

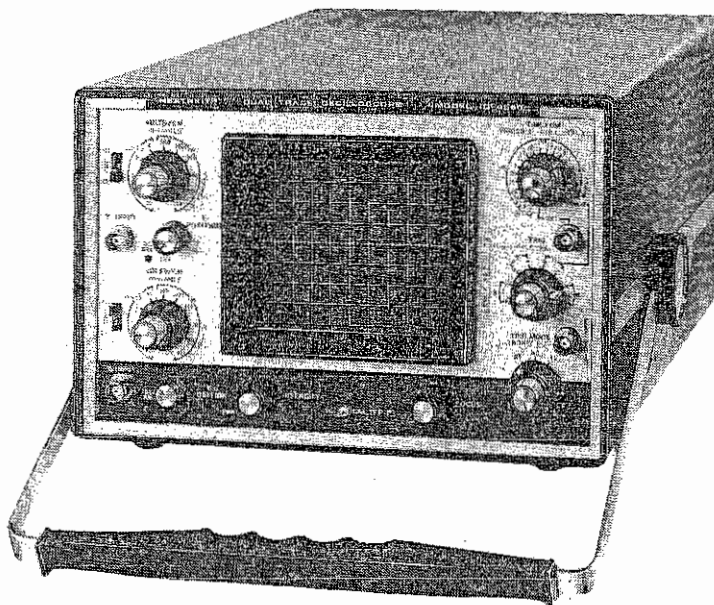
Heathkit® Manual

for the
**10 MHz,
DUAL-TRACE
OSCILLOSCOPE**

Model IO-4550

ASSEMBLY

595-1804-05



HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

This Oscilloscope is a portable, triggered-sweep, dual-trace, DC-to-10 MHz, laboratory-grade instrument. Outstanding features such as the fast vertical rise time, good trace brightness, and the high input sensitivity make the Oscilloscope ideal for the wide range of measurements typically encountered in electronics, development laboratories, and scientific research. In addition, the rugged construction and dependable operation make it a versatile tool for either the hobbyist or the service technician.

Each of the two identical vertical input channels provides a maximum signal sensitivity of 10 millivolts/centimeter. Their attenuator networks can be switched through 11 calibrated ranges to set the deflection factor from 10 millivolts/centimeter to 20 volts/centimeter.

Several modes of signal display are selected by each channel's position control and the Time Base switch. Either or both channels can be displayed as a function of time or as a function of each other. At slower sweep speeds, the vertical channel signals are alternately displayed at a 200 kHz (approximately) rate (chopped mode) so both signals appear as a function of the same time base. For faster sweep speeds, both signals are displayed alternately (alternate mode) on successive sweeps. During X-Y operation, the Channel Y1 (X) circuits provide horizontal (X axis) deflection and the Channel Y2 (Y) circuits provide vertical (Y axis) deflection.

Calibrated time-base ranges from 0.2 seconds/centimeter to 0.2 microsecond/centimeter are readily switched in a 1-, 2-, 5-step sequence. A control on the Time Base switch provides variable sweep speeds between switch positions. Any sweep speed can be expanded 5 times when the X5 control is pulled out, giving a maximum sweep speed of 40 nanoseconds/centimeter.

The Trigger Select switch and Level control allow the time base to be precisely triggered at any point along the positive or negative slope of the trigger signal. Various trigger signals can be selected. These include a sample of Channel Y1 or Channel Y2 input signals, an externally applied trigger signal, or a sample of the line voltage. The Trigger Mode switch controls the trigger input bandpass. A special TV position cuts off unwanted high frequency signals. This is especially useful when you want to trigger on TV vertical frame signals.

A calibrated 1-volt peak-to-peak square wave signal is provided through a front panel connector, allowing easy probe compensation, vertical amplifier calibration, and comparison.

Front panel display controls include Intensity, Focus, and Vertical and Horizontal position. An additional control, accessible through the rear panel, adjusts Astigmatism. An internal switch is used to match the regulated power supply to conventional line voltages from 100 volts to 280 volts AC.

Thus, this Oscilloscope combines the most desirable features required for precise measurement and display, while its solid-state circuitry provides excellent sensitivity, stability, and versatility.



UNPACKING INSTRUCTIONS

DO NOT UNPACK YOUR OSCILLOSCOPE PARTS UNTIL
YOU ARE INSTRUCTED TO DO SO.

The Oscilloscope packaging consists of the main carton which contains a small carton marked Packs #1–#4, and a number of containers and loose parts, some of which are wrapped. These parts will be considered the Final Pack even though they may not be marked as such. Packs #1 through #4 are used to assemble the four circuit boards, while the Final Pack is used to assemble the chassis. When you unpack Packs #1 through #4, you will also remove a number of parts from the Final Pack. Each assembly section has a Parts List that relates to a pack. NEVER UNPACK MORE THAN ONE PACK AT A TIME.

The carton marked Packs #1 – #4 contains the parts for the circuit boards and a "Pack Index Sheet." This sheet identifies the location of each pack in the carton. Do not unpack the entire carton at one time. Refer to the "Pack Index Sheet" when the Manual instructs you to locate a certain pack.

When you check parts, return any part, or group of parts, that is packaged in a bag or envelope with a part number to its container after you identify it, and leave it there until you actually use it in a step. This will prevent intermixing of parts and aid in part identification. Some parts, however, have been placed in a bag or envelope that is not marked with the actual part number but is instead marked with a packaging number that begins with the number "171-" or "172-". These numbers are used for packaging purposes only

and do not appear in the Manual Parts Lists. Open each bag or envelope that is marked with only a "171-" or "172-" packaging number to identify the parts it contains.

NOTE: Never use a "171-" or "172-" packaging number if you must order a replacement part. Use only the part numbers listed in the Manual Parts Lists for this purpose.

Each circuit part in this kit has its own "Circuit Component Number" (R2, C4, SW1, etc.). This is a specific number for only that one part. The purpose of this number is to help you easily identify the same part in each section of the Manual. These numbers will appear:

- In the Parts Lists;
- At the beginning of each step where a component is installed;
- In some illustrations;
- In the sections of the Operation Manual.

Save all packaging material until all parts have been located and/or until you have finished the assembly of the Oscilloscope.



ASSEMBLY NOTES

Before you start to assemble this kit, be sure you have read the wiring and soldering information in the "Kit Builders Guide."

Due to the small foil area around the circuit board holes and the small areas between foils, it will be necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use only a minimum amount of solder, and do not heat components excessively with the soldering iron. Diodes, transistors, etc., can be damaged if subjected to excessive amounts of heat. Use no larger than a 25-watt soldering iron with a small tip. Allow it to reach operating temperature, and then apply it only long enough to make a good solder connection.

Resistors will be called out by their resistance value in Ω , $k\Omega$, or $M\Omega$, and color code.

Capacitors will be called out by the capacitance value (in pF or μF) and type (ceramic, mica, electrolytic, etc.).

A separate "Illustration Booklet" contains numbered illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. The step-by-step assembly instructions will direct you to the proper illustration in the Booklet. After you have completed the assembly of your kit, place the "Illustration Booklet" with the Manual and save them for future reference.



LOW VOLTAGE CIRCUIT BOARD

PARTS LIST

Unpack the pack marked #1 and check each part against the following list. Make a check (✓) in the space provided as you identify each part. The key numbers correspond to the numbers on the Parts Pictorials (in the "Illustration Booklet").

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

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

RESISTORS

NOTE: The following resistors have a tolerance of 5% unless they are listed otherwise. 5% is indicated by a fourth color band of gold, while 10% is indicated by a silver band.

1/4-Watt

A1	() 2	100 Ω , 10% (brown black-brown)	6-101-12	R304, R305
----	-------	--	----------	------------

1/2-Watt

A2	() 2	100 Ω (brown-black-brown)	6-101	R312, R314
A2	() 1	15 k Ω (brown-green-orange)	6-153	R308
A2	() 1	27 k Ω (red-violet-orange)	6-273	R311



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

Resistors (cont'd.)**2-Watt**

NOTE: The following resistors are 2-watt wire-wound resistors and are the same size physically as 1-watt composition resistors.

A3	() 2	.33 Ω (orange-orange-silver)	3-2-2	R306, R307
A3	() 1	.51 Ω (green-brown-silver)	3-6-2	R315
A3	() 1	2.7 Ω (red-violet-gold)	3-3-2	R313
A3	() 2	100 Ω , 10% (brown-black-brown)	1-20-2	R302, R303

5-Watt

A4	() 1	90 Ω , 10%, wire-wound	3-28-5	R301
----	-------	-------------------------------	--------	------

CONTROL

B1	() 1	10 k Ω	10-386	R309
----	-------	---------------	--------	------

CAPACITORS**Mylar***

C1	() 2	.1 μ F	27-47	C305, C306
----	-------	------------	-------	------------

Electrolytic

C2	() 2	2 μ F	25-123	C303, C304
C3	() 1	1000 μ F, tubular	25-111	C4
C4	() 4	1000 μ F, <u>15V</u>	25-148	C309, C311, C312, C313
C4	() 4	1000 μ F, <u>25V</u>	25-164	C301, C302, C307, C308

*DuPont Registered Trademark



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

DIODES-TRANSISTORS-INTEGRATED CIRCUIT

D1	() 2	1N5232 zener diode	56-616	ZD313, ZD314
D1	() 12	1N2071 diode	57-27	D301-D312

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

1. Part number.
2. Type number. (In integrated circuits, this refers only to the numbers in bold type. Disregard any other numbers or letters on the IC.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

D2	() 1	2N3393 transistor	417-118	Q304
D2	() 1	X29A829 transistor	417-201	Q306
D3	() 1	2N3638A transistor	471-234	Q305
D4	() 1	MJE181 transistor	417-818	Q302
D4	() 1	MJE171 transistor	417-819	Q301
D5	() 1	MPSU05 transistor	417-224	Q303
D6	() 1	SG4501N integrated circuit	442-65	IC301

HARDWARE

E1	() 2	4-40 x 5/16" screw	250-213
E2	() 2	4-40 nut	252-2
E3	() 2	#4 lockwasher	254-9

MISCELLANEOUS

F1	() 2	Heat sink	215-94
F2	() 1	14-pin socket	434-298
F3	() 1	Nut starter	490-5
F4	() 1	IC puller	490-111

PARTS FROM FINAL PACK

() 1	Low voltage circuit board	85-1540-1
() 1	Assembly Manual	595-1804
() 1	Operation Manual	595-1850
() 1	Parts Order Form	597-260
() 1	Kit Builders Guide	597-308

Solder



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

Stranded Wire

() 21-1/2"	Large black	344-2
() 27-1/2"	Large red	344-21
() 19"	Large blue	344-29
() 30"	Large brown	344-34
() 18"	Large orange	344-35
() 18"	Large yellow	344-36
() 35"	Small brown	344-91
() 24"	Small orange	344-93

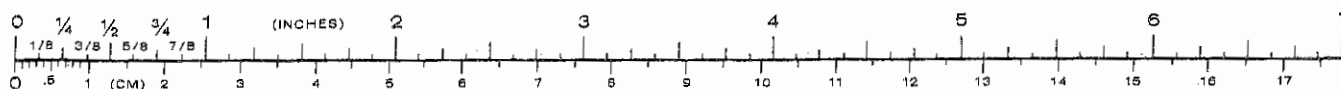
Solid Wire

() 12"	Small black	344-50
() 3-1/2"	Small red	344-52
() 6"	Small yellow	344-54
() 12"	Small green	344-55
() 15-1/2"	Small white	344-59
() 19"	White-black	344-70
() 14-1/2"	White-brown	344-71
() 20-1/2"	White-red	344-72
() 21-1/2"	White-orange	344-73
() 32-1/2"	White-yellow	344-74
() 20-1/2"	White-green	344-75
() 24"	White-blue	344-76
() 26-1/2"	White-gray	344-78

Other

() 12"	Twin lead	347-2
() 8"	Teflon* sleeving	346-21
() 3"	Large sleeving	346-7
() 4"	Fiber sleeving	346-4

*DuPont Registered Trademark





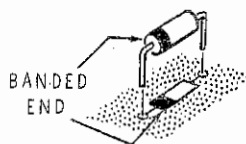
STEP-BY-STEP ASSEMBLY

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

START

- () Position the circuit board as shown.

NOTE: When you install a diode, always match the band or bands on the diode with the band mark on the circuit board.



- () ZD313: 1N5232 zener diode (#56-616).

- () ZD314: 1N5232 zener diode (#56-616).

- () D309: 1N2071 diode (#57-27).

- () D311: 1N2071 diode (#57-27).

- () D312: 1N2071 diode (#57-27).

- () D310: 1N2071 diode (#57-27).

- () D306: 1N2071 diode (#57-27).

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

- () D308: 1N2071 diode (#57-27).

- () D307: 1N2071 diode (#57-27).

- () D305: 1N2071 diode (#57-27).

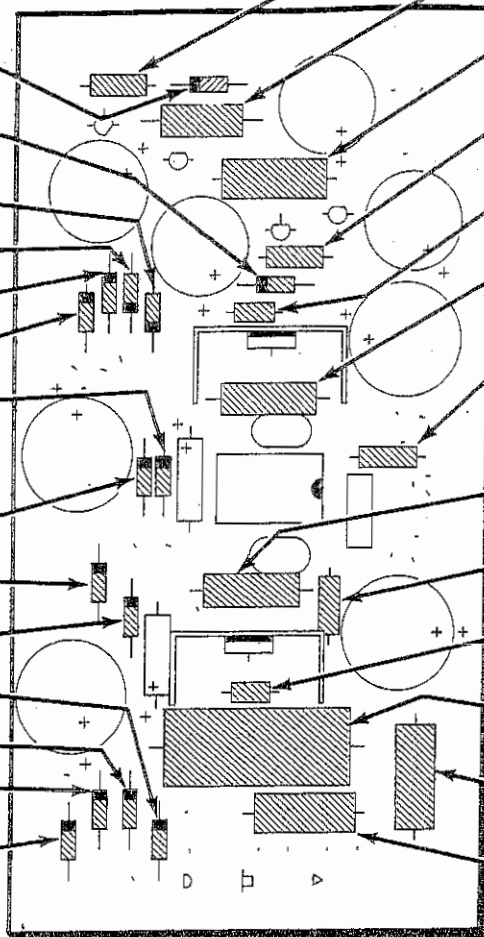
- () D301: 1N2071 diode (#57-27).

- () D302: 1N2071 diode (#57-27).

- () D304: 1N2071 diode (#57-27).

- () D303: 1N2071 diode (#57-27).

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



CONTINUE

- () R314: 100 Ω , 1/2-watt (brown-black-brown).

- () R315: .51 Ω , 2-watt (green-brown-silver). The circuit board may be marked "1W."

- () R313: 2.7 Ω , 2-watt (red-violet-gold).

- () R312: 100 Ω , 1/2-watt (brown-black-brown).

- () R304: 100 Ω , 1/4-watt (brown-black-brown).

- () R306: .33 Ω , 2-watt (orange-orange-silver).

- () R308: 15 k Ω , 1/2-watt (brown-green-orange).

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

- () R307: .33 Ω , 2-watt (orange-orange-silver).

- () R311: 27 k Ω , 1/2-watt (red-violet-orange).

- () R305: 100 Ω , 1/4-watt (brown-black-brown).

- () R301: 90 Ω , 10%, 5-watt wire-wound. Mount the resistor 1/16" above the circuit board.

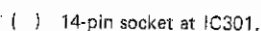
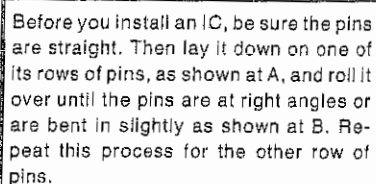
- () R303: 100 Ω , 2-watt (brown-black-brown).

- () R302: 100 Ω , 2-watt (brown-black-brown).

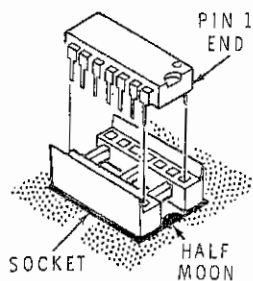
- () Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-1

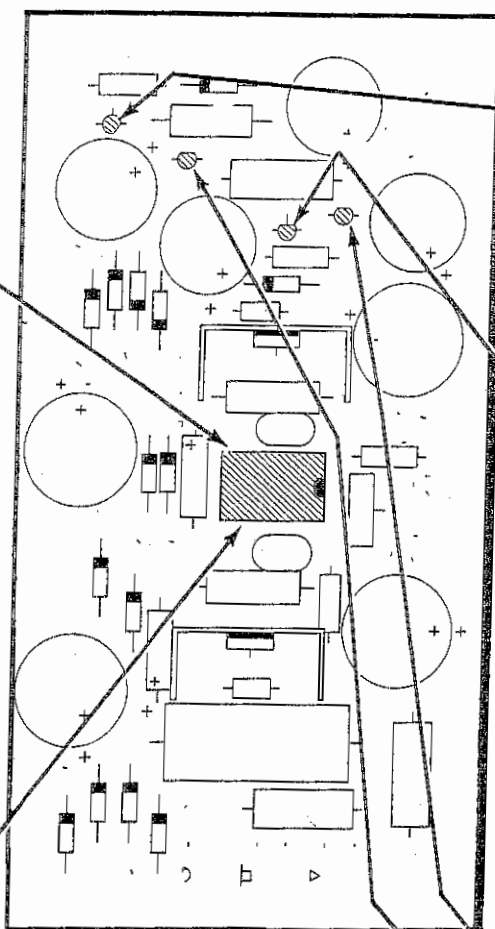
NOTE: To install a 14-pin socket, be sure the socket pins are straight. Then insert the socket pins and solder them to the foil.



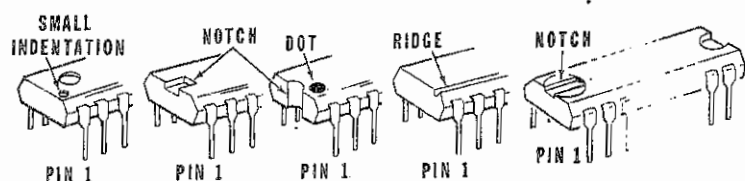
NOTE: To install an integrated circuit, first refer to Detail 1-2A and identify the pin 1 end. Then position the pin 1 end toward the half-moon mark on the circuit board and carefully install the integrated circuit. Make sure all the pins are in their respective holes. (If you ever need to remove the IC, use the IC puller as shown on Page 20.)



() IC301: SG4501N integrated circuit (#442-65).



PICTORIAL 1-2

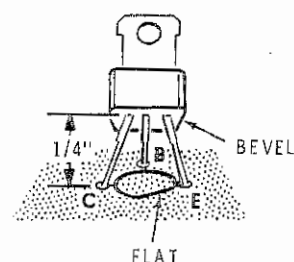


Detail 1-2A

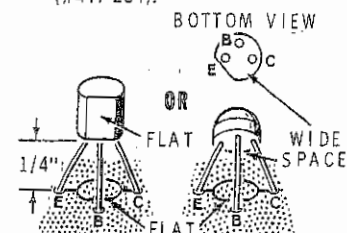
In the following steps, install each transistor as follows:

1. Refer to the illustrations and identify the shape of the transistor you received. Then identify the C, B, and E leads.
2. Insert the transistor leads into the corresponding E, C, and B 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.

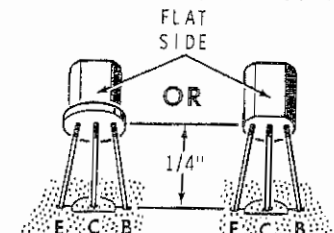
() Q303: MPSU05 transistor
(#417-224).



() Q305: 2N3638A transistor
(#417-234).



Install the next two transistors as shown.



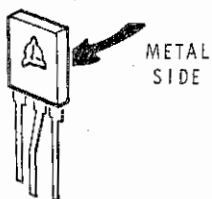
() Q306: X29A829 transistor
(#417-201).

() Q304: 2N3393 transistor
(#417-118).

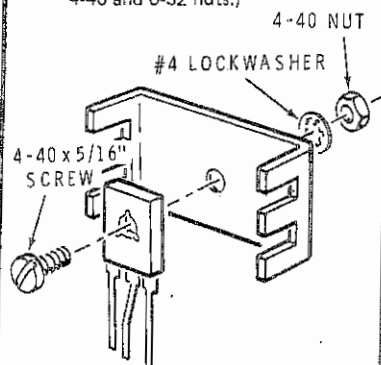
**START**

() Prepare a transistor heat sink combination as follows:

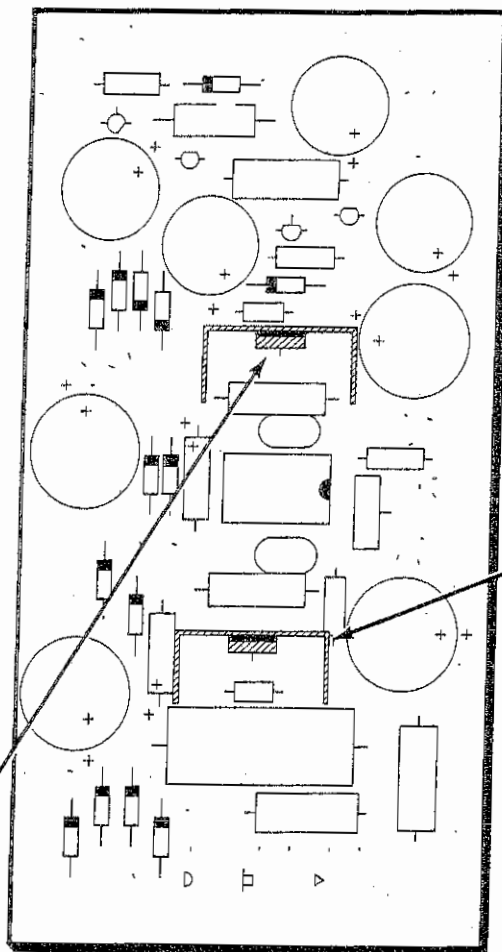
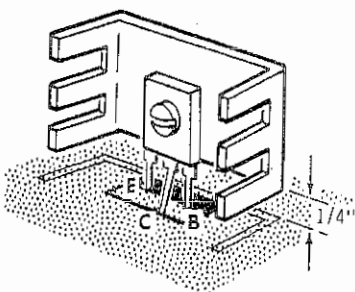
1. Bend the center (c) lead of an MJE171 transistor (#417-819) as shown.



2. Mount a heat sink to the transistor with a 4-40 x 5/16" screw, a #4 lockwasher, and a 4-40 nut. (Use the plastic nut starter to hold and start 4-40 and 6-32 nuts.)

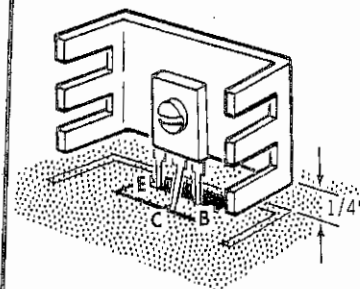


- () Q301: MJE171 transistor heat sink combination (#417-819). Solder the leads to the foil and cut off the excess lead lengths.

**CONTINUE**

- () As before, prepare another transistor heat sink combination. Use the MJE181 transistor (#417-818).

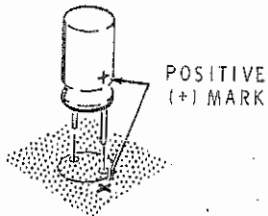
- () Q302: MJE181 transistor heat sink combination (#417-818). Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-3

START

NOTE: When you install the following electrolytic capacitors, be sure you match the positive (+) marking on the capacitor with the positive (+) marking on the circuit board.

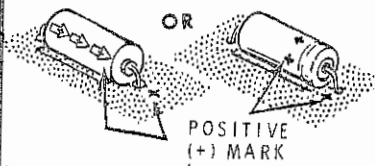


() C311: 1000 μ F, 15V electrolytic.

() C309: 1000 μ F, 15V electrolytic.

() C302: 1000 μ F, 25V electrolytic.

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.

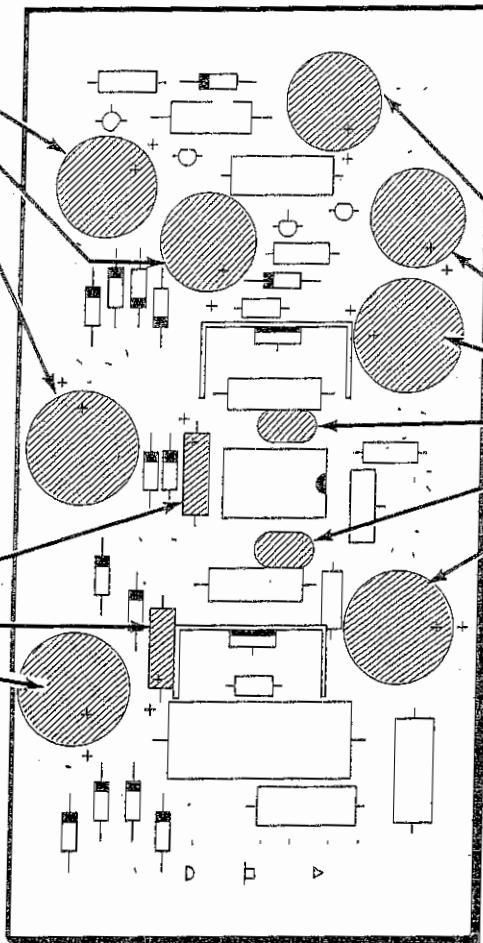


() C303: 2 μ F electrolytic.

() C304: 2 μ F electrolytic.

() C301: 1000 μ F, 25V electrolytic.

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



CONTINUE

() C313: 1000 μ F, 15V electrolytic.

() C312: 1000 μ F, 15V electrolytic.

() C307: 1000 μ F, 25V electrolytic.

() C305: .1 μ F Mylar.

() C306: .1 μ F Mylar.

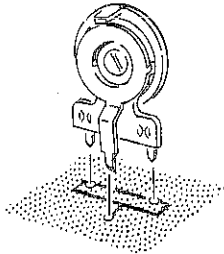
() C308: 1000 μ F, 25V electrolytic.

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

PICTORIAL 1-4

**START**

- () Cut both leads of a 1000 μ F tubular electrolytic capacitor to 1-1/2".
- () Cut two 1-1/4" lengths of fiber sleeving.
- () Slide a length of sleeving over each lead of a 1000 μ F electrolytic capacitor.
- () C4: 1000 μ F electrolytic. Connect the capacitor to the foil side of the circuit board and solder the leads to the foil as shown in Detail 1-5A.
- () R309: 10 k Ω control (#10-386). Solder the lugs to the foil.



NOTE: When a wire is called for, cut the wire to the specified length and remove 1/4" of insulation from each end. Solder each wire to the foil as it is installed. The loose wire ends will be connected later.

- () 2" white-red wire at C Δ .
- () 1-3/4" smaller red wire at C \square .
- () 2-3/4" white-blue wire at C \Diamond .
- () 3" larger black wire at GND.

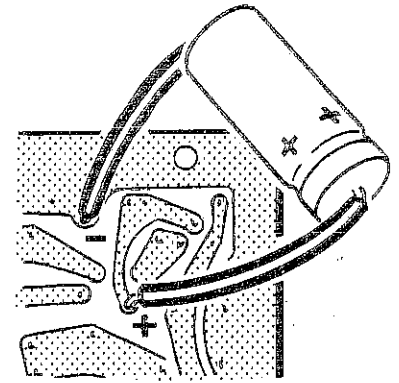
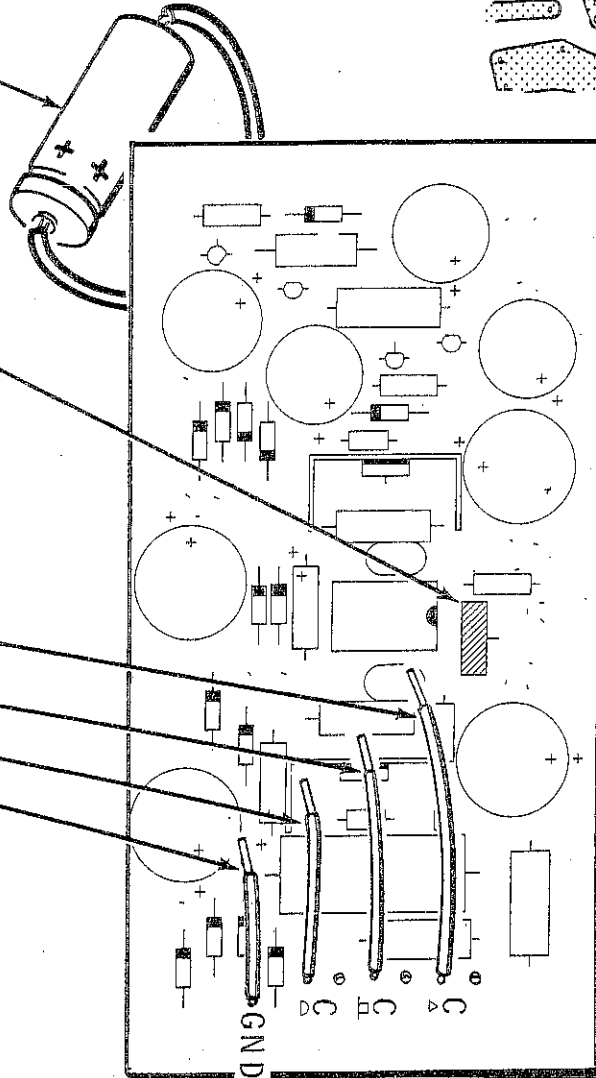
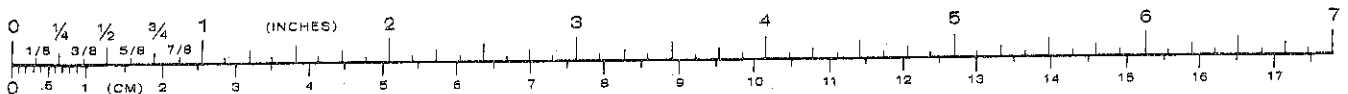
CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

- () Unsoldered connections.
- () "Cold" solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.
- () Transistors and integrated circuit for proper installation.
- () Capacitors for the correct position of the positive end.
- () Diodes for the correct position of the banded end.

FINISH

Set the circuit board aside temporarily. The remaining circuit board holes will be used later.

**Detail 1-5A****PICTORIAL 1-5**



HIGH VOLTAGE CIRCUIT BOARD

PARTS LIST

Unpack the pack marked #2 and check each part against the following list. Make a check (✓) in the space provided as you identify each part.

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

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

RESISTORS

NOTE: The following resistors have a tolerance of 5% unless they are listed otherwise. 5% is indicated by a fourth color band of gold, while 10% is indicated by a silver band. The resistors may be packed in more than one envelope. Open all the resistor envelopes in this pack before you check the resistors against the Parts List.

1/2-Watt

A1	() 2	47 Ω (yellow-violet-black)	6-470	R415, R416
A1	() 1	120 Ω (brown-red-brown)	6-121	R401
A1	() 1	1000 Ω (brown-black-red)	6-102	R408
A1	() 1	1200 Ω (brown-red-red)	6-122	R414
A1	() 3	10 k Ω (brown-black-orange)	6-103	R402, R407, R418
A1	() 2	22 k Ω (red-red-orange)	6-223	R417, R421
A1	() 1	39 k Ω (orange-white-orange)	6-393	R422



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

Resistors (cont'd.)**1/2 Watt**

A1	() 2	56 k Ω (green-blue-orange)	6-563	R404, R405
A1	() 2	82 k Ω (gray-red-orange)	6-823	R427, R432
A1	() 1	220 k Ω (red-red-yellow)	6-224	R423
A1	() 1	270 k Ω (red-violet-yellow)	6-274	R424
A1	() 3	680 k Ω (blue-gray-yellow)	6-684	R411, R412, R413

1-Watt

A2	() 1	15 k Ω , 10% (brown-green-orange)	1-26-1	R429
A2	() 2	680 k Ω , 10% (blue-gray-yellow)	1-33-1	R425, R426

2-Watt

A3	() 2	2700 Ω , 10% (red-violet-red)	1-1-2	R403, R406
A3	() 1	5600 Ω (green-blue-red)	1-23-2	R431

CONTROLS

B1	() 1	20 k Ω	10-390	R419
B1	() 1	100 k Ω	10-941	R409
B1	() 1	200 k Ω	10-317	R428
B1	() 1	500 k Ω	10-946	R430

CAPACITORS**Ceramic**

C1	() 2	18 pF	21-60	C404, C405
C1	() 1	130 pF	21-107	C415
C1	() 1	470 pF	21-56	C417
C1	() 2	.001 μ F	21-90	C403, C406
C1	() 1	.002 μ F	21-36	C407
C1	() 1	.0033 μ F (3300)	21-141	C414
C1	() 3	.005 μ F	21-116	C410, C411, C418
C1	() 1	.01 μ F	21-16	C416

Paper

C2	() 2	.1 μ F	23-62	C408, C409
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KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
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Tantalum

C3	() 2	10 μ F (10M)	25-220	C412, C413
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Electrolytic

C4	() 2	100 μ F	25-267	C401, C402
----	-------	-------------	--------	------------

DIODES-TRANSISTORS-INTEGRATED CIRCUIT

D1	() 1	1N4149 diode	56-56	D406
D1	() 2	ZVR-68 zener diode	56-68	ZD401, ZD403
D1	() 1	1N2071 diode	57-27	D402
D1	() 2	SCM-30 diode	57-56	D404, D405

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

1. Part number.
2. Type number. (In integrated circuits, this refers only to the numbers in bold type. Disregard any other numbers or letters.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

D2	() 2	2N4889 transistor	417-805	Q402, Q403
D3	() 1	MPSL01 transistor	417-811	Q401
D4	() 3	MPSU10 transistor	417-834	Q404, Q405, Q406
D5	() 1	N5741 V integrated circuit	442-22	IC401

MISCELLANEOUS

E1	() 1	8-pin socket	434-230
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PART FROM FINAL PACK

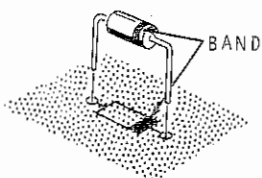
() 1	High voltage circuit board	85-1962-1
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STEP-BY-STEP ASSEMBLY

START

- () Position the circuit board as shown in the identification drawing.

NOTE: When you install a diode, always match the band or bands on the diode with the band mark on the circuit board.



- () ZD401: ZVR-68 zener diode (#56-68).

- () R422: 39 k Ω (orange-white-orange).

- () R416: 47 Ω (yellow-violet-black).

- () R418: 10 k Ω (brown-black-orange).

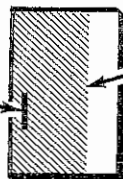
- () R414: 1200 Ω (brown-red-red).

- () D406: 1N4149 diode (#56-56).

- () D405: SCM-30 diode (#57-56).

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

PART
NUMBER



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

IDENTIFICATION
DRAWING

CONTINUE

- () R421: 22 k Ω (red-red-orange).

- () R426: 680 k Ω , 1-watt (blue-gray-yellow).

- () R417: 22 k Ω (red-red-orange).

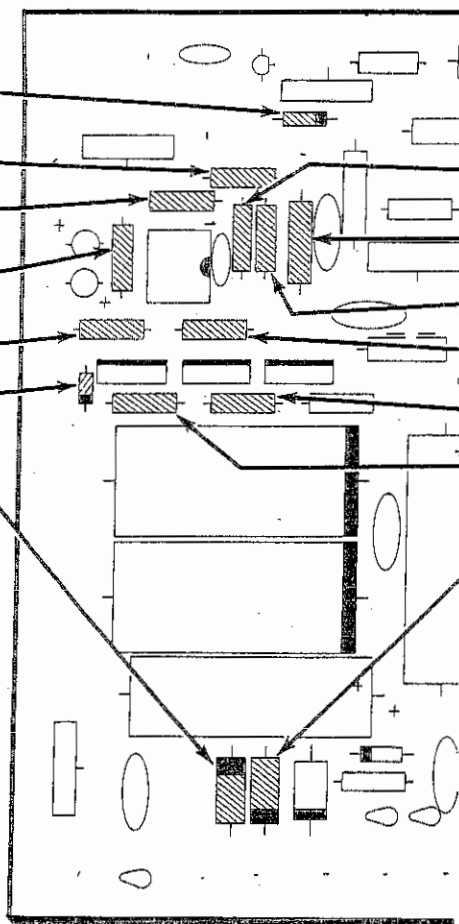
- () R415: 47 Ω (yellow-violet-black).

- () R412: 680 k Ω (blue-gray-yellow).

- () R413: 680 k Ω (blue-gray-yellow).

- () D404: SCM-30 diode (#57-56).

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



PICTORIAL 2-1

PART
NUMBER

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

IDENTIFICATION
DRAWING

START

() R432: 82 k Ω (gray-red-orange).

() R423: 220 k Ω (red-red-yellow).

() R424: 270 k Ω (red-violet-yellow).

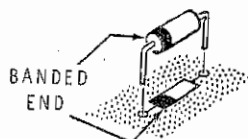
() 1" bare wire.

() R425: 680 k Ω , 1-watt (blue-gray-yellow).

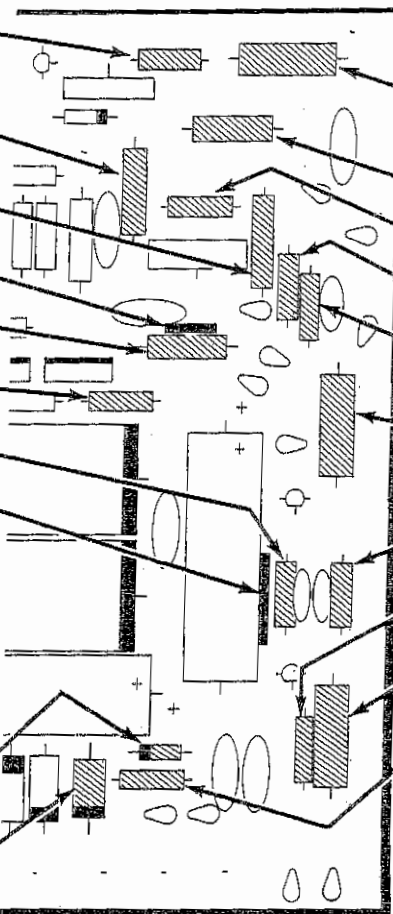
() R411: 680 k Ω (blue-gray-yellow).

() R405: 56 k Ω (green-blue-orange).

() 1" bare wire.

NOTE: When you install a diode, always
match the band or bands on the diode
with the band mark on the circuit board.

() ZD403: ZVR-68 zener diode
(#56-68).

() D402: 1N2071 diode (#57-27).

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

CONTINUE

() R431: 5600 Ω , 2-watt (green-blue-red).

() R429: 15 k Ω , 1-watt (brown-green-orange).

() R427: 82 k Ω (gray-red-orange).

() R408: 1000 Ω (brown-black-red).

() R407: 10 k Ω (brown-black-orange).

() R406: 2700 Ω , 2-watt (red-violet-red).

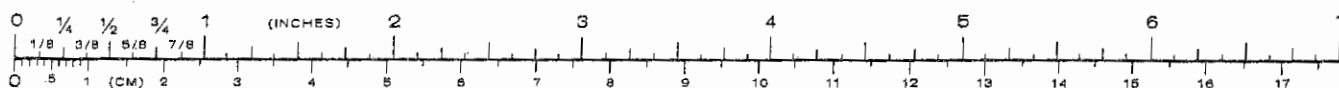
() R404: 56 k Ω (green-blue-orange).

() R402: 10 k Ω (brown-black-orange).

() R403: 2700 Ω , 2-watt (red-violet-red).

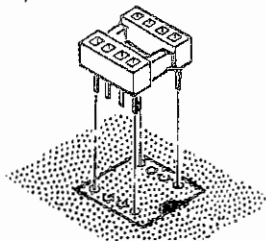
() R401: 120 Ω (brown-red-brown).

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

PICTORIAL 2-2


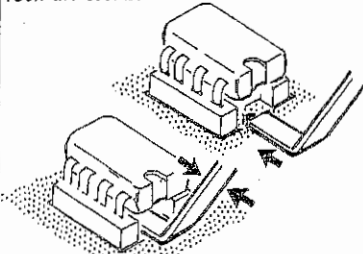
START

NOTE: To install an 8-pin socket, be sure the socket pins are straight. Then insert the socket pins and solder them to the foil.

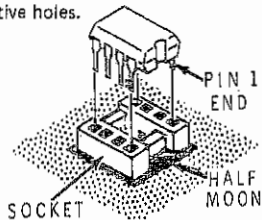


() 8-pin socket at IC401.

NOTE: An IC puller has been included with this kit in case you have to remove an IC from its socket. To use the puller, insert its foot beneath the IC; then gently rock the tool back and forth to lift the IC.



NOTE: To install an integrated circuit, first refer to Detail 2-3A (at the bottom of this column) and identify the pin 1 end. Then position the pin 1 end toward the half-moon mark on the circuit board and carefully install the integrated circuit. Make sure all the pins are in their respective holes.



() IC401: N5741V integrated circuit (#442-22).

PART
NUMBER

IDENTIFICATION
DRAWING

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

CONTINUE

NOTE: When you install .1 μ F paper capacitors, always match the banded end of the capacitor with the band outline on the circuit board.



BANDED END

() C409: .1 μ F paper.

() C408: .1 μ F paper.

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.

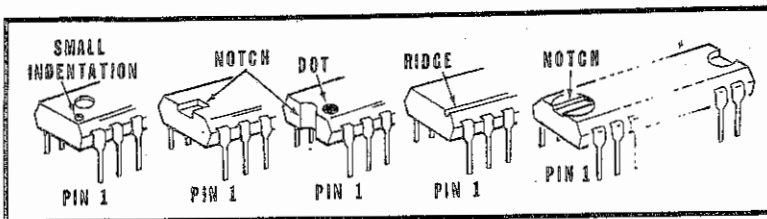


POSITIVE (+)
MARK

() C402: 100 μ F electrolytic.

() C401: 100 μ F electrolytic.

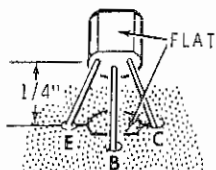
() Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-3

Detail 2-3A

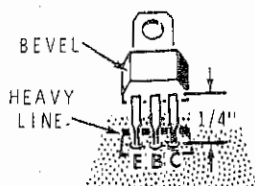
START

NOTE: In the following step, line up the flat on the transistor with the flat on the circuit board and insert the transistor leads into the corresponding E, B, and C holes in the circuit board. Solder the transistor as it is installed and cut off the excess lead lengths.



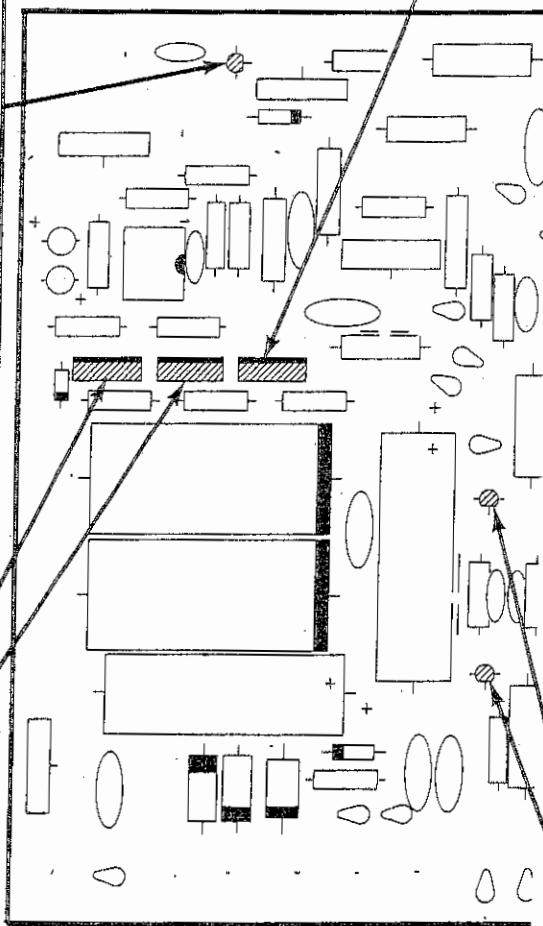
() Q401: MPSL01 transistor (#417-811).

NOTE: When you install each of the next three transistors, position the beveled edges as shown. Then insert the E, B, and C leads of the transistor into the corresponding E, B, and C holes in the circuit board. Solder the leads to the foil and cut off the excess lead lengths.



() Q406: MPSU10 transistor (#417-834).

() Q405: MPSU10 transistor (#417-834).

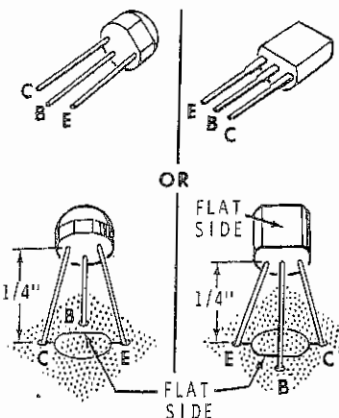


CONTINUE

() Q404: MPSU10 transistor (#417-834).

In the next two steps, install each transistor as follows:

1. The transistors supplied with your kit may be one of two different shapes. Refer to the illustrations below and identify the shape of the transistor you have received. Then identify the E, B, and C leads.
2. Study the appropriate mounting detail carefully, as each style transistor is mounted differently.
3. Insert the transistor leads into the corresponding E, B, and C holes in the circuit board.
4. Position the transistor 1/4" above the circuit board.
5. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.



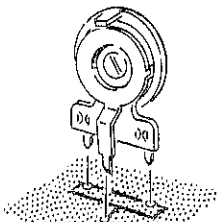
() Q403: 2N4889 transistor (#417-805).

() Q402: 2N4889 transistor (#417-805).

PICTORIAL 2-4

START

- () R428: 200 k Ω control (#10-317).
Solder the leads to the foil.

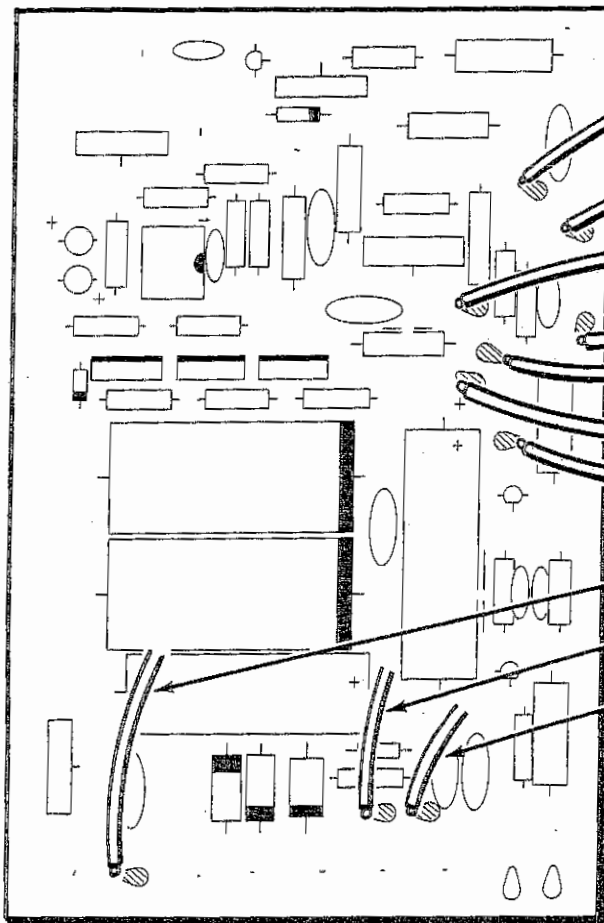


- () C417: 470 pF ceramic.
- () C415: 130 pF ceramic. NOTE: Board may be marked 150.
- () C414: .0033 μ F ceramic.
- () R419: 20 k Ω control (#10-390).
- () C411: .005 μ F ceramic.
- () C405: 18 pF ceramic.
- () C406: .001 μ F ceramic.
- () C416: .01 μ F ceramic.
- () R430: 500 k Ω control (#10-946).
- () Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

- () C410: .005 μ F ceramic.
- () R409: 100 k Ω control (#10-941).
Solder the leads to the foil.
- () C418: .005 μ F ceramic.
- () C407: .002 μ F ceramic.
- NOTE: When you install a tantalum capacitor, always match the positive (+) or dot marked side of the capacitor with the positive (+) mark on the circuit board.
- POSITIVE (+) MARK COLOR DOT
- () C413: 10 μ F tantalum.
- () C412: 10 μ F tantalum.
- () C404: 18 pF ceramic.
- () C403: .001 μ F ceramic.
- () Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-5



PICTORIAL 2-6

START

In the following steps, when you prepare a wire, twist the bare wire strands together and apply a small amount of solder to hold them together. Solder each wire as you install it and cut off the excess wire length.

- () 10" larger yellow wire at K.
- () 10" larger orange wire at G.
- () 5-1/2" larger red wire at B.
- () 2-1/2" larger red wire at A.
- () 2-1/2" larger orange wire at C.
- () 5-1/2" larger yellow wire at D.
- () 2-1/2" larger yellow wire at E.
- () 12" green wire at M.
- () 13" larger brown wire at L.
- () 13" larger brown wire at J.

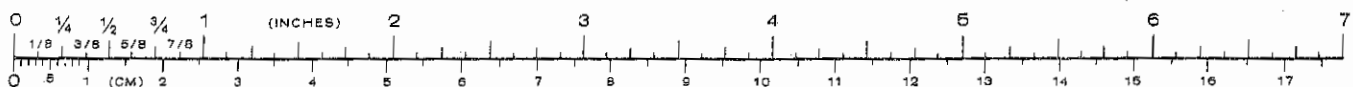
CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

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

FINISH

Set the circuit board aside temporarily. The remaining holes will be used later.





VERTICAL CIRCUIT BOARD

PARTS LIST

Unpack the pack marked #3 and check each part against the following list. Make a check (✓) in the space provided as you identify each part.

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

KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
RESISTORS				
1/8-Watt, 1%				
A1	() 2	200 Ω	2-32-11	R157-1, R157-2
A1	() 6	1000 Ω (1k)	2-15-11	R102-1, R102-2, R122-1, R122-2, R125-1, R125-2
A1	() 2	2000 Ω (2k)	2-12-11	R156-1, R156-2
A1	() 2	10.1 k Ω	2-40-11	R104-1, R104-2
A1	() 2	13 k Ω	2-41-11	R155-1, R155-2
A1	() 2	111 k Ω	2-42-11	R106-1, R106-2
A1	() 2	900 k Ω	2-43-11	R105-1, R105-2
A1	() 2	990 k Ω	2-44-11	R103-1, R103-2
A1	() 2	999 k Ω	2-45-11	R101-1, R101-2
1/4-Watt, 1%				
A1	() 2	523 Ω	2-725-12	R132-1, R132-2
A1	() 4	900 Ω	2-610-12	R121-1, R121-2, R126-1, R126-2
A1	() 2	2050 Ω (2.05k)	2-61-12	R131-1, R131-2
A1	() 2	1 M Ω	2-96-12	R107-1, R107-2
1/4-Watt				

NOTE: The following resistors have a tolerance of 5% unless they are listed otherwise. 5% is indicated by a fourth color band of gold, while 10% is indicated by a silver band.

B1	() 2	33 Ω (orange-orange-black)	6-330-12	R112-1, R112-2
B1	() 2	68 Ω (blue-gray-black)	6-680-12	R127-1, R127-2



<u>KEY</u> <u>No.</u>	<u>QTY.</u>	<u>DESCRIPTION</u>	<u>HEATH</u> <u>Part No.</u>	<u>CIRCUIT</u> <u>Component No.</u>
1/2-Watt				
C1	() 22	10 Ω , 10% (brown-black-black)	6-100	R117-1, R117-2, R118-1, R118-2, R133-1, R133-2, R134-1, R134-2, R142-1, R142-2, R143-1, R143-2, R154-1, R154-2, R158-1, R158-2, R162-1, R162-2, R163-1, R163-2, R178, R187
C1	() 4	33 Ω , 10% (orange-orange-black)	6-330	R108-1, R108-2, R169, R171
C1	() 8	47 Ω (yellow-violet-black)	6-470	R115-1, R115-2, R116-1, R116-2, R159-1, R159-2, R161-1, R161-2
C1	() 2	68 Ω (blue-gray-black)	6-680	R160, R170
C1	() 6	100 Ω (brown-black-brown)	6-101	R136-1, R136-2, R141-1, R141-2, R175, R177
C1	() 4	180 Ω (brown-gray-brown)	6-181	R146-1, R146-2, R147-1, R147-2
C1	() 2	330 Ω (orange-orange-brown)	6-331	R123-1, R123-2
C1	() 2	360 Ω (orange-blue-brown)	6-361	R129-1, R129-2
C1	() 1	390 Ω (orange-white-brown)	6-391	R184
C1	() 2	470 Ω (yellow-violet-brown)	6-471	R165, R167
C1	() 2	560 Ω (green-blue-brown)	6-561	R111-1, R111-2
C1	() 1	620 Ω (blue-red-brown)	6-621	R166
C1	() 4	680 Ω (blue-gray-brown)	6-681	R119-1, R119-2, R179, R186
C1	() 4	820 Ω (gray-red-brown)	6-821	R137-1, R137-2, R139-1, R139-2
C1	() 3	1000 Ω (brown-black-red)	6-102	R135-1, R135-2, R182
C1	() 2	1200 Ω (brown-red-red)	6-122	R151-1, R151-2
C1	() 3	1500 Ω (brown-green-red)	6-152	R144-1, R144-2, R181
C1	() 4	1800 Ω (brown-gray-red)	6-182	R145-1, R145-2, R148-1, R148-2



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
1/2-Watt (cont'd.)				
C1	() 2	2000 Ω (red-black-red)	6-202	R153-1, R153-2
C1	() 1	2700 Ω (red-violet-red)	6-272	R183
C1	() 1	6800 Ω (blue-gray-red)	6-682	R172
C1	() 1	10 k Ω (brown-black-orange)	6-103	R185
C1	() 2	33 k Ω (orange-orange-orange)	6-333	R152-1, R152-2
C1	() 2	100 k Ω (brown-black-yellow)	6-104	R109-1, R109-2
C1	() 2	1 M Ω (brown-black-green)	6-105	R113-1, R113-2

1-Watt

D1	() 1	33 k Ω , 10% (orange-orange-orange)	1-27-1	R173
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2-Watt

D2	() 1	180 Ω , 10% (brown-gray-brown)	1-46-2	R168
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7-Watt

D3	() 2	1200 Ω wire-wound	3-36-7	R174, R176
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CONTROLS-SWITCHES

F1	() 2	100 Ω control	10-314	R124-1, R124-2
F1	() 4	500 Ω control	10-918	R164-1, R164-2, R149-1, R149-2
F2	() 2	2000 Ω (2k) control with switch	19-718	R138-1/SW102-1, R138-2/SW102-2
F3	() 2	11-position rotary switch with control	63-1231	SW101-1/R128-1, SW101-2/R128-2

CAPACITORS**Mica**

G1	() 2	90 pF	20-119	C119-1, C119-2
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Ceramic

G2	() 2	5 pF	21-157	C121-1, C121-2
G2	() 2	33 pF	1-155	C146-1, C146-2
G2	() 1	75 pF	21-86	C126
G2	() 2	270 pF	21-17	C125-1, C125-2
G2	() 2	680 pF	21-171	C106-1, C106-2
G2	() 2	2000 pF (.002)	21-36	C129, C132



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
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Transistors (cont'd.)

J1	() 2	36632 or 2N3053	417-100	Q111, Q112
J2	() 2	X29A829	417-201	Q104-1, Q104-2
J3	() 4	2N5771	417-292	Q105-1, Q105-2, Q106-1, Q106-2
J3	() 10	2N5770	417-293	Q109-1, Q109-2, Q110-1, Q110-2, Q115-1, Q115-2, Q116-1, Q116-2, Q117-1, Q117-2
J4	() 4	SF50077	417-854	D101-1, D101-2, D102-1, D102-2
J4	() 12	MPSA20	417-801	Q103-1, Q103-2, Q107-1, Q107-2, Q108-1, Q108-2, Q118-1, Q118-2, Q119-1, Q119-2, Q120, Q121
J5	() 4	E304	417-828	Q101-1, Q101-2, Q102-1, Q102-2
J6	() 2	MPSU10	417-834	Q113, Q114

HARDWARE

K1	() 2	4-40 x 1/4" screw	250-52
K2	() 4	#4 x 3/8" self-tapping screw	250-186
K3	() 2	4-40 nut	252-2
K4	() 2	1/4" nut	252-39
K5	() 2	#4 lockwasher	254-9
K6	() 2	1/4" flat washer	253-170

MISCELLANEOUS

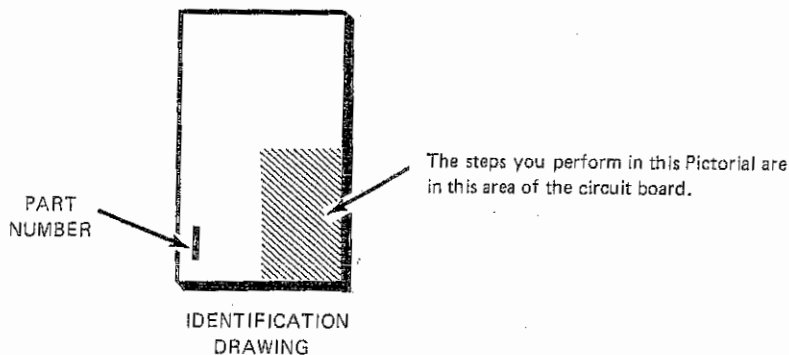
L1	() 2	4.65 μ H coil	45-39	L101, L102
L2	() 2	Control mounting bracket	204-2140	
L3	() 1	Vertical input shield	206-1183	
L4	() 2	Small heat sink	215-45	
L5	() 2	Large heat sink	215-65	
L6	() 13	Socket pin (one extra pin supplied)	432-134	
L7	() 2	Ferrite bead	475-16	

PART FROM FINAL PACK

() 1	Vertical circuit board	85-1989-2
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STEP-BY-STEP ASSEMBLY



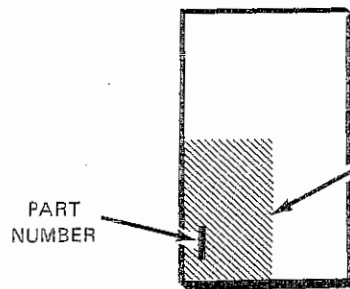
START

- () Position the circuit board as shown in the identification drawing.
- () R123-1: 330 Ω (orange-orange-brown).
- () R125-1: 1000 Ω (1k), 1%.
- () R133-1: 10 Ω (brown-black-black).
- () R122-1: 1000 Ω (1k), 1%.
- () R117-1: 10 Ω (brown-black-black).
- () R113-1: 1 M Ω (brown-black-green).
- () R116-1: 47 Ω (yellow-violet-black).
- () R115-1: 47 Ω (yellow-violet-black).
- () R112-1: 33 Ω , 1/4-watt (orange-orange-black).
- () R109-1: 100 k Ω (brown-black-yellow).
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R106-1: 111 k Ω , 1%.
- () R105-1: 900 k Ω , 1%.
- () R104-1: 10.1 k Ω , 1%.
- () R103-1: 990 k Ω , 1%.
- () Solder all leads to the foil and cut off the excess lead lengths.

CONTINUE

- () R134-1: 10 Ω (brown-black-black).
- () R132-1: 523 Ω , 1%.
- () R131-1: 2.05 k Ω (2050), 1%.
- () R126-1: 900 Ω , 1%.
- () R121-1: 900 Ω , 1%.
- () R119-1: 680 Ω (blue-gray-brown).
- () R127-1: 68 Ω , 1/4-watt (blue-gray-black).
- () R118-1: 10 Ω (brown-black-black).
- () R129-1: 360 Ω (orange-blue-brown).
- () R111-1: 560 Ω (green-blue-brown).
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R108-1: 33 Ω (orange-orange-black).
- () R107-1: 1 M Ω , 1%.
- () R102-1: 1000 Ω (1k), 1%.
- () R101-1: 999 k Ω , 1%.
- () Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-1



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

IDENTIFICATION
DRAWING

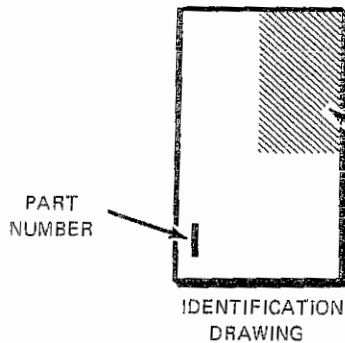
START

- () R139-2: 820 Ω (gray-red-brown).
- () R137-2: 820 Ω (gray-red-brown).
- () R141-2: 100 Ω (brown-black-brown).
- () R136-2: 100 Ω (brown-black-brown).
- () R123-2: 330 Ω (orange-orange-brown).
- () R125-2: 1000 Ω (1k), 1%.
- () R133-2: 10 Ω (brown-black-black).
- () R122-2: 1000 Ω (1k), 1%.
- () R117-2: 10 Ω (brown-black-black).
- () Solder all leads to the foil and cut off the excess lead lengths.
- () R113-2: 1 M Ω (brown-black-green).
- () R115-2: 47 Ω (yellow-violet-black).
- () R116-2: 47 Ω (yellow-violet-black).
- () R112-2: 33 Ω , 1/4-watt (orange-orange-black).
- () R109-2: 100 k Ω (brown-black-yellow).
- () R106-2: 111 k Ω , 1%.
- () R105-2: 900 k Ω , 1%.
- () R104-2: 10.1 k Ω , 1%.
- () R103-2: 990 k Ω , 1%.
- () Solder all leads to the foil and cut off the excess lead lengths.

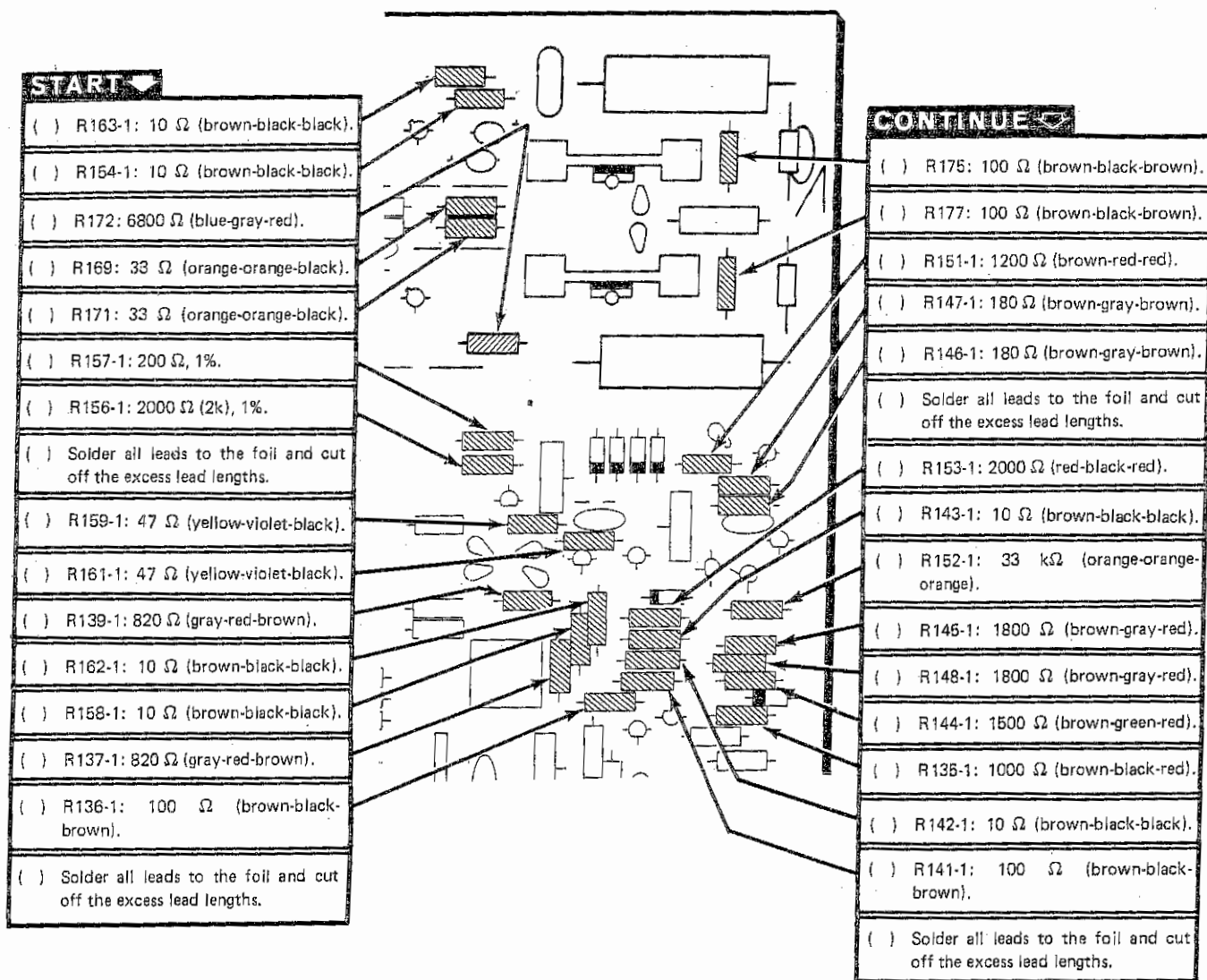
CONTINUE

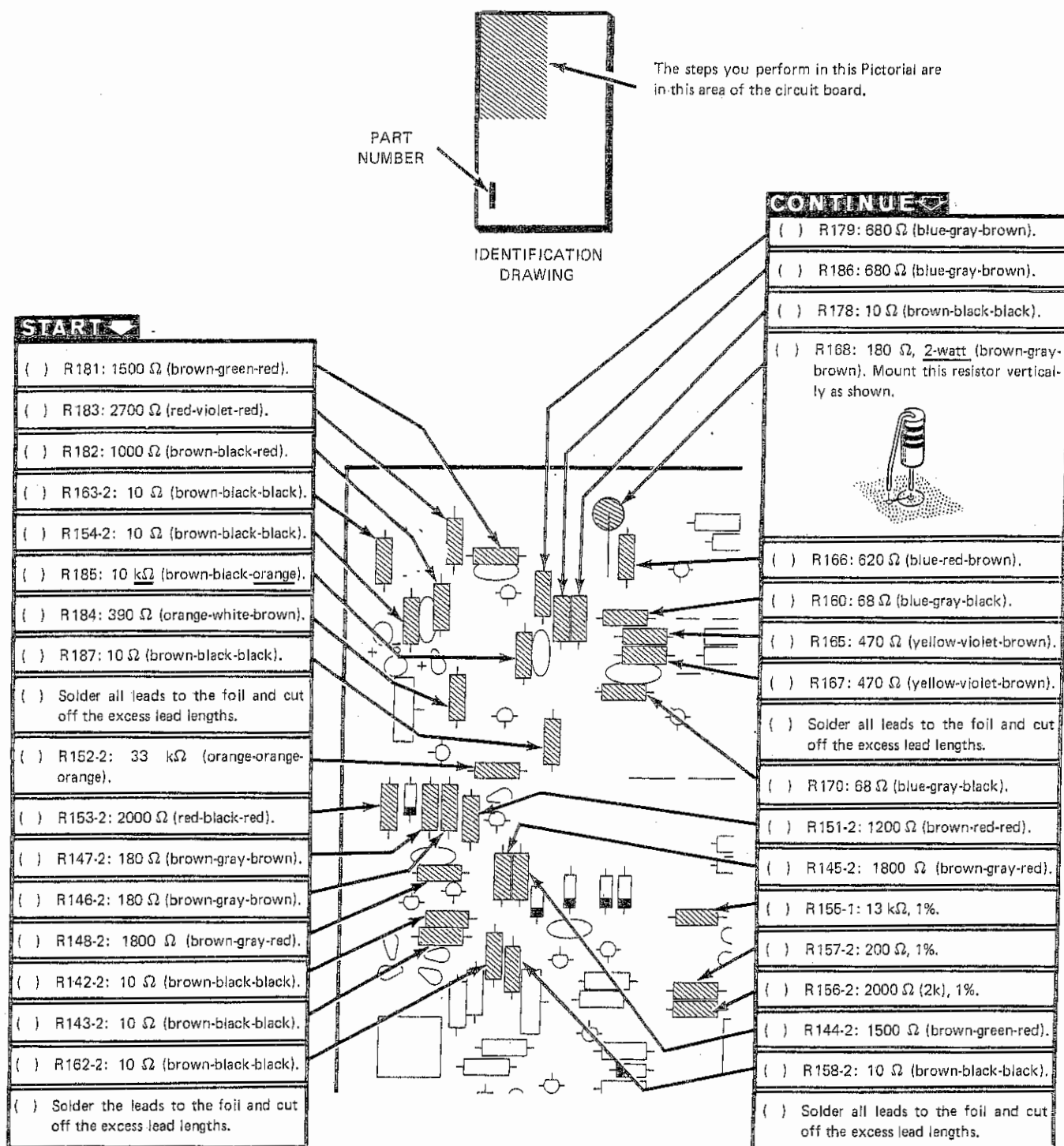
- () R159-2: 47 Ω (yellow-violet-black).
- () R161-2: 47 Ω (yellow-violet-black).
- () R155-2: 13 k Ω , 1%.
- () R135-2: 1000 Ω (brown-black-red).
- () R134-2: 10 Ω (brown-black-black).
- () R132-2: 523 Ω , 1%.
- () R131-2: 2.05 k Ω (2050), 1%.
- () R126-2: 900 Ω , 1%.
- () R121-2: 900 Ω , 1%.
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R119-2: 680 Ω (blue-gray-brown).
- () R118-2: 10 Ω (brown-black-black).
- () R127-2: 68 Ω , 1/4-watt (blue-gray-black).
- () R129-2: 360 Ω (orange-blue-brown).
- () R111-2: 560 Ω (green-blue-brown).
- () R107-2: 1 M Ω , 1%.
- () R102-2: 1000 Ω (1k), 1%.
- () R101-2: 999 k Ω , 1%.
- () R108-2: 33 Ω (orange-orange-black).
- () Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-2



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





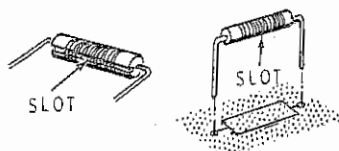
PICTORIAL 3-4

NOTE: The remaining resistors will be installed later.

START

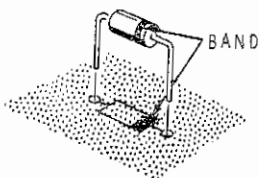
() Reposition the circuit board as shown in the identification drawing.

() L102: 4.65 μ H coil (45-39). Bend the leads toward the slots.



() L101: 4.65 μ H coil (45-39). Bend the leads toward the slots.

NOTE: When you install a diode, always match the band or bands on the diode with the band mark on the circuit board.



() D108-1: 1N4149 diode (#56-56).

() D110-1: 1N4149 diode (#56-56).

() D109-1: 1N4149 diode (#56-56).

() D107-1: 1N4149 diode (#56-56).

() 1" bare wire.

() 1-1/4" bare wire.

() 1-1/4" bare wire.

() 1-1/2" bare wire.

() D108-2: 1N4149 diode (#56-56).

() D110-2: 1N4149 diode (#56-56).

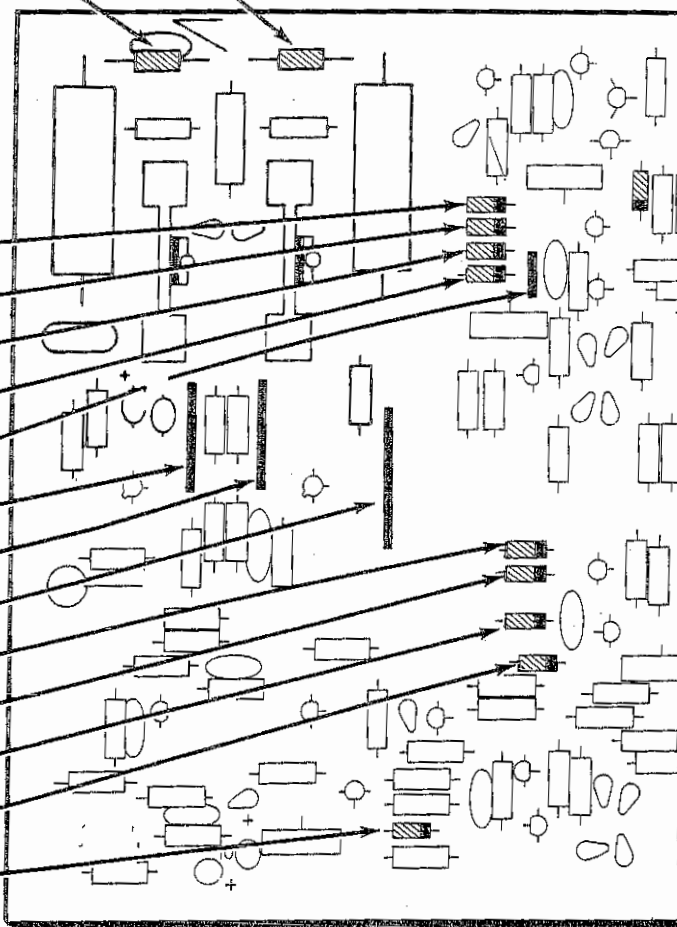
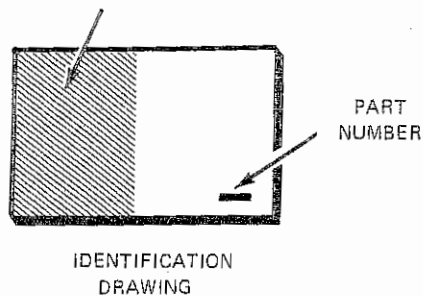
() D107-2: 1N4149 diode (#56-56).

() D109-2: 1N4149 diode (#56-56).

() D106-2: 1N4149 diode (#56-56).

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

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

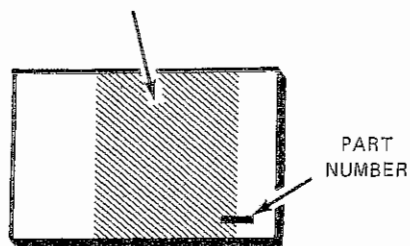


PICTORIAL 3-5





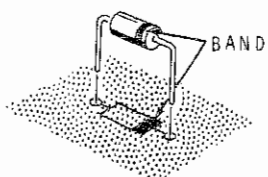
The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION
DRAWING

START

NOTE: When you install a diode, always match the band or bands on the diode with the band mark on the circuit board.



() ZD105-1: DO-7 zener diode (#56-50).

() 1" bare wire.

() D106-1: 1N4149 diode (#56-56).

() 1" bare wire.

() 1" bare wire.

() D103-1: 1N4149 diode (#56-56).

() D104-1: 1N4149 diode (#56-56).

() ZD105-2: DO-7 zener diode (#56-50).

() 1" bare wire.

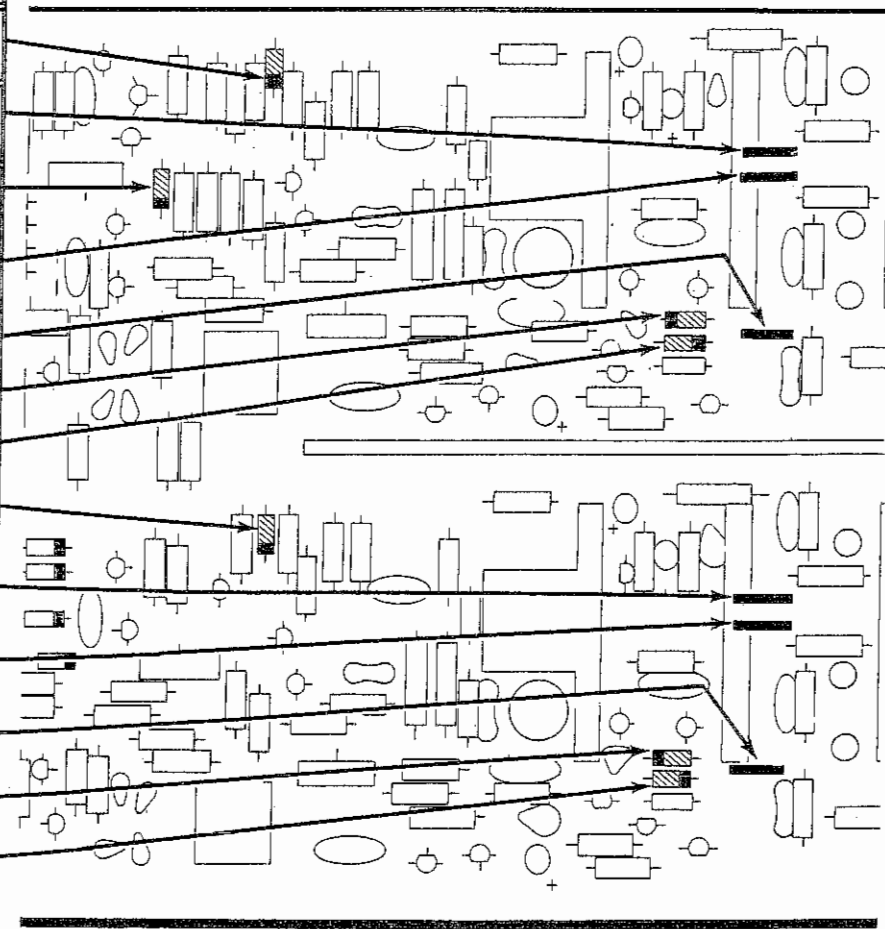
() 1" bare wire.

() 1" bare wire.

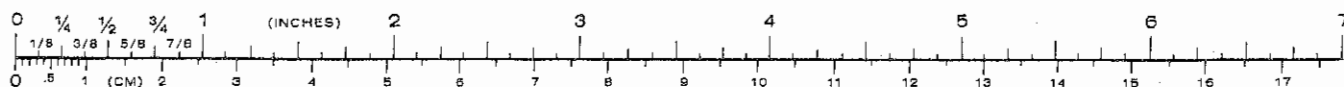
() D103-2: 1N4149 diode (#56-56).

() D104-2: 1N4149 diode (#56-56).

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



PICTORIAL 3-6

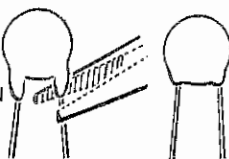


START

() Reposition the circuit board as shown in the identification drawing.

NOTE: Before you install ceramic capacitors, use long-nose pliers to remove the excess insulation from the capacitor leads.

REMOVE
INSULATION
ON LEADS



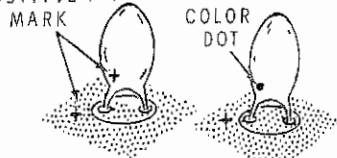
() C117-1: .01 μ F ceramic.

() C119-1: 90 pF mica. (The circuit board may be marked 62.)

() C113-1: .01 μ F ceramic.

NOTE: When you install a tantalum capacitor, always match the positive (+) or dot marked side of the capacitor with the positive (+) mark on the circuit board.

POSITIVE (+)
MARK



() C116-1: 10 μ F tantalum.

() C112-1: .01 μ F ceramic.

() C106-1: 680 pF ceramic.

() C109-1: 50 pF ceramic (violet-green-black-black-green).

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

() NOTE: Solder each of the following trimmer capacitors to the foil as you install it.

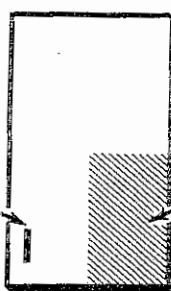


() C107-1: 3.2-18 pF trimmer (blue dot).

() C108-1: 3.2-18 pF trimmer (blue dot).

() C105-1: 3.2-18 pF trimmer (blue dot).

PART
NUMBER



IDENTIFICATION
DRAWING

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

CONTINUE

() C122-1: 25 pF ceramic (violet-red-green-black-green).

() C121-1: 5 pF ceramic.

() C118-1: 15-60 pF trimmer.

() C114-1: 10 μ F tantalum.

() C115-1: 10 μ F tantalum.

() C104-1: 3.2-18 pF trimmer (blue dot).

() C103-1: .005 μ F ceramic.

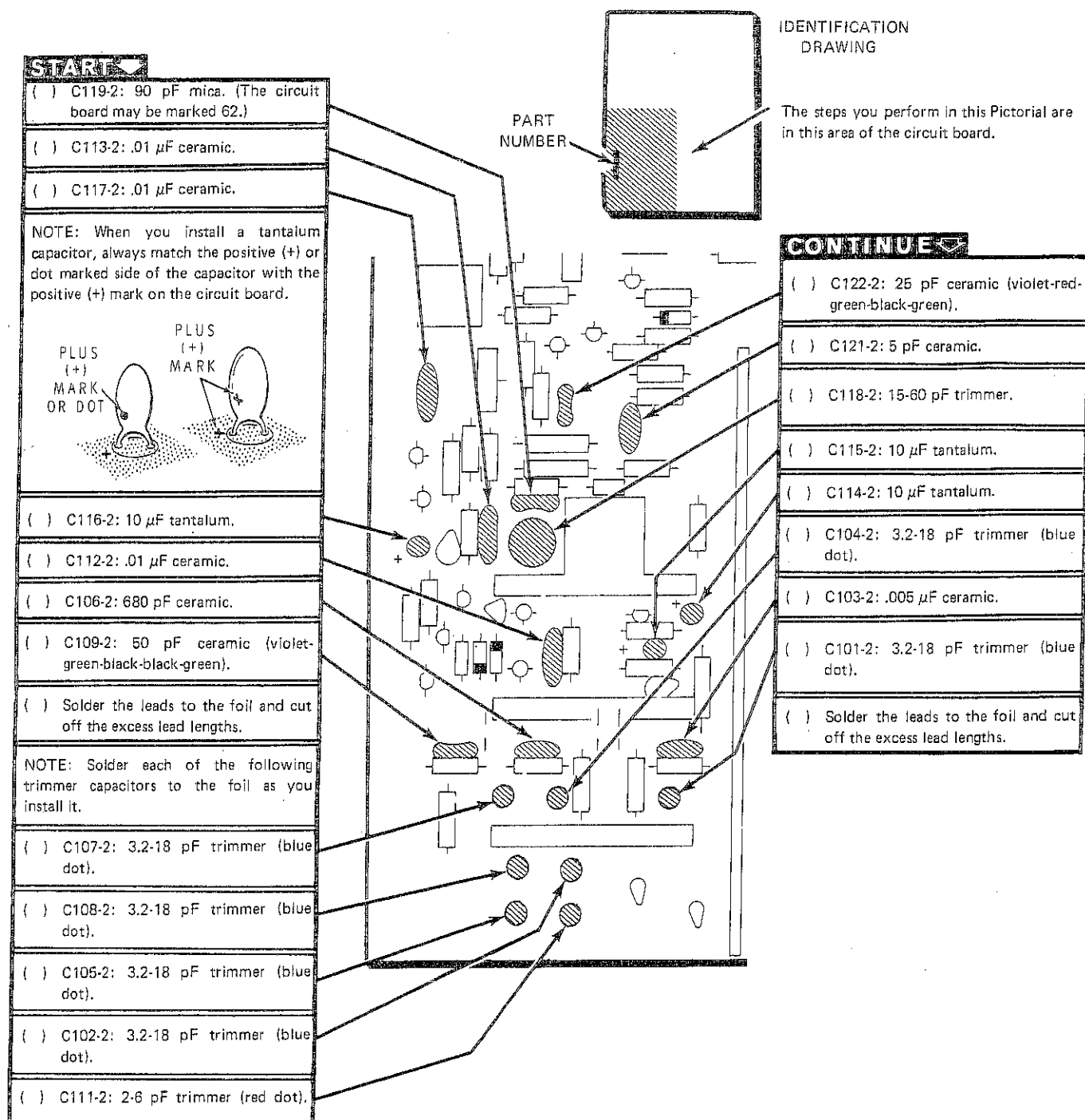
() C101-1: 3.2-18 pF trimmer (blue dot).

() C102-1: 3.2-18 pF trimmer (blue dot).

() C111-1: 2-6 pF trimmer (red dot).

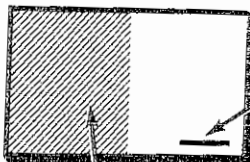
() Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-7



PICTORIAL 3-8

IDENTIFICATION
DRAWING



PART
NUMBER

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

START

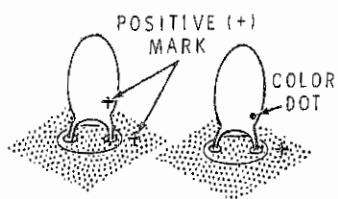
() Reposition the circuit board as
shown in the identification drawing.

() C146-1: 33 pF ceramic.

() C128: .01 μ F ceramic.

() C125-1: 270 pF ceramic.

() C127: .1 μ F Mylar.



() C124-1: 10 μ F tantalum.

() C123-1: 10 μ F tantalum.

() C125-2: 270 pF ceramic.

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

() C126: 75 pF ceramic.

() C131: .001 μ F ceramic.

() C146-2: 33 pF ceramic.

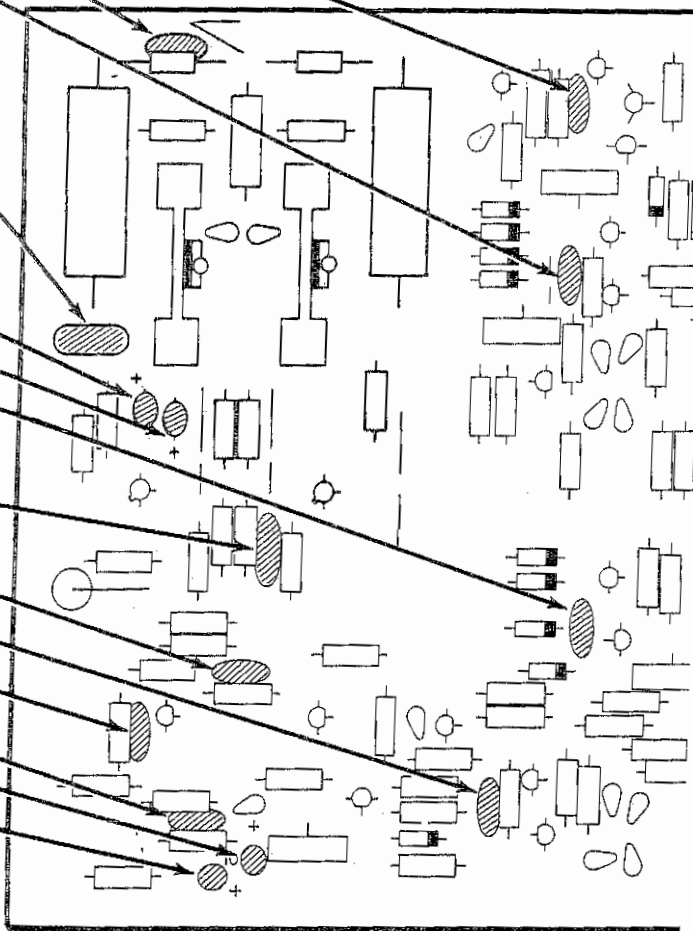
() C129: .002 μ F ceramic.

() C132: .002 μ F ceramic.

() C123-2: 10 μ F tantalum.

() C124-2: 10 μ F tantalum.

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

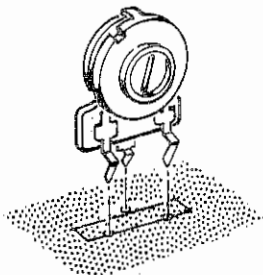


PICTORIAL 3-9

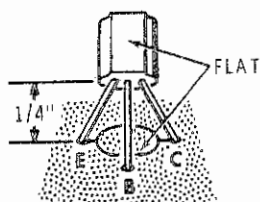
**START**

() Reposition the circuit board as shown in the identification drawing.

() R124-1: 100 Ω control (#10-314). Solder the lugs to the foil.



NOTE: Install the next transistors as shown. Line up the flat on the transistor with the flat on the circuit board. Solder each transistor as it is installed and cut off the excess lead lengths.

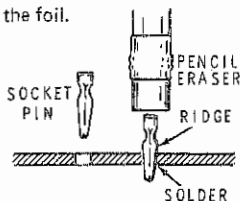


() Q106-1: 2N5771 transistor (#417-292).

() Q105-1: 2N5771 transistor (#417-292).

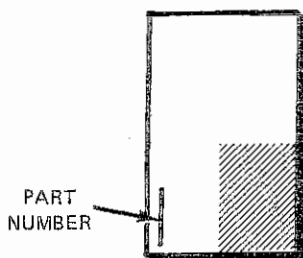
() Q103-1: MPSA20 transistor (#417-801).

NOTE: To install a socket pin, insert it until the ridge is against the board. Use a pencil eraser to press the pin into the hole. Make sure the pin is straight; then solder the pin to the foil.



() Install three socket pins at Q102-1.

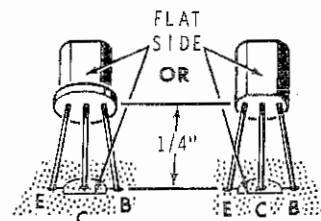
() Install three socket pins at Q101-1.

**IDENTIFICATION
DRAWING**

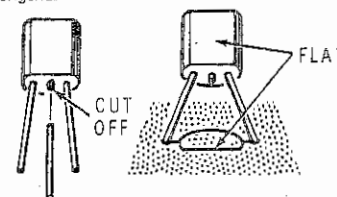
The steps you perform in this Pictorial are in this area of the circuit board.

CONTINUE

() Q104-1: X29A829 transistor (#417-201).



NOTE: In the next two steps, carefully cut off the center lead of the diode as shown. Line up the flat on the diode with the flat on the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

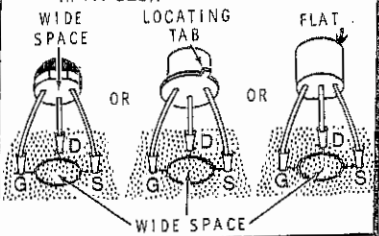


() D101-1: SF50077 diode (#417-854).

() D102-1: SF50077 diode (#417-854).

() Locate two E304 transistors (#417-828). Cut their leads 1/2" from the body. NOTE: When you install them in the next two steps, do not solder the leads.

() Q102-1: E304 transistor (#417-828).



() Q101-1: E304 transistor (#417-828).

PICTORIAL 3-10

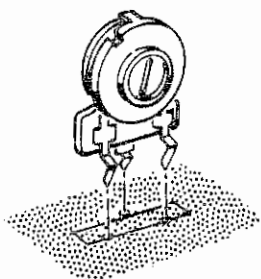
IDENTIFICATION
DRAWING

PART
NUMBER

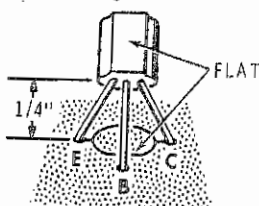
The steps you perform in this Pictorial are
in this area of the circuit board.

START

- () R124-2: 100 Ω control (#10-314).
Solder the lugs to the foil.



NOTE: Install the next transistors as
shown. Line up the flat on the transistor
with the flat on the circuit board. Solder
each transistor as it is installed and cut off
the excess lead lengths.

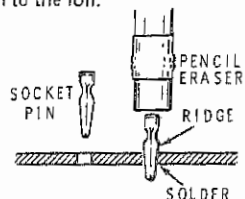


- () Q106-2: 2N5771 transistor
(#417-292).

- () Q105-2: 2N5771 transistor
(#417-292).

- () Q103-2: MPSA20 transistor
(#417-801).

NOTE: To install a socket pin, insert it
until the ridge is against the board. Use a
pencil eraser to press the pin into the hole.
Make sure the pin is straight; then solder
the pin to the foil.

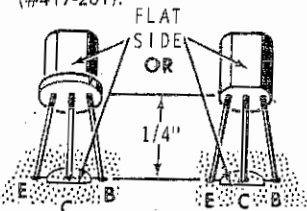


- () Install three socket pins at Q102-2.

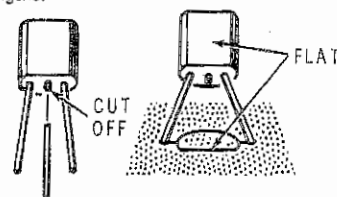
- () Install three socket pins at Q101-2.

CONTINUE

- () Q104-2: X29A829 transistor
(#417-201).



NOTE: In the next two steps, carefully
cut off the center lead of the diode as
shown. Line up the flat on the diode with
the flat on the circuit board. Solder the
leads to the foil and cut off the excess lead
lengths.

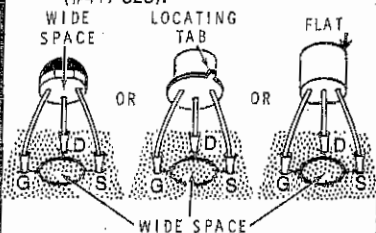


- () D101-2: SF50077 diode
(#417-854).

- () D102-2: SF50077 diode
(#417-854).

- () Locate two E304 transistors
(#417-828). Cut their leads 1/2"
from the body. NOTE: When you
install them in the next two steps,
do not solder the leads.

- () Q102-2: E304 transistor
(#417-828).

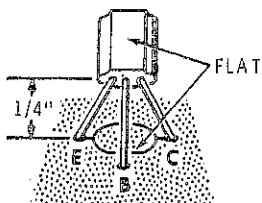


- () Q101-2: E304 transistor
(#417-828).

PICTORIAL 3-11

**START**

NOTE: Install the following transistors as shown.

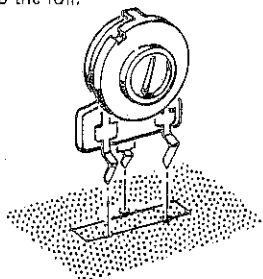


() Q120: MPSA20 transistor (#417-801).

() Q121: MPSA20 transistor (#417-801).

() Q118-2: MPSA20 transistor (#417-801).

NOTE: As you install a control, solder the leads to the foil.



() R149-2: 500 Ω control (#10-918).

() Q117-2: 2N5770 transistor (#417-293).

() Q115-2: 2N5770 transistor (#417-293).

() Q116-2: 2N5770 transistor (#417-293).

() Q110-2: 2N5770 transistor (#417-293).

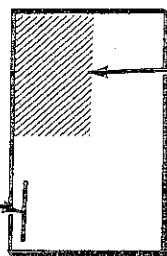
() Q109-2: 2N5770 transistor (#417-293).

() R164-2: 500 Ω control (#10-918).

() Q119-2: MPSA20 transistor (#417-801).

() Q108-2: MPSA20 transistor (#417-801).

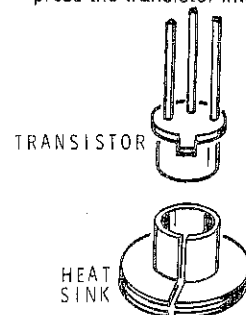
() Q107-2: MPSA20 transistor (#417-801).

IDENTIFICATION
DRAWINGPART
NUMBER

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

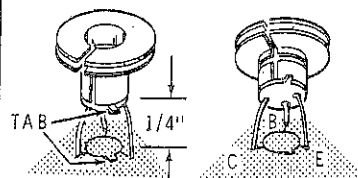
CONTINUE

() Install a small heat sink onto a 36632 or 2N3053 transistor (#417-100). Place the heat sink on your work area as shown, and press the transistor into it.



() In the same manner, press the other 36632 or 2N3053 transistor into the other small heat sink.

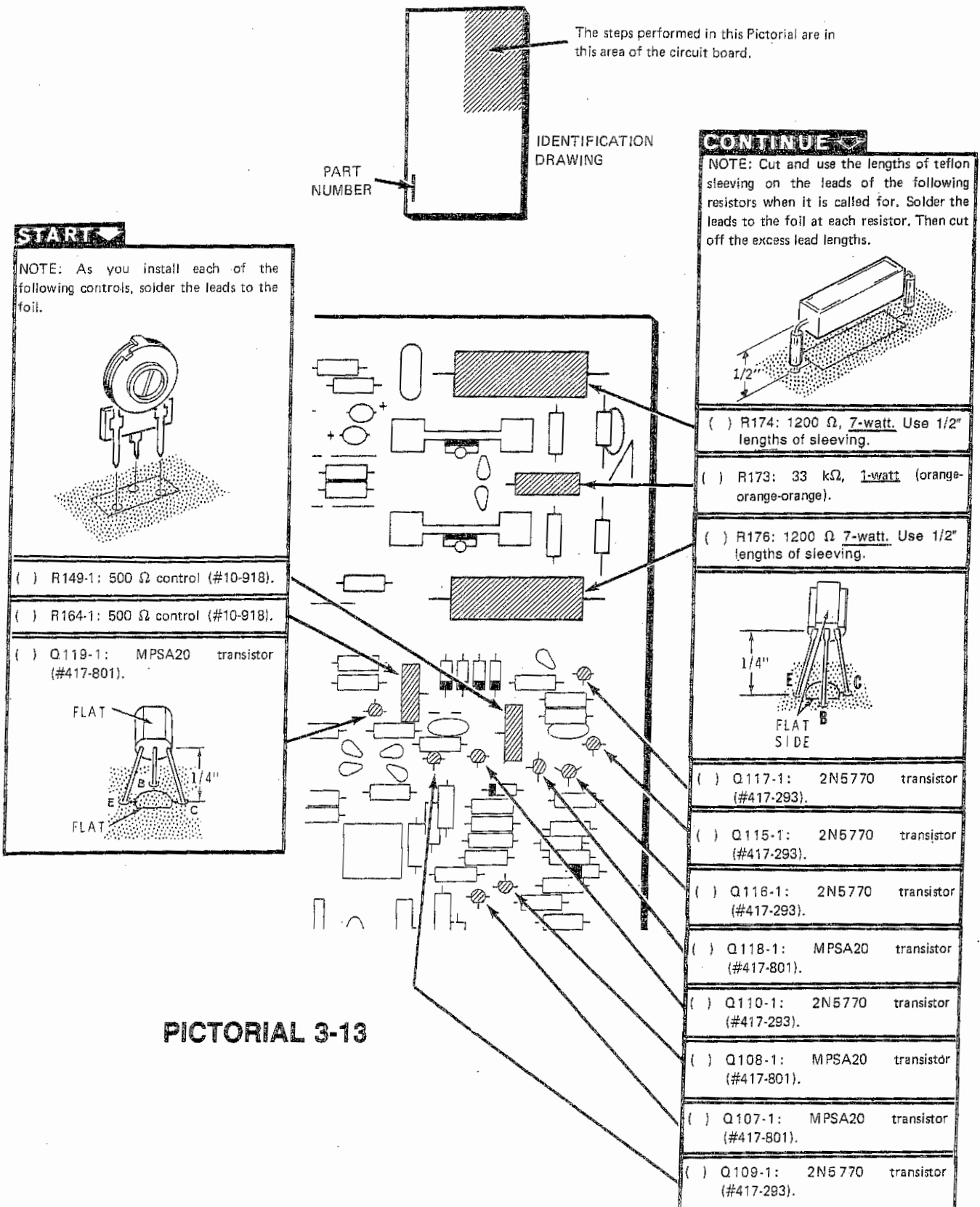
NOTE: Install each of the following transistors in the manner shown. First line up the locating tab on the transistor with the outline of the locating tab on the circuit board. Then insert the transistor leads into their correct holes which are indicated by C, B, and E. Solder each lead to the foil and cut off the excess lead length.



() Q112: 36632 or 2N3053 transistor (#417-100).

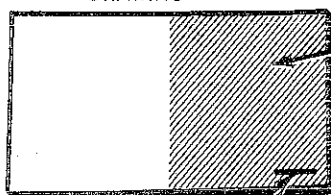
() Q111: 36632 or 2N3053 transistor (#417-100).

PICTORIAL 3-12





IDENTIFICATION DRAWING



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

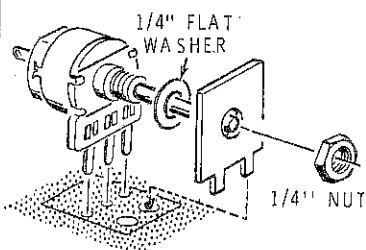
PART
NUMBER

START

() Reposition the circuit board as shown in the identification drawing.

() R138-1/SW-102-1:

1. Mount a 2000 Ω (2k) control (#19-718) to a control mounting bracket as shown. Use a 1/4" flat washer and nut. Be sure the bracket lugs are parallel with the control lugs.
2. Install the assembly and solder the lugs to the foil. Be sure the control shaft is parallel with the circuit board.

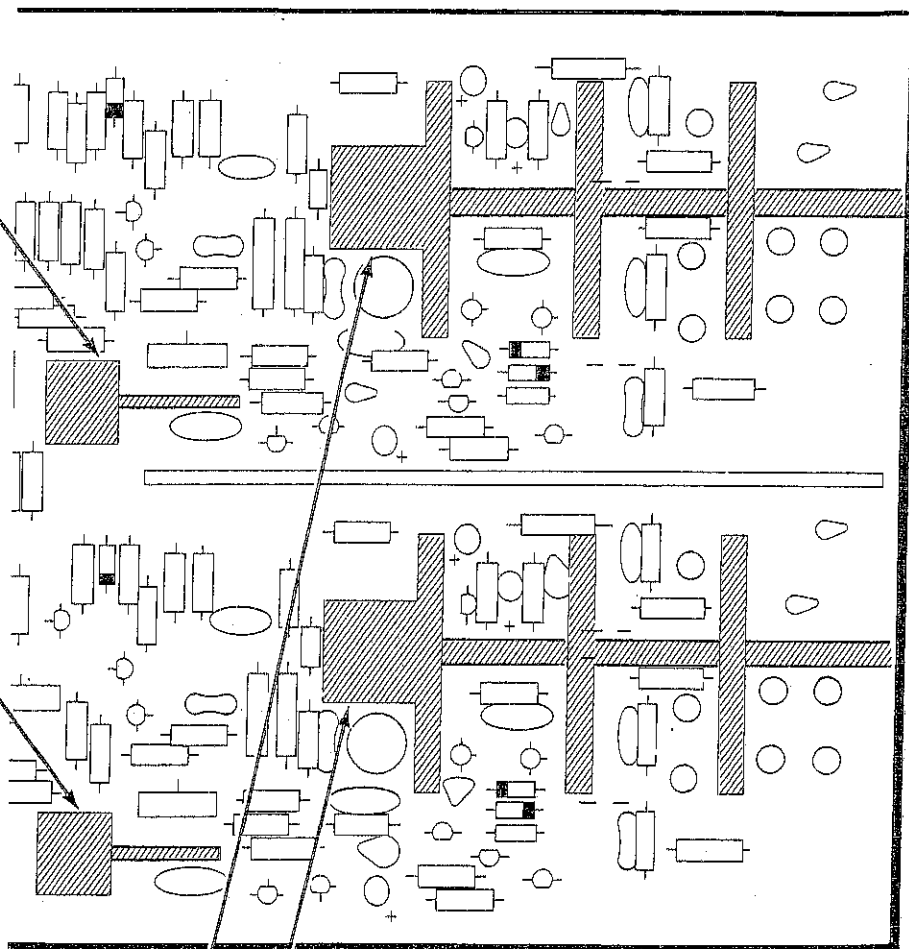


() R138-2/SW102-2: In the same manner, assemble and install the other 2000 Ω (2k) control (#19-718) and control mounting bracket.

NOTE: In the next two steps you will install switches. Be sure the bare circuit board wires at these switch locations are down flat on the circuit board and do not keep the switches from being mounted all the way down onto the circuit board.

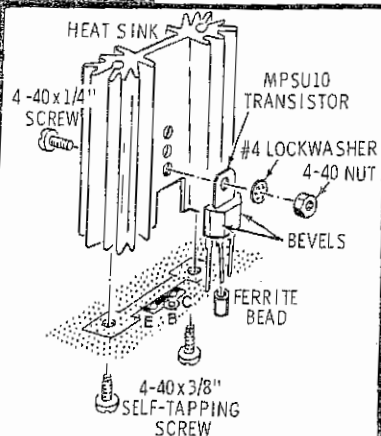
() SW101-1: 11-position rotary switch. Make sure the lugs on each wafer are straight. Install the lugs, one wafer at a time, into the circuit board. Be sure the switch is down onto the circuit board as far as it will go. Then solder one lug of each switch wafer to the foil. Check the switch to be sure it is properly seated. Then solder the remaining lugs.

() SW101-2: In the same manner, install the other 11-position rotary switch.



PICTORIAL 3-14

START



() Q114: Assemble and mount a transistor heat sink assembly as follows:

1. Loosely mount an MPSU10 transistor (#417-834) on a large heat sink with a 4-40 x 1/4" screw, a #4 lockwasher, and a 4-40 nut as shown. Be sure the bevels of the transistor are positioned as shown.
2. Slide a ferrite bead over the center transistor lead.
3. Mount the transistor heat sink assembly onto the circuit board at Q114 with two 4-40 x 3/8" self-tapping screws.
4. Solder the transistor leads to the foil and cut off the excess lead lengths.
5. Tighten the transistor heat sink screw.

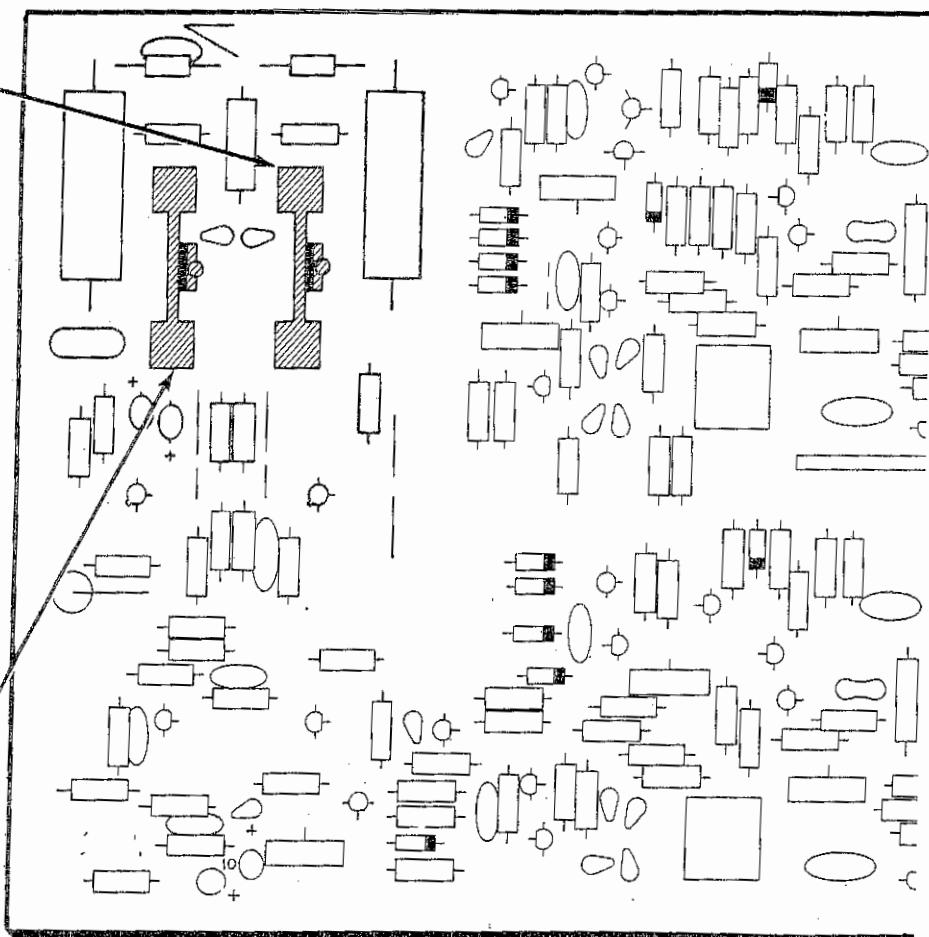
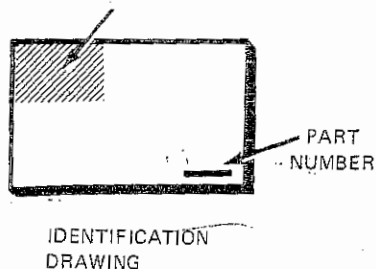
() Q113: In the same manner, assemble and mount another transistor heat sink assembly.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

- () Unsoldered connections.
- () "Cold" solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.
- () Transistors for proper type and installation.
- () Capacitors for the correct position of the positive lead.
- () Diodes for the correct position of the banded end.

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

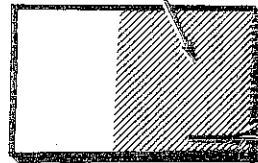


PICTORIAL 3-15

**START****NOTES:**

1. In the following steps you will connect wires to switch lugs. (NS) means not to solder because other wires will be added later. "S-" with a number, such as (S-3), means to solder the connection. The number following "S" tells how many wires are at the connection.
2. When you install a wire in the circuit board, solder it to the foil.

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



PART
NUMBER

IDENTIFICATION
DRAWING

() 2-1/2" smaller black wire at hole R.

() 1-3/4" smaller orange wire at wafer 1 lug 1 (S-1).

() 1-1/4" bare wire from hole T to wafer 2 lug 1 (S-1).

() 1-1/2" bare wire from wafer 1 lug 2 (NS) to wafer 2 lug 2 (S-1).

() 1-3/4" white wire from hole S to wafer 1 lug 2 (S-2).

() 3-1/2" white-black wire at hole U.

() 4-1/2" white-gray wire at hole X.

() 1" bare wire from hole B to switch SW102-1 lug 1 (S-1).

() 1" bare wire from hole D to switch SW102-1 lug 2 (S-1).

() 2-1/2" smaller black wire at hole Y.

() 1-3/4" smaller orange wire at wafer 1 lug 1 (S-1).

() 1-1/4" bare wire from hole AA to wafer 2 lug 1 (S-1).

() 1-1/2" bare wire from wafer 1 lug 2 (NS) to wafer 2 lug 2 (S-1).

() 1-3/4" white wire from hole Z to wafer 1 lug 2 (S-2).

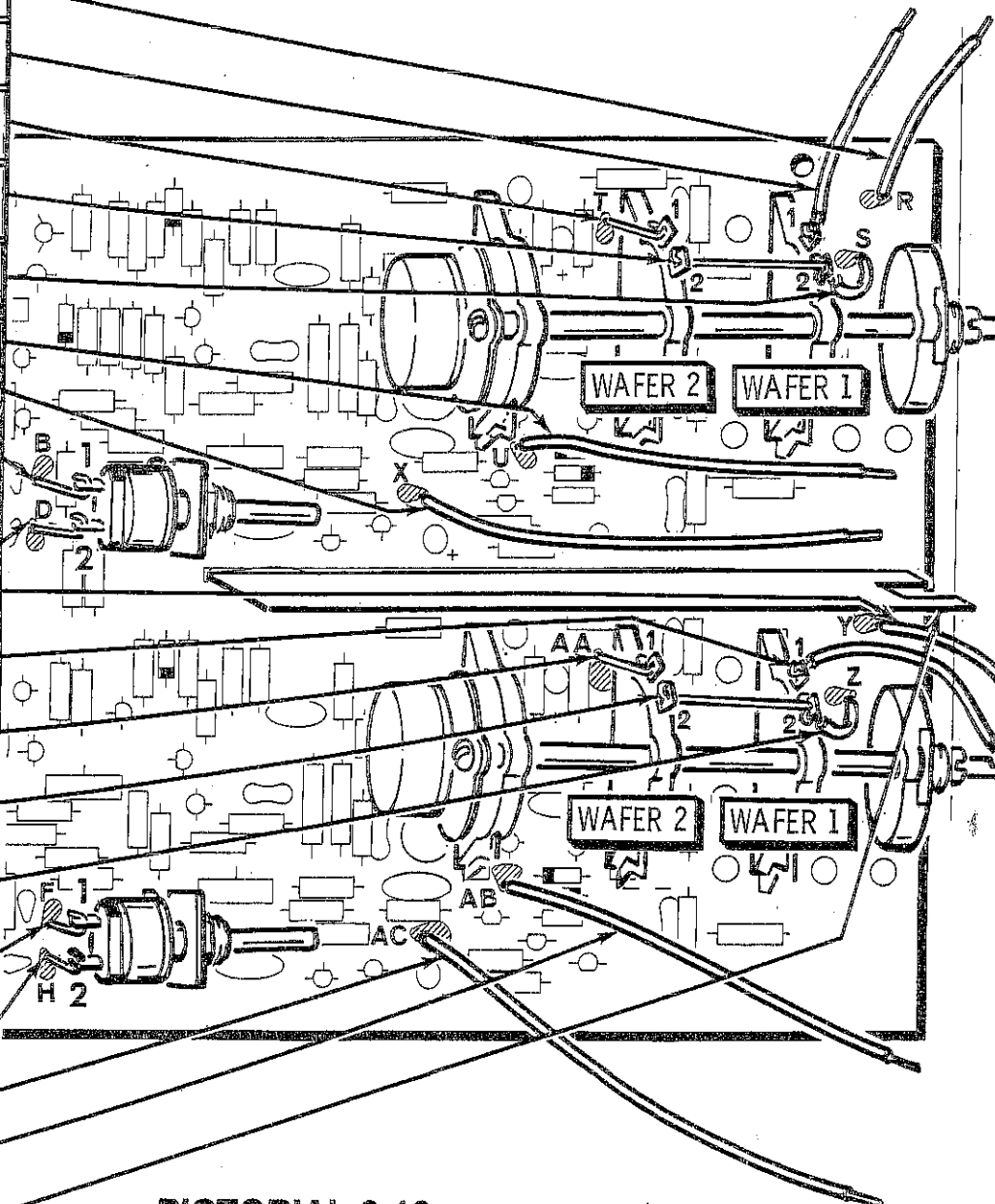
() 1" bare wire from hole F to SW102-2 lug 1 (S-1).

() 1" bare wire from hole H to SW102-2 lug 2 (S-1).

() 4-1/4" white-gray wire at hole AC.

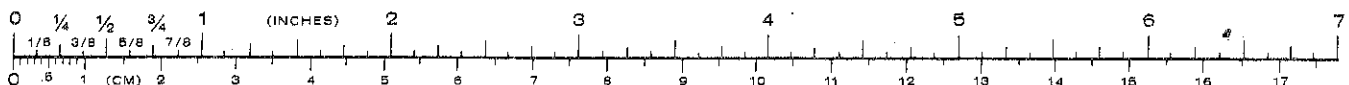
() 3-1/2" white-black wire at hole AB.

() Vertical input shield. Position the notched end as shown and solder the tabs to the foil. Keep the shield perpendicular to the circuit board.



PICTORIAL 3-16

Set the circuit board aside temporarily.





HORIZONTAL CIRCUIT BOARD

PARTS LIST

Unpack the pack marked #4 and check each part against the following list. Make a check (✓) in the space provided as you identify each part.

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

KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
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RESISTORS

1/2-Watt, 1%

A1	() 1	200 Ω	2-83	R238
A1	() 1	1000 Ω (1k)	2-58	R237
A1	() 1	1800 Ω (1.8k)	2-232	R236
A1	() 1	20 k Ω	2-38	R246
A1	() 1	30 k Ω	2-201	R245
A1	() 1	50 k Ω	2-99	R244
A1	() 1	100 k Ω	2-11	R243
A1	() 1	300 k Ω	2-204	R242
A1	() 1	500 k Ω	2-76	R241
A1	() 1	1 M Ω	2-14	R239

1/4-Watt

NOTE: The following resistors have a tolerance of 5% unless they are listed otherwise. 5% is indicated by a fourth color band of gold, while 10% is indicated by a silver band.

B1	() 2	150 Ω (brown-green-brown)	6-151-12	R203, R205
B1	() 1	100 k Ω (brown-black-yellow)	6-104-12	R202
B1	() 1	1 M Ω (brown-black-green)	6-105-12	R204



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
1/2-Watt				
C1	() 1	2.7 Ω (red-violet-gold)	6-279	R271
C1	() 3	10 Ω (brown-black-black)	6-100	R212, R284, R285
C1	() 1	22 Ω (red-red-black)	6-220	R207
C1	() 1	51 Ω (green-brown-black)	6-510	R208
C1	() 2	100 Ω (brown-black-brown)	6-101	R249, R269
C1	() 6	180 Ω (brown-gray-brown)	6-181	R223, R274, R275, R281, R282, R283
C1	() 1	200 Ω (red-black-brown)	6-201	R257
C1	() 5	220 Ω (red-red-brown)	6-221	R232, R233, R256, R261, R276
C1	() 5	270 Ω (red-violet-brown)	6-271	R214, R215, R225, R226, R227
C1	() 2	330 Ω (orange-orange-brown)	6-331	R247, R264
C1	() 1	390 Ω (orange-white-brown)	6-391	R229
C1	() 1	510 Ω (green-brown-brown)	6-511	R270
C1	() 2	680 Ω (blue-gray-brown)	6-681	R267, R273
C1	() 9	1000 Ω (brown-black-red)	6-102	R206, R216, R218, R222, R224, R231, R234, R259, R262
C1	() 1	1100 Ω (brown-brown-red)	6-112	R278
C1	() 1	1200 Ω (brown-red-red)	6-122	R235
C1	() 2	1500 Ω (brown-green-red)	6-152	R266, R277
C1	() 1	2200 Ω (red-red-red)	6-222	R291
C1	() 3	3900 Ω (orange-white-red)	6-392	R219, R251, R254
C1	() 1	4700 Ω (yellow-violet-red)	6-472	R221
C1	() 2	6800 Ω (blue-gray-red)	6-682	R209, R211
C1	() 2	8200 Ω (gray-red-red)	6-822	R279, R280
C1	() 1	10 k Ω (brown-black-orange)	6-103	R289
C1	() 1	39 k Ω (orange-white-orange)	6-393	R228
C1	() 1	47 k Ω (yellow-violet-orange)	6-473	R217



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
C1	() 1	100 k Ω (brown-black-yellow)	6-104	R288
C1	() 1	1 M Ω (brown-black-green)	6-105	R201

1-Watt

D1	() 1	68 k Ω , 10% (blue-gray-orange)	1-8-1	R252
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7-Watt

E1	() 2	4700 Ω (4.7k), wire-wound	3-21-7	R286, R287
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CONTROLS-SWITCHES

F1	() 1	100 Ω control	10-314	R272
F1	() 1	500 Ω control	10-918	R268
F1	() 2	1000 Ω (1k) control	10-936	R248, R258
F1	() 1	5000 Ω (5k) control	10-904	R255
F2	() 1	10 k Ω control with switch	19-717	R253/SW205
F3	() 1	21-position rotary switch	63-1232	SW203
F4	() 1	8-position rotary switch	63-1233	SW201/R213/ SW204
F5	() 1	3-position rotary switch	63-1234	SW202/R263A/ R263B

CAPACITORS**Mica**

G1	() 1	100 pF	20-102	C201
G1	() 1	150 pF	20-103	C228
G1	() 1	290 pF	20-121	C224

Ceramic

G2	() 1	56 pF	21-85	C223
G2	() 1	100 pF	21-172	C222
G2	() 2	200 pF	21-21	C211, C233
G2	() 1	.001 μ F	21-163	C221
G2	() 1	.0033 μ F	21-141	C215
G2	() 2	.005 μ F	21-27	C213, C214
G2	() 3	.01 μ F	21-16	C202, C203, C207
G2	() 1	.02 μ F	21-82	C219
G2	() 2	.1 μ F	21-95	C218, C235
G2	() 2	.2 μ F	21-99	C236, C237



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
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Electrolytic

G3	() 1	5 μ F	25-125	C227
G4	() 1	6 μ F nonpolarized	25-165	C206
G5	() 2	10 μ F	25-54	C212, C234
G6	() 2	100 μ F	25-117	C204, C205

Tantalum

G7	() 1	2.2 μ F, 15V	25-195	C217
G8	() 2	2.2 μ F, 20V	25-221	C225, C226
G8	() 1	22 μ F	25-212	C216

Polystyrene

G9	() 1	.02 μ F	29-40	C231
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Mylar

G10	() 2	.1 μ F	27-47	C208, C209
G11	() 1	2 μ F	27-168	C232

Trimmer

G12	() 1	8-50 pF	31-36	C229
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DIODES-TRANSISTORS-INTEGRATED CIRCUITS

H1	() 4	1N751 zener diode (violet-green-brown)	56-16	ZD210, ZD211, ZD203, ZD204
H1	() 2	PS18775 zener diode	56-31	ZD214, ZD217
H1	() 6	1N4149 diode	56-56	D205, D206, D207, D208, D215, D216 ZD209
H1	() 1	1N750A zener diode	56-59	

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways. (On integrated circuits, the description may have letters other than those given in the list. Example: SN7400N or MC7400P.)

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

H2	() 2	2N2369 transistor	417-154	Q203, Q206
H2	() 2	SE6020 transistor	417-237	Q212, Q213
H3	() 4	2N3393 transistor	417-118	ZD201, ZD202, ZD212, ZD213
H3	() 1	X29A829 transistor	417-201	Q208
H4	() 3	2N4121 transistor	417-235	Q210, Q211, Q216
H4	() 1	MPSA20 transistor	417-801	Q207
H5	() 1	2N5770 transistor	417-293	Q209



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
Integrated Circuits (cont'd.)				
H6	() 4	E304 transistor	417-828	Q201, Q202, Q204, Q205
H7	() 2	MPSU10 transistor	417-834	Q214, Q215
H8	() 1	U760 integrated circuit	442-50	IC201
H8	() 3	SN7400N integrated circuit	443-1	IC202, IC204, IC208
H8	() 1	SN7472N integrated circuit	443-4	IC211
H8	() 1	SN7476N integrated circuit	443-16	IC203
H8	() 2	SN74122N integrated circuit	443-23	IC205, IC206
H8	() 1	SN7413N integrated circuit	443-44	IC207
H8	() 2	SN7408N integrated circuit	443-45	IC209, IC210

HARDWARE

J1	() 2	4-40 x 1/4" screw	250-52	
J2	() 4	#4 x 3/8" self-tapping screw	250-186	
J3	() 4	4-40 nut	252-2	
J4	() 2	#4 lockwasher	254-9	
J5	() 2	#6 x 1/4" self-tapping screw	250-170	
J6	() 1	Control nut	252-7	

MISCELLANEOUS

K1	() 2	2.2 μ H coil (red-red-gray)	45-73	L201, L202
K2	() 1	Control mounting bracket	204-2078	
K3	() 2	Heat sink	215-95	
K4	() 10	14-pin socket	434-298	
K4	() 1	16-pin socket	434-299	
K5	() 2	Ferrite bead	475-16	

PART FROM FINAL PACK

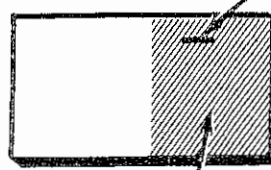
() 1	Horizontal circuit board 85-1990-2
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STEP-BY-STEP ASSEMBLY

IDENTIFICATION
DRAWING

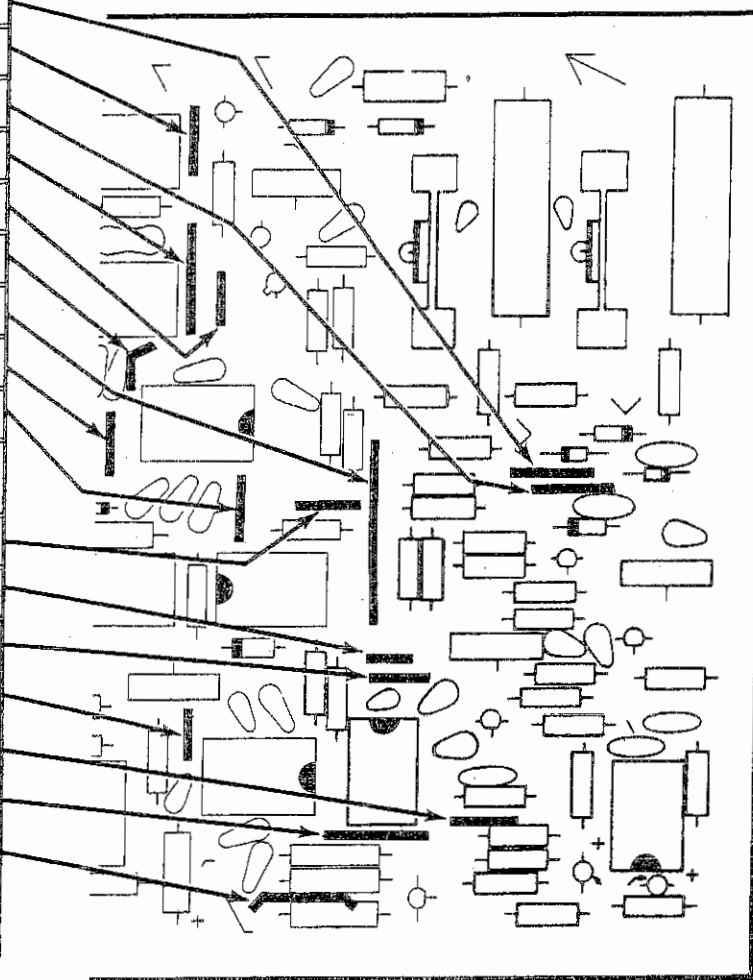
PART
NUMBER



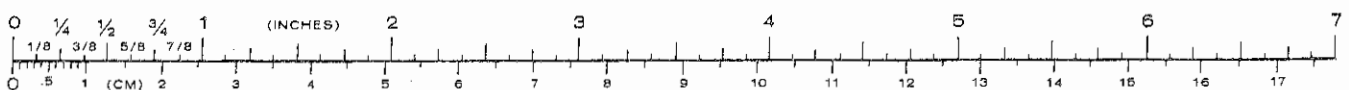
The steps performed in this Pictorial are in this area of the circuit board.

START

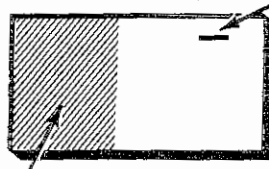
- () Position the circuit board as shown in the identification drawing.
- () 1" bare wire.
- () 1" bare wire.
- () 1" bare wire.
- () 1-1/4" bare wire.
- () 1" bare wire.
- () 1" bare wire.
- () 1-3/4" bare wire.
- () 1" bare wire.
- () 1" bare wire.
- () Solder the leads to the foil and cut off the excess lead lengths.
- () 1" bare wire.
- () 1" bare wire.
- () 1" bare wire.
- () 1" bare wire.
- () 1-1/4" bare wire.
- () 1-1/4" bare wire.
- () Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 4-1

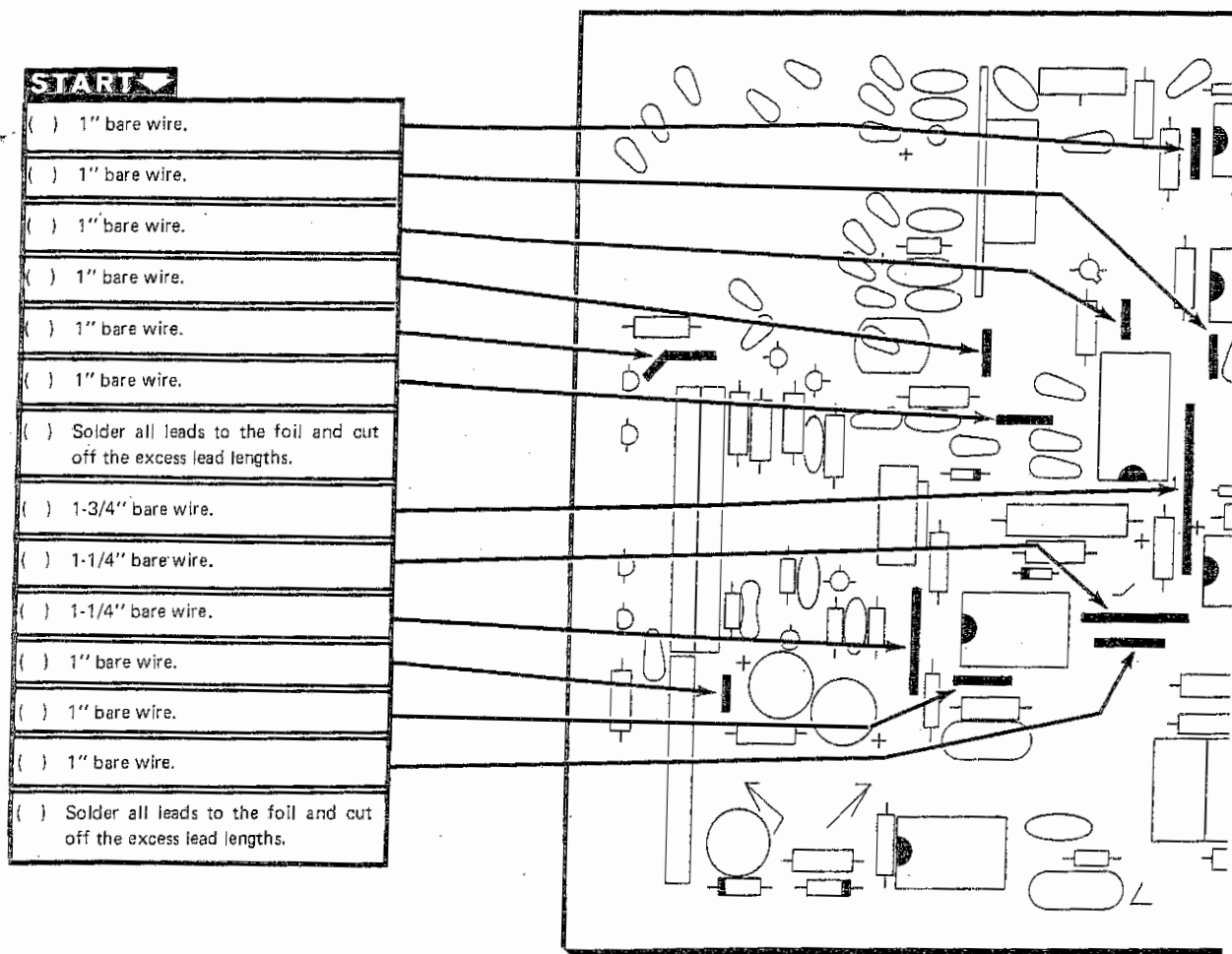


IDENTIFICATION
DRAWING

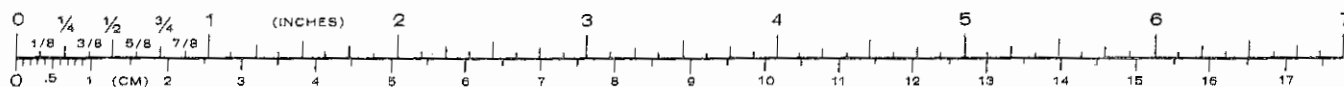


PART
NUMBER

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

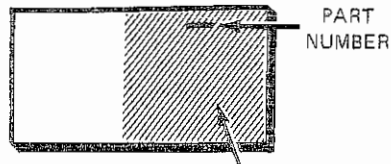


PICTORIAL 4-2





IDENTIFICATION
DRAWING

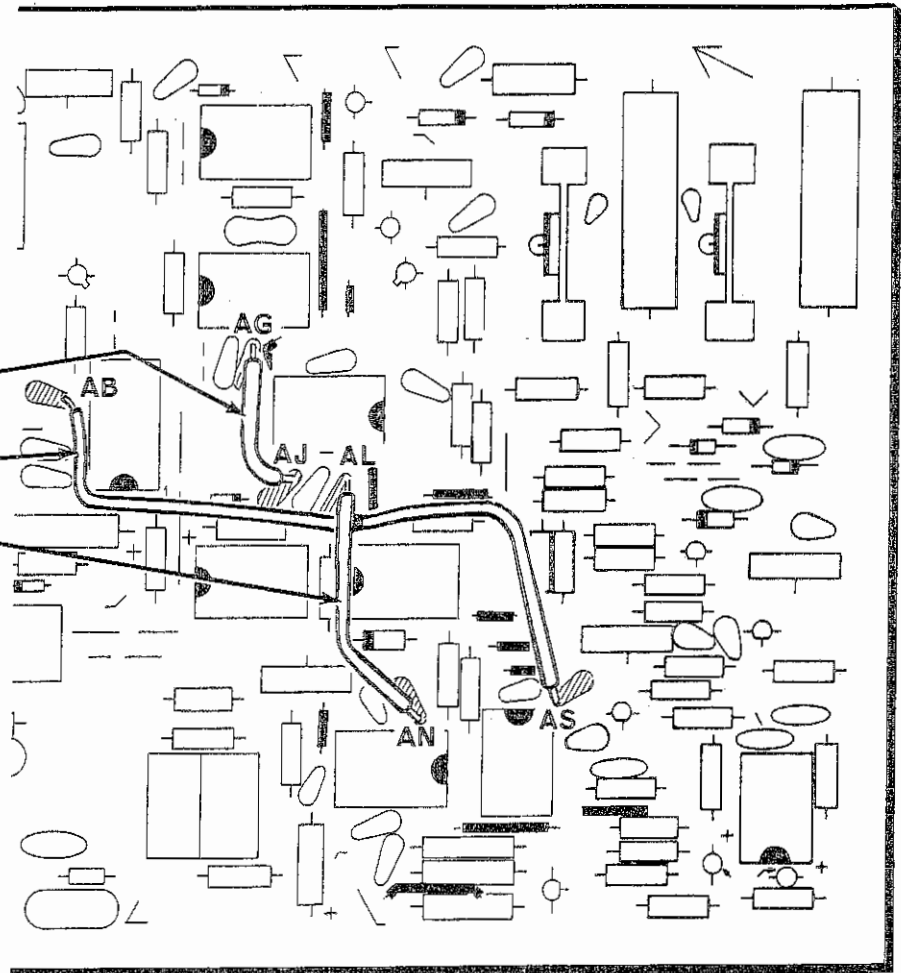


The steps performed in this Pictorial are in
this area of the circuit board.

START

NOTE: In the following steps, route the wires as shown and solder each wire to the foil as you install it. Be careful that heat does not melt the wire insulation and cause a short circuit.

- () 1-3/8" white wire between holes AG and AJ.
- () 5" white wire between holes AB and AS.
- () 2-1/2" white wire between holes AL and AN.



PICTORIAL 4-3



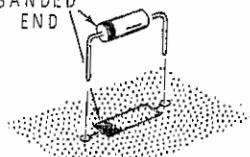
IDENTIFICATION
DRAWING

PART
NUMBER


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

START

NOTE: When you install a diode, always
match the band or bands on the diode
with the band mark on the circuit board.

BAND
END

() ZD210: 1N751 zener diode
(#56-16).

() R283: 180 Ω (brown-gray-brown).

() R280: 8200 (gray-red-red).

() R261: 220 Ω (red-red-brown).

() R279: 8200 Ω (gray-red-red).

() R276: 220 Ω (red-red-brown).

() R278: 1100 Ω (brown-brown-red).

() R274: 180 Ω (brown-gray-brown).

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

() R275: 180 Ω (brown-gray-brown).

() R269: 100 Ω (brown-black-
brown).

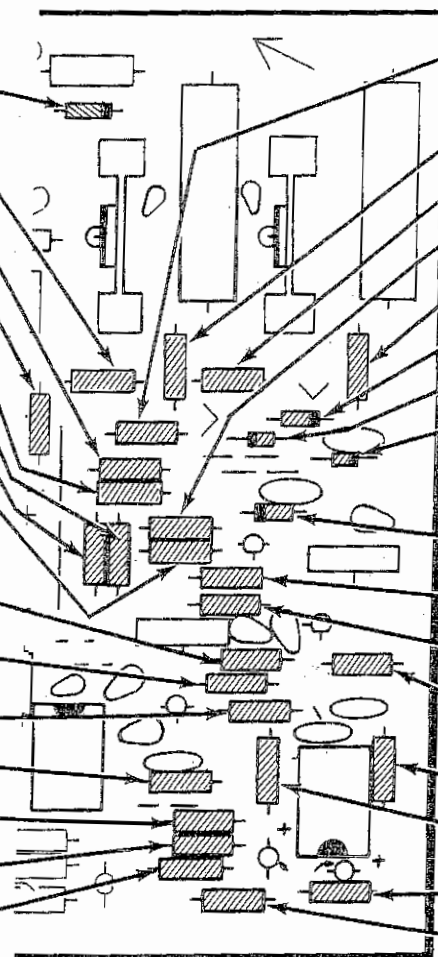
() R277: 1500 Ω (brown-green-red).

() R223: 180 Ω (brown-gray-brown).

() R235: 1200 Ω (brown-red-red).

() R234: 1000 Ω (brown-black-red).

() R233: 220 Ω (red-red-brown).

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


CONTINUE

() R281: 180 Ω (brown-gray-brown).

() R285: 10 Ω (brown-black-black).

() R282: 180 Ω (brown-gray-brown).

() R267: 680 Ω (blue-gray-brown).

() R284: 10 Ω (brown-black-black).

() ZD217: PS18775 zener diode
(#56-31).

() D216: 1N4149 diode (#56-56).

() D215: 1N4149 diode (#56-56).

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

() ZD214: PS18775 zener diode
(#56-31).

() R271: 2.7 Ω (red-violet-gold).

() R273: 680 Ω (blue-gray-brown).

() R270: 510 Ω (green-brown-
brown).

() R224: 1000 Ω (brown-black-red).

() R222: 1000 Ω (brown-black-red).

() R232: 220 Ω (red-red-brown).

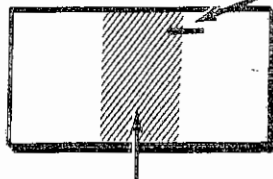
() R231: 1000 Ω (brown-black-red).

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

PICTORIAL 4-4



IDENTIFICATION
DRAWING



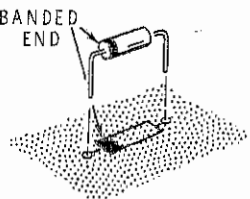
PART
NUMBER

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

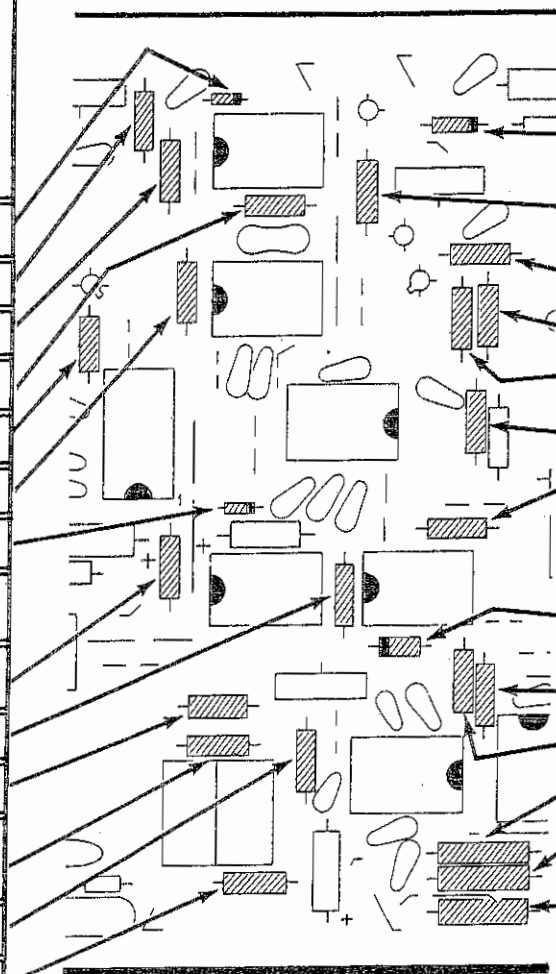
START

NOTE: When you install a diode, always
match the band or bands on the diode
with the band mark on the circuit board.

BANDED
END



- () D208: 1N4149 diode (#56-56).
- () R221: 4700 Ω (yellow-violet-red).
- () R228: 39 k Ω (orange-white-orange).
- () R229: 390 Ω (orange-white-brown).
- () R219: 3900 Ω (orange-white-red).
- () R218: 1000 Ω (brown-black-red).
- () D207: 1N4149 diode (#56-56).
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R217: 47 k Ω (yellow-violet-orange).
- () R256: 220 Ω (red-red-brown).
- () R262: 1000 Ω (brown-black-red).
- () R264: 330 Ω (orange-orange-brown).
- () R227: 270 Ω (red-violet-brown).
- () R266: 1500 Ω (brown-green-red).
- () Solder the leads to the foil and cut off the excess lead lengths.



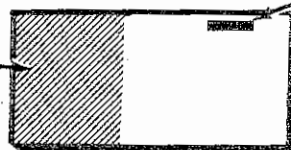
CONTINUE

- () ZD211: 1N751 zener diode (#56-16).
- () R247: 330 Ω (orange-orange-brown).
- () R249: 100 Ω (brown-black-brown).
- () R251: 3900 Ω (orange-white-red).
- () R254: 3900 Ω (orange-white-red).
- () R259: 1000 Ω (brown-black-red).
- () R257: 200 Ω (red-black-brown).
- () Solder the leads to the foil and cut off the excess lead lengths.
- () ZD209: 1N750A zener diode (#56-59).
- () R225: 270 Ω (red-violet-brown).
- () R226: 270 Ω (red-violet-brown).
- () R236: 1800 Ω (1.8k), 1%.
- () R237: 1000 Ω (1k), 1%.
- () R238: 200 Ω , 1%.
- () Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 4-5

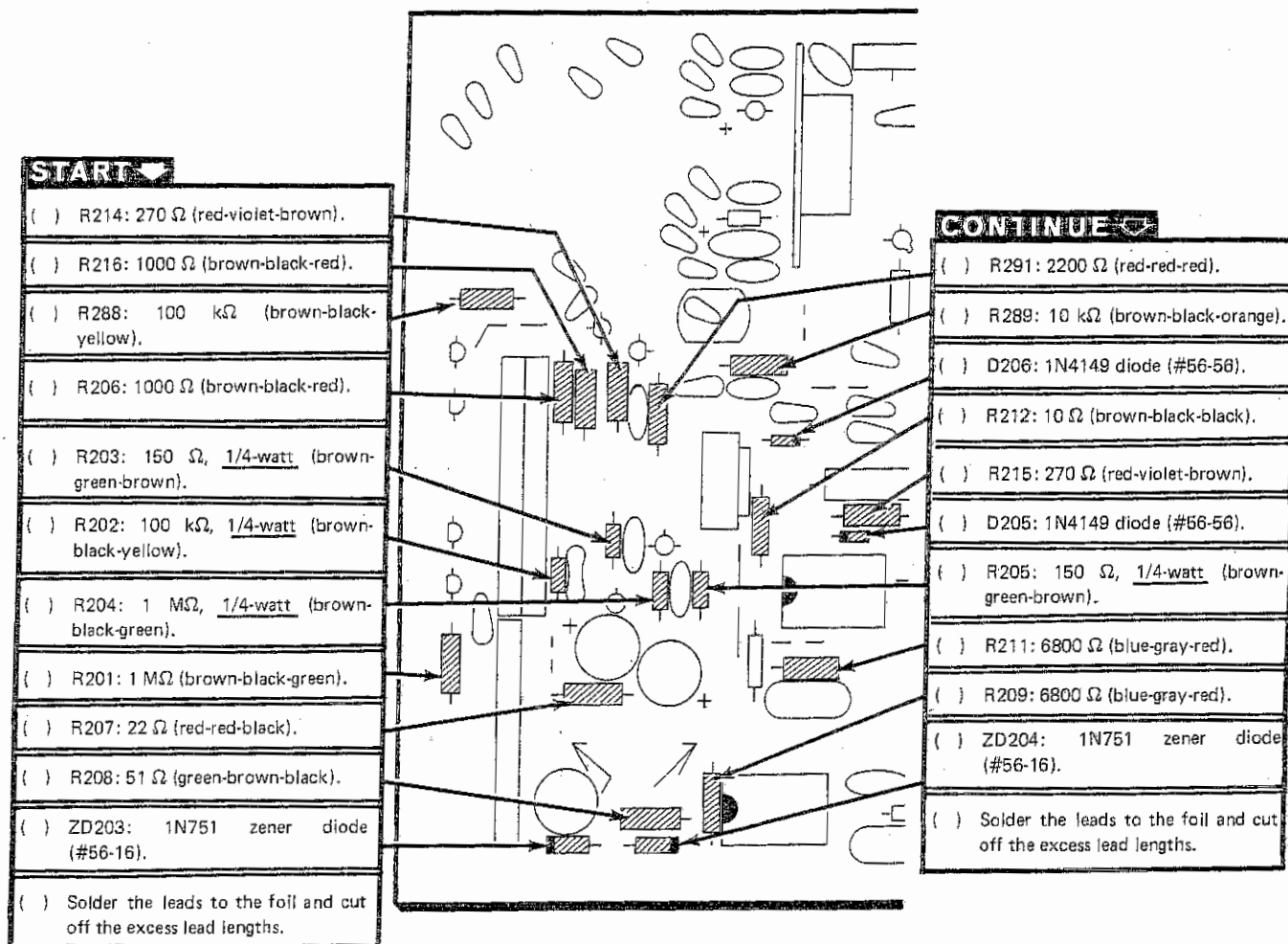


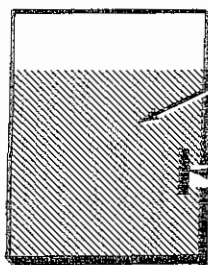
The steps performed in this Pictorial are in this area of the circuit board.



PART
NUMBER

IDENTIFICATION
DRAWING





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

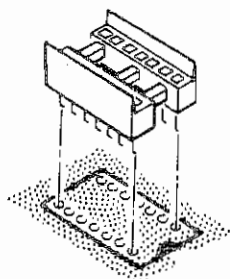
PART
NUMBER

IDENTIFICATION
DRAWING

START

() Reposition the circuit board as shown in the identification drawing.

NOTE: To install an IC socket, be sure the socket pins are straight. Then insert the socket pins and solder them to the foil.



() 14-pin socket at IC201.

() 14-pin socket at IC202.

() 16-pin socket at IC203.

() 14-pin socket at IC206.

() 14-pin socket at IC204.

() 14-pin socket at IC205.

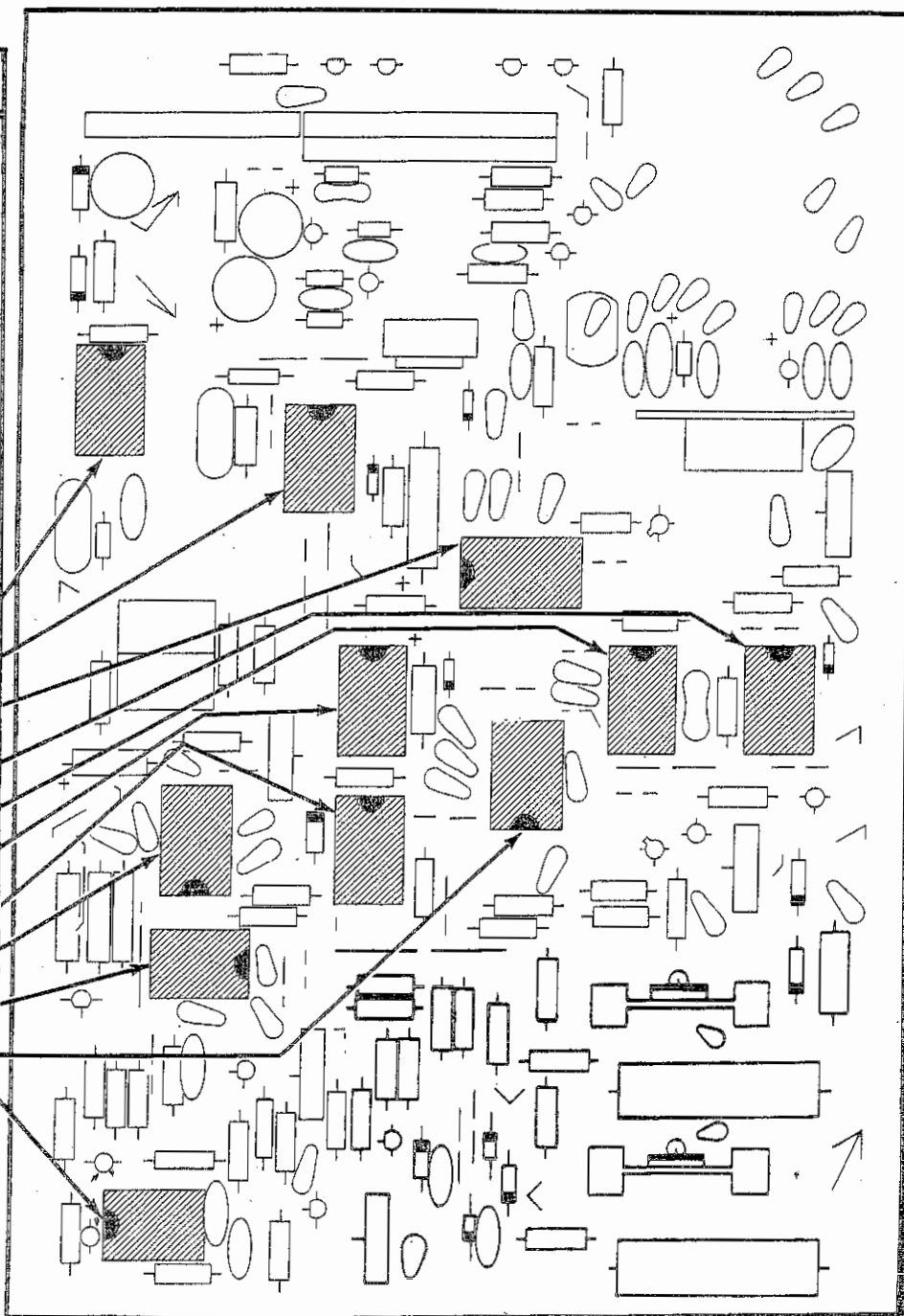
() 14-pin socket at IC207.

() 14-pin socket at IC211.

() 14-pin socket at IC210.

() 14-pin socket at IC209.

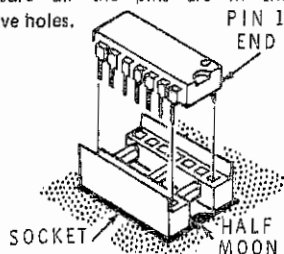
() 14-pin socket at IC208.



PICTORIAL 4-7

START

NOTE: To install an integrated circuit, refer to Detail 4-8A and identify the pin 1 end of the integrated circuit. Then position the pin 1 end toward the half-moon mark on the circuit board and carefully install the integrated circuit. Make sure all the pins are in their respective holes.



() IC201: U760 integrated circuit (#442-50).

() IC202: SN7400N integrated circuit (#443-1).

() IC203: SN7476N integrated circuit (#443-16).

() IC206: SN74122N integrated circuit (#443-23).

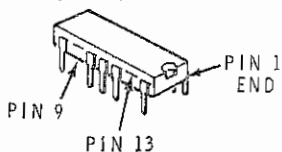
() IC205: SN74122N integrated circuit (#443-23).

() IC207: SN7413N integrated circuit (#443-44).

() IC211: SN7472N integrated circuit (#443-4).

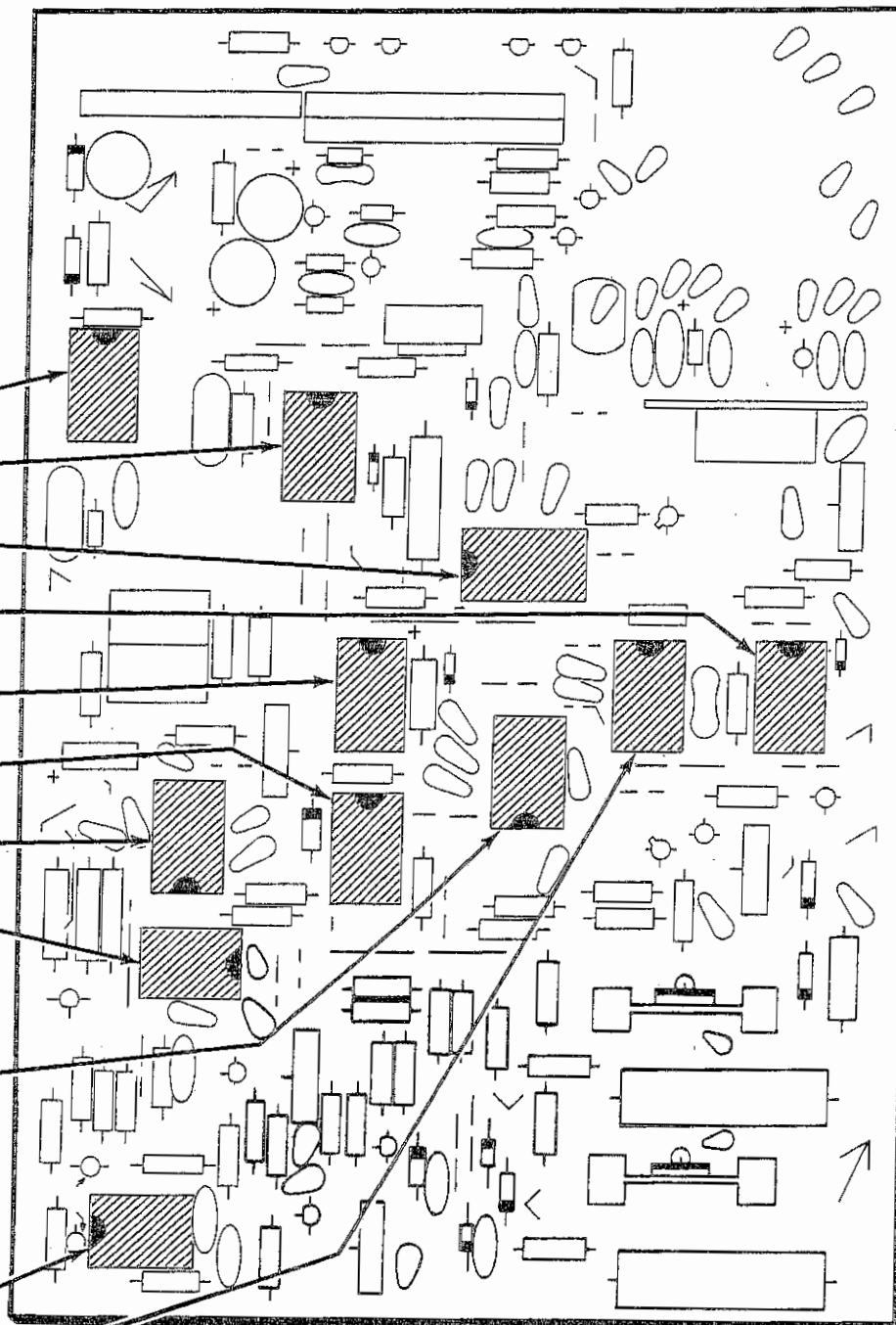
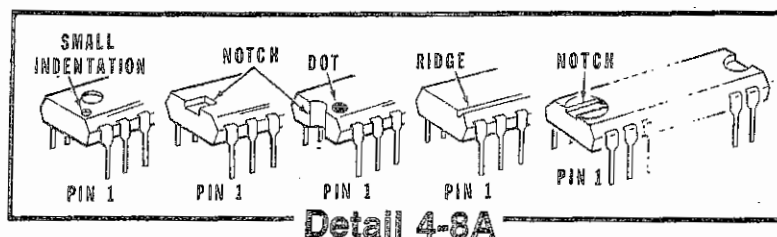
() IC210: SN7408N integrated circuit (#443-45).

() IC209: SN7408N integrated circuit (#443-45). After you identify the pin 1 end of this IC, break off pins 9 and 13 at the base of the IC with a pair of long-nose pliers.



() IC204: SN7400N integrated circuit (#443-1).

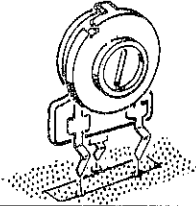
() IC208: SN7400N integrated circuit (#443-1).

**PICTORIAL 4-8****Detail 4-8A**

**START**

- () Reposition the circuit board as shown in the identification drawing.

NOTE: As you install each of the following controls, solder the leads to the foil.



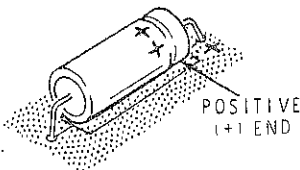
- () R248: 1000 Ω control (#10-936).
(The circuit board may be marked 500.)

- () C224: 290 pF mica.

- () R272: 100 Ω control (#10-314).

- () R268: 500 Ω control (#10-918).

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.



- () C212: 10 μ F electrolytic.

- () R255: 5000 Ω (5k) control (#10-904).

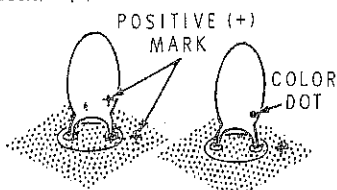
- () C213: .005 μ F ceramic.

- () C214: .005 μ F ceramic. This may be a tight fit.

- () C215: .0033 μ F ceramic.

- () C234: 10 μ F electrolytic.

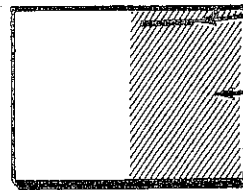
NOTE: When you install a tantalum capacitor, always match the positive (+) or dot marked side of the capacitor with the positive (+) mark on the circuit board.



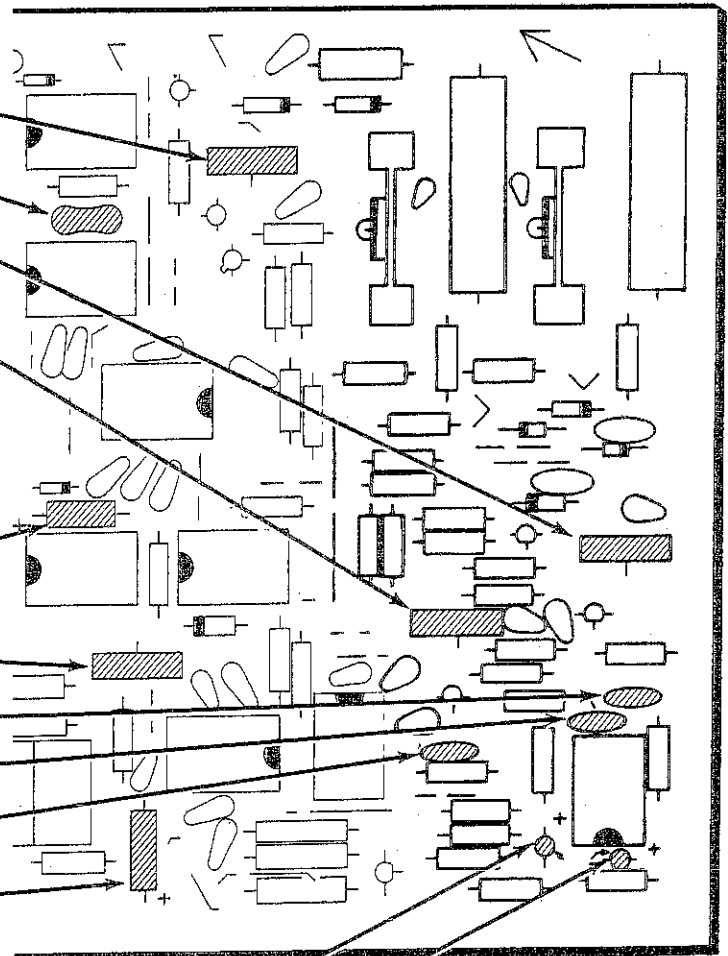
- () C226: 2.2 μ F, 20V tantalum.

- () C225: 2.2 μ F, 20V tantalum.

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

IDENTIFICATION
DRAWINGPART
NUMBER

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



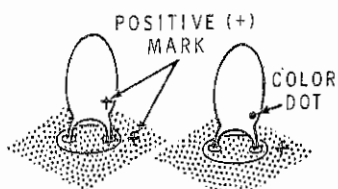
PICTORIAL 4-9

START

() C223: 56 pF ceramic.

() C222: 100 pF ceramic. Position the capacitor to the left so it will not interfere with the large switch that you will install later.

NOTE: When you install a tantalum capacitor, always match the positive (+) or dot marked side of the capacitor with the positive (+) mark on the circuit board.



() C216: 22 μ F tantalum.

() C221: 1000 pF (.001) ceramic.

() C217: 2.2 μ F, 15V tantalum. Position the positive (+) marked (or red-colored) end as indicated on the circuit board screen.

() C219: .02 μ F ceramic.

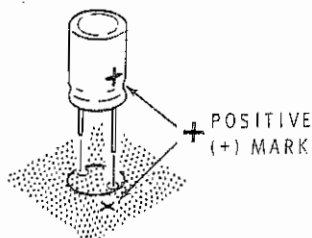
() C218: .1 μ F ceramic.

() C211: 200 pF ceramic.

() C202: .01 μ F ceramic.

() C201: 100 pF mica.

NOTE: When you install each of the following electrolytic capacitors, be sure you match the positive (+) marking on the capacitor with the positive (+) marking on the circuit board.

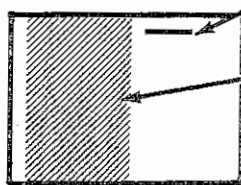


() C204: 100 μ F electrolytic.

() C205: 100 μ F electrolytic.

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

IDENTIFICATION
DRAWING



PART
NUMBER

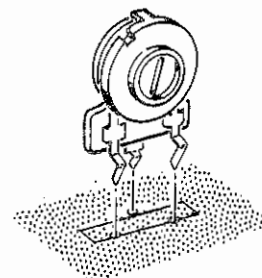
The steps you perform in this Pictorial are in this area of the circuit board.

LARGE SWITCH
GOES HERE LATER

CONTINUE

() C233: 200 pF ceramic.

NOTE: As you install the following control, solder the leads to the foil.

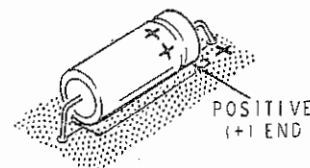


() R258: 1000 Ω (1k) control (#10-936).

() C235: .1 μ F ceramic.

() C203: .01 μ F ceramic.

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.



() C227: 5 μ F electrolytic.

() L201: 2.2 μ H coil (red-red-gray).

() C208: .1 μ F Mylar.

() C207: .01 μ F ceramic.

() L202: 2.2 μ H coil (red-red-gray).

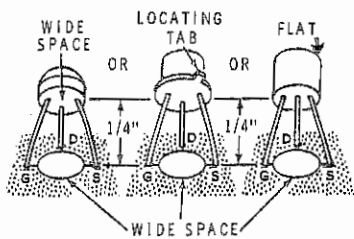
() C209: .1 μ F Mylar.

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

PICTORIAL 4-10

**START**

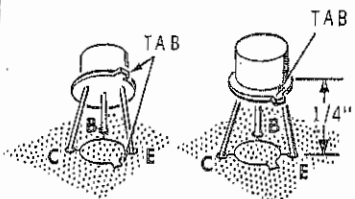
NOTE: Each of the following two transistors are one of the three types shown below. First note the wide space or locating tab on the transistor. Then note the outline of the locating tab on the circuit board. Line up the transistor with its outline on the circuit board and insert the leads into their correct holes, which are indicated by G, D, and S. Solder the leads to the foil and cut off the excess lead lengths.



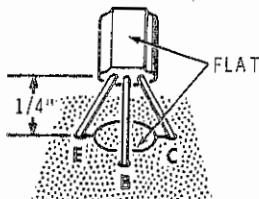
() Q204: E304 transistor (#417-828).

() Q205: E304 transistor (#417-828).

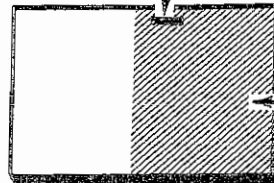
() Q206: 2N2369 transistor (#417-154).



() Q209: 2N5770 transistor (#417-293).



PART
NUMBER

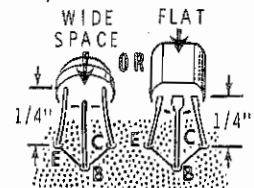


IDENTIFICATION
DRAWING

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

CONTINUE

() Q212: SE6020 transistor (#417-237).



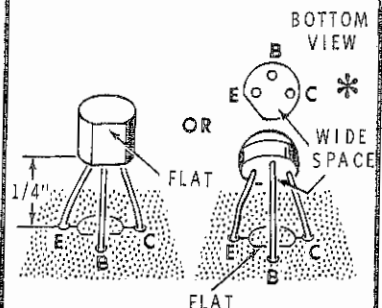
() Q213: SE6020 transistor (#417-237).

() C237: .2 μ F ceramic.

() C236: .2 μ F ceramic.

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

NOTE: Install the next three transistors as shown. Note the position of the wide space of the transistor marked with an asterisk.

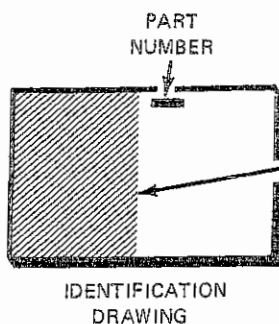


() Q210: 2N4121 transistor (#417-235).

() Q211: 2N4121 transistor (#417-235).

() Q216: 2N4121 transistor (#417-235).

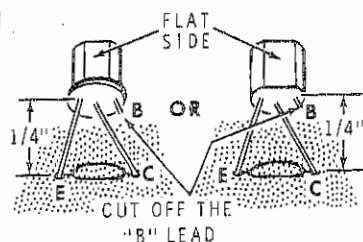
PICTORIAL 4-11



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

START

NOTE: Install the following transistors as shown. Solder each lead to the foil and cut off the excess lead lengths.

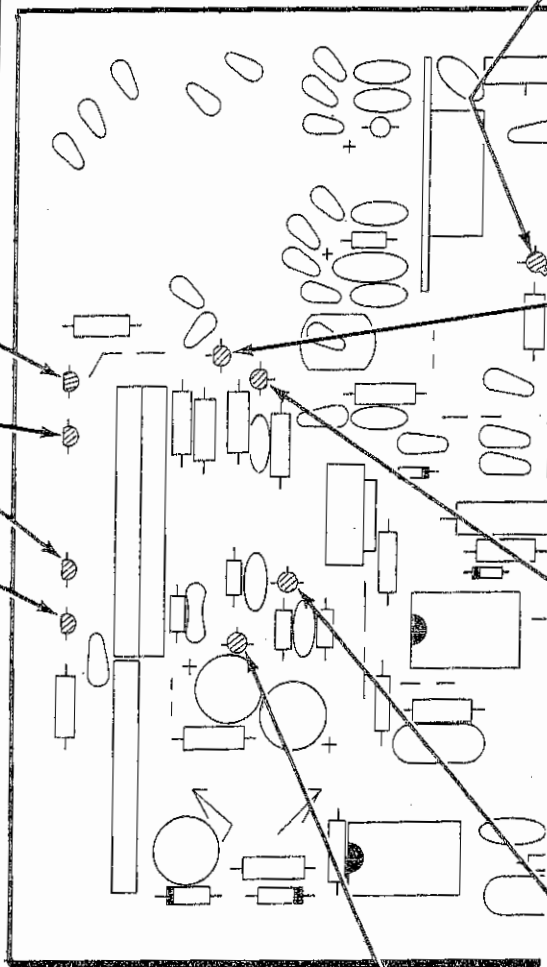


() ZD212: 2N3393 transistor (#417-118).

() ZD213: 2N3393 transistor (#417-118).

() ZD202: 2N3393 transistor (#417-118).

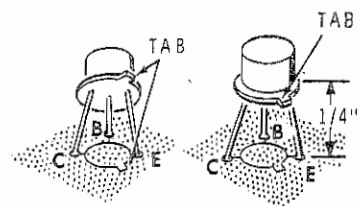
() ZD201: 2N3393 transistor (#417-118).



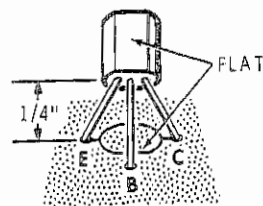
PICTORIAL 4-12

CONTINUE

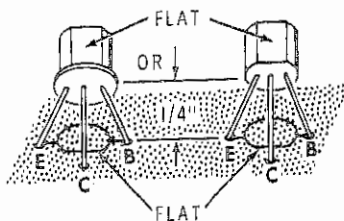
() Q203: 2N2369 transistor (#417-154).



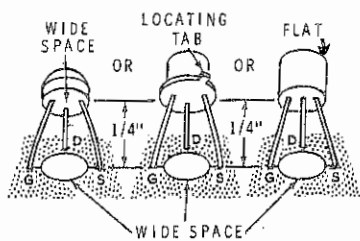
() Q207: MPSA20 transistor (#417-801).



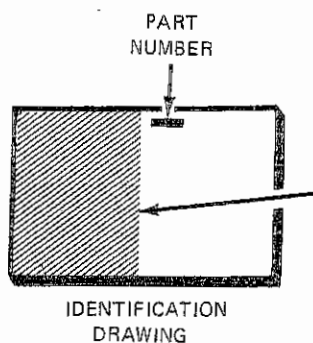
() Q208: X29A829 transistor (#417-201).



() Q202: E304 transistor (#417-828).



() Q201: E304 transistor (#417-828).



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

START

NOTE: In the following steps, solder each wire to the foil as you install it on the circuit board.

() 2-1/4" white-green wire at hole N.

() SW201/R213/SW204: 8-position rotary switch with 100 Ω control. Make sure the pins on each wafer are straight. Install the pins, one wafer at a time, into the circuit board. Make sure the switch is seated down against the circuit board. Solder the pins to the foil.

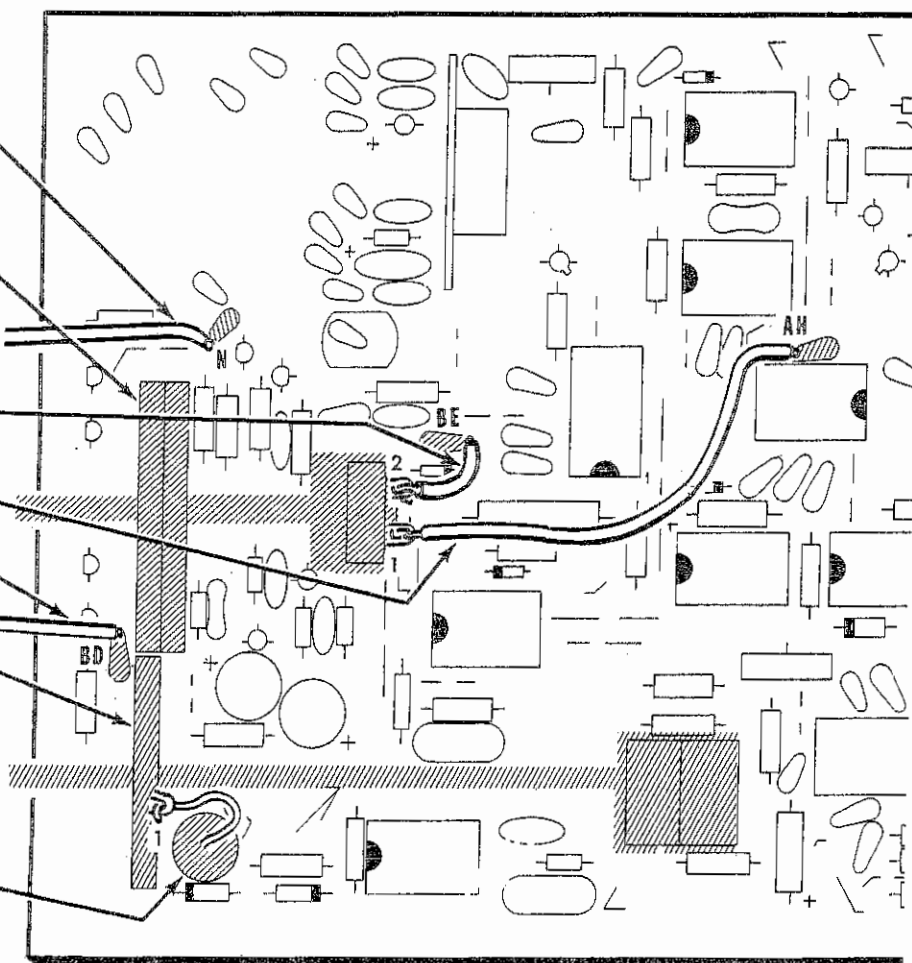
() 1-1/2" white-black wire from SW204 lug 2 (S-1) to hole BE.

() 3-1/4" white-brown wire from SW204 lug 1 (S-1) to hole AH.

() 2-1/4" white-black wire at hole BD.

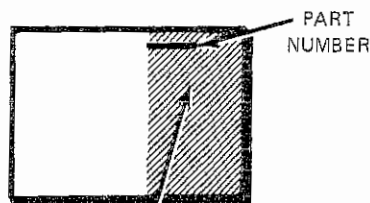
() SW202/R263A/R263B: 3-position rotary switch with dual 1000 Ω controls. Make sure the pins on the wafer are straight. Install the pins, one wafer at a time, into the circuit board. Make sure the switch is seated down against the circuit board. Solder the pins to the foil.

() C206: 6 μ F nonpolarized electrolytic. Position this capacitor with either lead to the circuit board. Connect the other lead to SW202 lug 1 (S-1).

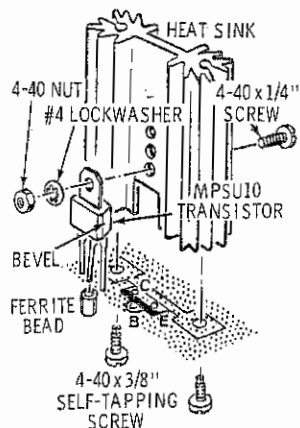


PICTORIAL 4-13



IDENTIFICATION
DRAWING


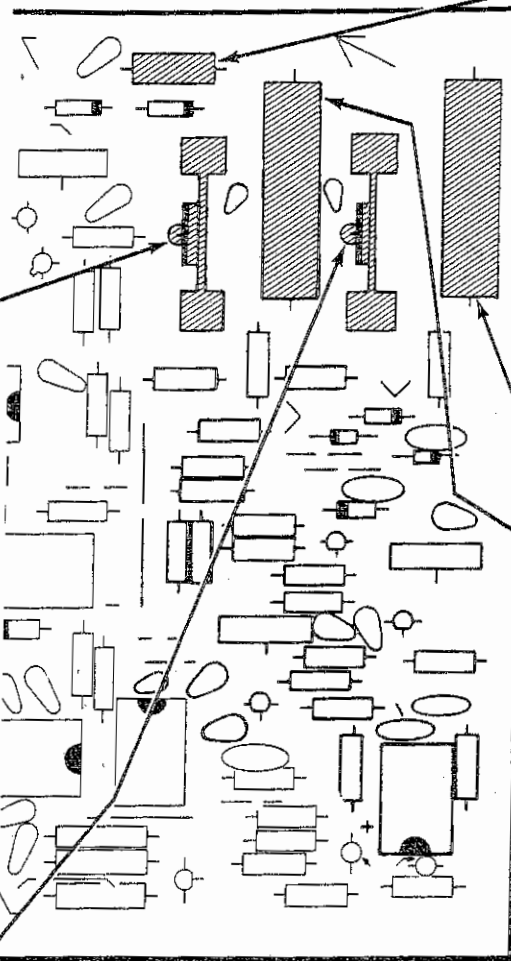
The steps you perform in this Pictorial are in this area of the circuit board.

START


() Q214: Assemble and mount a transistor heat sink assembly as follows. (NOTE: This assembly is different from those on the vertical circuit board.)

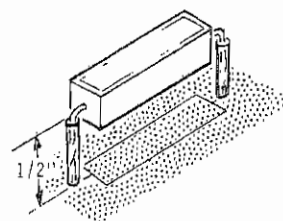
1. Loosely mount an MPSU10 transistor (#417-834) on a large heat sink with a 4-40 x 1/4" screw, a #4 lockwasher, and a 4-40 nut as shown. Be sure the bevels are positioned as shown.
2. Slide a ferrite bead over the center transistor lead.
3. Mount the transistor heat sink assembly onto the circuit board at Q214 with two 4-40 x 3/8" self-tapping screws.
4. Solder the transistor leads to the foil and cut off the excess lead lengths.
5. Tighten the screw.

() Q215: In the same manner, mount another transistor heat sink assembly.


CONTINUE

() R252: 68 k Ω , 1-watt (blue-gray-orange). Solder the leads to the foil and cut off the excess lead lengths.

NOTE: Cut and use the lengths of sleeving called for on the leads of the following resistors. Solder the leads to the foil as you install each resistor. Then cut off the excess lead lengths.



() R286: 4700 Ω , 7-watt. Use 1/2" lengths of sleeving.

() R287: 4700 Ω , 7-watt. Use 1/2" lengths of sleeving.

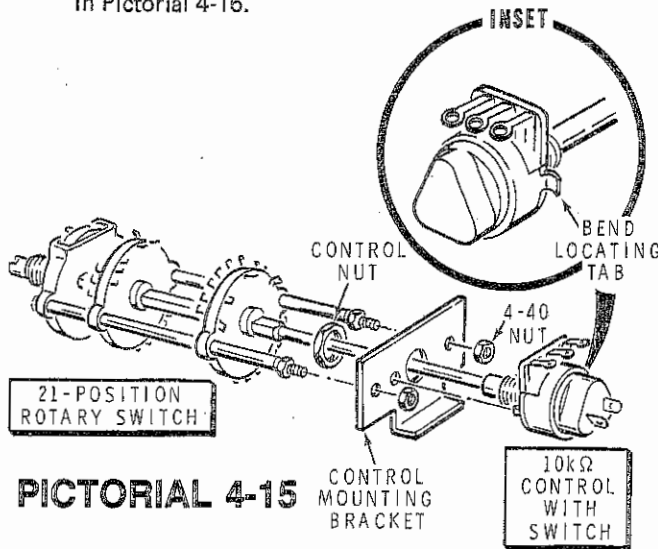
() Set the circuit board aside temporarily.

PICTORIAL 4-14

TIME/CM SWITCH

Refer to Pictorial 4-15 for the following steps.

- () R253/SW205: Mount a 10 k Ω control with switch (#19-717) to the control mounting bracket as shown. Use a control nut. Bend the locating tab away from the control as shown in the inset drawing.
- () SW203: Mount the 21-position rotary switch to the control mounting bracket with two 4-40 nuts. Be sure to position the rotary switch so the lugs are as shown in Pictorial 4-16.



Refer to Pictorial 4-16 for the following steps.

- () Position the switch assembly as shown.

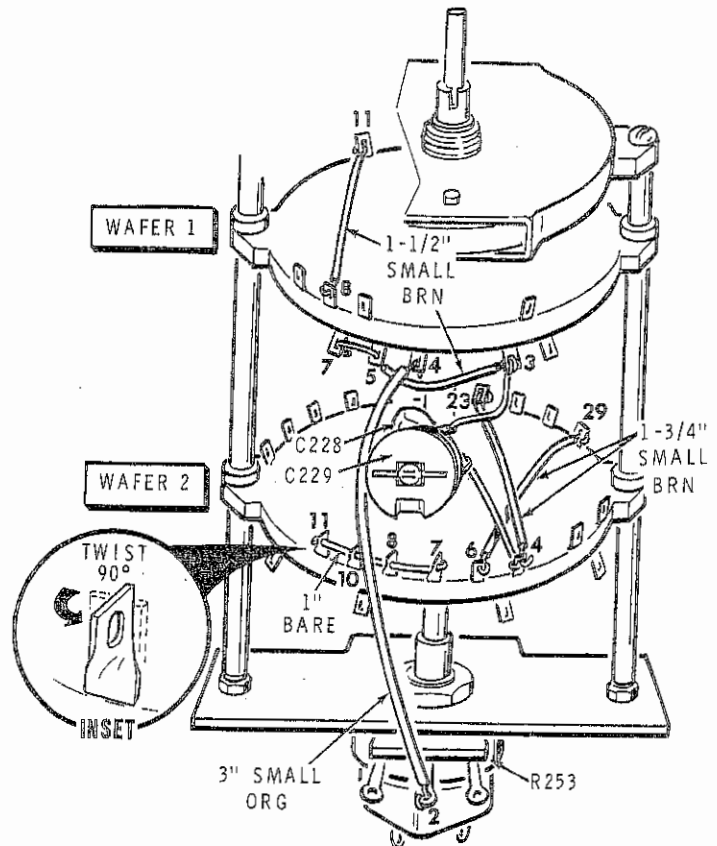
NOTE: To prepare the lengths of wire in the following steps, cut the wire to the specified length. Then remove 1/4" of insulation from each end. Position all wires as shown in the Pictorial.

- () Prepare the following wires:

QUANTITY	WIRE
2	1-1/2" smaller brown
2	1-3/4" smaller brown
1	3" smaller orange

NOTE: In the following steps, bend the switch lugs as shown in the drawings. Also, use only a minimum amount of solder on the switch lugs.

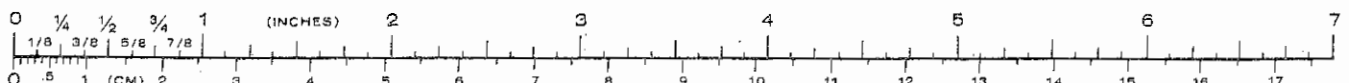
- () Connect a 1-1/2" smaller brown wire to wafer 1 lugs 8 (NS) and 11 (S-1).
- () Remove an additional 1/4" of insulation from one end of the remaining 1-1/2" smaller brown wire.

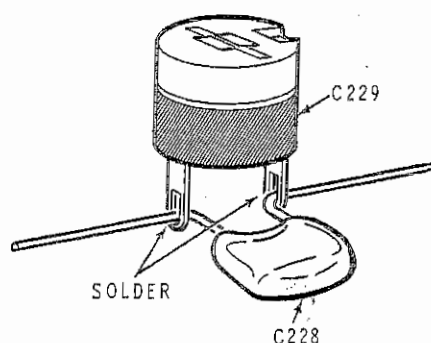


- () Connect the 1/4" bare end of this wire to wafer 1 lug 3 (NS). Connect the bare 1/2" end through wafer 1 lug 5 (NS) to lug 7 (NS).
- () Connect a 1-3/4" smaller brown wire between wafer 2 lugs 6 (S-1) and 29 (NS).
- () Connect a 1-3/4" smaller brown wire between wafer 2 lugs 4 (NS) and 23 (NS).
- () Carefully twist lugs 7, 8, 10, and 11 (of wafer 2) 90° as shown in the inset drawing.

NOTE: Where a wire end passes through a lug and then goes elsewhere, as in the following step, it will be treated as two wires in the soldering instructions (S-2), one entering and one leaving the lug.

- () Connect a 1" bare wire from wafer 2 lug 7 (S-1), through lug 8 (S-2), through lug 10 (S-2), to lug 11 (NS).





Detail 4-16A

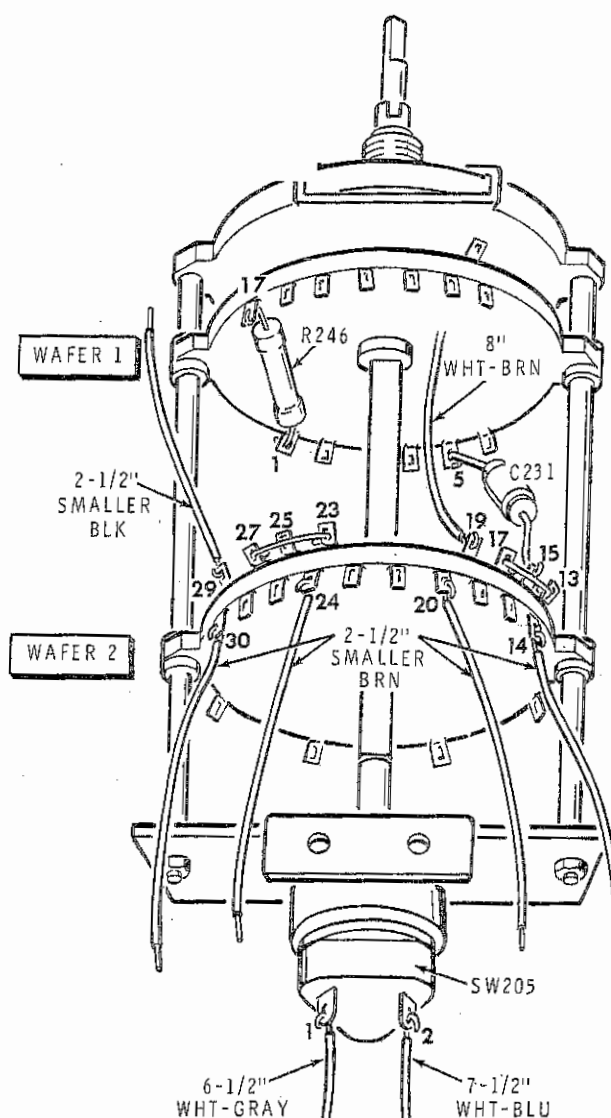
- () Refer to Detail 4-16A and prepare a 150 pF mica capacitor (C228) and an 8-50 pF trimmer capacitor (C229) assembly as shown. (Do not cut off any excess mica capacitor lead lengths.)
- () C228, C229: Connect the capacitor assembly from wafer 1 lug 3 (S-2) to wafer 2 lug 4 (S-2).
- () Connect a 3" smaller orange wire from wafer 1 lug 4 (S-1) to R253 lug 2 (S-1).

Refer to Pictorial 4-17 for the following steps.

- () Position the switch assembly as shown.
- () R246: Connect a 20 k Ω , 1% resistor between wafer 1 lugs 17 (NS) and 1 (NS).
- () Connect a 1" bare wire from wafer 2 lug 13 (S-1), through lug 15 (NS), to lug 17 (S-1).
- () Connect a 1" bare wire from wafer 2, lug 23 (S-2), through lug 25 (S-2), to lug 27 (S-1).
- () C231: Connect a .02 μ F polystyrene capacitor between wafer 1 lug 5 (S-3) and wafer 2 lug 15 (S-3).
- () Prepare the following wires:

QUANTITY WIRE

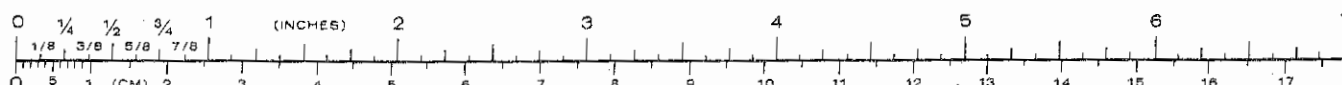
4	2-1/2" smaller brown
1	2-1/2" smaller black
1	8" white-brown
1	7-1/2" white-blue
1	6-1/2" white-gray

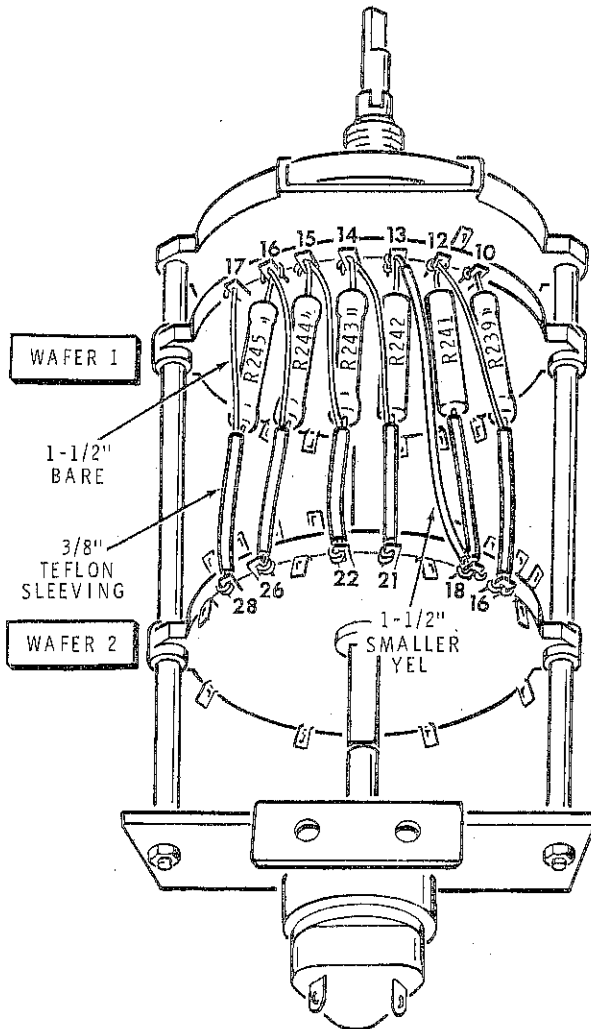


PICTORIAL 4-17

NOTE: Connect only one end of the following wires. The free ends will be connected later.

- () 2-1/2" smaller brown wire to wafer 2 lug 30 (S-1).
- () 2-1/2" smaller black wire to wafer 2 lug 29 (S-2).
- () 2-1/2" smaller brown wire to wafer 2 lug 24 (S-1).
- () 2-1/2" smaller brown wire to wafer 2 lug 20 (S-1).
- () 8" white-brown wire to wafer 2 lug 19 (S-1).
- () 2-1/2" smaller brown wire to wafer 2 lug 14 (S-1).
- () 7-1/2" white-blue wire to switch SW205 lug 2 (S-1).
- () 6-1/2" white-gray wire to switch SW205 lug 1 (S-1).



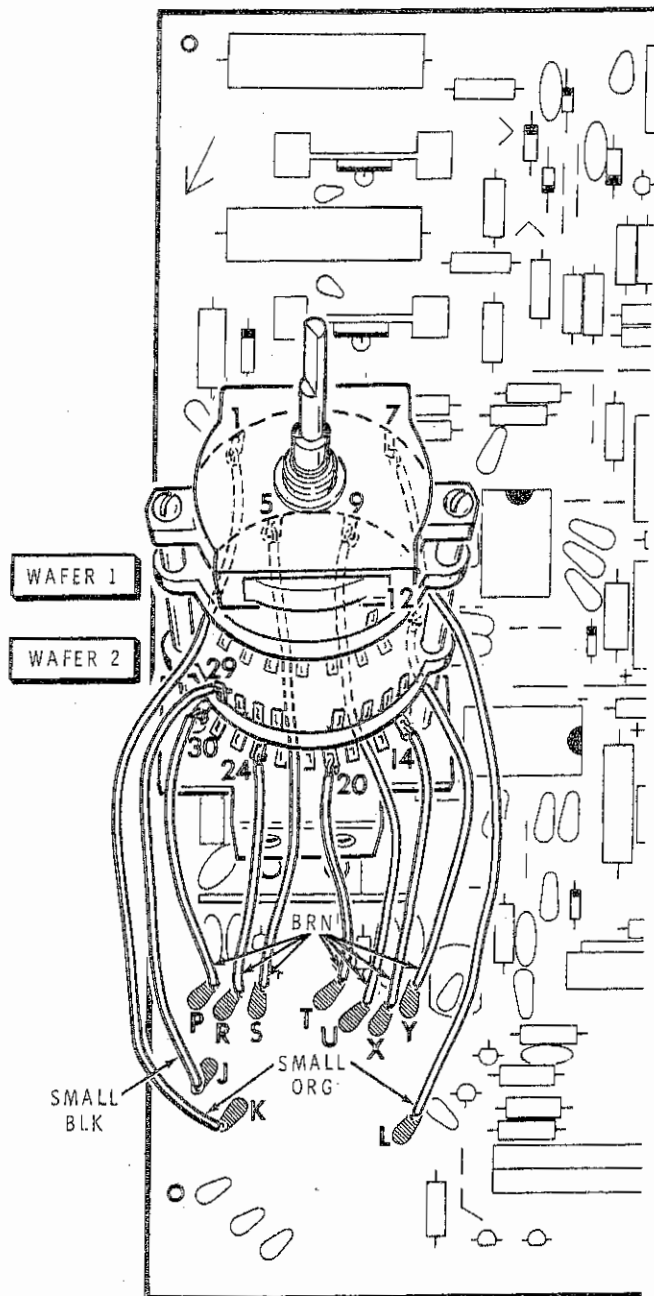


PICTORIAL 4-18

Refer to Pictorial 4-18 for the following steps.

- () Cut five 1-1/2" lengths of bare wire.
- () Cut six 3/8" lengths of teflon sleeving.
- () Lay a 30 k Ω , 1% resistor and a 1-1/2" bare wire side-by-side. Then place a 3/8" length of sleeving over one lead of the resistor and the bare wire. Refer to resistor R245 in Pictorial 4-18.
- () R245: Connect the bare wire and resistor lead to wafer 2 lug 28 (S-2).
- () Connect the other end of the bare wire to wafer 1 lug 17 (S-2).
- () Connect the other end of the 30 k Ω , 1% resistor to wafer 1 lug 16 (NS).
- () Place a length of sleeving over one lead of a 50 k Ω , 1% resistor and a length of bare wire.
- () R244: Connect the bare wire and resistor lead to wafer 2 lug 26 (S-2).
- () Connect the other end of the bare wire to wafer 1 lug 16 (S-2).
- () Connect the other lead of the 50 k Ω , 1% resistor to wafer 1 lug 15
- () Place a length of sleeving over one lead of a 100 k Ω , 1% resistor and a length of bare wire.
- () R243: Connect the bare wire and resistor lead to wafer 2 lug 22 (S-2).
- () Connect the other end of the bare wire to wafer 1 lug 15 (S-2).
- () Connect the other lead of the 100 k Ω , 1% resistor wafer 1 lug 14 (NS).
- () Place a length of sleeving over one lead of a 300 k Ω , 1% resistor and a length of bare wire.
- () R242: Connect the bare wire and resistor lead to wafer 2 lug 21 (S-2).
- () Connect the other end of the bare wire to wafer 1 lug 14 (S-2).
- () Connect the other lead of the 300 k Ω , 1% resistor to wafer 1 lug 13 (NS).
- () Connect a 1-1/2" smaller yellow wire from wafer 1 lug 13 (S-2) to wafer 2 lug 18 (NS).
- () Place a length of sleeving over one lead of a 500 k Ω , 1% resistor.
- () R241: Connect this lead of the resistor to wafer 2 lug 18 (S-2).
- () Connect the other lead of the 500 k Ω , 1% resistor to wafer 1 lug 12 (NS).
- () Place a length of sleeving over one lead of a 1 M Ω , 1% resistor and a length of bare wire.
- () R239: Connect the bare wire and resistor lead to wafer 2 lug 16 (S-2).





PICTORIAL 4-20

Refer to Pictorial 4-20 for the following steps.

- () Position the switch assembly near the horizontal circuit board as shown.

Connect the wires coming from wafer 2 to the circuit board as follows. Solder each wire to the foil as you install it. (NOTE: The brown wires called for are smaller brown wires.)

- () Brown wire from lug 30 to hole P.

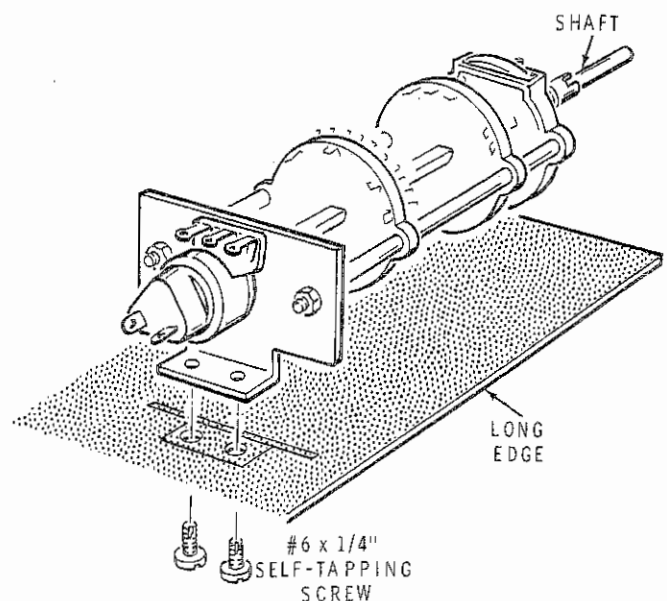
- () Brown wire from lug 24 to hole R.
- () Brown wire from lug 5 to hole S.
- () Brown wire from lug 20 to hole T.
- () Brown wire from lug 9 to hole U.
- () Brown wire from lug 14 to hole X.
- () Brown wire from lug 12 to hole Y.
- () Smaller black wire from lug 29 to hole J.

Connect the wires coming from wafer 1 to the circuit board as follows. Solder each wire to the foil as you install it.

- () Smaller orange wire from lug 1 to hole K.
- () Smaller orange wire from lug 7 to hole L.

Refer to Pictorial 4-21 (in the "Illustration Booklet") for the following steps.

- () Refer to Detail 4-21A and loosely mount the switch assembly to the circuit board at SW203 as shown. Use two #6 x 1/4" self-tapping screws. Do not pinch any wires between the circuit board and switch.



Detail 4-21A



Connect the wires coming from wafer 2 to the circuit board as follows. Solder each wire to the foil as you install it. Position each wire down neatly on the circuit board.

- () White-orange from lug 1 to hole AK.
- () Smaller brown from lug 2 to hole AE.
- () White-green from lug 3 to hole AF.
- () White-brown from lug 19 to hole AT.

Connect the wires coming from wafer 1 to the circuit board as follows. Solder each wire to the foil as you install it.

- () White-black from lug 2 to hole BB.
- () White-black from lug 6 to hole AA.
- () White-yellow from lug 8 to hole BA.
- () White-red from lug 9 to hole BC.

Connect the wires coming from control R253 to the circuit board as follows. Solder each wire to the foil as you install it.

- () White-blue from lug 1 to hole AU.
- () White-yellow from lug 3 to hole AX.
- () C232: Install one lead of the 2 μ F capacitor in hole Z on the circuit board as shown. Solder the lead to the foil and cut off the excess lead length. NOTE: If your capacitor has a band on one end you may disregard this band.
- () Connect the other capacitor lead to switch SW203 wafer 2 lug 11 (S-2).

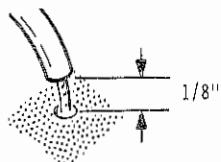
Connect the wires coming from switch SW205 to the circuit board as follows. Solder each wire to the foil as you install it.

- () White-blue from lug 2 to hole AZ.
- () White-gray from lug 1 to hole AY.
- () Position all the wires down neatly on the circuit board.

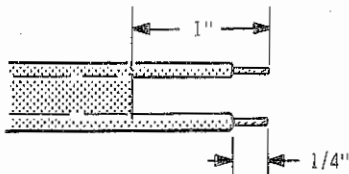
**START**

- () Turn the circuit board over and position it as shown.

In the following steps, install the wires to the foil side of the circuit board as shown. Solder each wire as you connect it and then gently tug on the wire to be sure it is properly soldered. Leave the wire insulation 1/8" from the circuit board so the connection can be soldered.



- () 7" white-blue wire at hole F.
- () 9" white-green wire at hole E.
- () 9" white-gray wire at hole D.
- () 11" twin lead at H and G. Prepare both ends as shown.



- () 7" white-red wire at hole C.
- () 18" white-yellow wire at hole B.
- () 12" white-orange wire at hole A.

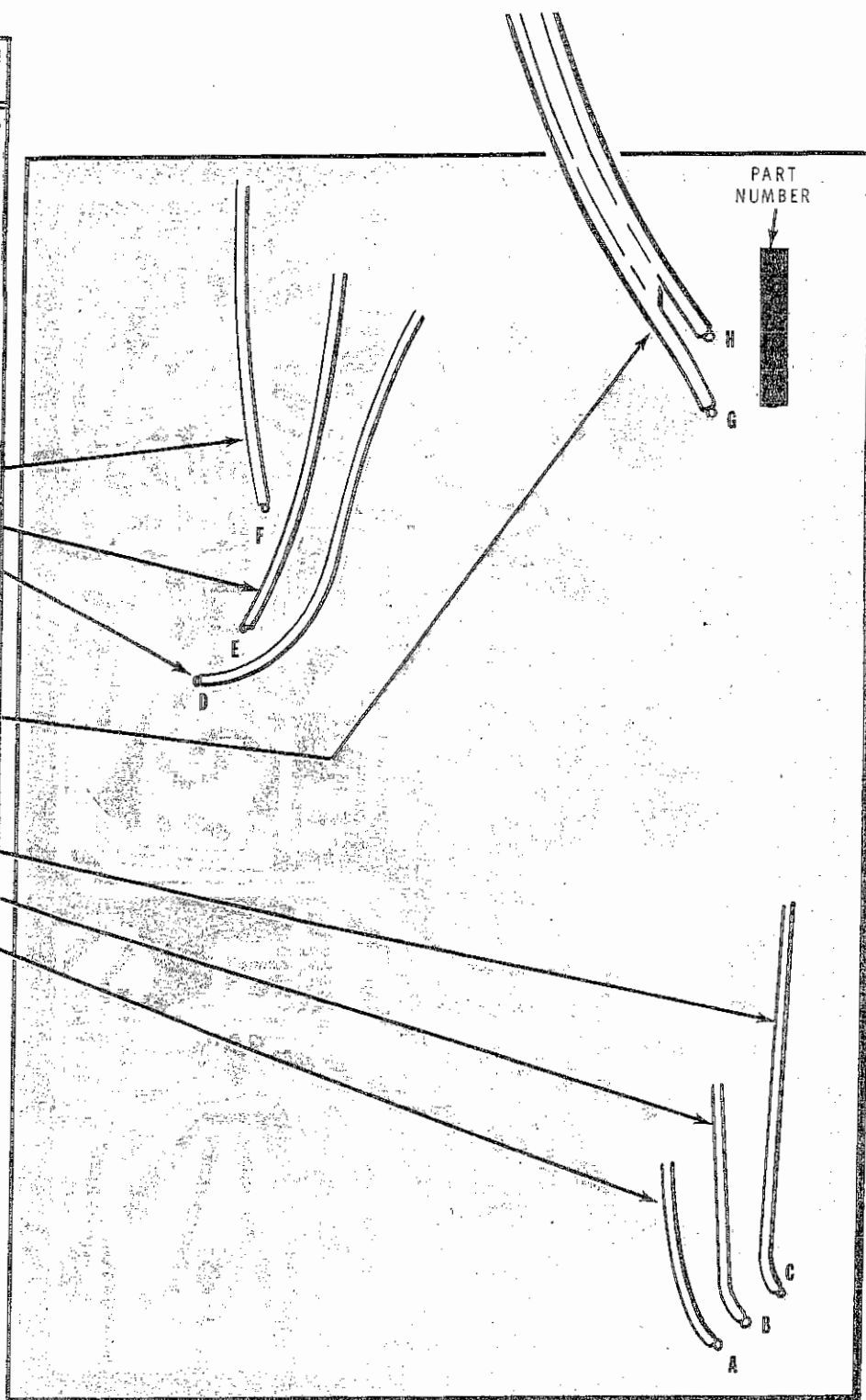
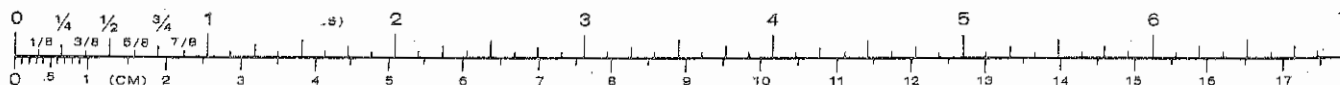
CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

- () Unsoldered connections.
- () "Cold" solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.
- () Transistors and integrated circuits for proper type and installation.
- () Capacitors for the correct position of the banded end.
- () Diodes for the correct position of the banded end.

FINISH

Set the circuit board aside temporarily.

**PICTORIAL 4-22**



CHASSIS ASSEMBLY

PARTS LIST

Unpack the remaining parts (Final Pack) and check each part against the following list. Make a check mark (✓) in the space provided as you identify each part.

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

KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
RESISTORS-CONTROLS-CAPACITORS				
A1	() 1	22 Ω , 1/2-watt (red-red-black) resistor	6-220	R7
A2	() 1	47 k Ω , 1-watt (yellow-violet-orange) resistor	1-7-1	R4
A2	() 1	1.5 M Ω , 1-watt (brown-green-green)	1-35-1	R8
A3	() 1	1 M Ω , precision resistor	2-14	
A3	() 1	10 M Ω , precision resistor	2-17	
A4	() 2	200 Ω control	10-1058	R5, R6
A5	() 1	10 k Ω control with switch	19-716	R2/SW3
A6	() 1	1 M Ω control	10-1043	R3
A7	() 2	.1 μ F Mylar capacitor	27-132	C1, C2
A8	() 1	100-100-300 electrolytic capacitor	25-228	C3

SWITCHES-INSULATORS

B1	() 1	120-240 switch	60-54	SW4
B1	() 1	NOR-LOW switch	60-608	SW5
B2	() 2	DP3T slide switch	60-610	SW1, SW2
B3	() 1	Cushion strip	73-5	
B4	() 5	Alligator clip insulator	73-34	
B5	() 5	Grommet	73-45	
	() 1	Fish paper	75-103	
B6	() 1	Line cord strain relief	75-182	
B7	() 4	Circuit board standoff	75-710	



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
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HARDWARE

NOTE: The hardware may be in more than one packet.
Open all the hardware packets in this pack before you check
the hardware against the Parts List.

#1-#2-#3 Hardware

C1	() 4	1-78 x 1/4" flat head screw	250-1231
C2	() 2	#4 x 1/4" screw	250-420
C3	() 4	3-48 x 3/8" flat head screw	250-251
C4	() 4	3-48 nut	252-1
C5	() 4	#3 lockwasher	254-7

#4 Hardware

C6	() 4	4-40 x 1/8" setscrew	250-156
C7	() 8	4-40 x 1/4" screw	250-52
C8	() 3	4-40 x 5/16" black flat head screw	250-1106
C9	() 8	4-40 nut	252-15
C10	() 8	#4 lockwasher	254-9

#6 Hardware

C11	() 4	6-32 x 3/16" flat head screw	250-70
C12	() 11	#6 x 1/4" self-tapping screw	250-170
C13	() 12	6-32 x 1/4" screw	250-235
C14	() 8	6-32 x 1/4" flat head screw	250-416
C15	() 4	6-32 x 5/16" setscrew	250-100
C16	() 5	6-32 x 3/8" screw	250-89
C17	() 1	6-32 x 3/8" flat head screw	250-32
C18	() 4	#6 x 3/8" self-tapping flat head screw	250-441
C19	() 8	#6 x 3/8" hex head screw	250-475
C20	() 1	6-32 x 1/2" screw	250-162
C21	() 4	6-32 x 3/4" flat head screw	250-503
C22	() 19	6-32 nut	252-3
C23	() 21	#6 lockwasher	254-1
C24	() 1	#6 solder lug	259-1
C25	() 4	6-32 tapped hex spacer	255-188



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
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#8 Hardware

C26	() 4	8-32 x 1/2" screw	250-585	
C27	() 2	8-32 x 1" screw	250-97	
C28	() 6	8-32 nut	252-4	
C29	() 10	#8 lockwasher	254-2	
C30	() 2	#8 flat washer	253-45	

Other Hardware

C31	() 2	10-32 x 5/8" thumbscrew	250-1162	
C32	() 7	Control nut	252-7	
C33	() 5	Control flat washer	253-10	
C34	() 2	Large solder lug	259-27	
C35	() 1	Push-on nut	252-193	
C36	() 4	5/16" spacer	255-49	
C37	() 2	1-3/8" threaded spacer	255-66	

METAL PARTS

	() 1	Top cover	90-1109-2	
	() 1	Bottom cover	90-1110-2	
	() 1	Front subpanel	100-1676	
	() 1	Front panel	203-1723-1	
	() 1	Rear subpanel	200-1205	
	() 1	Left subpanel	200-1206	
	() 1	Right subpanel	200-1207	
	() 1	Rear panel	203-1631-1	
D1	() 1	Right shield bracket	204-2066	
D2	() 1	Left shield bracket	204-2067	
D3	() 2	Control bracket	204-2139	
	() 2	Side rail	205-1414	
	() 1	CRT shield	206-1120	
D4	() 1	CRT subshield	206-1205	
D5	() 2	CRT clamp	207-606	
	() 1	Rear panel ring	210-97	
	() 1	Front panel ring	210-98	
D6	() 1	CRT ring	210-76	
D7	() 1	Handle	211-61	
D8	() 2	Detent	266-807	

KNOBS-BUSHINGS-FEET

E1	() 5	Large black control knob	462-951	
E2	() 5	Concentric knob bushing	455-613	
E3	() 7	Small knob bushing	455-71	
E4	() 5	Small red knob	462-363	
E4	() 2	Small black knob	462-390	
E5	() 2	Black knob with skirt	462-399	



KEY No.	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
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Knobs-Bushings-Feet (cont'd.)

E6	() 2	Large knob bushing	455-50	
E7	() 2	Detent cover	462-908	
E8	() 2	Large nylon bearing	455-54	
E8	() 2	Small nylon bearing	455-62	
E9	() 8	Small rubber foot	261-1	
E10	() 4	Large rubber foot	261-9	

LABELS-CRT-WINDOW

	() 1	Danger label	390-147	
	() 1	Fuse replacement label	390-1255	
	() 1	Heathkit label	390-1213	
	() 1	Blue and white label	391-34	
	() 1	CRT (cathode ray tube)	411-815	
F1	() 1	Graticule	414-36	
F2	() 1	CRT window	446-646	
F3	() 1	CRT bezel	210-74	

MISCELLANEOUS

	() 1	Power transformer	54-919	
	() 1	Line cord	89-22	
	() 2	Test cable	134-237	
	() 1	Wire harness	134-940	
G1	() 2	1/8" coupling	456-36	
G1	() 2	1/4" coupling	456-7	
G2	() 1	Plastic clamp	207-38	
G3	() 1	Top handle grip	211-67	
G4	() 1	Bottom handle grip	211-68	
G5	() 2	Coil spring	258-192	
G6	() 5	Alligator clip	260-16	
G7	() 4	Cord retainer	261-39	
G8	() 1	Cable tie	354-6	
G9	() 2	Decorative insert	391-81	
G10	() 1	#53 lamp	412-17	PL1
G11	() 1	1/2-ampere slow-blow fuse	421-20	F1
G11	() 1	1-ampere slow-blow fuse	421-23	F1
G12	() 1	Fuse block	422-1	
G13	() 1	Terminal strip	431-14	
G14	() 4	BNC connector	432-59	
G15	() 1	Feed-through connector	432-893	
G16	() 1	CRT socket	434-41	
G17	() 1	Lamp socket	434-44	
G18	() 2	Long control shaft	453-271	
G18	() 2	Short control shaft	453-272	
G19	() 1	Allen wrench	490-23	
G20	() 1	Alignment tool	490-71	

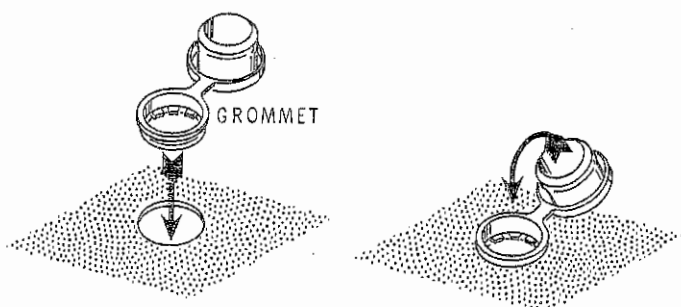


STEP-BY-STEP ASSEMBLY

REAR SUBPANEL ASSEMBLY

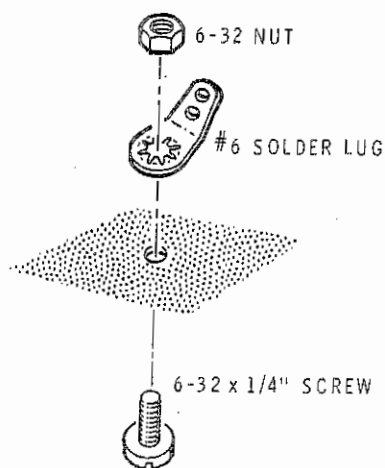
Refer to Pictorial 5-1 (in the "Illustration Booklet") for the following steps.

- () Position the rear subpanel as shown.
- () Refer to Detail 5-1A and install grommets in holes A, B, and C.



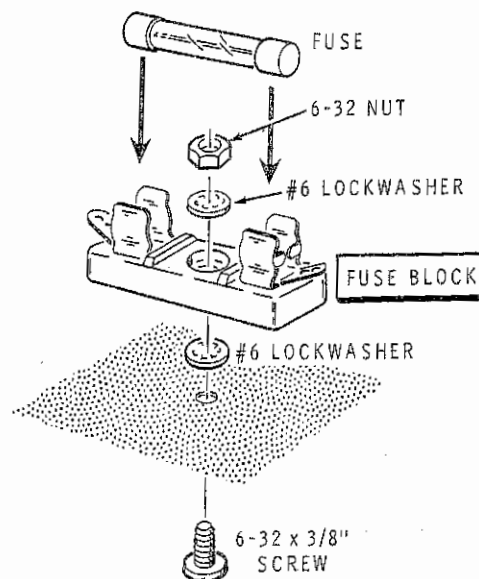
Detail 5-1A

- () Refer to Detail 5-1B and install a #6 solder lug at D with a 6-32 x 1/4" screw and a 6-32 nut. Position the solder lug as shown.



Detail 5-1B

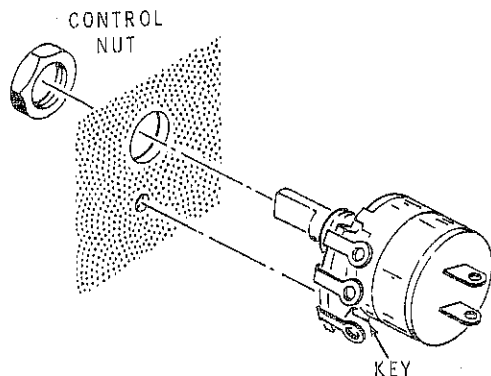
- () Refer to Detail 5-1C and install the fuse block at F1. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut.



Detail 5-1C

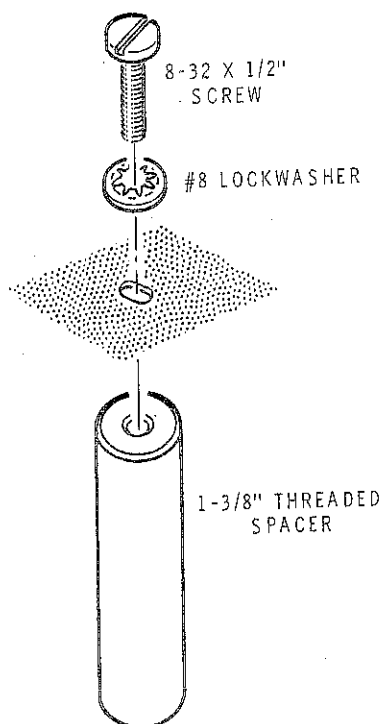
- () F1: If you intend to operate your Oscilloscope from 120 volts, install a 1-ampere slow-blow fuse at F1. However, if you intend to operate your Oscilloscope from 240 volts, install a 1/2-ampere slow-blow fuse.
- () Mark the fuse rating on the fuse replacement label (1-ampere for 120-volt operation, or 1/2-ampere for 240-volt operation). Then remove the paper backing and press the label onto the subpanel near the fuse block as shown in the Pictorial.
- () Push the circuit board standoffs into holes E, F, G, and H. See the inset drawing.

- () R2/SW3: Refer to Detail 5-1D and install a 10 k Ω control with switch (#19-716) at R2/SW3 with a control nut. Be sure the control key goes into the subchassis hole.



Detail 5-1D

- () R3: In a similar manner, install a 1 M Ω control (#10-1043) at R3 with a control nut.
- () Refer to Detail 5-1E and mount a 1-3/8" threaded spacer at J. Use an 8-32 x 1/2" screw and a #8 lockwasher. Center the screw in the slot.



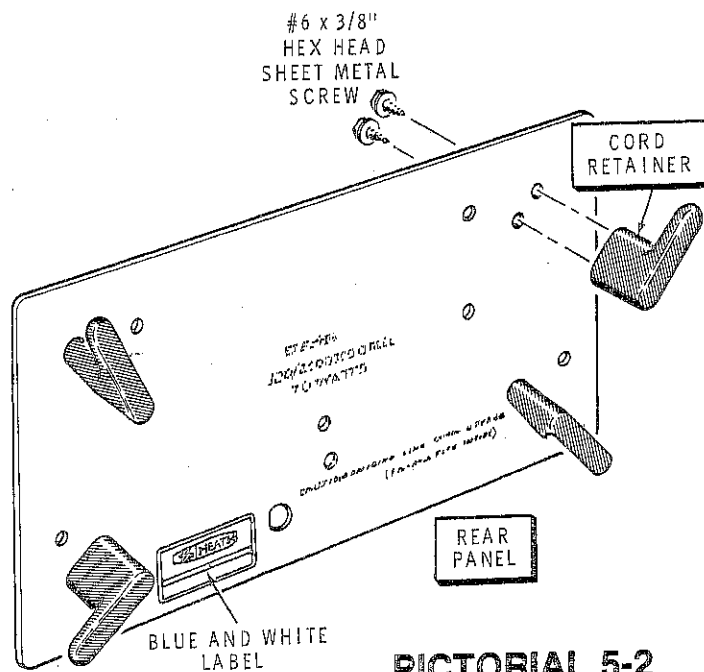
Detail 5-1E

- () Similarly, mount another 1-3/8" threaded spacer at K with an 8-32 x 1/2" screw and a #8 lockwasher.

- () Set this subpanel aside temporarily.

REAR PANEL ASSEMBLY

Refer to Pictorial 5-2 for the following steps.



PICTORIAL 5-2

- () Mount the four cord retainers to the rear panel with #6 x 3/8" hex head, sheet metal screws as shown. Be sure to fit the locating ridges on the retainers into the panel holes before you tighten the screws. DO NOT overtighten the screws.

- () Remove the backing paper from the blue and white label and press the label to the rear panel as shown. Refer to the numbers on this label in any communications you have with the Heath Company about this kit.

CHASSIS ASSEMBLY AND WIRING

Refer to Pictorial 5-3 (in the "Illustration Booklet") for the following steps.

- () Position the rear panel so that hole AA is as shown.

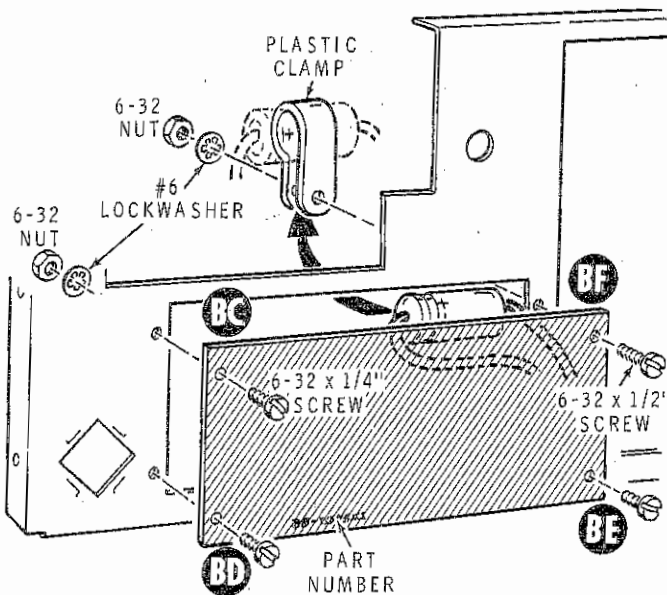
- () Mount the rear subpanel to the rear panel with three #6 x 1/4" sheet metal screws as shown.



- () Install a grommet in the left subpanel at hole BB.
- () Loosely attach the left subpanel to the rear panel and rear subpanel with four #6 x 1/4" sheet metal screws. Then tighten the four screws.
- () Install a grommet in the right subpanel at hole BA.
- () Loosely attach the right subpanel to the rear panel and rear subpanel with four #6 x 1/4" sheet metal screws. Then tighten the four screws.

NOTE: When hardware is called for in a step, only the screw size will be given. For instance, if "6-32 x 1/4" hardware" is called for, it means that a 6-32 x 1/4" screw, one or more #6 lockwashers, and a 6-32 nut should be used for each mounting hole. The Detail referred to in the step will show the proper number of lockwashers to use.

- () Refer to Detail 5-3A and mount the low voltage circuit board to the right subpanel. Use three sets of 6-32 x 1/4" hardware at corners BC, BD, and BE. Be sure to position the circuit board so the part number is as shown. Do not pinch any wires between the circuit board and the subpanel. Also, be sure the circuit board does not protrude into other cutout areas of the subpanel.



Detail 5-3A

- () At hole BF, secure the indicated capacitor to the subpanel [with the positive (+) end as shown] with a plastic clamp and 6-32 x 1/2" hardware. Be sure neither the capacitor nor its leads protrude into the area where the horizontal circuit board goes.

NOTE: The next two circuit boards must mount flush against the subpanels. When you install these boards, refer to the inset drawing and check along the edge of the rectangular cutout in the subpanel to see if any excess solder or wire ends are keeping the circuit board from fitting properly against the subpanel. Reheat or trim connections as necessary to make the circuit boards fit properly. (The circuit boards must fit properly so the switch shafts will line up properly with the front panel.)

- () Loosely mount the vertical circuit board (#85-1538) to the left subpanel with six sets of 4-40 x 1/4" hardware.
- () In a similar manner, loosely mount the horizontal circuit board (#85-1539) to the right subpanel with four sets of 6-32 x 1/4" hardware. Be careful that you do not pinch any wires between the circuit board and the subpanel.
- () Refer to Detail 5-3B (in the "Illustration Booklet") and temporarily mount the front subpanel to the left and right subpanels with four #6 x 3/8" flat head sheet metal screws.
- () Install and tighten five control nuts on the five shafts protruding through the front subpanel. Tighten all the screws that hold both the vertical and horizontal circuit boards and the two screws holding switch SW203. Then remove the five control nuts.

Refer to Pictorial 5-4 (in the "Illustration Booklet") for the following steps.

- () Prepare a 4" smaller yellow wire and connect it between vertical circuit board holes C (S-1) and G (S-1).
- () Prepare two 9" blue wires.
- () Connect one blue wire to hole N (S-1).
- () Connect the other blue wire to hole P (S-1). The free ends of these wires will be connected later.

In the following steps, connect the wires coming from the foil side of the horizontal circuit board to the foil side of the vertical circuit board. Solder each wire as you connect it. Do not shorten any of the wires, but route and group the wires as shown in Detail 5-4A.

- () White-orange to hole J.
- () White-green to hole A.
- () White-blue to hole E.
- () White-gray to hole L.
- () White-yellow to hole K. Route this wire as shown.

The white-red wire and the twin lead will be connected later. Also the two blue wires coming from the vertical circuit board will be connected later.



Refer to Pictorial 5-5 (in the "Illustration Booklet") for the following steps.

- () Refer to Detail 5-5A (in the "Illustration Booklet") and form the wire harness as shown.

NOTE: In the following steps, the term "BO" (breakout) refers to a place where a group of wires come out of the harness. Each breakout is identified by a number.

- () Refer to the Pictorial and route BO #16 (breakout #16), BO#15, BO#14, BO#17, and BO#13 through grommet BA.
- () Route BO's #16, 15, 14, and 17 through grommet BB.
- () Route BO's #16 and 15 through grommet A.
- () Route BO#12 through grommet C.
- () Position the remaining breakouts as shown in the Pictorial.

Refer to Pictorial 5-6 (in the "Illustration Booklet") for the following steps.

In the following steps, connect the wires coming from the indicated breakouts. Solder each wire as you connect it to the horizontal circuit board. NOTE: Be very careful that solder does not flow down onto nearby foils and cause a solder bridge.

BO #8

- () Orange to hole ORG +15 V.
- () White-brown to hole AR.
- () Gray to hole GRY -15V.
- () White-violet to hole AP.

BO #9

- () Brown to hole BRN-5V.

BO #10

- () Either orange to either hole ORG +15V.
- () Other orange to other hole ORG +15V.
- () Either gray to either hole GRY -15V.
- () Other gray to other hole GRY -15V.
- () White-brown — route this wire through the indicated hole. It will be connected later.

BO #5

- () Either red to either hole RED +170V.
- () Other red to other hole RED +170V.

BO #6

- () Orange to hole ORG +15V.
- () Black to hole BLK/GND.
- () Gray to hole GRY -15V.

BO #7

Twisted red and white.

- () White to hole AC.
- () Red to hole AD.
- () Yellow to hole YEL +5V.

In the following steps, connect the wires coming from the indicated breakout to the low voltage circuit board. Solder each wire as you connect it.

BO #4

- () Either yellow to either hole +5VDC/YEL.
- () Other yellow to other hole +5VDC/YEL.
- () Brown to hole -5VDC/BRN.

BO #3

- () Three orange wires to three holes +15VDC/ORG.

BO #2

- () Three black wires to three holes GND.
- () Three gray wires to three holes -15VDC/GRY.

BO #1

- () White-red to hole +150V/WHT-RED.
- () Either red to hole +170V/RED.

The other red wire will be connected later.

BO #11

- () Two twisted green wires to two holes PL-1/GRN.

Refer to Pictorial 5-7 (in the "Illustration Booklet") for the following steps.

In the following steps, connect the wires coming from BO #17 to the vertical circuit board. Solder each wire as you connect it.

- () Either gray to either -15V/GRY.
- () Other gray to other -15V/GRY.
- () Either orange to either +15V/ORG.
- () Other orange to other +15V/ORG.
- () Yellow to switch SW102-2 lug 2 (S-1). Another wire was previously soldered to this lug.

Connect the wires coming from BO #14 as follows:

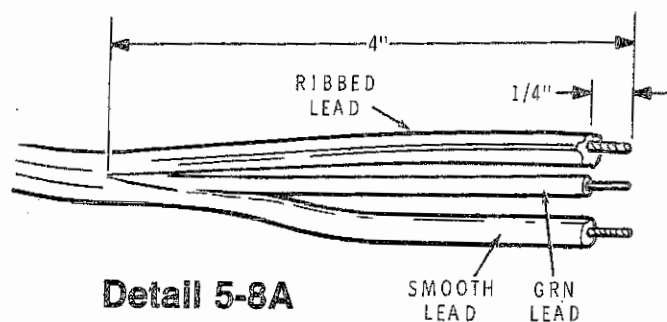
- () Black to GND/BLK.
- () White-red to +150/RED-WHT.

Refer to Pictorial 5-8 (in the "Illustration Booklet") for the following steps.

- () Reposition the Oscilloscope as shown.
- () SW4: Temporarily mount the 120-240 switch as shown with one 6-32 x 1/4" screw. Be sure the lugs with the shorting wire are positioned up as shown.
- () Set the switch to 120 or 240, depending on the line voltage that you will operate the Oscilloscope on.
- () SW5: Temporarily mount the NOR-LOW switch as shown with one 6-32 x 1/4" screw. Be sure LOW is showing on the switch and it is positioned as shown in inset drawing #1.

NOTE: One of the line cord leads is marked with a rib as shown in inset drawing #2. Be sure you identify this ribbed lead in the next step.

- () Refer to Detail 5-8A and carefully prepare the line cord leads as shown. Then twist and melt a small amount of solder on the bare wire ends.



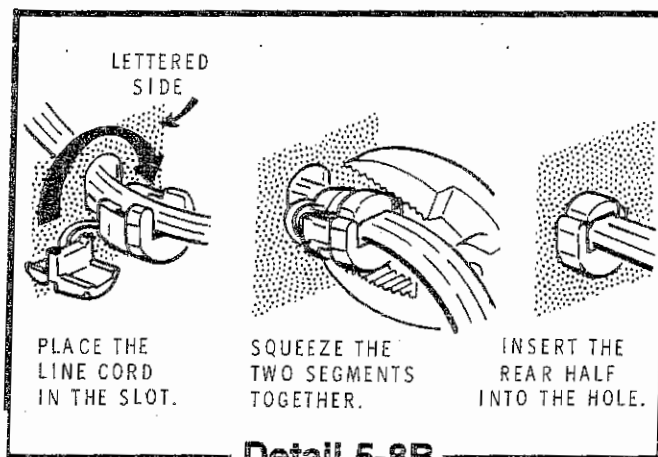
Detail 5-8A

- () Pass the prepared end of the line cord through hole AA from the lettered side of the rear panel.

In the following steps, wrap the leads around the lugs to make mechanically secure connections as shown in inset drawing #3.

Connect the line cord leads as follows:

- () Green lead to solder lug D (S-1).
- () Smooth lead to fuseholder F1 lug 1 (S-1).
- () Ribbed lead to switch SW4 lug 6 (NS).
- () Refer to Detail 5-8B and secure the line cord in rear panel hole AA with the strain relief.



Detail 5-8B

- () Securely wrap the line cord around the cord retainers on the rear panel.
- () Prepare two 7" larger black wires. Twist the bare ends and apply a small amount of solder to hold the wire strands together.





- () Connect one 7" larger black wire from fuseholder F1 lug 2 (S-1) to switch R2/SW3 lug 5 (S-1). Make mechanically secure connections.
- () Connect the other 7" larger black wire from switch R2/SW3 lug 4 (S-1) to switch SW4 lug 3 (NS). Make mechanically secure connections.
- () Prepare a 13" larger red wire.
- () Connect one end of the 13" larger red wire to control R3 lug 2 (S-1). Route the free end through grommet B; it will be connected later.
- () Position the high voltage circuit board as shown and route the following wires through grommet B. They will be connected later. (Do not mount the circuit board down onto the plastic standoffs until you are instructed to do so.)
- () Green from hole M.
- () Two brown from holes J and L. Twist these leads together as shown before you route them.
- () Orange from hole G.
- () Yellow from hole K.

Connect and solder the wire harness wires coming from grommet C to the circuit board as follows:

- () Short red to hole F.
- () White to hole H.
- () Long red to hole +170V.

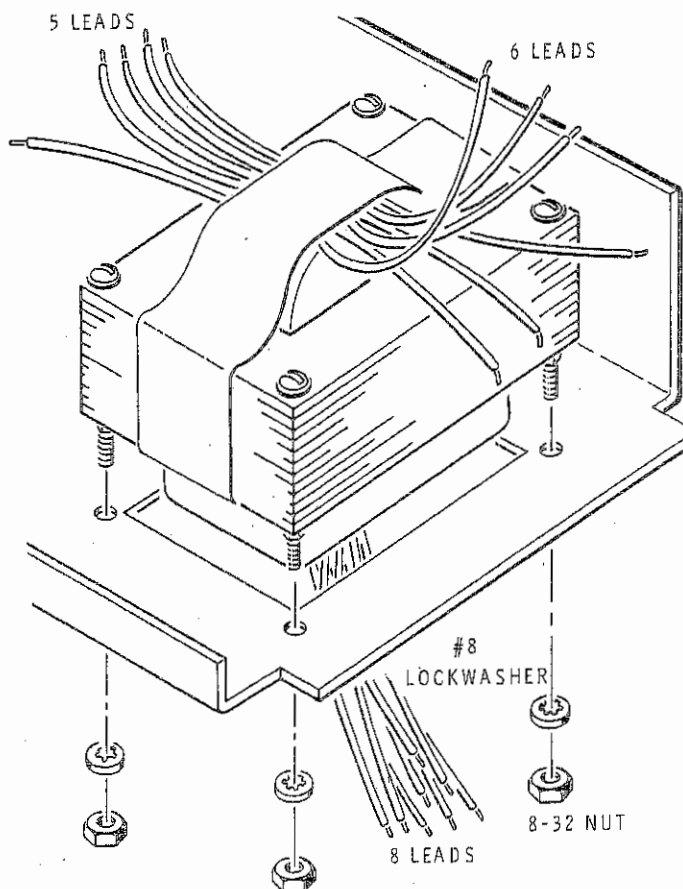
Connect and solder the five wire harness wires coming from grommet A to the circuit board as follows:

- () Red to hole +170V.
- () Orange to hole +15V/ORG.
- () Gray to hole -15V/GRY.
- () White-violet to hole CHOP BLANK IN.
- () Black to hole GND.
- () Cut each lead of a 1.5 M Ω , 1-watt, 10% (brown-green-green) resistor 3/4" from the resistor body.

- () R8: Connect the prepared 1.5 M Ω resistor to control R3, between lugs 1 (NS) and 3 (NS). Position the resistor body away from the control body.

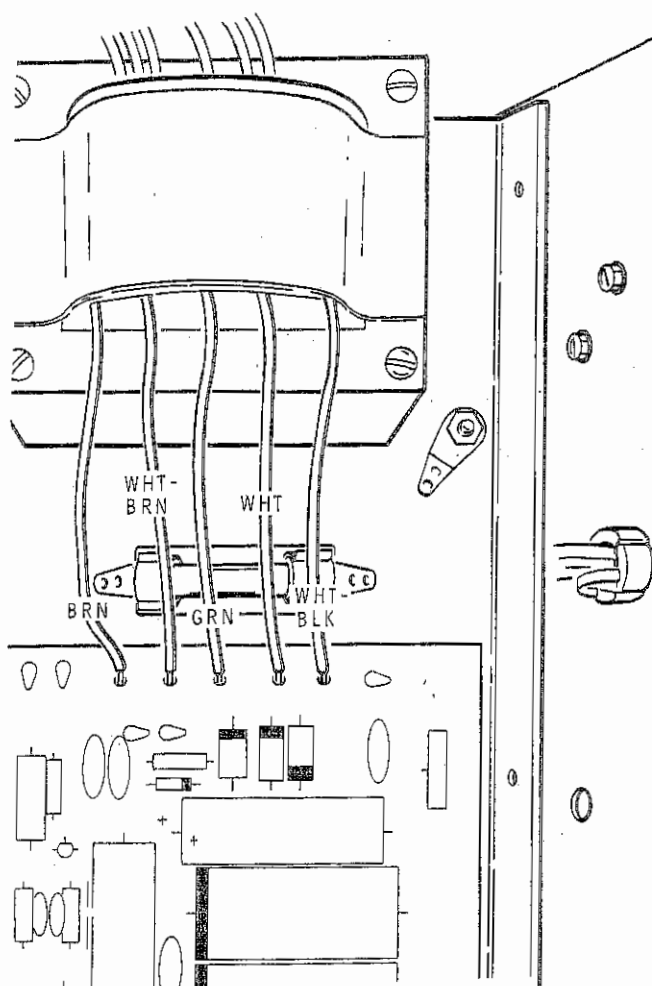
In the following steps, connect and solder the remaining wires coming from the circuit board as follows:

- () Yellow from hole D to control R3 lug 1 (S-2).
- () Red from hole B to control R3 lug 3 (S-2).
- () Red from hole A to control R2/SW3 lug 3 (S-1).
- () Orange from hole C to control R2/SW3 lug 2 (S-1).
- () Yellow from hole E to control R2/SW3 lug 1 (S-1).
- () T1: Refer to Detail 5-8C, be sure the leads are positioned as shown, and mount the transformer with four #8 lockwashers and four 8-32 nuts. Do not pinch any wires between the transformer and chassis.



Detail 5-8C



**Detail 5-8D**

Refer to Detail 5-8D and connect and solder the five indicated transformer leads to the high voltage circuit board as follows:

- () Brown to hole BRN.
- () White-brown to hole WHT/BRN.
- () Green to hole GRN.
- () White to hole WHT.
- () White-black to hole WHT/BLK.
- () Position the circuit board so the four circuit board standoffs line up with the circuit board holes. Then push the circuit board down until the standoffs latch in place. See inset drawing #4 on the Pictorial.

Refer to Pictorial 5-9 (in the "Illustration Booklet") for the following steps.

- () Prepare two 1-1/2" larger black wires. Twist the bare ends and apply a small amount of solder to hold the wire strands together.

NOTE: In the following steps, be sure to make mechanically secure connections.

- () Connect one 1-1/2" larger black wire between switch SW4 lug 2 (S-1) and switch SW5 lug 2 (S-1).
- () Connect the other 1-1/2" larger black wire between switch SW4 lug 5 (S-1) and switch SW5 lug 5 (S-1).

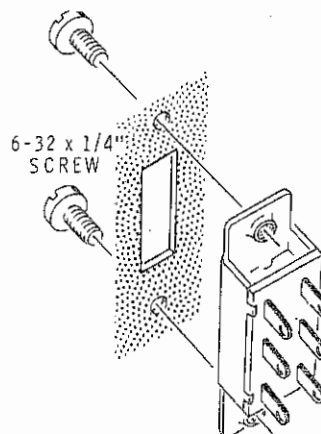
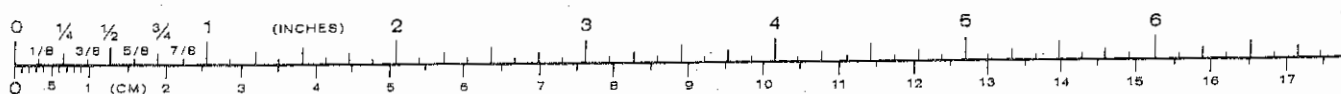
Connect transformer leads to switch SW4 as follows:

- () Black to lug 6 (S-2). Wrap the bare end around the switch lug if necessary.
- () Black-red to lug 3 (S-2). Wrap the bare end around the switch lug if necessary.

Connect transformer leads to switch SW5 as follows:

- () Black-yellow to lug 3 (S-1).
- () Black-green to lug 6 (S-1).
- () Black-gray to lug 1 (S-1).
- () Black-white to lug 4 (S-1).
- () Refer to Detail 5-9A, remove the two screws that hold the two switches, position the switches down into their permanent positions, and secure them in place with four 6-32 x 1/4" screws.

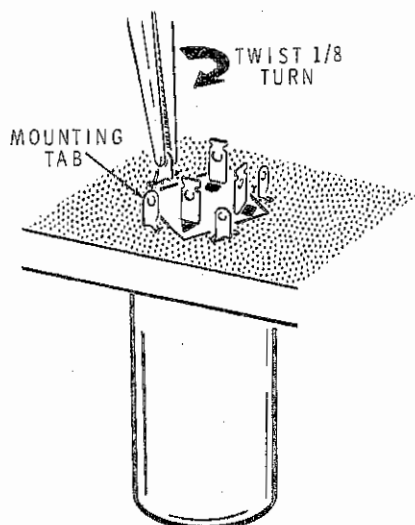
- () Install a cable tie around the six transformer leads, pull it tight, and cut off the excess length of cable tie.

**Detail 5-9A**



Refer to Pictorial 5-10 (in the "Illustration Booklet") for the following steps.

- () C3: Refer to Detail 5-10A and mount the 100-100-300 μ F electrolytic capacitor to the right subpanel as shown. Be sure to position the three center lugs as shown. Then twist the four mounting lugs 1/8 turn.



Detail 5-10A

- () R4: Cut both leads of a 47 k Ω (yellow-violet-orange), 1-watt resistor to 1/2". Then connect it between capacitor C3 lugs 3 (NS) and 4 (NS).

Connect the low voltage circuit board wires to capacitor C3 as follows:

- () Black to lug 4 (S-2).
- () White-blue to lug 1 (S-1).
- () Red to lug 2 (NS).
- () White-red to lug 3 (S-2).
- () Connect the red harness wire to capacitor C3 lug 2 (S-2).

Connect the power transformer leads to the low voltage circuit board as follows:

- () Short red to the indicated hole RED (S-1).
- () Long red to the other hole RED (S-1).
- () White-yellow to the hole WHT/YEL (S-1).

- () Either yellow to either hole YEL (S-1).
- () Other yellow to the other hole YEL (S-1).
- () Either orange to either hole ORG (S-1).
- () Other orange to the other hole ORG (S-1).
- () White-orange to hole WHT/ORG (S-1).

Refer to Pictorial 5-11 (in the "Illustration Booklet") for the following steps.

In the following steps connect the wires coming from grommet B to the CRT socket. Be sure to count the socket lugs by starting at the keyway.

Twisted brown wire pair:

- () Either wire to lug 12 (S-1).
- () Other wire to lug 1 (S-1).
- () Orange to lug 2 (S-1).
- () Yellow to lug 3 (S-1).
- () Red to lug 4 (S-1).
- () Green to lug 8 (S-1).

Connect the wires coming from the vertical circuit board to the CRT socket as follows:

- () Blue from hole N to lug 6 (S-1).
- () Blue from hole P to lug 7 (S-1).

Connect the twin lead coming from the horizontal circuit board to the CRT socket as follows:

- () Lead from hole H to lug 9 (S-1).
- () Lead from hole G to lug 10 (S-1).

FRONT PANEL ASSEMBLY

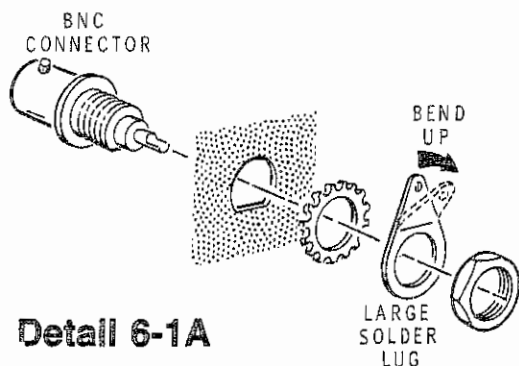
Refer to Pictorial 6-1 (in the "Illustration Booklet") for the following steps.

- () Remove the four screws that hold the front subpanel to the left and right subpanels, and position the front subpanel as shown. Set the rest of the chassis aside temporarily.



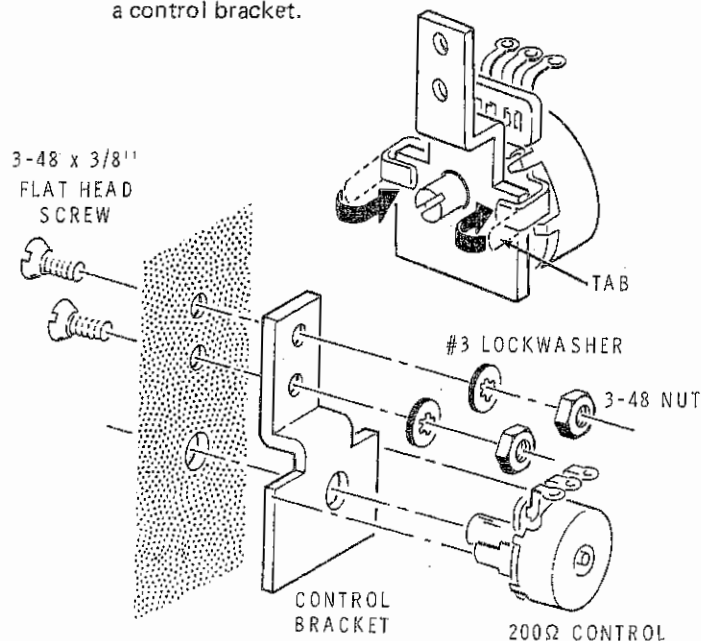


- () Refer to Detail 6-1A and mount a BNC connector, with its hardware, at Y1. Use a large solder lug and position it as shown. Then bend the solder lug up as shown.



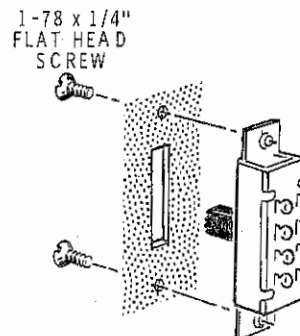
Detail 6-1A

- () In a similar manner, mount another BNC connector and large solder lug at Y2. Bend the solder lug up as shown.
- () Mount a BNC connector at CA. Use only the hardware supplied with the connector.
- () In a similar manner, mount another BNC connector at CB.
- () Refer to Detail 6-1B and mount a 200 Ω control (#10-1058) on a control bracket. Bend the control tabs over as shown and be sure the control lugs are positioned as shown.
- () In a similar manner, mount another 200 Ω control on a control bracket.



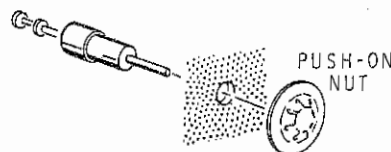
Detail 6-1B

- () R5: Refer again to Detail 6-1B and mount a control bracket at R5. Use two sets of 3-48 x 3/8" flat head hardware. Be sure the control knob lines up behind its hole in the front subpanel.
- () R6: In a similar manner, mount the other control bracket at R6.
- () SW1: Refer to Detail 6-1C and mount a DP3T switch at SW1. Use two 1-78 x 1/4" flat head screws.



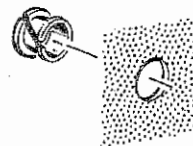
Detail 6-1C

- () SW2: In a similar manner, mount another DP3T switch at SW2.
- () Refer to Detail 6-1D and mount a feed-through connector at CG with a push-on nut. The connector is fragile — be careful not to break it off.



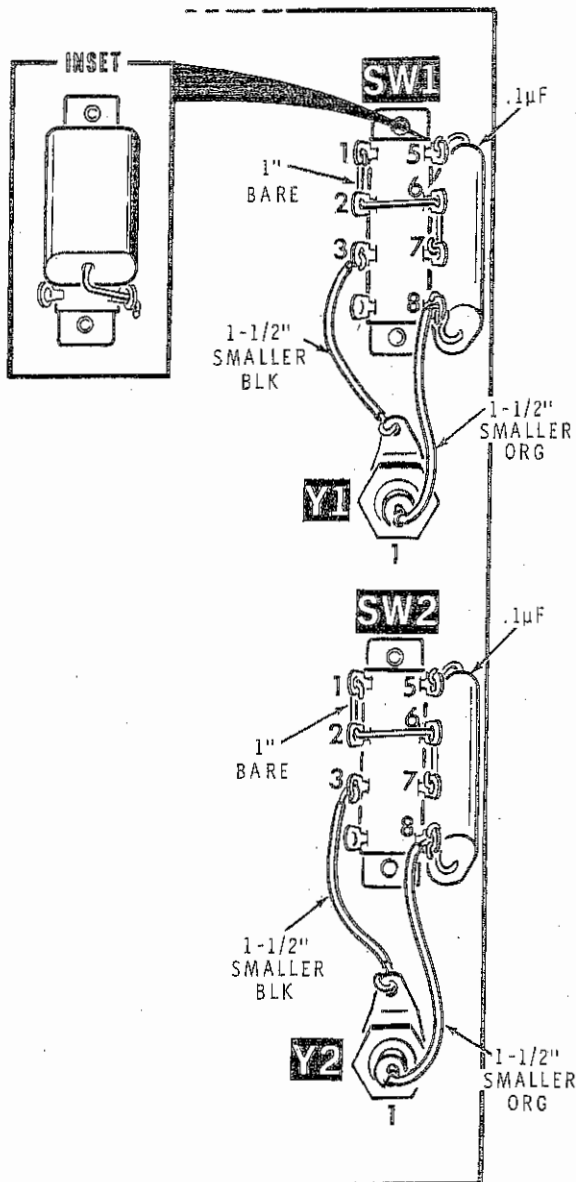
Detail 6-1D

- () Refer to Detail 6-1E and (from the front of the subpanel) install two large nylon bearings in holes CC and CD.



Detail 6-1E

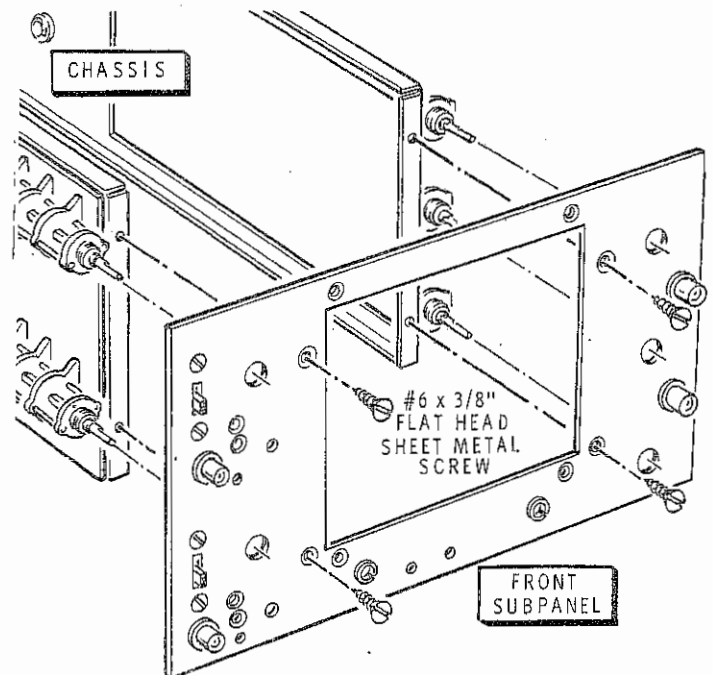
- () In a similar manner, install two small nylon bearings in holes CE and CF.

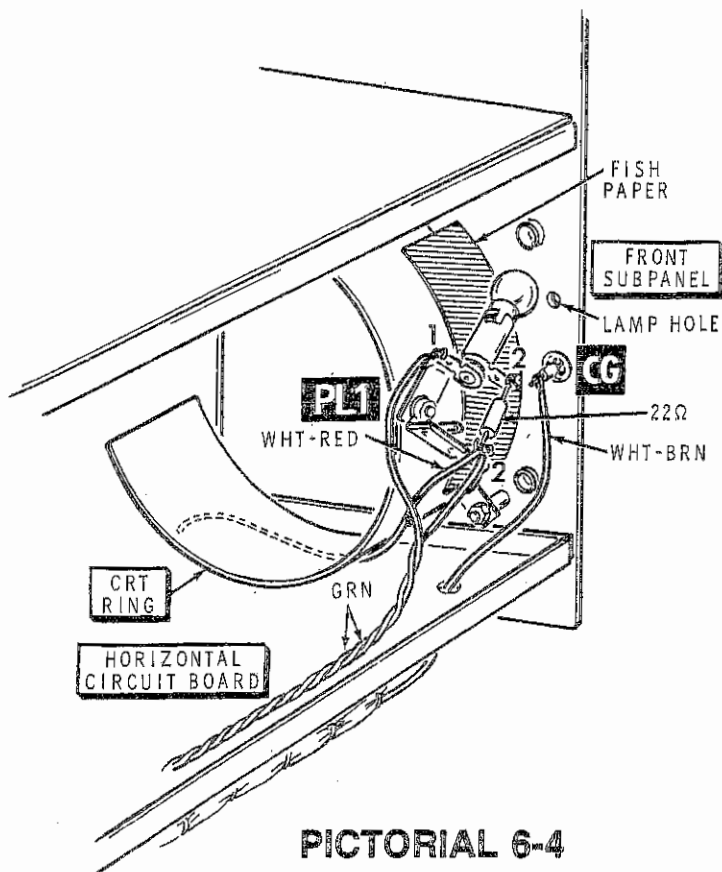
**PICTORIAL 6-2**

Refer to Pictorial 6-2 for the following steps.

- () Prepare the following wires:
 - Two 1-1/2" smaller black
 - Two 1-1/2" smaller orange
 - Two 1" bare
- () Connect a 1-1/2" smaller black wire from the solder lug of connector Y1 (S-1) to switch SW1 lug 3 (NS).
- () Connect a 1-1/2" smaller orange wire from connector Y1 lug 1 (S-1) to switch SW1 lug 8 (NS).

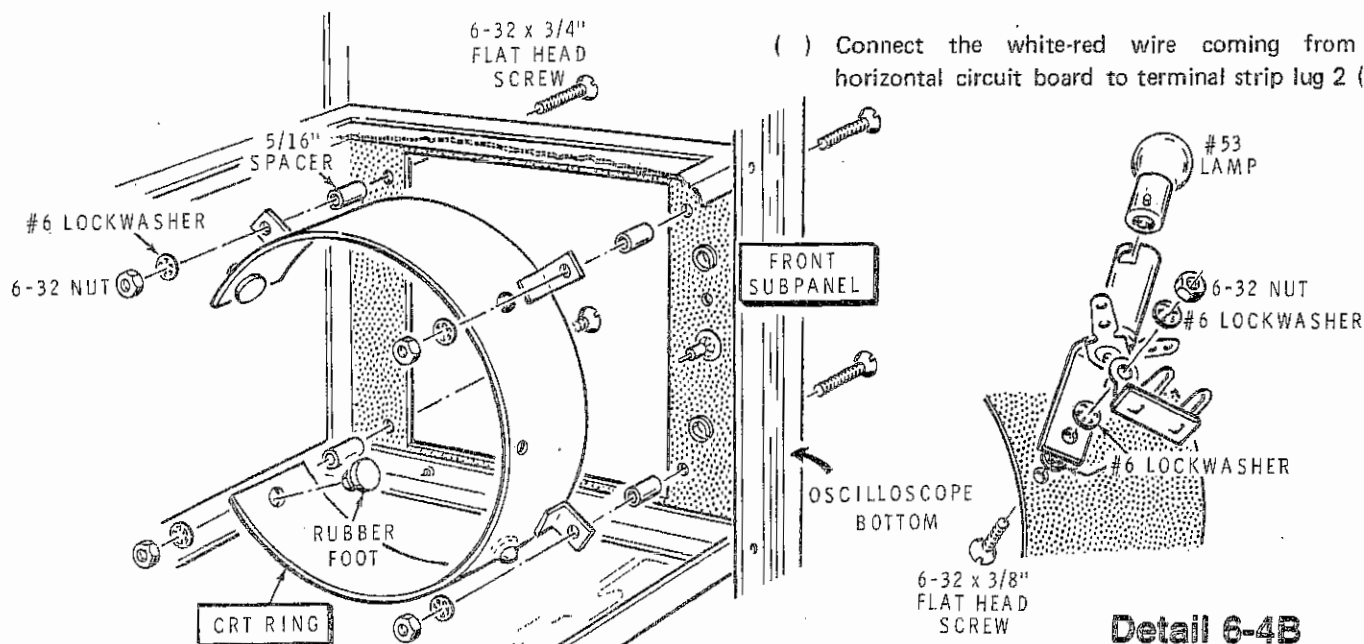
- () Connect a 1" bare wire from switch SW1 lug 1 (S-1), through lug 2 (S-2), through lug 6 (S-2), to lug 7 (S-1).
- () C1: Connect a .1 μ F capacitor between switch SW1 lugs 5 (S-1) and 8 (S-2). Position the capacitor as shown in the inset drawing. (This capacitor is not polarized and may be installed either way.)
- () Connect a 1-1/2" smaller black wire from the solder lug of connector Y2 (S-1) to switch SW2 lug 3 (NS).
- () Connect a 1-1/2" smaller orange wire from connector Y2 lug 1 (S-1) to switch SW2 lug 8 (NS).
- () C2: Connect a .1 μ F capacitor between switch SW2 lugs 5 (S-1) and 8 (S-2). Position the capacitor down against the switch as shown in the inset drawing. (This capacitor is not polarized and may be installed either way.)
- () Refer to Pictorial 6-3 and mount the front subpanel to the chassis. Use four #6 x 3/8" flat head sheet metal screws. Be careful you do not pinch any wires between the metal parts.

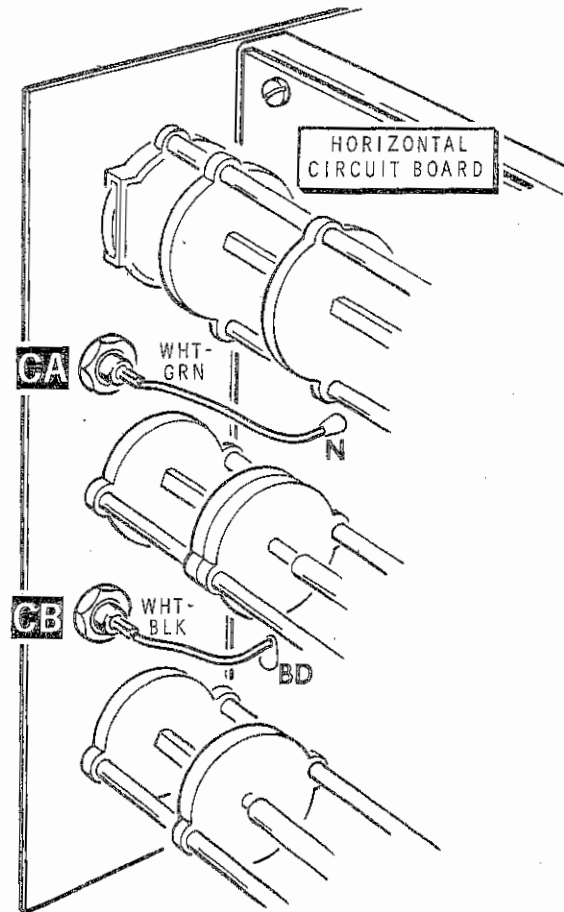
**PICTORIAL 6-3**


PICTORIAL 6-4

Refer to Pictorial 6-4 for the following steps.

- () Refer to Detail 6-4A and install four rubber feet in the CRT ring.
- () Mount the CRT ring to the front subpanel with four sets of 6-32 x 3/4" flat head hardware and four 5/16" spacers as shown.
- () Refer to the Pictorial. Then cut the piece of fish paper to 3-3/4" x 3/4", remove the protective paper backing, and mount the fish paper onto the CRT ring so the straightest edge of the paper is tight against the front subpanel. (This will keep light from leaking from the pilot lamp to the CRT face.)
- () Refer to Detail 6-4B and install a #53 lamp in the lamp socket.
- () Mount the lamp socket and terminal strip to the CRT ring with 6-32 x 3/8" flat head hardware. Position the socket so the lamp is behind the lamp hole.
- () Connect the white-brown wire coming from the hole in the horizontal circuit board to connector CG (S-1).
- () Cut both leads of the 22 Ω resistor to 1/2".
- () Connect the resistor between pilot lamp lug 2 (S-1) and terminal strip lug 2 (NS).
- () Locate the two twisted green wires coming from the wire harness and route them as shown.
- () Connect either of the twisted green wires to pilot lamp lug 1 (S-1).
- () Connect the other twisted green wire to terminal strip lug 2 (NS).
- () Connect the white-red wire coming from the horizontal circuit board to terminal strip lug 2 (S-3).


Detail 6-4A
Detail 6-4B



PICTORIAL 6-6

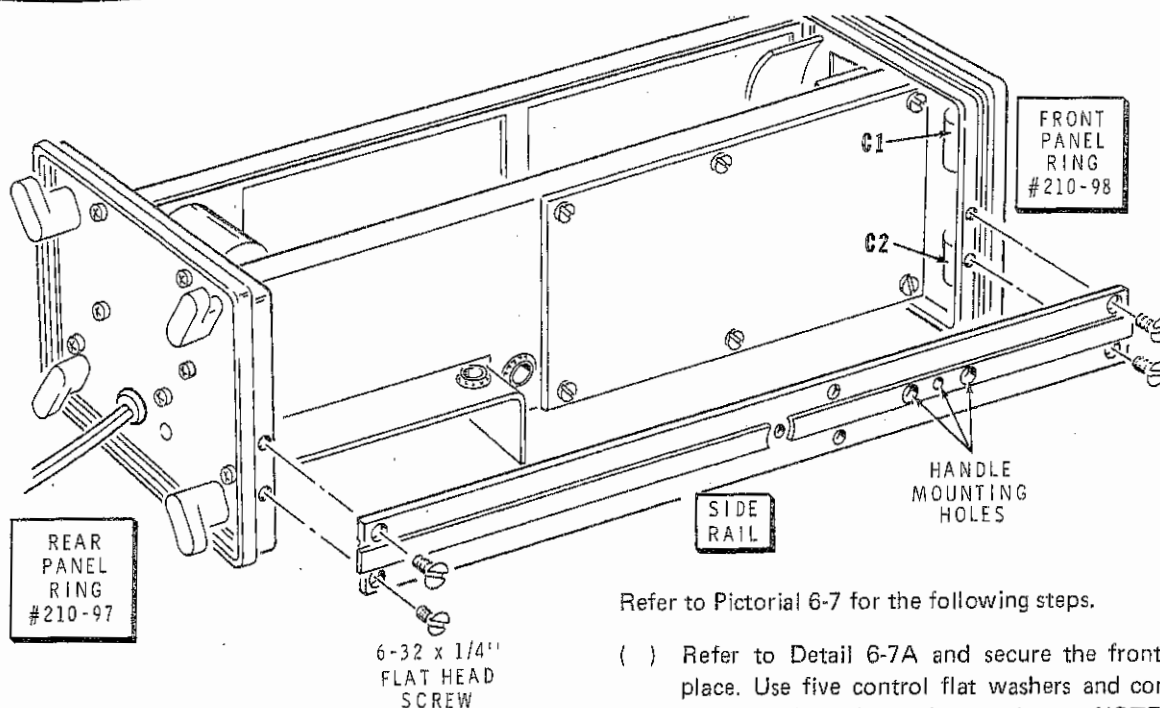
Refer to Pictorial 6-5 (in the "Illustration Booklet") for the following steps.

Connect the free ends of the remaining vertical circuit board wires as follows:

- () Black from hole R to switch SW1 lug 3 (S-2). Wrap the wire end around the lug.
- () Orange from switch SW101-1 to switch SW1 between lugs 1 and 2 (S-1).
- () Remove an additional 1/4" of insulation from the end of the white-gray wire coming from hole X. Then route this wire through control R5 lug 1 (S-2) to lug 2 (S-1).
- () White-black from hole U to control R5 lug 3 (S-1).
- () Black from hole Y to switch SW2 lug 3 (S-2). Wrap the wire end around the lug.
- () Orange from switch SW101-2 to switch SW2 between lugs 1 and 2 (S-1).
- () Remove an additional 1/4" of insulation from the end of the white-gray wire coming from hole AC. Then route this wire through control R6 lug 1 (S-2) to lug 2 (S-1).
- () White-black from hole AB to control R6 lug 3 (S-1).

Refer to Pictorial 6-6 for the following steps.

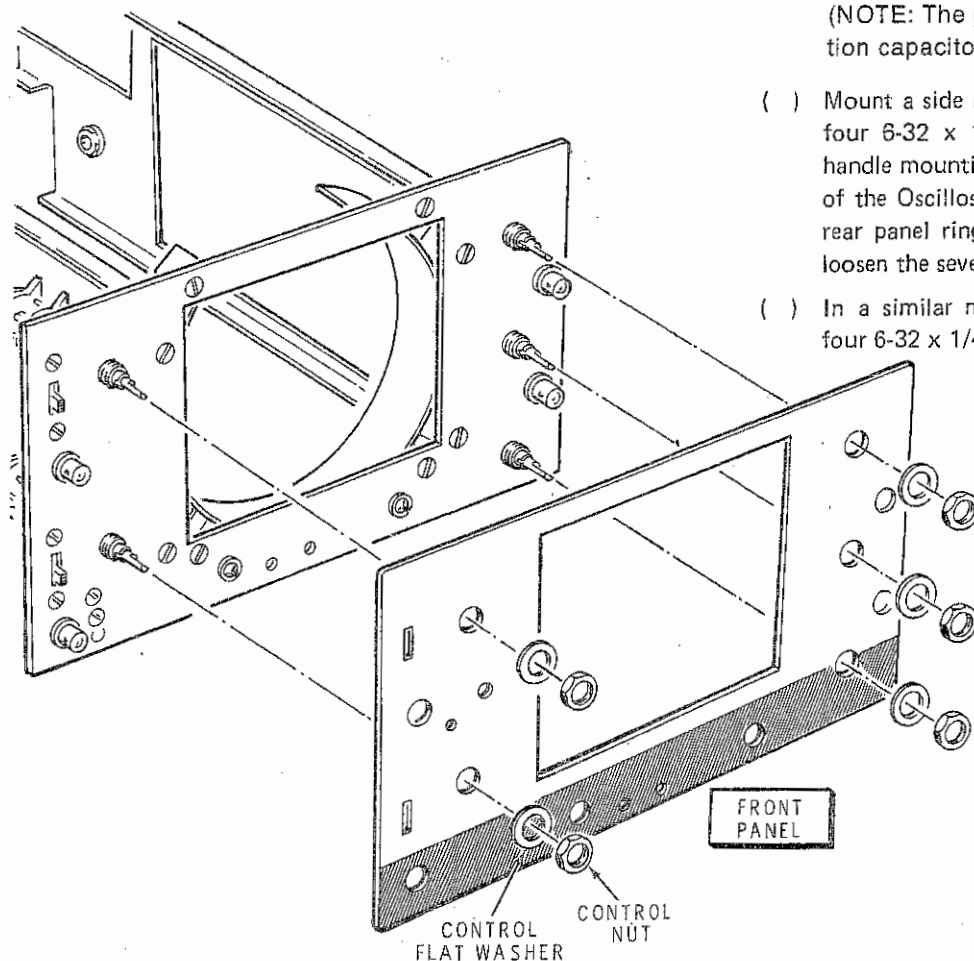
- () Connect the white-green wire coming from horizontal circuit board hole N to BNC connector CA (S-1).
- () Connect the white-black wire coming from hole BD to BNC connector CB (S-1).



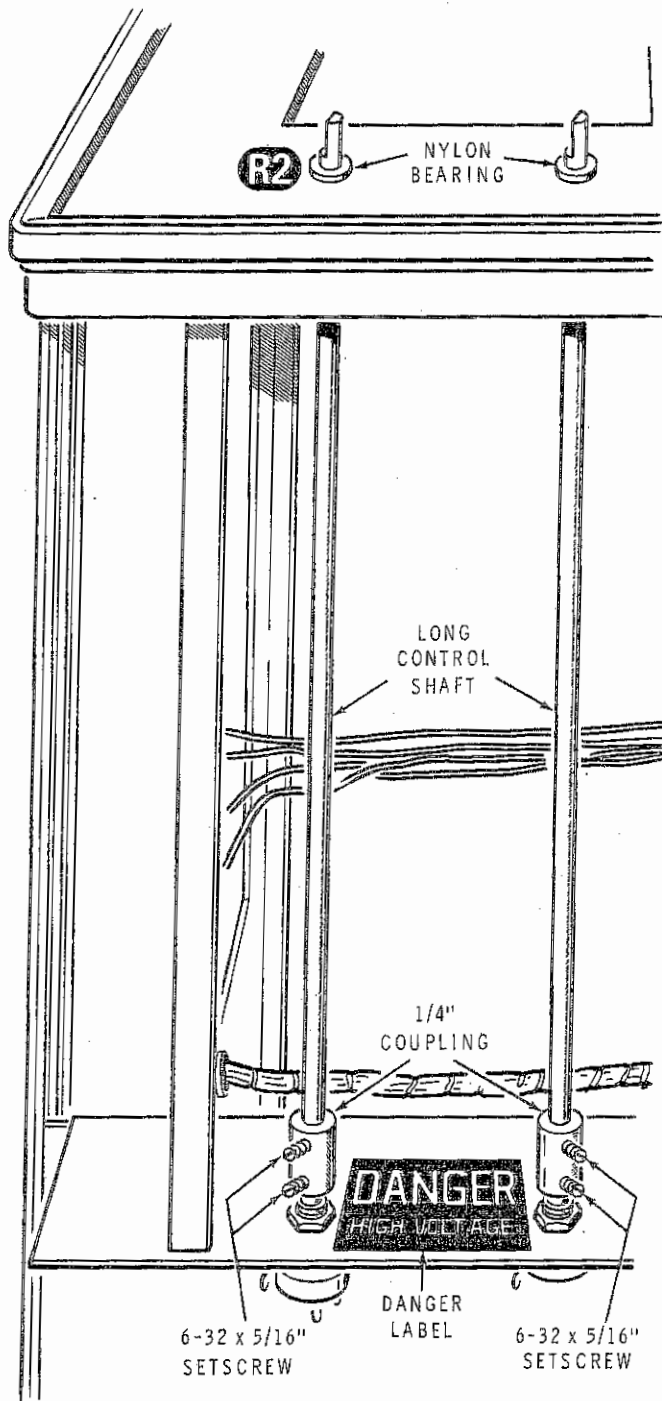
PICTORIAL 6-7

Refer to Pictorial 6-7 for the following steps.

- () Refer to Detail 6-7A and secure the front panel in place. Use five control flat washers and control nuts on the indicated switches as shown. NOTE: Do not overtighten these control nuts.
- () Refer to the Pictorial and position the front (#210-98) and rear panel (#210-97) rings over the front and rear panels. Position them so the side rail mounting holes are near the bottom as shown. (NOTE: The panel rings are not identical.) Reposition capacitors C1 and C2 as necessary.
- () Mount a side rail to the front and rear panel rings. Use four 6-32 x 1/4" flat head screws and be sure the handle mounting holes are positioned toward the front of the Oscilloscope as shown. Install the screws in the rear panel ring first. (In some cases you may need to loosen the seven rear panel screws.)
- () In a similar manner, mount the other side rail with four 6-32 x 1/4" flat head screws.



Detail 6-7A



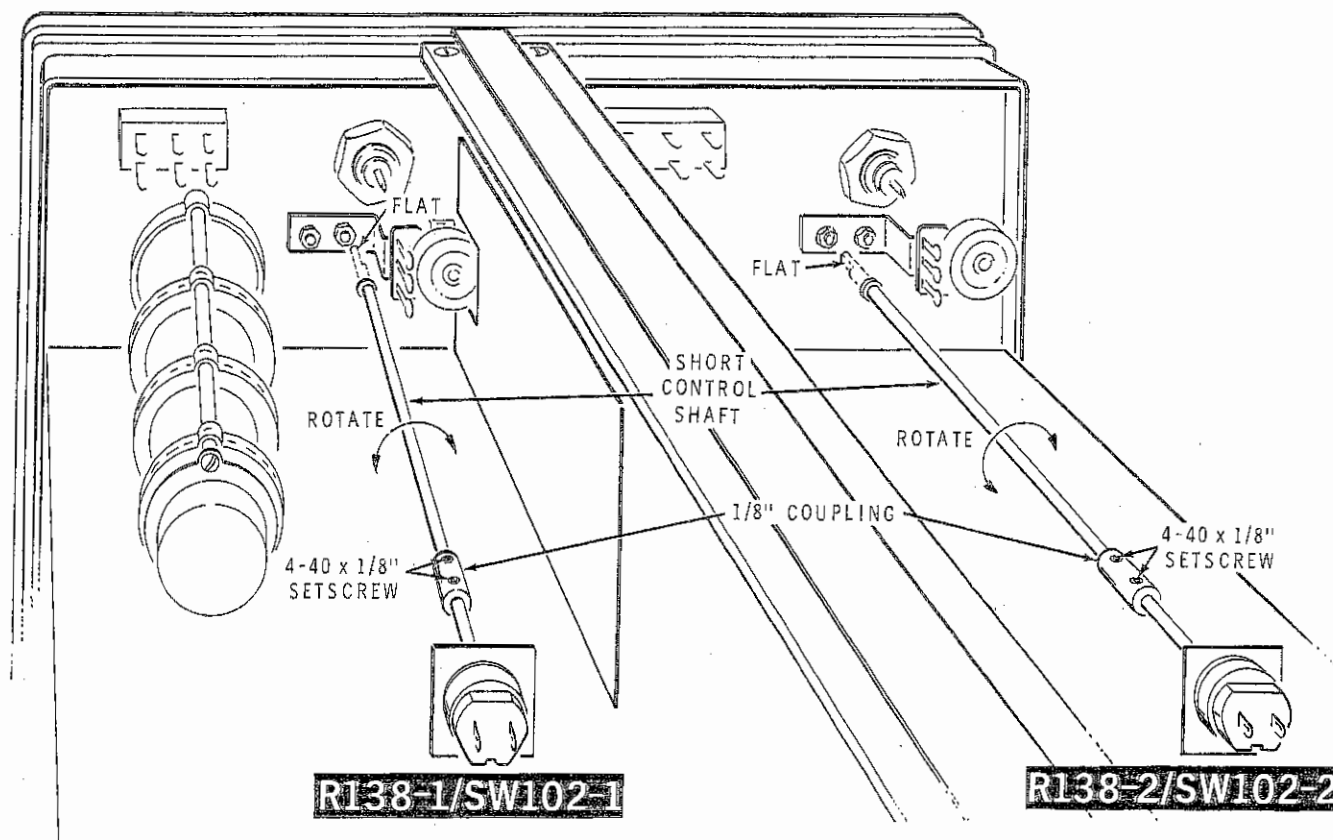
PICTORIAL 6-8

Refer to Pictorial 6-8 for the following steps.

- () Remove the backing paper from the danger label and apply the label as shown.
- () Start two 6-32 x 5/16" setscrews into each of the 1/4" couplings.
- () Place the couplings about halfway down over the shaft of both subchassis controls. Then tighten the lower setscrew of each coupling against the flat of the control shaft. DO NOT overtighten the setscrews!
- () Slide a long control shaft through each of the two indicated nylon bearings, and down into each coupling. NOTE: The flattened end of both shafts must extend above the front panel as shown. However, their rotational position is not important.
- () Temporarily tighten the upper setscrew of both couplings.
- () Turn both shafts fully counterclockwise. Shaft R2 should click to OFF.

Refer to Pictorial 6-9 for the following steps.

- () Start two 4-40 x 1/8" setscrews into each of the 1/8" couplings. Use the allen wrench supplied with your kit.
- () Place the 1/8" couplings about halfway down over the shaft of both controls R138-1/SW102-1 and R138-2/SW102-2. Then tighten one setscrew of each coupling against the control shaft. Carefully bend nearby circuit board parts out of the way as necessary.
- () Slide a short control shaft through each of the two indicated small nylon bearings and down into each coupling. NOTE: The flattened end of both shafts must extend out of the front panel. However, their rotational position is not important.
- () Temporarily tighten the upper setscrew of both couplings.
- () Rotate both control shafts as far as they will go both ways to be sure there is no interference between couplings and nearby circuit board parts. Carefully bend parts out of the way as necessary.



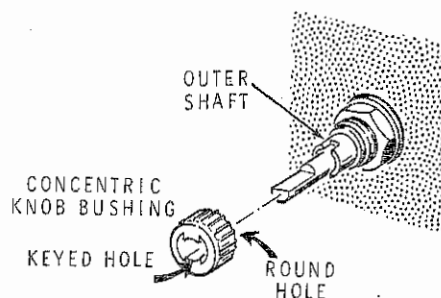
PICTORIAL 6-9

Refer to Pictorial 6-10 (in the "Illustration Booklet") for the following steps.

The front panel knobs use bushings that must be pressed into the knobs before the knobs are mounted on the control shafts. Perform the following steps carefully since it is very difficult to remove a knob bushing once it is fully inserted. You will line up the pointer on each knob with a specific mark on the front panel. Whenever you remove any knob, be sure to replace it on the control shaft from which you removed it.

NOTE: Examine the concentric shaft knob bushing (#455-613) before you perform the following steps. Note that the bushing has a round hole at one end and a "keyed hole" at the other end. In the following steps, be sure you place the bushing on the outer shaft so the round hole is toward the front panel.

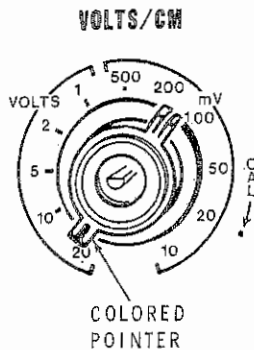
- () Refer to Detail 6-10A and place a concentric knob bushing (with the round hole toward the front panel) onto the outer shafts of switches SW101-1, SW101-2, SW203, SW201, and SW202.
- () Rotate the outer shaft of these switches fully counterclockwise.



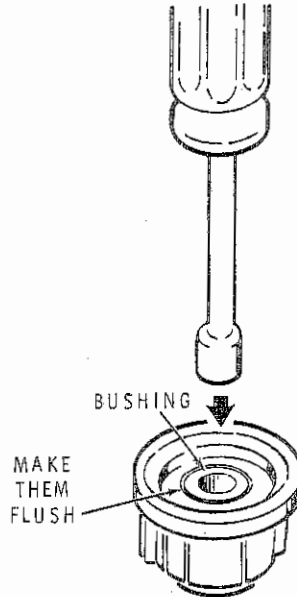
Detail 6-10A



PART A



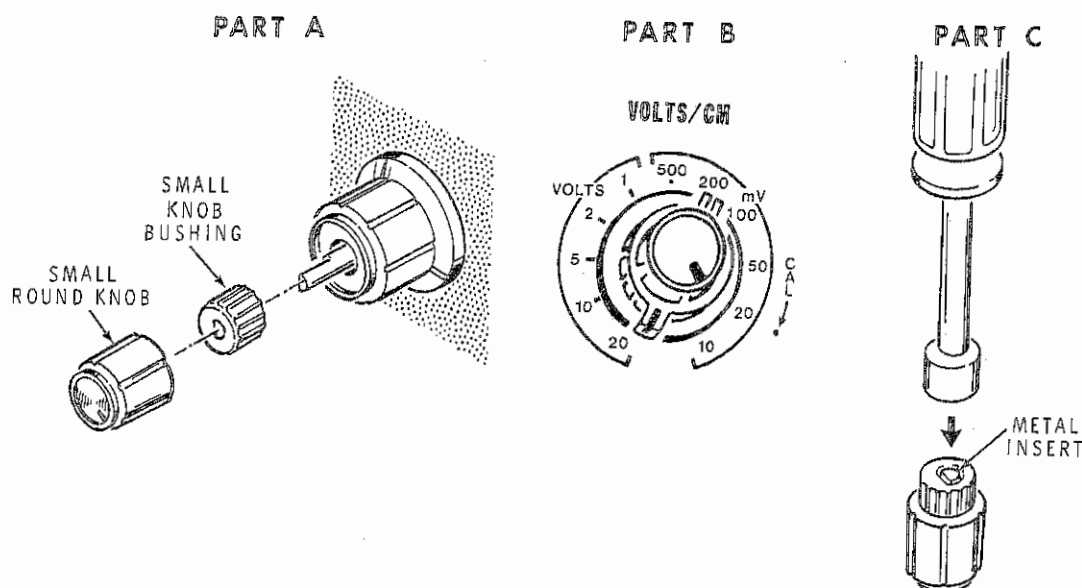
PART B



Detail 6-10B

- () Refer to Part A of Detail 6-10B and line up the colored pointer of a large black control knob (#462-951) with the 20 VOLTS mark on the front panel at SW101-1. Then press the knob part way onto the bushing.
- () Now carefully remove both the bushing and the knob. Do not allow the knob to come off the bushing.
- () Refer to Part B of Detail 6-10B and place the knob and bushing on a table or other firm surface. Place a soft cloth under the knob to prevent it from being marred. Use a nut driver or other tool and drive the bushing into the knob as shown.
- () Replace the knob onto switch SW101-1. Be sure the pointer is lined up with the 20 VOLTS mark.
- () In a similar manner, install large black control knobs onto the remaining switches with bushings. Be sure the knob pointers point to the most counterclockwise positions as shown in the Pictorial.
- () Refer to Part A of Detail 6-10C and install a small knob bushing onto the inner shaft of control R128-1. NOTE: One end of the bushing has a metal insert. This must be installed toward the shaft.
- () Turn the inner shaft fully clockwise.
- () Line up the pointer of a small red knob with the CAL "dot" as shown in Part B of Detail 6-10C. Then press the knob part way onto the bushing.
- () Carefully remove both the knob and bushing and drive the bushing into the knob.
- () Replace the knob on the shaft.
- () In a similar manner, install a small knob bushing and small red knob on control R128-2. Be sure the inner shaft is fully clockwise and the knob pointer lines up with the CAL "dot."
- () In a similar manner, install a small knob bushing and small red knob onto the inner shaft of control R253/SW205. Be sure the inner shaft is fully clockwise and the knob pointer lines up with the CAL arrow point.
- () Install a small knob bushing and small red knob onto the inner shaft of control R213/SW204. Be sure the inner shaft is fully clockwise and the knob pointer is at the 5 o'clock position.
- () Similarly install a small knob bushing and small red knob onto the inner shaft of control R263. Be sure the inner shaft is fully clockwise and the knob pointer is at the 5 o'clock position.

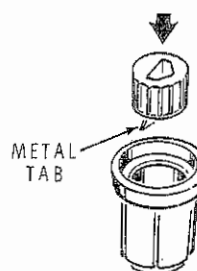
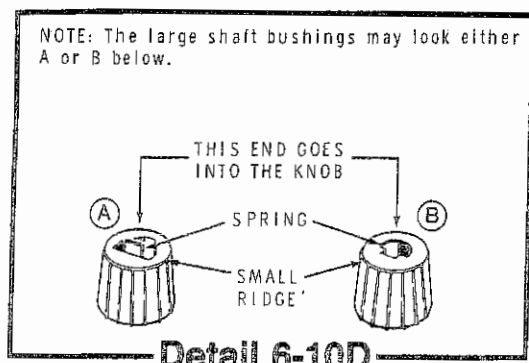
NOTE: As you install each of the next four knobs, first loosen the top setscrew that holds its control shaft. Then pull the shaft out through the front panel several inches and install the knob. (If you don't do this, the control can be damaged.) Then reconnect the shaft. Be sure the knob points to the proper position.

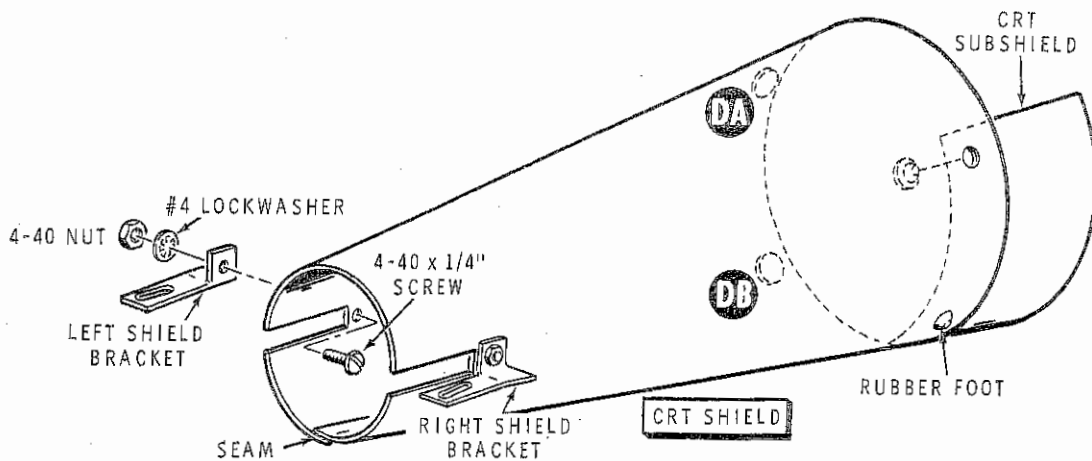
**Detail 6-10C**

- () Install a small knob bushing and small black knob onto the shaft of control R138-1/SW102-1. Be sure the shaft is fully counterclockwise and the pointer is lined up with the OFF dot.
- () Similarly install a small knob bushing and small black knob onto the shaft of control R138-2/SW102-2. Be sure the shaft is fully counterclockwise and the pointer is lined up with the OFF dot.
- () Install one black knob on control shaft R2. Line up the pointer with the PWR OFF dot.
- () Install the other black knob on control shaft R3. Position the pointer at the 7 o'clock position.

NOTE: Refer to Detail 6-10D and notice that the large shaft knob bushings are tapered. When you place one of these bushings in a knob, be sure the smaller (tapered) end goes in or the bushing will not slide into the knob. If you are not sure which end is smaller, roll the bushing across a flat surface; the bushing will gradually turn toward the smaller end.

- () Install two large shaft knob bushings into two small black knobs with skirts as shown in Detail 6-10E.

**Detail 6-10E****Detail 6-10D**



Detail 6-11A

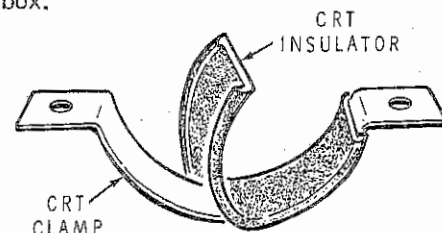
Refer to Pictorial 6-11 (in the "Illustration Booklet") for the following steps.

- () Refer to Detail 6-11A and position the CRT shield with its seam down as shown.
- () Mount the right shield bracket to the CRT shield. Use 4-40 x 1/4" hardware.
- () Similarly, mount the left shield bracket to the CRT shield. Use 4-40 x 1/4" hardware.
- () Install two small rubber feet to the inside of the CRT shield at holes DA and DB.
- () Use two small rubber feet and mount the CRT subshield to the inside of the CRT shield as shown.
- () Cut the CRT insulator strip into two 2-3/8" lengths.

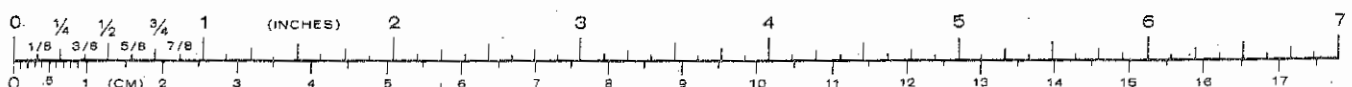
Refer to Detail 6-11B and fit an insulator strip over each CRT clamp.

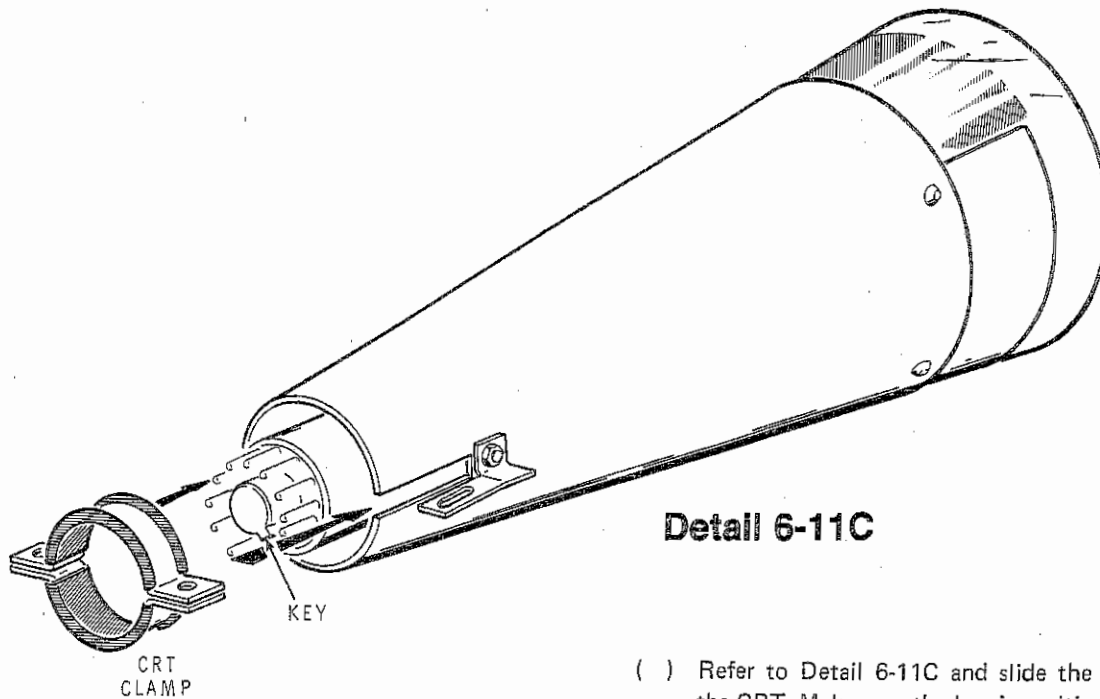
WARNING: Be extremely careful when you handle the CRT due to its high vacuum. Do not strike, scratch, or subject the CRT to more than moderate pressure at any time. A fracture of the glass could result in an implosion of considerable violence capable of causing personal injury.

- () Carefully remove the cathode ray tube (CRT) from its box.



Detail 6-11B




Detail 6-11C

() Refer to Detail 6-11C and slide the CRT shield over the CRT. Make sure the key is positioned as shown.

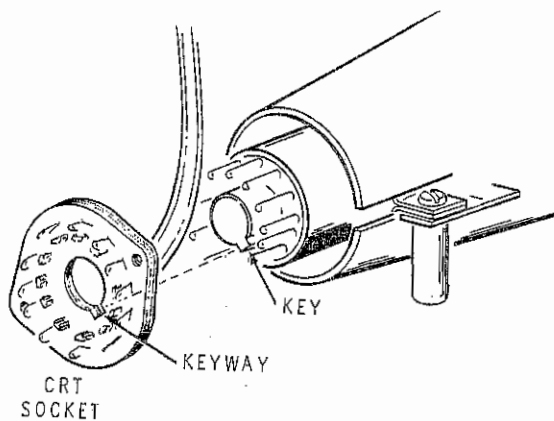
() Position the two CRT clamps onto the CRT.

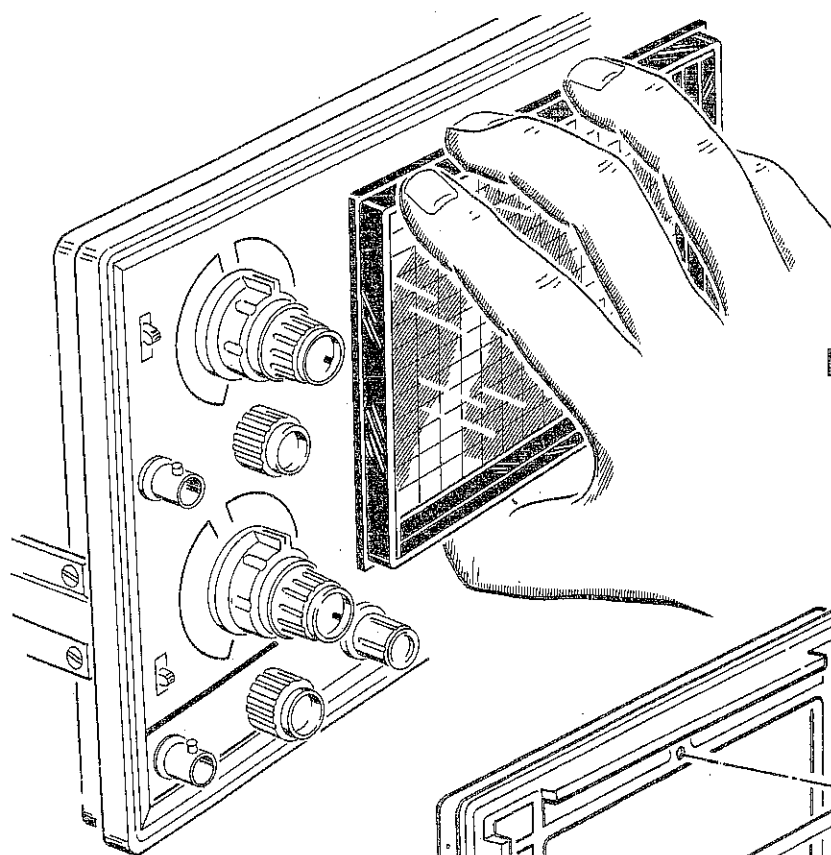
() Refer to the inset drawing on the Pictorial and carefully insert the CRT into the chassis. Be sure the CRT subshield is positioned in the CRT ring as shown and nearby wires are routed as shown. Loosen the CRT ring if necessary.

() Secure the entire assembly with two 8-32 x 1/2" screws and two #8 lockwashers.

() Refer to Detail 6-11D and position the CRT socket so its keyway is aligned with the CRT plug key. Then press the CRT socket onto the CRT plug. NOTE: The socket fit is very tight and it may not go on all the way.

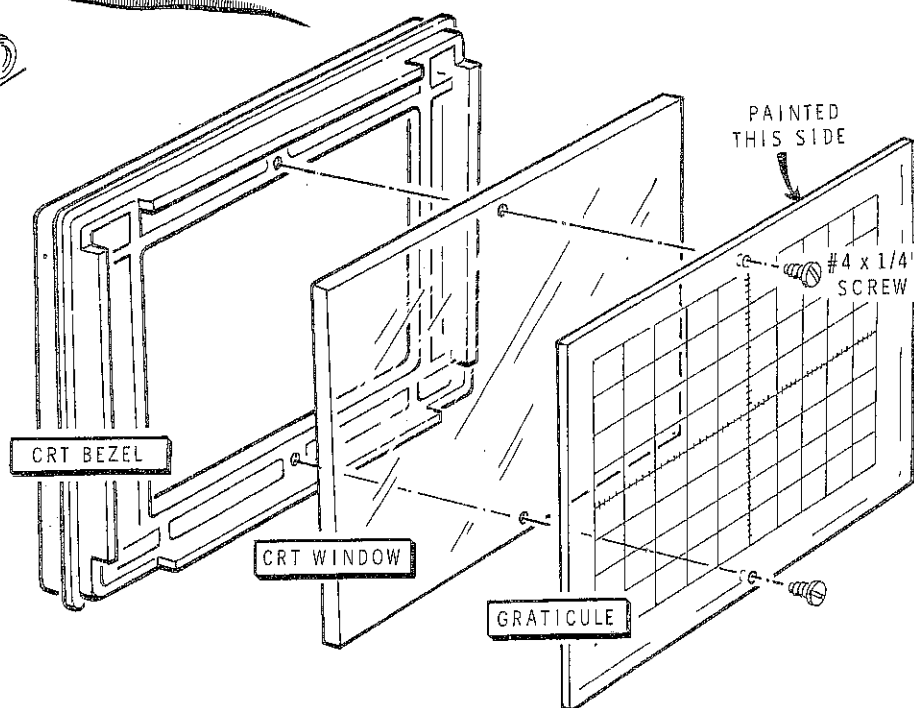
() Refer to Detail 6-11E (in the "Illustration Booklet") and position the two blue wires coming from the vertical circuit board so they are as far as possible from any nearby metal, and as far as possible from each other.


Detail 6-11D



PICTORIAL 6-12

Detail 6-12A



Refer to Pictorial 6-12 for the following steps.

- () Refer to Detail 6-12A and remove the protective covering from both sides of the CRT window and graticule.
- () Carefully wipe off the CRT window and graticule with a soft, lint-free cloth.
- () Insert the CRT window into the rear of the CRT bezel. Then insert the graticule with the painted lines toward the inside (next to the CRT window). Make sure the screw holes line up.
- () Secure the assembly with two #4 x 1/4" screws.
- () Position the CRT bezel over the front panel cutout and press on the bezel until it snaps into the cutout.

This completes the wiring of your Heathkit Oscilloscope. Carefully inspect all connections for loose wires or unsoldered connections. Remove any wire clippings or solder splashes.



HIGH VOLTAGE PROBE

During the "Initial Tests" you will adjust the high voltage power supply to -1700 volts. If your high input impedance voltmeter will measure 2500 volts, proceed to the "Initial Tests." However, if your voltmeter will not measure 2500 volts, refer to Pictorial 6-13 (in the "Illustration Booklet") and perform the following steps.

- () Prepare the ends of the remaining length of large red wire.
- () Locate the 10 M Ω and the 1 M Ω precision resistors and cut their leads to 1/2".

The following steps are grouped according to the input impedance of voltmeters. Only perform the steps that pertain to your voltmeter.

11 M Ω Voltmeters

- () Connect one end of the prepared large red wire to one end of the 10 M Ω resistor (S-1).
- () Connect the free end of the 10 M Ω resistor to one end of the 1 M Ω resistor (S-1).
- () Connect the free end of the 1 M Ω resistor to the alligator clip. Crimp the tabs over the resistor lead and solder the connection.

- () Slide the length of large sleeving over the resistor and the connections.
- () Slide the alligator clip insulator over the alligator clip as shown.

Proceed to "Initial Tests."

10 M Ω or 1 M Ω Voltmeters

- () Connect one end of the prepared large red wire to one end of the 10 M Ω resistor (S-1).
- () Connect the free end of the resistor to the alligator clip. Crimp the tabs over the resistor lead and solder the connection.

- () Slide the length of large sleeving over the resistor and its connections.

- () Slide the alligator clip insulator over the alligator clip as shown.

The 1 M Ω resistor will not be used. Proceed to "Initial Tests."





INITIAL TEST

In this section of the Manual you will test the completed Oscilloscope to verify the operation of the power supply circuits. It will direct you through specific tests as well as lead you to the possible cause or to the appropriate troubleshooting chart if a problem does exist.

If a problem exists and you are instructed to check a "component and the associated circuitry," keep the following points in mind as you work in that area — **THEY ARE IMPORTANT:**

1. Most of the kits that are returned for repair do not function properly due to poor soldering. Reheat all doubtful connections. Check carefully for solder bridges between circuit board foils.
2. Make sure all wires are soldered at connections where several wires are connected.
3. Check each transistor to make sure it is the proper type (part number) and that its leads are installed in the proper circuit board holes.
4. Check the value of each part. It is easy, for example, to misread the color code of a 510 Ω (green-brown-brown) resistor in a step that calls for a 150 Ω (brown-green-brown) resistor.
5. Have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.
6. Check all component leads connected to the circuit boards. Make sure leads and wires do not extend too far through the circuit boards and make contact with other connections or parts, such as shields or the chassis.

Use a high input impedance volt-ohmmeter to perform the following tests to make sure that a short circuit does not exist in the power supply circuits.



POWER SUPPLY TESTS

NOTE: Do not plug in the Oscilloscope until you are directed to do so in a step.

Refer to Figures 1-1 and 1-2 (in the "Illustration Booklet") for the following steps.

- () Connect the negative ohmmeter test lead to the chassis.

NOTE: The internal wiring of most ohmmeters is such that the positive terminal of the ohmmeter battery is connected to the positive test lead, and the negative battery terminal is connected to the negative test lead. In some ohmmeters this wiring is reversed and will cause erroneous readings when you make the following measurements. Try reversing the

ohmmeter test leads if the measurements do not check out correctly at first. Be sure your ohmmeter is capable of forward biasing diodes and transistors. Some ohmmeters use a voltage of less than 1.5 volts and cannot forward bias diodes and transistors.

- () Connect the positive test lead to the three prongs of the line cord plug. The center prong should produce a reading of zero ohms and the other two should read infinite. (If not, check the line cord wiring.)

Refer to Figure 1-1 for the following test points.

- () Check the heat sink on transistor Q301 and make sure it is not touching any nearby resistor leads.

	TEST POINT (TP)	METER RANGE	RESISTANCE	POSSIBLE CAUSE OF INCORRECT READING
()	1	RX10 Ω	100 Ω or higher	C311, C4, C313, Q303, Q304, and associated circuitry.*
()	2			C309, C312, Q305, Q306, and associated circuitry.*
()	3	RX100 Ω	200 Ω or higher	C307, IC301, Q301, and associated circuitry.*
()	4			C308, IC301, Q302, and associated circuitry.*
()	5	RX1 k Ω	10 k Ω or higher	D301, D302, D303, D304, C3, and associated circuitry.
()	6			
()	7			
()	8			Q215 and associated circuitry.
()	9			Q214 and associated circuitry.

*If the reading is low, the problem may be on another circuit board. Disconnect wires one by one to isolate the trouble. Example: If the +15 VDC (TP3) reading is low,

disconnect orange wires on the circuit board until the reading is correct. Then trace the last wire you disconnected to the proper circuit board and repair the trouble.

	TEST POINT	METER RANGE	RESISTANCE	POSSIBLE CAUSE OF INCORRECT READING
()	10	RX1 M Ω	2 M Ω or higher	Q404, Q405, Q406, D404, D405, R2, R3 and associated circuitry.
()	11		1 M Ω or higher.	
()	12	RX1 k Ω	10 k Ω or higher.	Q113 and associated circuitry.
()	13			Q114 and associated circuitry.

Refer to Figures 1-2 (in the "Illustration Booklet") and 1-3 for the following test points.

- () Disconnect the meter and set it aside temporarily.
- () Set all 14 controls on the four circuit boards to their centers of rotation.

Refer to Figure 1-4 (in the "Illustration Booklet") and set the front panel controls as follows:

Channel Y1 controls:

AC-GND-DC	GND
VOLTS/CM	50mV
VARIABLE	Fully clockwise (CAL)
POSITION	Center of rotation
DC BAL	Center of rotation

Channel Y2 controls:

AC-GND-DC	GND
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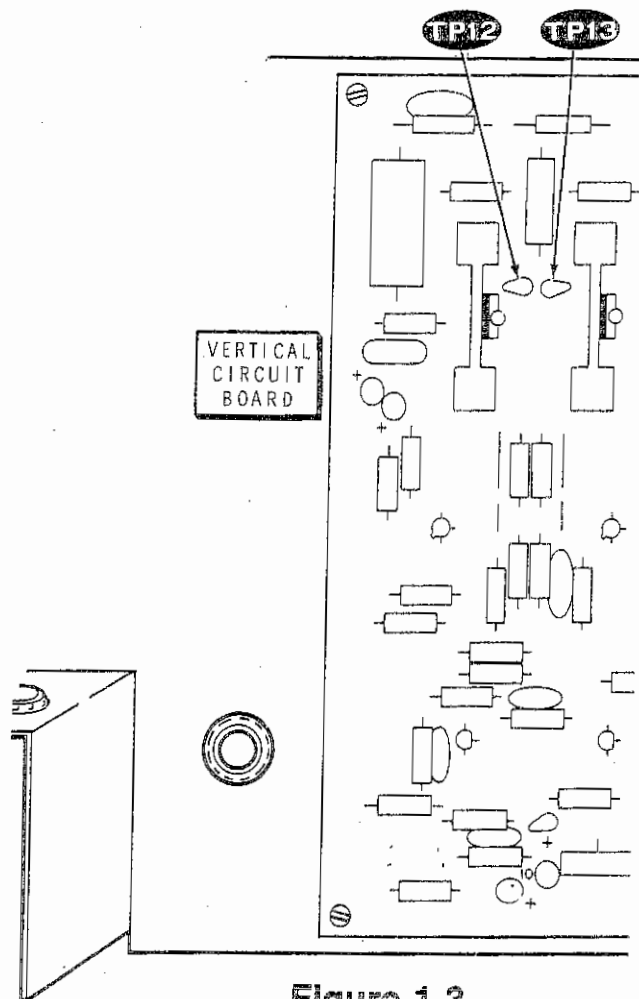


Figure 1-3

VOLTS/CM	50 mV
VARIABLE	Fully clockwise (CAL)
POSITION	Fully counterclockwise (OFF)
DC BAL	Center of rotation
INTENSITY	Fully counterclockwise (OFF)
FOCUS	Center of Rotation
TIME/CM	1mS
VARIABLE	Fully clockwise (CAL) and pushed in.
TRIG	Y1+
LEVEL	Center of rotation and pushed in.
MODE	AC
HORIZ POS	Center of rotation.

WARNING: When the line cord is connected to an AC outlet, AC line voltage will be present at several places on the chassis. Also, when the Oscilloscope is turned on, high voltage DC will also be present. Be careful that you do not contact this voltage or an electrical shock will result. See Figure 1-5 (in the "Illustration Booklet").

NOTE: If you do not get the proper results in the following tests, immediately unplug the Oscilloscope and proceed to the "In Case of Difficulty" section in your Operation Manual.

() Connect the common voltmeter lead to the chassis and set your voltmeter to read DC volts.

() Plug in the Oscilloscope line cord and turn the INTENSITY control clockwise enough to turn the Oscilloscope on.

Refer to Figures 1-1 and 1-2 (in the "Illustration Booklet") and make the following voltage tests.

	TEST POINT	DC VOLTAGE READING	IF NOT CORRECT, PROCEED TO:
()	1	4.8 to 5.3	Test #1 (In the "Illustration Booklet" with your Operational Manual.)
()	2	-4.8 to -5.3	Test #2
()	3	14 to 16	Test #3
()	4	-14 to -16	Test #3
()	6	150 to 190	Test #4
()	7	130 to 170	Test #4



- () Refer to Figure 1-1 and adjust control R309 until test point 4 is -15 volts.
 - () Turn off the Oscilloscope.
 - () If you prepared a high voltage probe earlier, connect your voltmeter probe to the bare end of the probe you prepared. If you did not prepare a probe, proceed directly to the next step.
 - () Adjust your voltmeter to read -2000 volts DC. NOTE: If you are using a high voltage probe you prepared earlier, it will cause your voltmeter to indicate one half of the actual voltage being measured if you use a 10 M Ω or 11 M Ω voltmeter. With a 1 M Ω voltmeter, the reading will be 1/11 the actual voltage.
 - () Refer to Figure 1-2 and connect the probe to control R2 lug 1.
 - () Let loose of the probe and control. Then turn on the Oscilloscope. The meter reading should be between -1500 and -2000 volts DC (-750 to -1000 volts if you are using the prepared high voltage probe with 10 M Ω or 11 M Ω voltmeter; -135 to -180 volts with a 1 M Ω voltmeter).
 - () Adjust the HI VOLT ADJ control on the high voltage circuit board to -1700 volts. (Your meter will indicate -850 volts if you are using the prepared high voltage probe with a 10 M Ω or 11 M Ω voltmeter; -155 volts with a 1 M Ω voltmeter).
 - () Turn off the Oscilloscope and disconnect the meter.
 - () Turn on the Oscilloscope.
 - () Check to see if the CRT trace is parallel with the horizontal graticule lines. If it is not parallel, perform the following numbered steps.
 1. Note the position of the trace and turn off the power.
 2. Refer to Figure 1-5 (in the "Illustration Booklet") and loosen the CRT clamp.
 3. Rotate the CRT to align the trace.
 4. Turn the power on and check the position of the trace.
 5. Repeat steps 1, 3, and 4 as necessary to align the trace to the horizontal graticule lines.
 6. After the correct results have been obtained, turn the power off and tighten the CRT clamp.
- This completes the "Initial Tests" section; proceed to "Final Assembly."

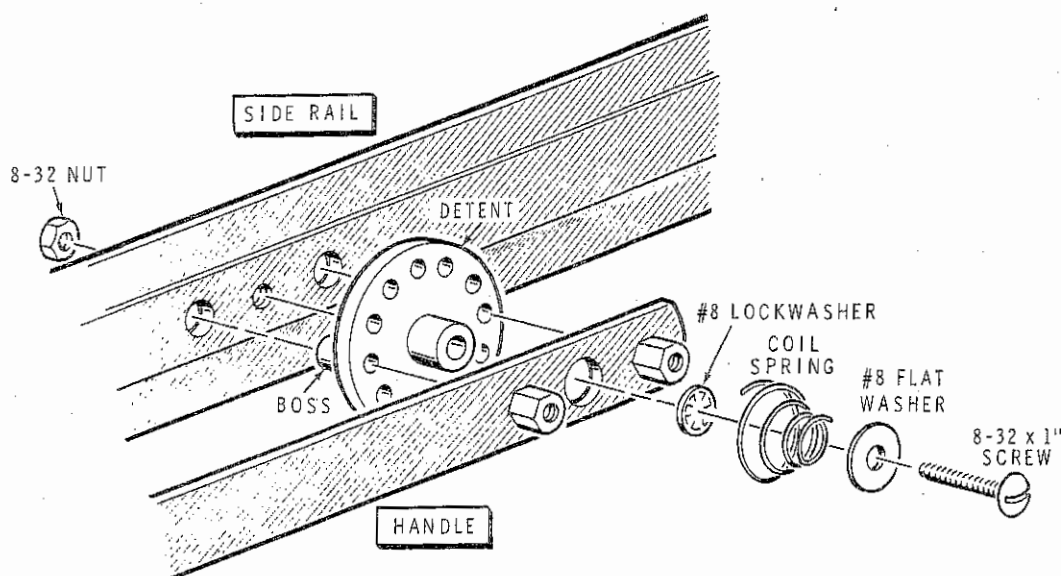


FINAL ASSEMBLY

HANDLE INSTALLATION

Refer to Pictorial 7-1 (in the "Illustration Booklet") for the following steps.

- () Refer to Detail 7-1A and install the top and bottom handle grips on the handle. Use three 4-40 x 5/16" black flat head screws.
- () Refer to Detail 7-1B and install two 6-32 tapped hex spacers into each end of the handle. Be sure to install these from the outside of the handle.
- () Place the handle around the front of the Oscilloscope as shown in the Pictorial.
- () Refer to Detail 7-1C and install the handle and a detent at EA and EB. Be sure the bosses on the detents are positioned in the holes in the side rails. Then install an 8-32 x 1" screw, a #8 flat washer, a coil spring, a #8 lockwasher, and an 8-32 nut at each location.
- () Refer to Pictorial 7-1 and install detent covers at EA and EB with 6-32 x 3/16" flat head screws. Be sure the cutout in the cover fits over the handle.
- () Carefully peel away the backing paper from the decorative inserts. Then press the inserts into the detent covers at EA and EB.



Detail 7-1C



Refer to Pictorial 7-2 (in the "Illustration Booklet") for the following steps.

- () Locate the bottom cover, four large rubber feet, four 6-32 x 3/8" screws, four #6 lockwashers, and four 6-32 nuts. The bottom cover is the cover with four mounting holes in it.
- () Install a foot at each of the four mounting holes with 6-32 x 3/8" hardware.
- () Turn a 10-32 x 5/8" thumbscrew two or three turns into hole ED as shown in the Pictorial.
- () Turn the remaining 10-32 x 5/8" thumbscrew into hole EC two or three turns.
- () Position the top and bottom covers on the Oscilloscope as shown. Be sure the ventilation holes in the covers are toward the back of the Oscilloscope and the covers are seated in the grooves in the side rails. Then tighten the two thumbscrews to hold the covers in place.
- () Remove the paper backing from the Heathkit label and press the label into place on the front of the Oscilloscope as shown.

TEST CABLE PREPARATION

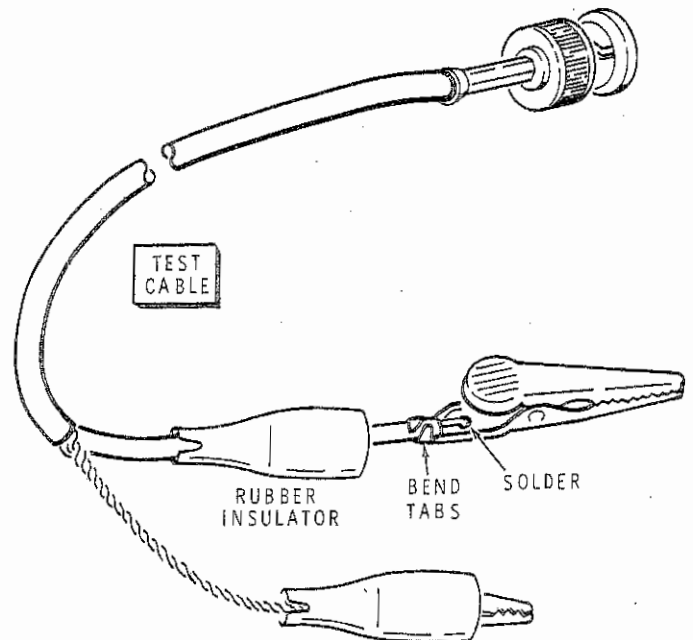
Refer to Pictorial 8-1 for the following steps.

In the following steps you will prepare two test cables. Perform the steps twice, once for each cable. Double checkoff spaces are provided for this. Completely prepare one test cable before you prepare the second one.

- () () Refer to Detail 8-1A (in the "Illustration Booklet") and prepare the indicated end of the cable assembly.

- () () Push rubber insulators onto the inner lead and shield lead of the cable.
- () () Solder an alligator clip to the end of the inner lead.
- () () Solder an alligator clip to the end of the shield lead.
- () () After the clips have cooled, bend the tabs around the wire. Then slide the rubber insulators over the alligator clip.

This completes the assembly of your Oscilloscope. Proceed to the Calibration section on Page 25 of the "Operation Manual" and calibrate your Oscilloscope before you attempt to use it as a test instrument.



PICTORIAL 8-1