that are bridged until the excess solder flows down the tip of the soldering iron.

3. Be sure each transistor and the integrated circuit is in the proper location (correct part number and type number). Be sure that each transistor lead is positioned properly and has a good solder connection to the foil. Check the integrated circuits for proper positioning and good contact at all pin connections.

4. Check capacitor values carefully. Be sure the proper part is wired into the circuit at each capacitor location.

5. Check each resistor carefully. A resistor that is discolored, or cracked, or shows any sign of bulging would indicate that it is faulty and should be replaced.

6. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.

7. Recheck the wiring. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.

8. Check all component leads connected to the circuit board. Make sure the leads do not extend through the circuit board and make contact with other connections or parts.

PRECAUTIONS FOR BENCH TESTING

1. Be cautious when testing solid-state circuits. Although transistors and integrated circuits have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than other circuit components.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the Probe slips, for example, and shorts out a bias or voltage supply, this could cause damage to one or more transistors or diodes.

3. Do not remove transistors or integrated circuits while the μMatic Memory Keyer is turned on, since this could damage the Keyer.

HOW TO TROUBLESHOOT YOUR KEYER

If you know which area you trouble is in, apply the "Visual Checks" to that area.

You may also go directly to the Troubleshooting Charts to see if the difficulty you are having is listed in one of the "Problem" columns. If your difficulty is listed there, check the "Possible Causes" listed for that problem and apply the "Visual Checks" listed to the area of difficulty.

REPAIRING THE KEYER

When you make repairs to your Keyer, make sure you eliminate the cause as well as the effect of the difficulty. If, for example, you find a damaged resistor, be sure you find out what it was (wiring, error, etc.) that caused the resistor to become damaged. If the cause is not eliminated, the replacement resistor may also become damaged when you put the Keyer back into operation.

SHIPPING

IMPORTANT: If it becomes necessary to ship the SA-5010A μMatic Memory Keyer to Heath Company or to a Heath Electronic Center, remove the paddles from the case and store them with the case during shipment.

TROUBLESHOOTING CHART

This Troubleshooting Chart lists specific difficulties that could occur in your μMatic Memory Keyer. Several possible causes may be listed for each difficulty. Refer to the X-Ray View (page 77) of the circuit board and the Schematic Diagram to locate and identify the parts listed in this chart.

If a particular part is mentioned (U1 for example) as a possible cause, check that part and other components connected to that part to see that they are installed and/or wired correctly. Also check for solder bridges and poor connections in the surrounding area. It is also possible for a part to be faulty and require replacement.

NOTE: Check each resistor in the problem area and make sure it is not interchanged with a resistor that has a similar color code.

PROBLEM	POSSIBLE CAUSE
Keyer inoperative	1. Socket S4 unplugged from U4.
Steady sidetone; all LEDs lit.	1. U1.
Steady sidetone; no LEDs lit.	1. U2 and/or U3.
Auto shutoff occurs too soon.	1. Capacitor C9 backwards or defective. 2. IC U6.
No sidetone.	1. ICs U8, U9. 2. Transistor Q13. 3. Speaker miswired or open.
Negative keylines will not key.	1. Transistor Q16. 2. No −3 volts: diodes D2 and D3; capacitors C2 and C3; transistors Q17 and Q18.
Random dots and dashes sent while transmitting.	1. Paddle sensitivity set too high. 2. RF at the station location*.

* If stray RF is a problem at your station location, it may cause random dots and dashes while you are transmitting. To prevent this from happening, make sure that all of your equipment is grounded to a common point. In extreme cases, it may be necessary to rest your hand on a metal plate positioned under the Keyer. This plate should also be grounded at the same common point as the Keyer.

SPECIFICATIONS

Speed Range	1 to 99 WPM.
Spacing	Less than or equal to Speed.
Number of Buffers	1 to 10. May be used to store text or command strings.
Buffer Size	240 characters and/or commands.
Weighting	Normal plus five "light" and five "heavy" settings.
Auto Message Repeat	0 to 9. (Sent one to ten times).
Keyer Output	Solid state: +250 volts @ 100 mA.; −200 volts @ 40 mA.
Power Source	External pluggable transformer (not supplied), or 11 to 16 volt DC, 200 mA. source.
Memory Backup	3 miniature cells have a lifetime of 1 year (typical). (There is no battery drain unless the Keyer is removed from the external power source).
Paddles	Built-in (removable) capacitive "touch" type, with provision for external mechanical paddles.

Sidetone Pitch	Approximately 300 – 1500 Hz; adjustable.
Microprocessor	Custom 3870.
Speed Algorithm	Words per minute (WPM) = 2.4 × dots per second.
LED Mode Indicators	Normal, Pause, Load, Send, Practice.
Practice Characters	A — Z, 0 — 9, Punct.: . , ?/ — — — : ; ' " (! Random length code groups of selectable types.
Operating Temperature Range	32 — 104°F. (0 — 40°C).
Dimensions (less paddles)	4-1/8" (W) × 6" (D) × 1-5/8" (H) (10.5 × 15.2 × 4.1 cm).
Weight	1 lb. 14 oz. (.86 kg).

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

CIRCUIT DESCRIPTION

Refer to the Block Diagrams (Illustration Booklet, Page 9) and the Schematic Diagrams (fold-in) as you read this Circuit Description.

CONTROLLER

The SA-5010A Memory Keyer is controlled mainly by U1 which is a custom 3870 single-chip microprocessor. This microprocessor services the keypad and paddles, determines basic keyer timing, keys the sidetone and output circuitry, stores and retrieves data from the external RAM, and updates the status LEDs.

The 3579.545 kHz crystal (Y1) determines the frequency of the clock, and its output is divided internally to provide a 500 μs basic timing interval. This time interval forms the dots, dashes, interelement, intercharacter, and interword spaces, which all depend on the speed, spacing and weight for which the Memory Keyer is set from the keypad.

Capacitor C1 and an internal pull-up resistor provide a power-on reset to the microprocessor. Diode D1 allows capacitor C1 to discharge quickly when the Memory Keyer is turned off.

Port 0 is an address bus for the external RAM, which consists of ICs U2 and U3. This RAM is a message buffer memory, and also stores the last-set Keyer parameters.

Port 4 is the data bus for the external RAM, and for the LED latch, IC U7. This port has a strobe pin that clocks data into either RAM or the latch, whichever is enabled, when data is output to this port.

Port 5 is a multipurpose output port that selects either the RAM or the LED latch for a "write" operation, or enables RAM for a "read" operation (bits 6 & 7). It gates the sidetone to the speaker (bit 4), and determines whether the Keyer output will be keyed with the sidetone (bit 5). It also lowers the sidetone pitch when necessary (bit 3), and scans the three keypad columns (bits 0, 1, & 2).

Port 1 inputs the key pattern from the selected column. Internal pull-ups cause all inputs to be held high until a key is pressed. When you press a key in the selected column, the low level on the column line is passed through the switch contacts to the associated bit in port 1. The key is recognized by U1, and the appropriate action taken. The dot/dash paddles are effectively part of the keypad matrix, but are handled differently by the microprocessor.

The TUNE key is not part of the keypad matrix. It is connected to the external interrupt pin on U1. This key is active only when the Keyer is in "Normal" or "Paused" modes, and only when the Keyer has completed the last character sent. The Keyer is then latched in the Tune mode until you press some other key (or touch a paddle.) At this time, the Tune mode is unlatched, and that key performs its normal function.

SIDETONE OSCILLATOR/TOUCH PADDLE CIRCUITRY

OR gate IC U9D, inverter U8B, and their associated components form an astable oscillator. This oscillator runs continuously while the Keyer is turned on. The oscillator frequency is manually adjusted with Pitch control R39. The output of this oscillator is gated through IC U9C by the microprocessor to transistor Q13 which drives speaker SP201.

The output of the oscillator, which is buffered by transistors Q17 and Q18, also drives the "D" input and clock input of flip-flop IC U11A & B. With paddle controls R12 and R13 properly set, the D input will go high just in time for the rising edge of the clock to SET the flip-flops. When you touch a paddle, your body capacitance is added to delay the D input enough that it is still low when the clock goes high, resetting the associated flip-flop. This turns transistors Q2 and Q3 on and acts as a closed switch in the matrix. When you use external paddles, transistors Q4 or Q5 are turned off by a paddle closure, also resetting the associated flip-flop, producing the same results.

The oscillator also drives a "charge-pump". This circuit consists of capacitors C2 and C3, and diodes D2 and D3. These components provide a negative potential to the negative (−) keyer output circuitry.

OUTPUT CIRCUITRY

OR Gate IC U9B allows the microprocessor to determine whether the output on port 5, bit 4, will key the output circuitry and sidetone, or just the sidetone. If U9B is enabled, its output will go low on each dot and dash, turning off transistor Q12. This allows transistor Q14 to turn on through resistors R31 and R32, to key a positive keyline to ground. At the same time, the base of transistor Q15 goes to near zero volts, turning it off, and allowing transistor Q16 to key a negative keyline to ground. Protective diodes across the two keyer output jacks prevent damage to the output transistors if the wrong jack is selected for a particular transmitter. The transmitter would then be keyed continuously.

POWER SWITCHING CIRCUIT

The power switching circuitry allows the keyer to be turned on and off with a momentary switch. It also forces the Keyer to be off whenever you plug it in, and provides automatic turn-off after a period of nonuse. Transistor Q8 is a series pass transistor between the diode bridge and the major part of the circuitry. Note that IC U6 is connected to the output of the bridge at all times. (It draws virtually no current itself.) U6B and U6D form an R-S flip-flop which drives ICs U6A and C in parallel to turn transistor Q8 on or off. When the Keyer is plugged in, capacitor C9 will have discharged through diode D13, which holds the output of IC U6D high. Both inputs to U6B will therefore be high, making the output of IC U6B low, and the output of U6A and C high. This keeps transistor Q8, and thus the Keyer, turned off.

When you press the On button, one input of IC U6B goes low, and causes its output to go high. The output of IC U6A and C goes low. This turns transistor Q8 on and supplies power to the Keyer. At the same time, transistor Q9 is turned on and charges capacitor C9. Both inputs of IC U6D are high, and its low output holds the R-S flip-flop in the "on" state when the On button is released. When you leave the Keyer on for a period of time, but do not use it, capacitor C9 discharges far enough to take the input of IC U6D to a low state. The R-S flip-flop now toggles to turn the Keyer off. Transistor Q11 is connected to effectively "push" the On button whenever the sidetone sounds, and resets the automatic shutoff interval.

MEMORY BACKUP CIRCUIT

ICs U2 and U3 are "256 × 4" CMOS RAMs connected as a 256 × 8 RAM. They have very low power consumption in the standby mode. This allows them to retain data with a supply voltage as low as 2 volts. This standby mode is selected by bringing chip-enable pin CE2 on ICs U2 and U3 low. To insure that data is not lost when the Keyer is shut off or loses power, transistors Q6 and Q7 and their associated components sense a drop in the supply voltage below the minimum required for ICs U4 and U5 to remain in regulation, and pull CE2 low.

As the collector voltage of transistor Q8 falls, capacitor C7 discharges quickly through diode D7. When this voltage reaches approximately 8 volts, transistors Q6 and Q7 turn off, allowing CE2 to go low through resistor R21. As the output of IC U5 falls below the battery voltage, diode D4 becomes forward biased and diode D5 reverse biased. (Diode D6 makes up for the voltage drop across diode D5 when the Keyer is on). The RAM is now in the standby mode. The backup batteries are only switched in when the Keyer is disconnected from its source of power; thus, you can extend the battery life by leaving the Keyer plugged into an AC outlet when it is not in use.

STATUS LEDS

Whenever the status of the Keyer is changed, the data in an internal status register is latched into IC U7, and causes the appropriate LED(s) to light. One of the status bits goes low when a digit key is pressed. This bit turns off transistor Q101 when the Keyer is in the Normal mode, and dims the Norm LED as a reminder that the Keyer is expecting a function key to be pressed.

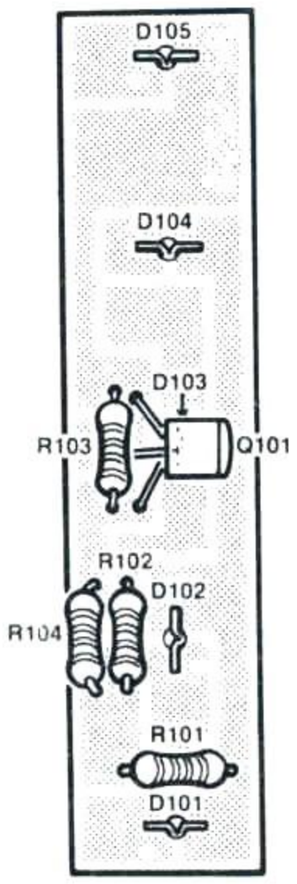
CIRCUIT BOARD X-RAY VIEWS

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

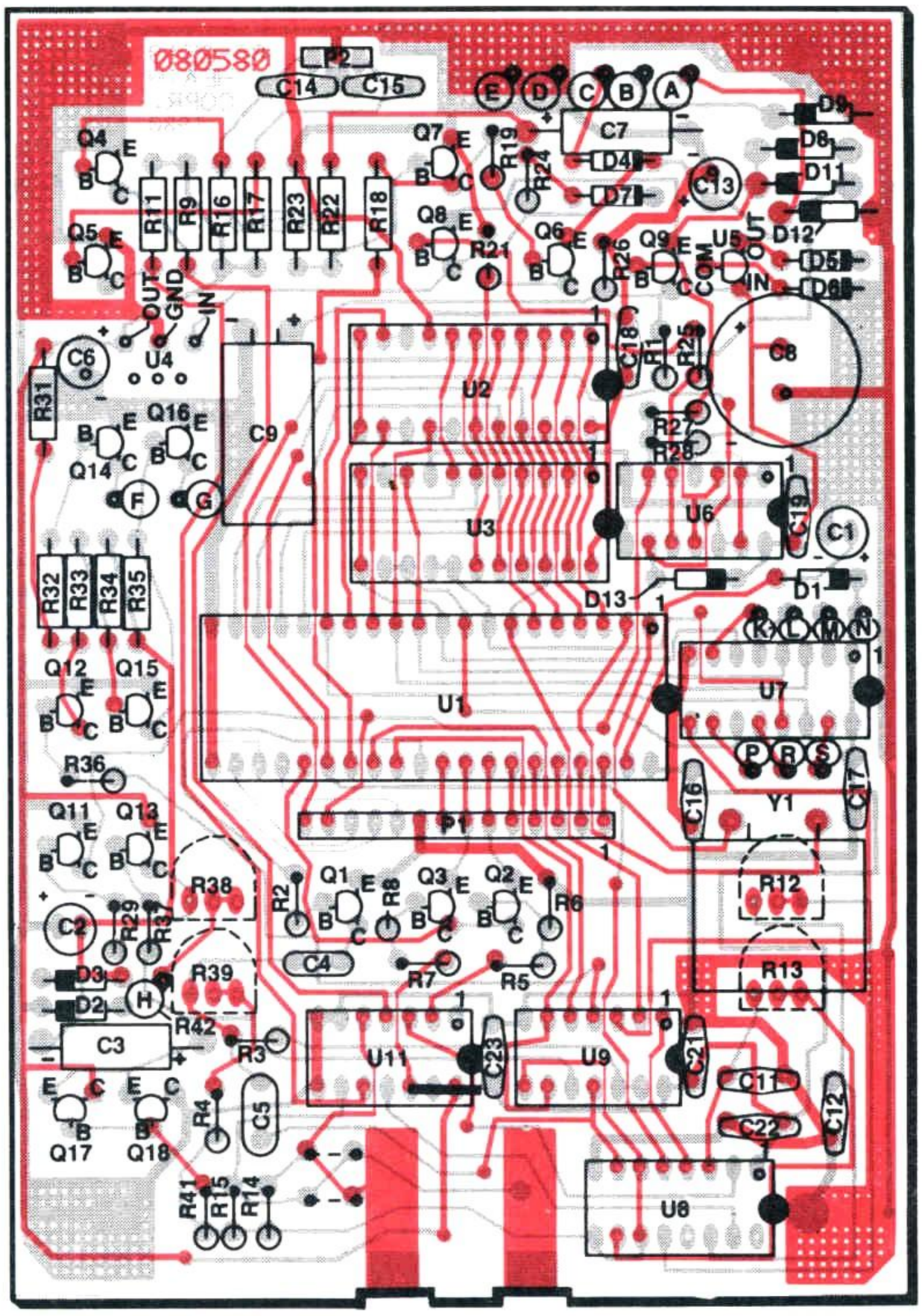
A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View."

B. Locate this same number in the "Circuit Component Number" column of the "Parts List."

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



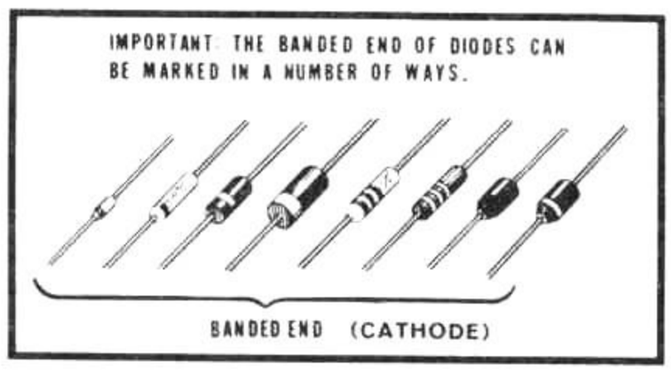
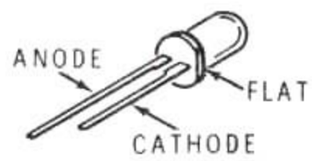
LED CIRCUIT BOARD



MAIN CIRCUIT BOARD

SEMICONDUCTOR IDENTIFICATION CHARTS

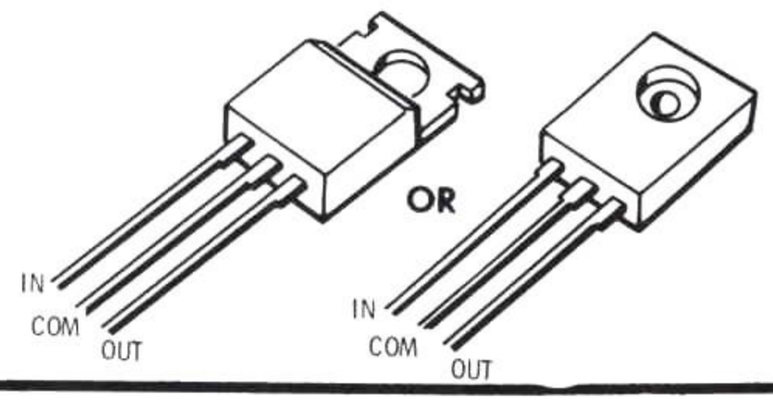
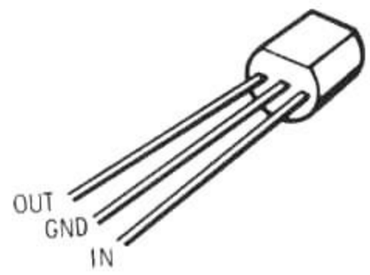
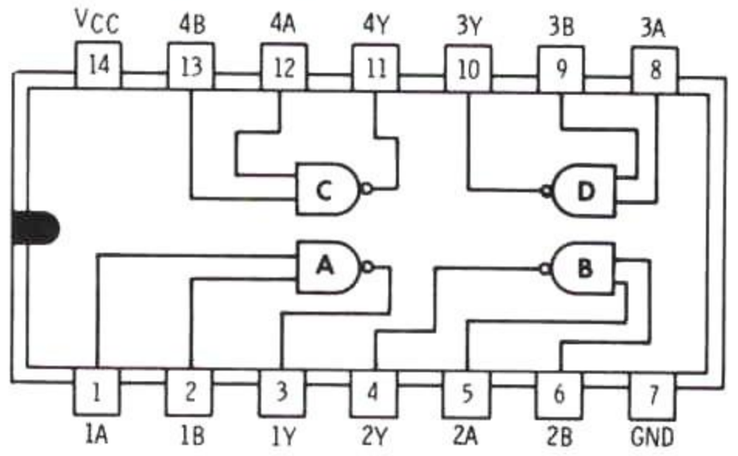
DIODES

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMP. NO	IDENTIFICATION
56-56	1N4149	D1, D5, D6, D7, D13	
56-89	GD510	D2, D3, D4	
57-64	DRS110, 1N5399	D201, D202	
57-65	1N4002	D8, D9, D11, D12	
412-79	TIL209 LED	D101 through D105	

TRANSISTORS

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMP. NO.	IDENTIFICATION
417-235	2N4121	Q6, Q15	
417-294	MPSA42	Q14	
417-801	MPSA20	Q1, Q2, Q3, Q4 Q5, Q7, Q11, Q12 Q101	
417-864	MPSA05	Q17	
417-865	MPSA55	Q8, Q9, Q13, Q18	
417-927	MPSA93	Q16	

INTEGRATED CIRCUITS

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMP. NO.	IDENTIFICATION
442-54	7805	U4	
442-627	78L05	U5	
443-603	CD4011	U6	

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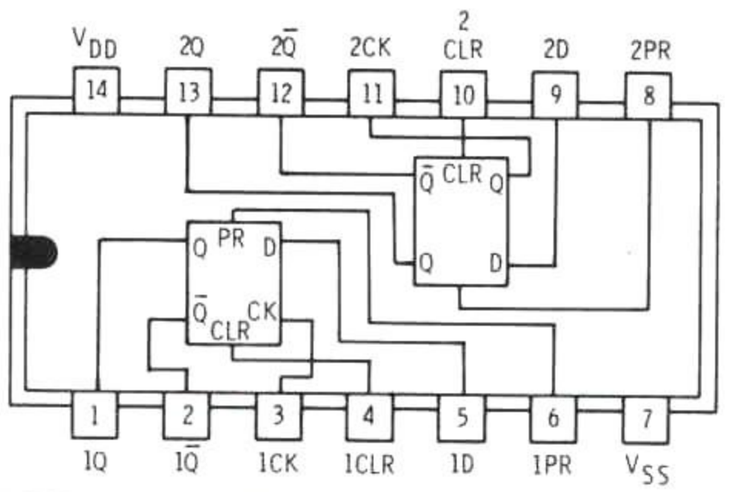
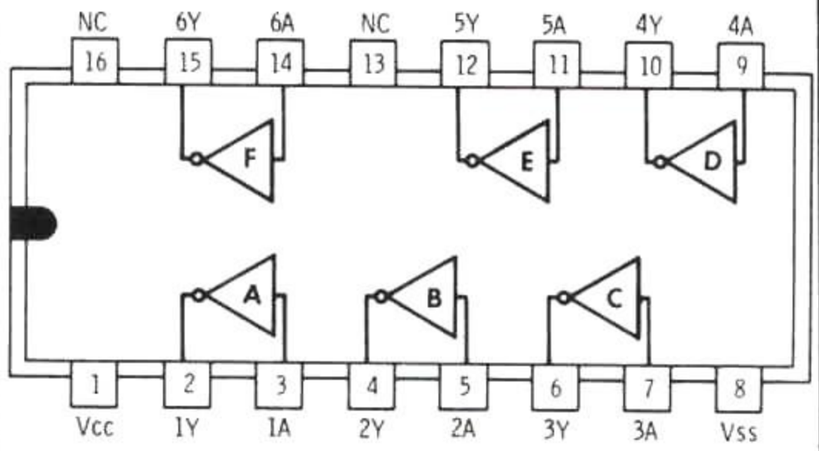
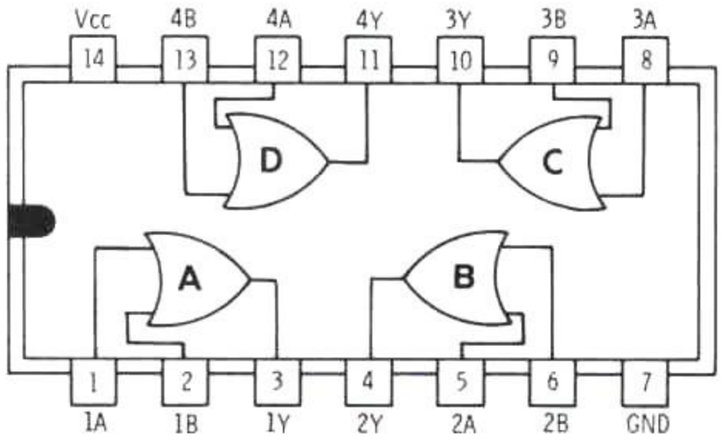
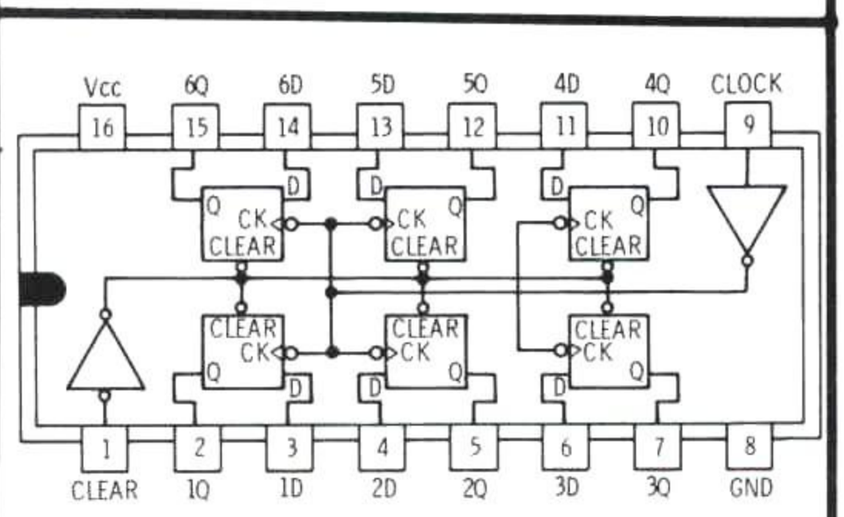
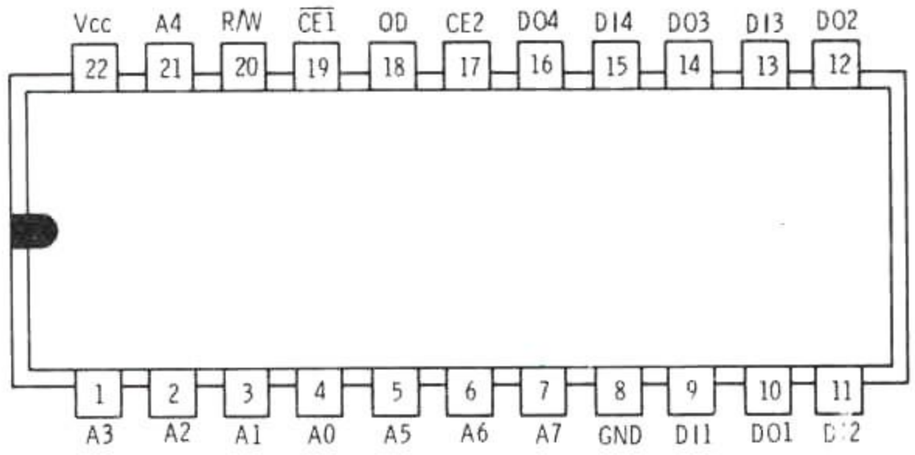
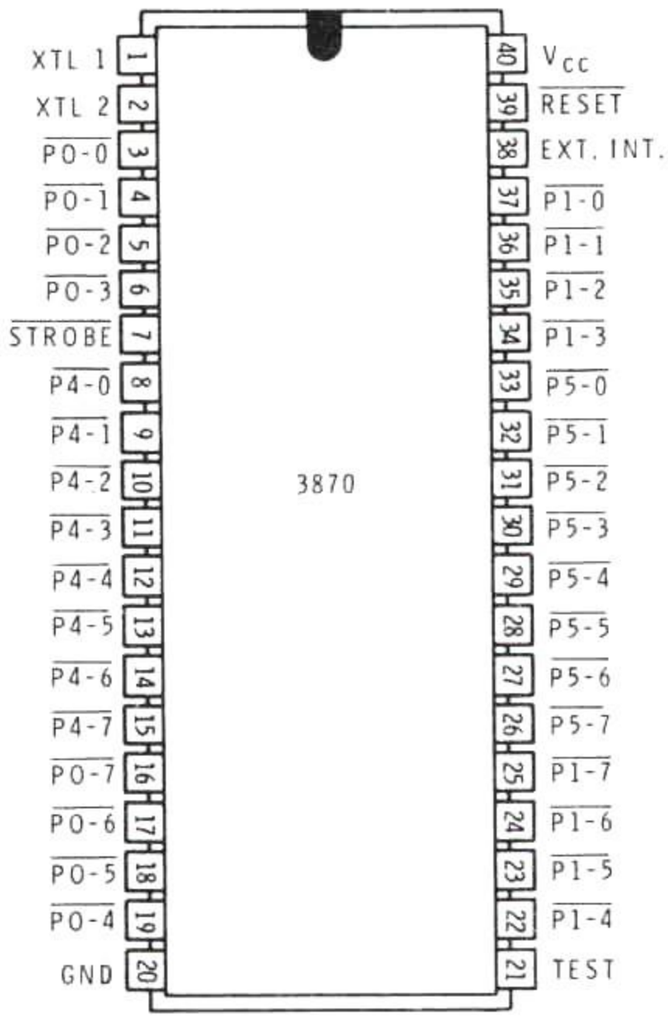
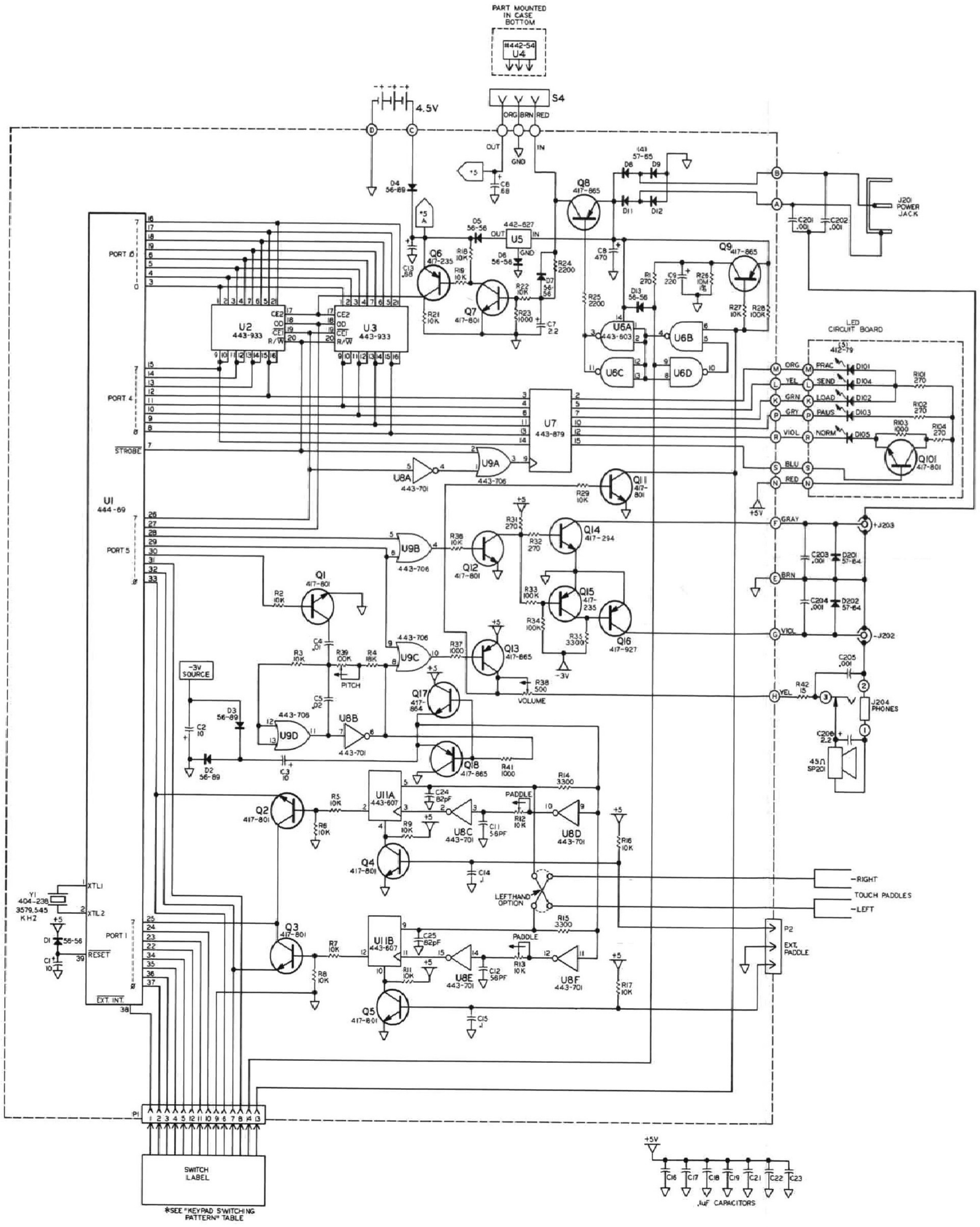
Integrated Circuits (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	IDENTIFICATION
443-607	14013	U11	
443-701	14049	U8	
443-706	14071	U9	
443-879	74LS174	U7	

Integrated Circuits (Cont'd.)

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMP. NO.	IDENTIFICATION
443-933	5101 or 51L01	U2,U3	
444-69	3870	U1	



SCHEMATIC OF THE HEATHKIT® SA-5010 μMATIC KEYER

NOTES:

1. PARTS ARE NUMBERED IN THE FOLLOWING GROUPS:
   1-49 PARTS ON THE MAIN CIRCUIT BOARD.
   100-109 PARTS ON THE LED CIRCUIT BOARD.
   200-209 PARTS ON THE CASE.
2. ALL RESISTORS ARE 1/4-WATT, 5% UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000, M=1,000,000).
3. CAPACITOR VALUES ARE IN μF UNLESS MARKED OTHERWISE.
4. ▽ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
5. ○ THIS SYMBOL WITH A LETTER OR NUMBER IN IT INDICATES A WIRE CONNECTED TO THE CIRCUIT BOARD.
6. →>— THIS SYMBOL INDICATES A PLUG-IN CONNECTION.

*KEYPAD SWITCHING PATTERN

PRESSED KEY	PINS CONNECTED
OFF	9, 14
ON	9, 13
TUNE	1, 9
STOP	2, 6
P/C	6, 11
LOAD	6, 10
SEND	3, 6
WPM	2, 7
SPC'G	3, 7
WT	7, 11
RPT	7, 12
PRAC	6, 12
0	5, 8
1	8, 11
2	4, 8
3	2, 8
4	8, 12
5	8, 10
6	3, 8
7	7, 10
8	5, 7
9	4, 7

IC Vcc AND GROUND PIN CONNECTIONS

IC	GND PIN #	+5V PIN #	+5A PIN #
U1	20, 21	40	
U2	8		22
U3	8		22
U4			
U5			
U6	7		
U7	8	1, 16	
U8	8	1	
U9	7	14	
U11	6, 7, 8	14	

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath/Zenith Computers and Electronics 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/ZENITH COMPUTER AND ELECTRONICS CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath/Zenith Computer and Electronics 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/Zenith Computer and Electronics center.

TECHNICAL CONSULTATION

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

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

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

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

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

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

Heath/Zenith Computer and Electronics center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

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

If it is convenient, personally deliver your kit to a Heath/Zenith Computers and Electronics center. For warranty parts replacement, supply a copy of the invoice or sales slip.

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

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

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

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

Heath Company
Service Department
Benton Harbor, Michigan 49022

Heath Company
Benton Harbor, Michigan