

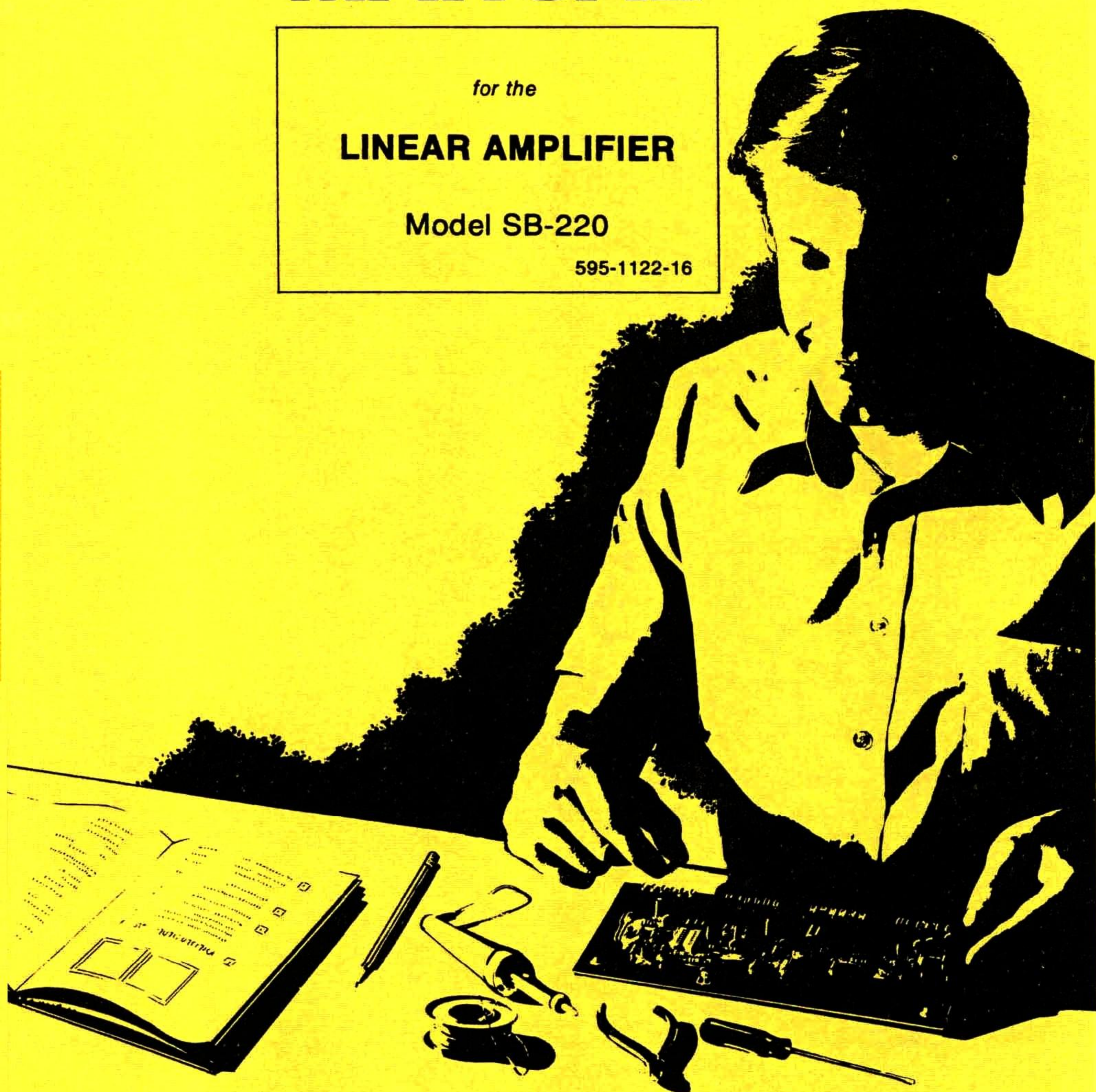
HEATHKIT[®] MANUAL

for the

LINEAR AMPLIFIER

Model SB-220

595-1122-16



HEATH COMPANY • BENTON HARBOR, MICHIGAN

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Assembly
and
Operation
of the



LINEAR AMPLIFIER

MODEL SB-220



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BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit Model SB-220 Linear Amplifier is a completely self-contained, table top, grounded grid, linear amplifier. It is designed to operate at the maximum amateur power limit on SSB, CW, and RTTY. Its styling matches the Heath SB series of amateur equipment.

The Amplifier is designed to be used with exciters which deliver 100 watts or more output. It can be used with less driving power, but will give a lower output.

A broad-band, tuned input circuit for each band feeds the two Eimac 3-500Z triode tubes connected in grounded grid configuration. The tubes are biased beyond cut-off in the receive mode, and zener-regulated bias controls the idling current in the transmit mode. The tubes are cooled by a fan.

An ALC circuit develops negative voltage to be fed back to the exciter to reduce its gain when the Amplifier is overdriven.

The antenna change-over relay is normally actuated by exciter relay contacts to place the Amplifier in the transmit mode.

The Amplifier can be operated from either 120 VAC or 240 VAC 50/60 Hz lines and can be easily changed from one to the other. Operation from a 240 volt line is recommended. Each side of the line cord is equipped with a circuit breaker to protect against overloads.

An important feature of this Amplifier is that it can be tuned up at the one kilowatt limit and can then be switched to operate on SSB at two kilowatts P.E.P. input. As the switching changes both the voltage and current to the final tubes, the impedance remains the same and no additional adjustment of tuned circuits is required.

The tubes are "instant heating" types, and transmission may be started as soon as the Amplifier is switched on (after tune-up).

Here is a full legal-limit Amplifier that can take its place on your operating table and give you years of trouble-free pleasure. This Amplifier has a commanding voice.

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

PARTS LIST

This Parts List contains all of the parts used in the assembly of the kit. Some parts are packaged in envelopes with the part number of the contents printed on the outside. Except for the initial parts check, retain these parts in their envelopes until they are called for in the assembly steps.

Check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Pages 4 and 7).

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

KEY PART No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2 Watt			
1	1-9	1	1000 Ω (brown-black-red)
	1-44	2	2200 Ω (red-red-red)
	1-18	1	5600 Ω (green-blue-red)
	1-22	1	22 k Ω (red-red-orange)
	1-23	1	27 k Ω (red-violet-orange)
	1-24	1	33 k Ω (orange-orange-orange)
	1-25	1	47 k Ω (yellow-violet-orange)
	1-26	1	100 k Ω (brown-black-yellow)
Other Resistors			
2	1-8-1	1	68 k Ω 1 watt (blue-gray-orange)
	1-38-1	3	4.7 M Ω 1 watt (yellow-violet-green)
	3-1-2	1	.82 Ω wire-wound 2 watt (gray-red-silver) (same size as 1 watt), 5%
3	3-25-5	1	1 Ω wire-wound, 5 watt, 1%
	3-22-5	1	3600 Ω wire-wound, 5 watt, 1%
4	5-2-7	8	30 k Ω film, 7 watt

KEY PART No.	PART No.	PARTS Per Kit	DESCRIPTION
CAPACITORS			
Molded Mica			
5	20-3	6	200 pF (red-black-brown)
6	20-123	1	500 pF (.0005 μ F)
Mica			
7	20-99	2	22 pF
	20-124	2	115 pF
	20-103	1	150 pF
	20-105	1	180 pF
	20-120	1	220 pF
	20-116	2	400 pF
	20-113	2	470 pF
	20-107	2	680 pF
Disc			
8	21-79	1	.001 μ F 6 kV
9	21-140	2	.001 μ F 500 volt
	21-70	3	.01 μ F 1.4 kV
	21-31	12	.02 μ F 500 volt



KEY PART No.	PARTS No.	PARTS Per Kit	DESCRIPTION	KEY PART No.	PARTS No.	PARTS Per Kit	DESCRIPTION	
Other Capacitors				INSULATORS-GROMMETS-TERMINAL STRIPS-CONNECTORS				
10	21-28	1	10 pF (10 MMF or 10 $\mu\mu\text{F}$) tubular ceramic	38	71 2	1	Ceramic feedthrough insulator (disassembled in bag)	
11	21-165	2	.001 μF (1000 MMFD) 6 kV, ceramic	39	73 4	1	5/16" grommet	
12	25-19	1	20 μF (MFD) electrolytic		73 3	4	1/2" grommet	
13	25-224	8	200 μF (MFD) electrolytic		73 2	1	3/4" grommet	
14	26-145	1	840 pF variable	40	75 123	1	Line cord strain relief	
15	26-131	1	250 pF variable		75 124	1	6" x 4-1/2" fish paper insulator	
CONTROLS-SWITCHES					41	75 125	8	Capacitor mounting insulator
16	10-12	1	100 k Ω control	42	75-39	1	6-32 x 1-1/4" tapped phenolic spacer	
17	61-14	1	DPST rocker switch	43	75-42	3	6-32 x 3/4" tapped phenolic spacer	
18	61-15	1	DPDT rocker switch	44	431-14	1	2-lug terminal strip	
19	63-47	1	3-position rotary switch	45	431-10	3	3-lug terminal strip	
20	63-561	1	5-position rotary switch	46	431-42	1	5-lug terminal strip	
21	63-562	1	Rotary switch wafer	47	431-20	1	6-lug terminal strip	
22	65-28	2	Circuit breaker	48	431-13	1	4-screw terminal strip	
23	69-55	1	TPDT 110 VDC relay	49	432-137	6	Connector tab	
COILS-CHOKES-TRANSFORMERS				50	434-42	2	Phono socket	
24	40-1666	1	80/20 plate coil	51	434-93	2	5-lug ceramic tube socket	
25	40-964	2	10/15-meter input coil	52	436-5	2	Coaxial jack	
	40-965	1	20-meter input coil	53	438-9	2	Coaxial plug	
	40-966	1	40-meter input coil	54	438-12	1	Coaxial plug insert	
	40-1012	1	80-meter input coil	WIRE-CABLE-SLEEVING				
26	40-968	1	15/10 plate coil	89-40		1	Line cord	
27	45-53	2	Parasitic choke	134-36		2	Phono cable assembly	
28	45-4	3	1 mH RF choke	340-1		1	Small bare wire	
29	45-6	1	8.5 μH RF choke	340-4		1	Large bare wire	
30	45-78	1	9 μH RF choke	343-2		1	Coaxial cable, RG-58A/U	
31	45-61	1	50 μH RF choke	343-8		1	Coaxial cable, RG-8/U	
32	54-237	1	High voltage transformer	344-2		1	Small black stranded wire	
	54-238	1	Filament and bias transformer	344-7		1	Large black stranded wire	
DIODES-TUBES				344-13		1	Blue hookup wire (thick insulation)	
33	56-24	1	1N458 silicon diode (yellow-green-gray)	344-50		1	Black hookup wire	
34	56-26	1	1N191 germanium diode (brown-white-brown)	344-51		1	Brown hookup wire	
35	56-82	1	1N3996A zener diode, 5.1V, 10 watt, w/mounting hardware	344-52		1	Red hookup wire	
36	57-27	15	Silicon diode	344-53		1	Orange hookup wire	
37	411-245	2	3-500Z tube	344-54		1	Yellow hookup wire	
				344-55		1	Green hookup wire	
				344-56		1	Blue hookup wire	
				345-1		1	Large metal braid	
				345-2		1	Small metal braid	
				346-4		1	Black sleeving	
				346-7		2	Clear sleeving (large)	
				346-29		1	Clear sleeving (small)	
				55	354-5	6	Cable tie	

KEY PART No.	PARTS No.	PARTS Per Kit	DESCRIPTION	KEY PART No.	PARTS No.	PARTS Per Kit	DESCRIPTION
HARDWARE				Other Hardware (cont'd.)			
#6 Hardware				97	258-115	1	Brass spring 5/8" x 3-1/2"
56	250-138	9	6-32 x 3/16" screw	98	259-10	1	Control solder lug
57	250-56	31	6-32 x 1/4" binder head screw	99	259-24	1	Long solder lug
58	250-416	1	6-32 x 1/4" flat head screw	100	260-12	2	Plate connector
59	250-8	29	#6 x 3/8" sheet metal screw	101	456-16	1	Shaft coupler
60	250-32	18	6-32 x 3/8" flat head screw	METAL PARTS			
61	250-89	15	6-32 x 3/8" binder head screw	102	90-464	1	Cabinet
62	250-218	4	6-32 x 3/8" phillips head screw	103	200-1251	1	Chassis
63	250-206	13	6-32 x 11/16" screw	104	100-1022	1	Capacitor bank bracket
64	250-40	4	6-32 x 1-1/2" screw	105	203-643	1	Front panel
65	250-47	1	6-32 x 2" screw	106	203-644	1	Rear panel
66	252-3	63	6-32 nut	107	203-646	1	Left side panel
67	253-1	17	#6 fiber flat washer	108	203-645	1	Right side panel
68	253-2	2	#6 fiber shoulder washer	109	204-1041	2	Angle bracket
69	253-96	4	#6 flat metal washer	110	204-2102	1	Plate coil bracket
70	254-1	64	#6 lockwasher	111	205-723	1	Top rear plate cover
71	255-77	2	7/16" spacer	112	205-724	1	Perforated top cover
72	255-71	4	6-32 x 3/4" tapped metal spacer	113	205-874	1	Perforated fan cover
73	255-21	3	6-32 x 7/8" tapped spacer	114	206-493	1	RF shield
74	259-1	19	#6 solder lug	115	206-457	1	Coil mounting shield
#8 Hardware				MISCELLANEOUS			
75	250-43	8	8-32 x 1/4" setscrew		85-344-1	1	Printed circuit board
76	250-137	8	8-32 x 3/8" screw	116	255-59	2	Black tapered spacer
77	252-4	8	8-32 nut	117	261-9	4	Rubber foot
78	254-2	8	#8 lockwasher		266-296	1	Fan blade
79	255-66	1	8-32 x 1-3/8" spacer	118	352-13	1	Silicone grease
80	259-2	1	#8 solder lug	119	407-145	1	Plate amperes meter
#10 Hardware					407-146	1	Multi-meter
81	250-331	1	10-32 x 1" screw		420-601	1	Fan motor
82	252-5	2	10-32 nut	120	453-135	1	Phenolic shaft
83	252-163	1	10-32 wing nut	121	462-191	2	Small knob
84	254-3	2	#10 lockwasher	122	462-210	3	Large knob
Other Hardware					390-147	1	Danger high voltage label
85	207-8	2	Cable clamp	123	391-64	1	Nameplate
86	250-213	8	4-40 x 5/16" screw		391-34	1	Blue and white label
87	252-15	8	4-40 nut	124	432-199	1	Wire nut
88	252-7	3	Control nut		490-5	1	Nut starter
89	252-10	2	Speednut		597-260	1	Parts Order Form
90	253-10	3	Control flat washer		597-308	1	Kit Builders Guide
91	253-42	14	1/2" flat washer			1	Manual (See front cover for part number.)
92	253-19	2	3/4" flat washer	Solder			
93	254-4	2	Control lockwasher				
94	254-9	16	#5 lockwasher				
95	259-25	1	#10 double lug				
96	259-16	1	#10 solder lug				

STEP-BY-STEP ASSEMBLY

Before starting to assemble this kit, read the "Kit Builders Guide" for complete information on wiring, soldering, and step-by-step assembly procedures.

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

As the drawings in the Manual may be slightly distorted to show all the parts clearly, look at the Chassis Photos (Pages

86 through 89) from time to time to see the actual positions of wires and components.

Lockwashers and nuts will be used with most screws when mounting parts, unless the assembly steps state otherwise. Consequently, the applicable steps will call out only the size and type of hardware used. For example, the phrase "Use 6-32 x 1/4" hardware" means to use 6-32 x 1/4" screws, one or more #6 lockwashers, and 6-32 nuts. Refer to the Details for the proper installation of hardware. Be sure to position each part as shown in the Pictorials. Follow the instructions carefully, and read the entire step before performing the operation.

When a step directs you to "connect" an insulated wire, first prepare its ends by removing 1/4" of insulation.

CIRCUIT BOARD

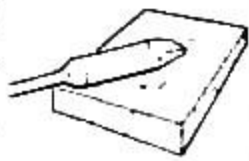
Solder a part or group of parts only when directed. Use 1/2 watt resistors unless directed otherwise in a step. Each resistor will be called out by the resistance value (in Ω , $k\Omega$, or $M\Omega$) and color code. Capacitors will be called out by the capacitance value and type.

On the circuit board, be especially careful not to cover unused holes with solder or bridge solder across foils during assembly. Perform the steps in Pictorial 1-1.

START



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



NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. THE CATHODE END OF THE DIODE IS MARKED WITH A BAND OR BANDS. ALWAYS POSITION THIS END AS SHOWN IN THE PICTORIAL.



() Position the circuit board as shown and install diodes (#57-27) at D7, D5, D3, D1, D9, D11, and D13. Make sure all seven cathode banded ends are to the right.

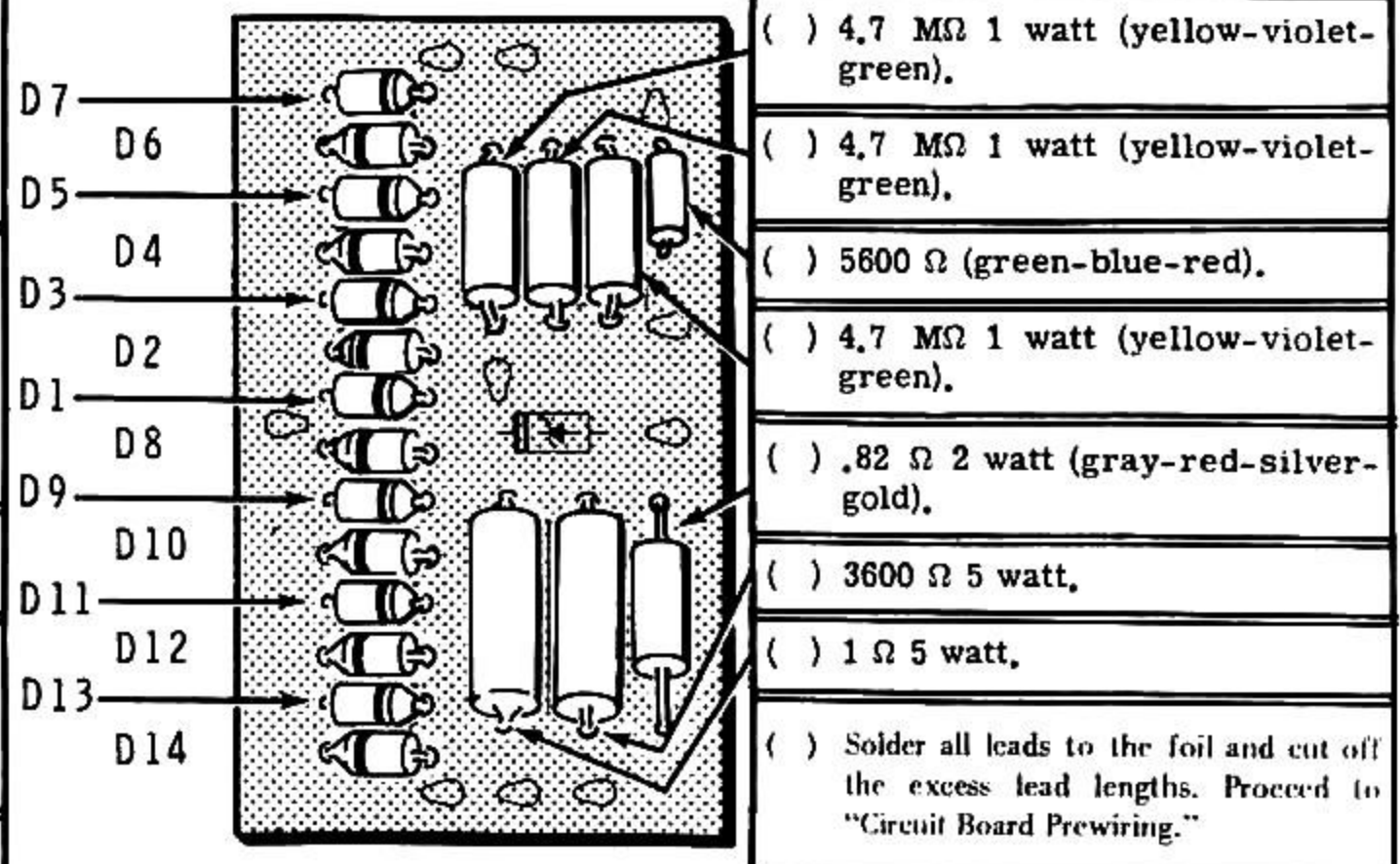
() Solder all leads to the foil and cut off the excess lead lengths.

() Install diodes (#57-27) at D6, D4, D2, D8, D10, D12, and D14 with their cathode ends to the left.

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

() CAREFULLY INSPECT ALL DIODES IN THE PRECEDING STEPS TO BE SURE THEY ARE POSITIONED AS SHOWN IN THE PICTORIAL AND ON THE CIRCUIT BOARD.

CONTINUE



PICTORIAL 1-1

CIRCUIT BOARD PREWIRING

NOTE: To prepare lengths of hookup wire, as in the following step, cut the wire to the indicated length and remove 1/4" of insulation from each end. If the wire is stranded, twist the ends tightly and apply a small amount of solder to hold the strands together. Unless otherwise stated, "hookup wire" will mean the small solid-conductor wire supplied in various colors.

() Prepare the following lengths of hookup wire:

5-1/4" red

3-3/4" black

6-1/2" black

17-1/2" small black stranded wire

7-1/2" orange

6-1/2" yellow

9-1/2" heavy blue (thick insulation)

2-3/4" heavy blue (thick insulation)

Refer to Pictorial 1-2 for the following steps.

From the component side of the circuit board, insert one end of each of the following wires into the designated hole. Solder each wire on the foil side.

() Connect a 5-1/4" length of red hookup wire to hole A in the circuit board (S-1).

() Connect a 3-3/4" length of black hookup wire to hole B on the circuit board (S-1).

() Connect a 6-1/2" length of black hookup wire to hole C on the circuit board (S-1).

() Connect a 17-1/2" length of black stranded wire to hole E on the circuit board (S-1).

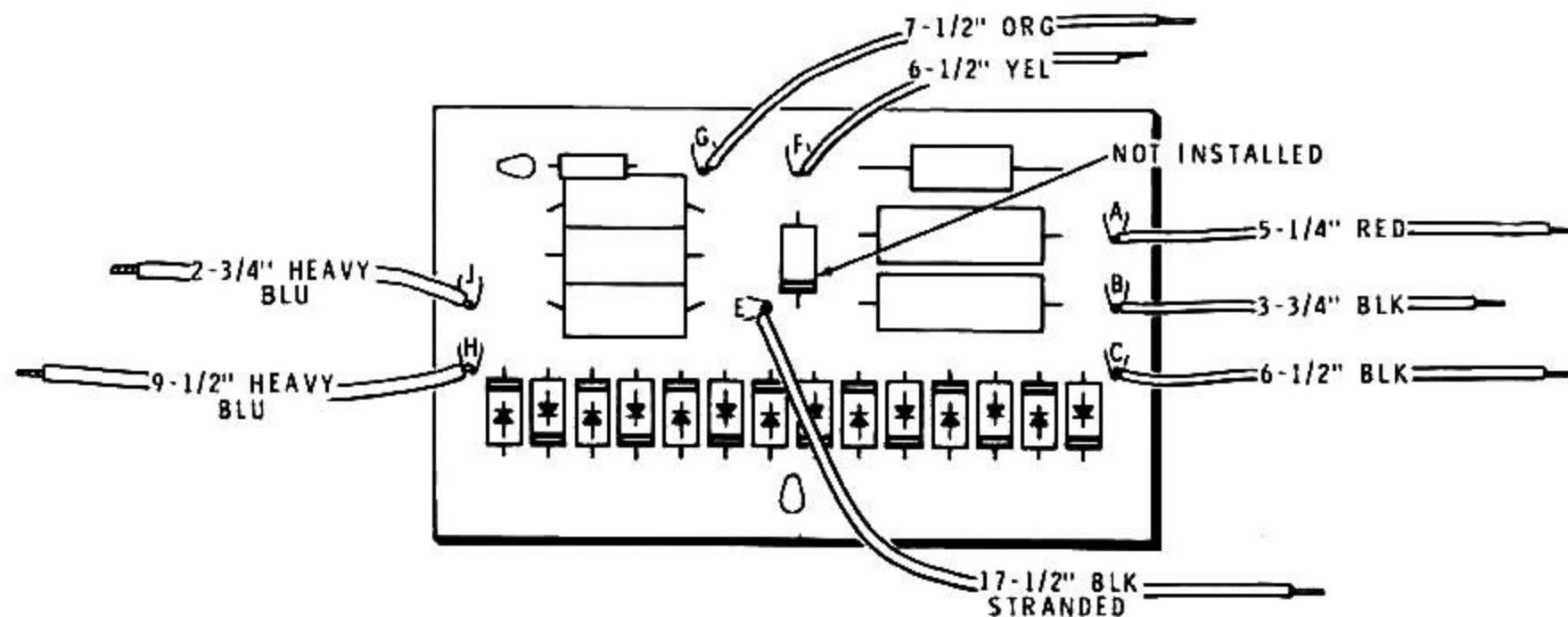
() Connect a 7-1/2" length of orange hookup wire to hole G on the circuit board (S-1).

() Connect a 6-1/2" length of yellow hookup wire to hole F on the circuit board (S-1).

() Connect a 9-1/2" length of heavy blue hookup wire to hole H on the circuit board (S-1).

() Connect a 2-3/4" length of heavy blue hookup wire to hole J on the circuit board (S-1).

() Trim all excess lead lengths from the foil side of the circuit board.



PICTORIAL 1-2



- () Carefully inspect the foil side of the circuit board; all lettered holes except D and K should be soldered. Make sure there are no solder bridges between foils. Also note that one diode is not installed.

This completes the prewiring of the circuit board. Set it aside until called for later. Proceed with the "Input Coil Assembly" section.

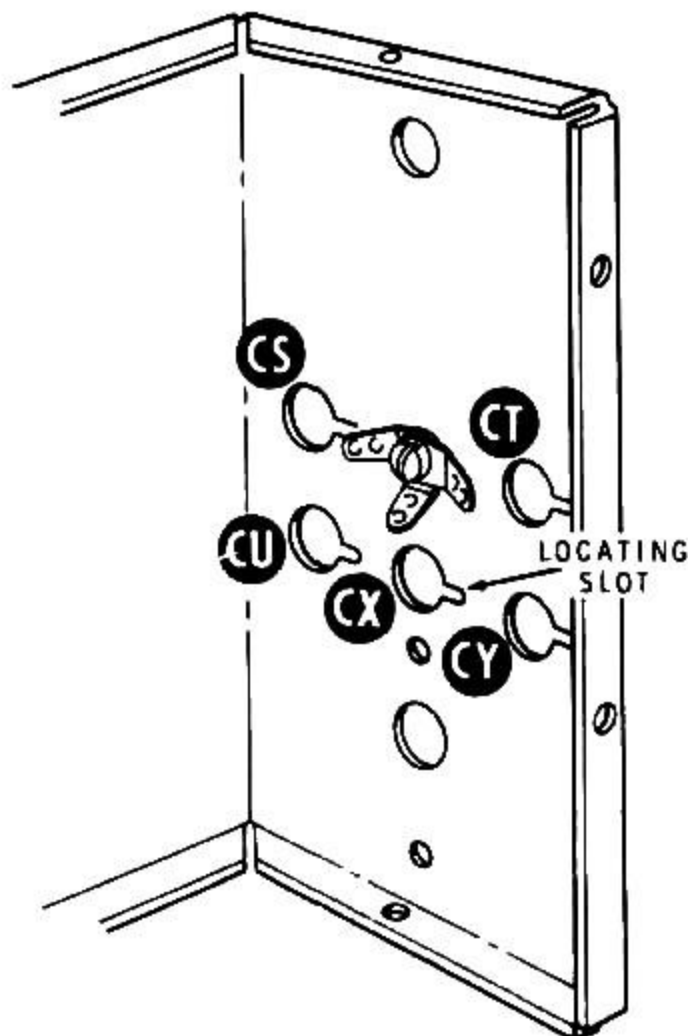
INPUT COIL ASSEMBLY

Refer to Pictorial 2-1 for the following steps.

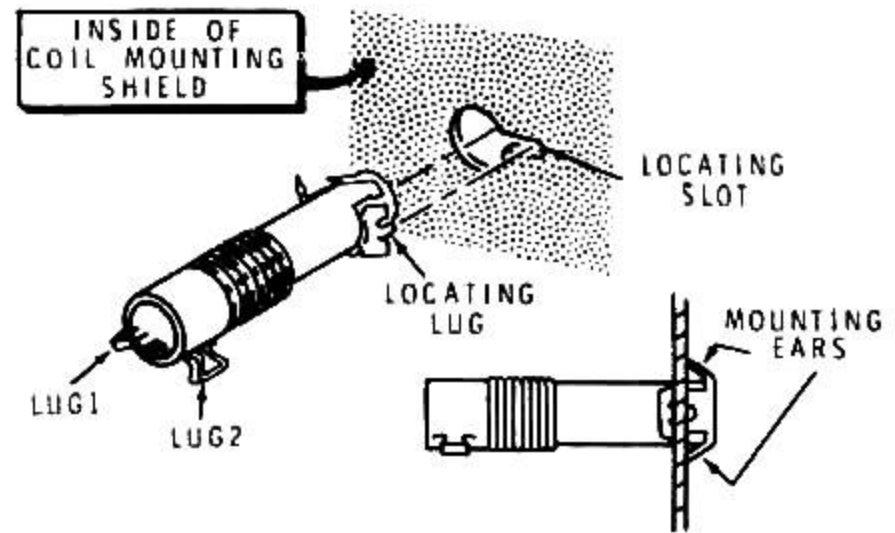
Refer to Detail 2-1A for the next two steps.

NOTE: A plastic nut starter has been provided with this kit. Use it to hold and start nuts on screws. See Page 3 of the "Kit Builders Guide" for more information.

- () Install three #6 solder lugs on the coil mounting shield (#206-457) at CL with 6-32 x 3/8" hardware. Position the lugs as shown in Detail 2-1B.
- () Install a #6 solder lug at DF with a 6-32 x 1/4" screw and a 6-32 nut. Form the solder lug as shown.



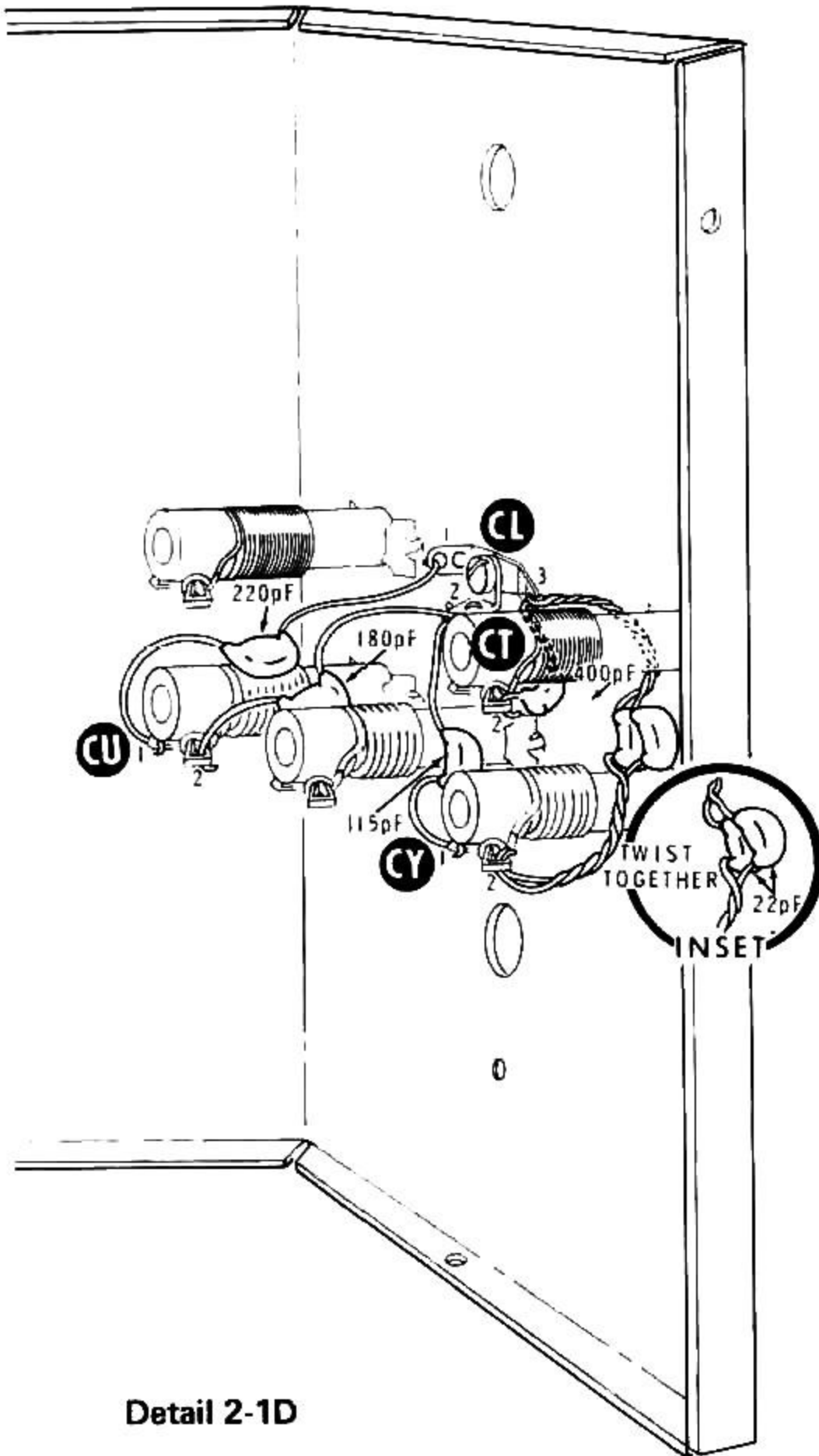
Detail 2-1B



Detail 2-1C

Detail 2-1B shows the coil mounting locations for the following steps. Note that the locating lug of each coil must be positioned in the locating slot, and that each coil must be pushed into its mounting hole until the mounting ears snap out to hold the coil in place as shown in Detail 2-1C.

- () Install the 20-meter coil (#40-965) at CU. See Detail 2-1C.
- () Install a 10/15-meter coil (#40-964) at CX.
- () Install a 10/15-meter coil (#40-964) at CY.
- () Install the 80-meter coil (#40-1012) at CS.
- () Install the 40-meter coil (#40-966) at CT.



Detail 2-1D

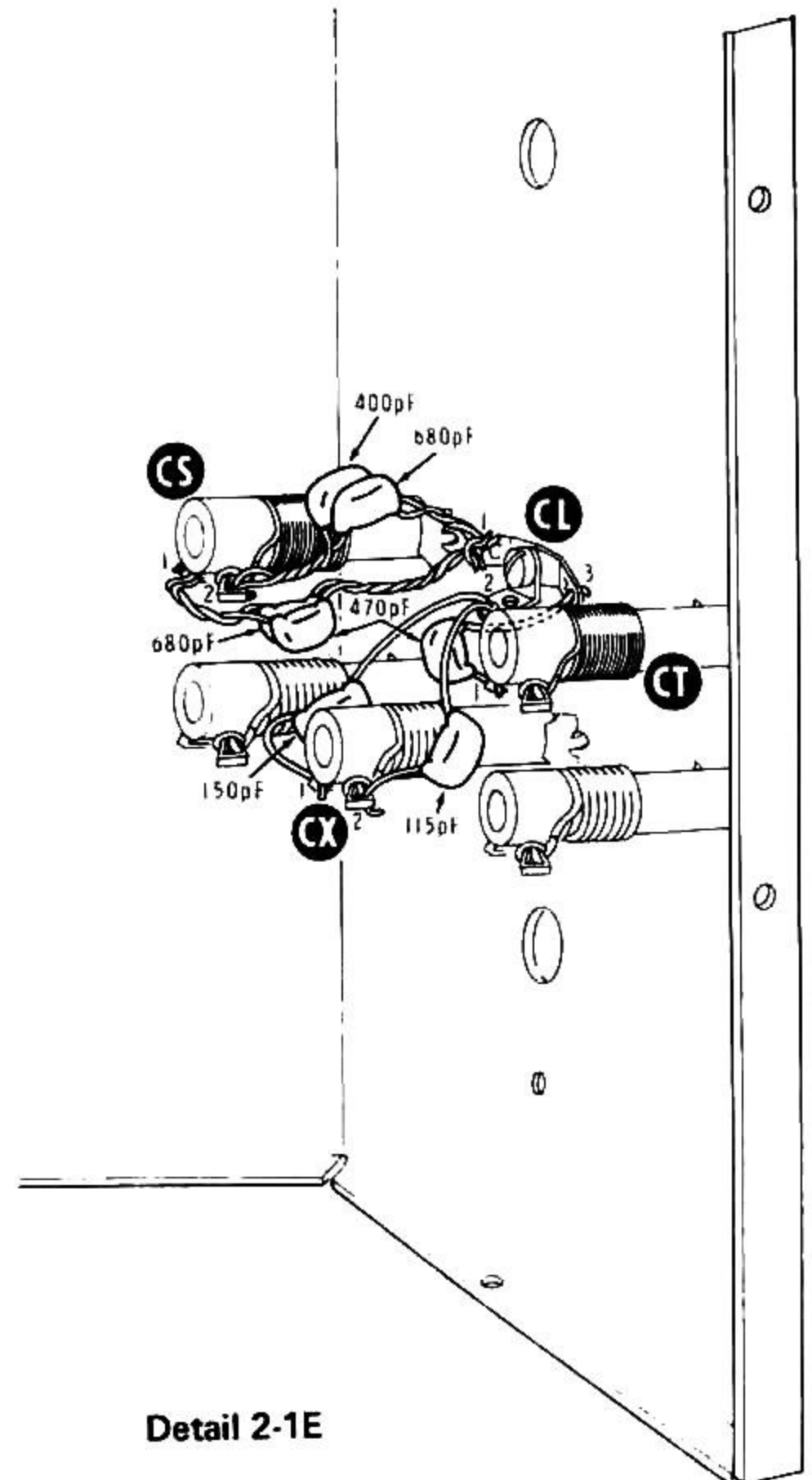
Refer to Detail 2-1D for the following steps.

NOTE: When you wire capacitors to the five coils in the following steps, position the body of each capacitor against its coil. However, be sure the capacitor leads do not touch the wire of the coil.

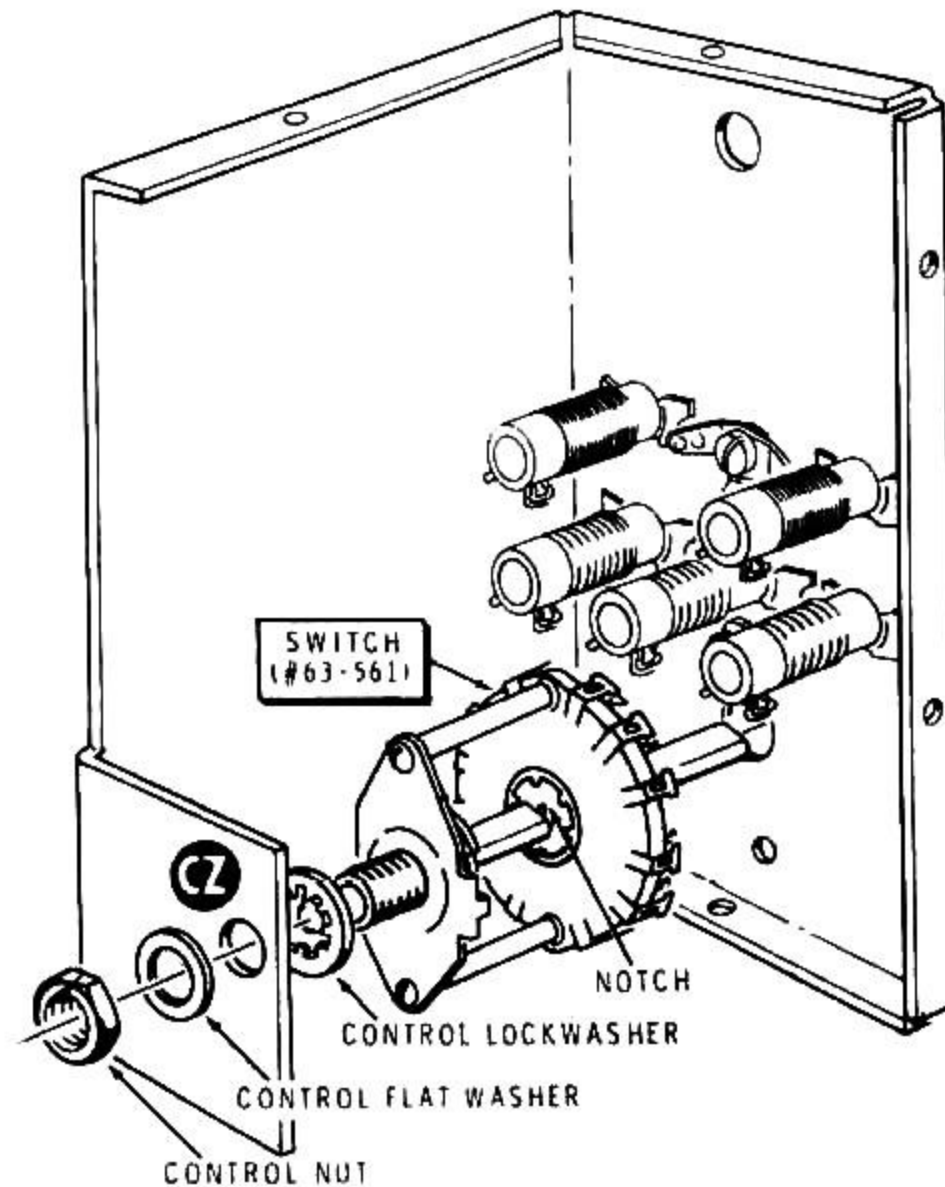
Note the positions of lugs 1 and 2 of each coil as shown in Detail 2-1C, on Page 13.

- () Connect a 220 pF mica capacitor from lug 1 of coil CU (NS) to ground lug CL-1 (NS). Position the capacitor close to the coil as shown.

- () Connect a 180 pF mica capacitor from lug 2 of coil CU (NS) to ground lug CL-2 (NS).
- () Connect a 400 pF mica capacitor from lug 2 of coil CT (NS) to ground lug CL-3 (NS).
- () Connect a 115 pF mica capacitor from lug 1 of coil CY (NS) to ground lug CL-2 (NS).
- () Refer to the inset drawing on Detail 2-1D and twist together the leads of two 22 pF mica capacitors as shown. **NOTE:** Each twisted pair of leads will be counted as two leads in a solder step.
- () Connect one pair of leads to lug 2 of coil CY (NS) and the other pair of leads to ground lug CL-3 (NS).



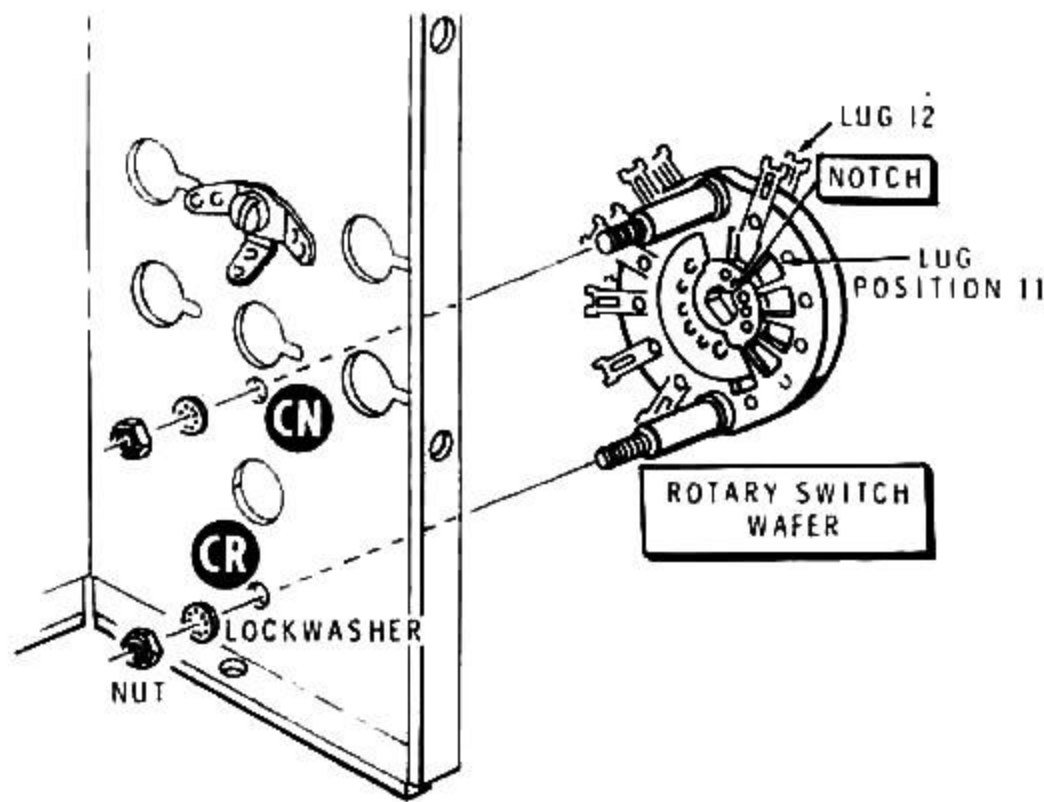
Detail 2-1E



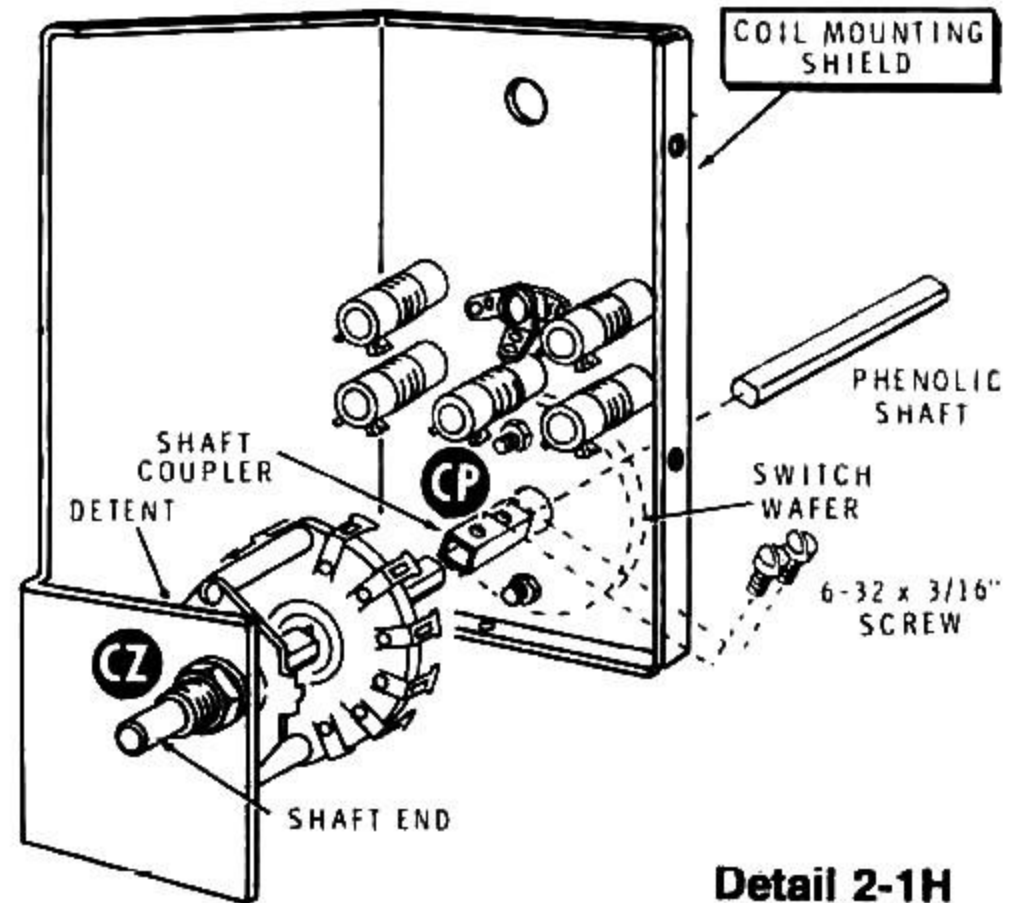
Detail 2-1F

Refer to Detail 2-1E for the following steps.

- () Connect a 150 pF mica capacitor from lug 1 of coil CX (NS) to ground lug CL-2 (NS). Position the capacitor as shown.
- () Connect a 115 pF mica capacitor from lug 2 of coil CX (NS) to ground lug CL-2 (S-4).
- () Twist the leads of a 470 pF and a 680 pF mica capacitor together as in a previous step. Connect one pair of leads to lug 1 of coil CS (NS) and the other pair of leads to ground lug CL-1 (NS). Position the capacitors as shown.
- () Twist the leads of a 400 pF and a 680 pF mica capacitor together. Connect one pair of leads to lug 2 of coil CS (NS) and the other pair of leads to ground lug CL-1 (S-5).
- () Connect a 470 pF mica capacitor from lug 1 of coil CT (NS) to ground lug CL-3 (S-4). Position the capacitor as shown.
- () Turn the shaft of the 5-position rotary switch (#63-561) fully clockwise as viewed from the shaft end.
- () Refer to Detail 2-1F and mount the 5-position rotary switch on the coil mounting shield at CZ. Use a control nut, a control lockwasher, and a control flat washer. Be sure the two switch spacers and the switch shaft are aligned vertically and that the notch in the rotor is positioned as shown. Tighten the hardware only finger tight.



Detail 2-1G



Detail 2-1H

- () Refer to Detail 2-1G and remove the two nuts from the screws passing through the two spacers of the separate rotary switch wafer (#63-562). Retain the spacers on the screws.
- () Insert the bared screw ends into holes CN and CR of the coil mounting shield with lug 12 positioned as shown. Secure the switch with two #6 lockwashers and with the two nuts previously removed.
- () Position the rotating portion of the switch wafer as shown so the notch points between switch lugs 11 and 12. The phenolic shaft (#453-135) may be used to turn the switch rotor.
- () Check to be sure that switch CZ is still turned fully clockwise (viewed from the shaft end).

Refer to Detail 2-1H for the following steps.

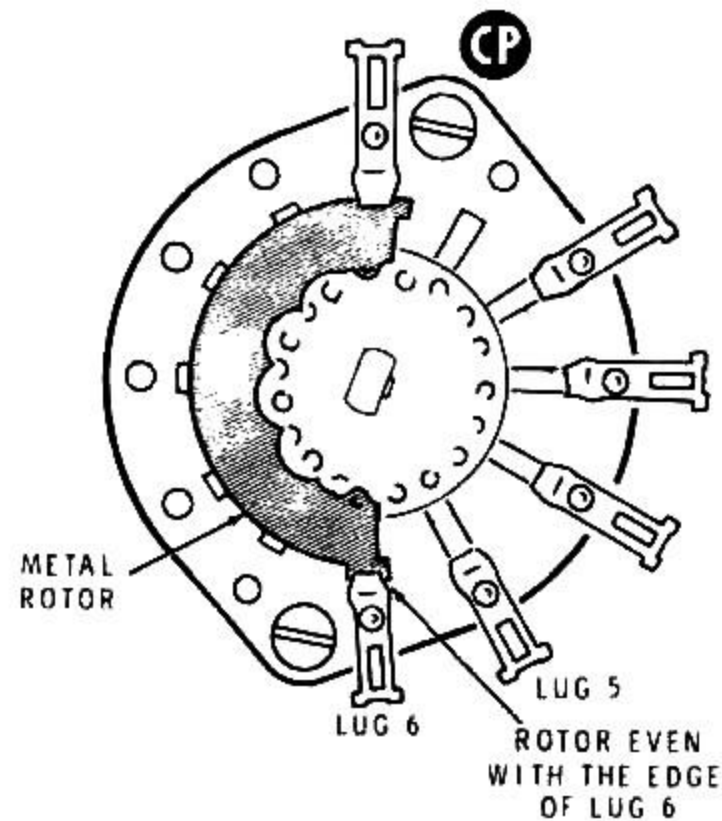
- () Start two 6-32 x 3/16" screws into the tapped holes of the shaft coupler (#456-16). Then slide half the length of the shaft coupler onto the shaft of switch CZ and tighten one screw. The screws should be at the one o'clock position (viewed from the shaft end).

CAUTION: Be careful when you tighten the setscrew in the following step. Use an angle screwdriver if one is available.

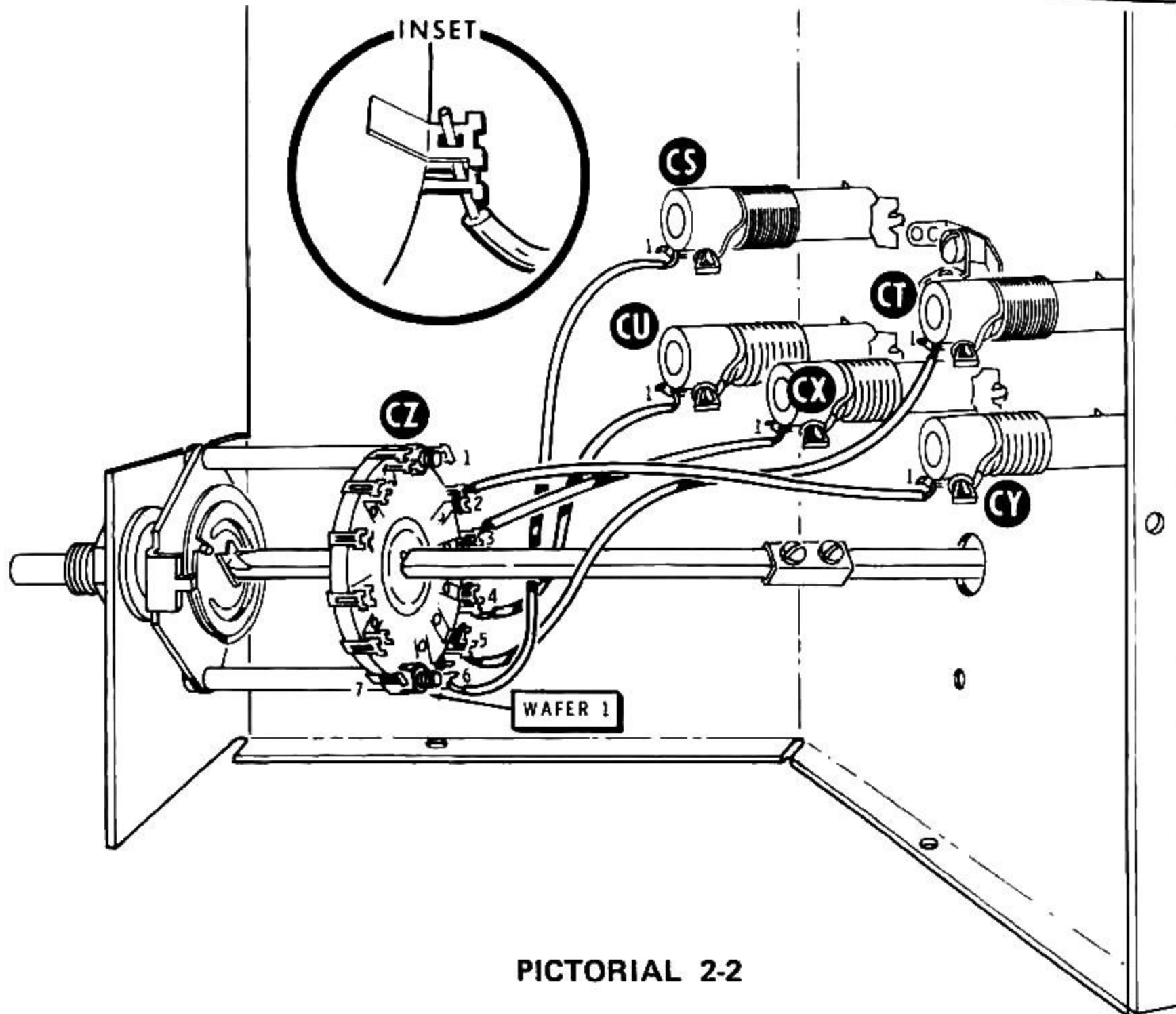
- () Slide the phenolic shaft (#453-135) through the switch wafer on the rear of the coil mounting shield, through hole CP in the shield, and into the shaft coupler. Tighten the remaining setscrew in the shaft coupler onto the phenolic shaft.
- () Hold the 5-position rotary switch detent (at CZ) stationary and turn the shaft coupler fully counterclockwise.

Refer to Pictorial 2-1 and Detail 2-1H and Detail 2-1J for the next three steps.

- () Note the metal rotor of switch wafer CP. Turn the switch detent at CZ slightly so the metal rotor of switch wafer CP is just even with the edge of lug 6 as shown. Then tighten the hardware on switch CZ.
- () Check the metal rotor of switch wafer CP again. If the metal rotor extends past lug 6, arcing can occur between the rotor and lug 5.
- () Turn the switch shaft through each of its five positions and check the metal rotor to make sure it makes contact with each lug in turn.



Detail 2-1J



PICTORIAL 2-2

Refer to Pictorial 2-2 for the following steps.

() Prepare the following lengths of black hookup wire. The wires are listed in the order in which they will be used.

2-1/4"

3-1/2"

3-1/2"

1-3/4"

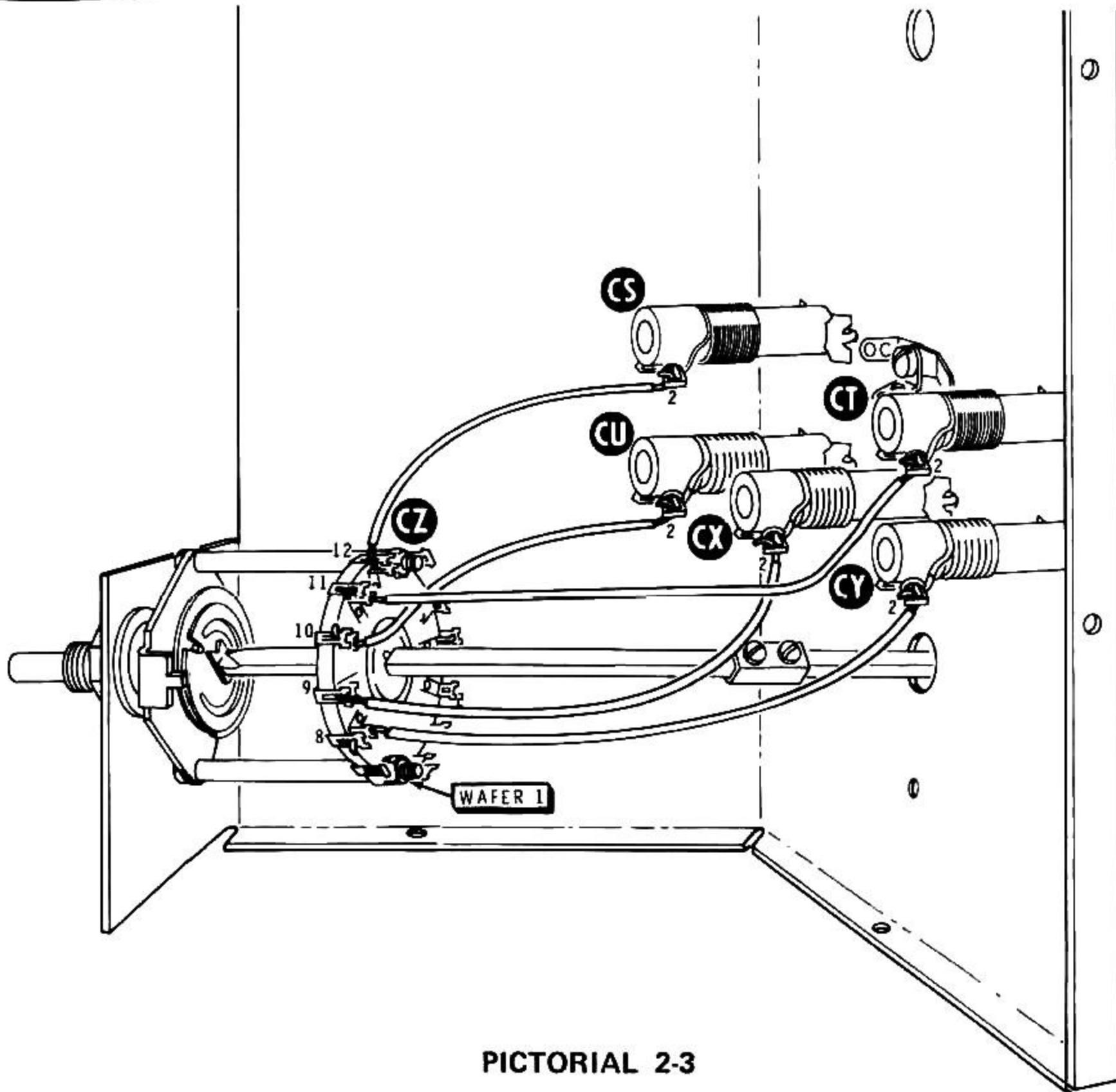
2"

NOTE: Switch CZ has lugs only on the front of the wafer at positions 1 and 7. All other positions on this wafer have lugs on the front and on the rear of the wafer. Be sure to connect the wire to both lugs when there are double lugs.

When a wire passes through a connection and then goes to another point, it will count as two wires in the solder instructions, one entering and one leaving the connection. Thus, when a wire passes through one switch lug and then goes on to the other switch lug at the same position, it will count as three wires (S-3) in the solder instructions.

Connect the prepared hookup wires from the coils to wafer 1 of switch CZ as follows:

Wire Length	Connect From Lug 1 of	Connect to Wafer 1 of Switch CZ
() 2-1/4"	Coil CU (S-2)	Lug 4 (S-3)
() 3-1/2"	Coil CT (S-2)	Lug 5 (S-3)
() 3-1/2"	Coil CS (S-3)	Lug 6 (S-3)
() 1-3/4"	Coil CX (S-2)	Lug 3 (S-3)
() 2"	Coil CY (S-2)	Lug 2 (S-3)



PICTORIAL 2-3

Refer to Pictorial 2-3 for the following steps.

Connect the prepared hookup wire from the coils to wafer 1 of switch CZ as follows:

() Prepare the following lengths of black hookup wire. Wires are listed in the order in which they will be used.

2-1/2"

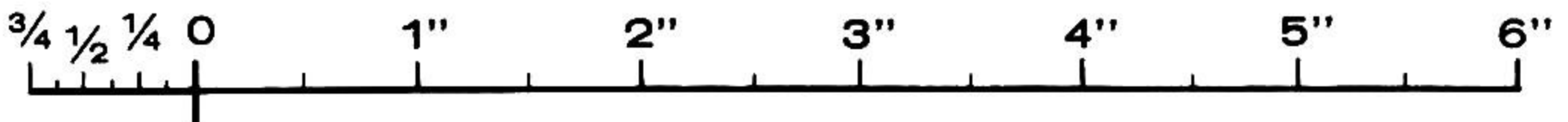
2"

2-1/2"

2-1/2"

2-1/2"

Wire Length	Connect From Lug 2 of	Connect to Wafer 1 of Switch CZ
() 2-1/2"	Coil CY (S-3)	Lug 8 (S-3)
() 2"	Coil CX (S-2)	Lug 9 (S-3)
() 2-1/2"	Coil CU (S-2)	Lug 10 (S-3)
() 2-1/2"	Coil CT (S-2)	Lug 11 (S-3)
() 2-1/2"	Coil CS (S-3)	Lug 12 (S-3)



PART A

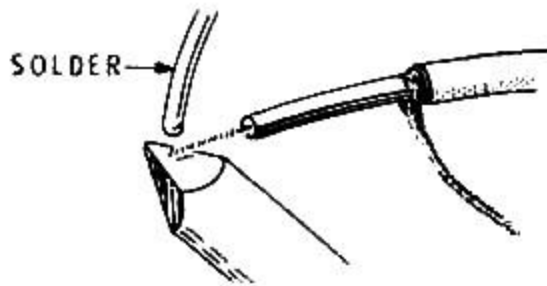
TAKING CARE NOT TO CUT THE OUTER SHIELD OF VERY THIN WIRES, REMOVE THE OUTER INSULATION.



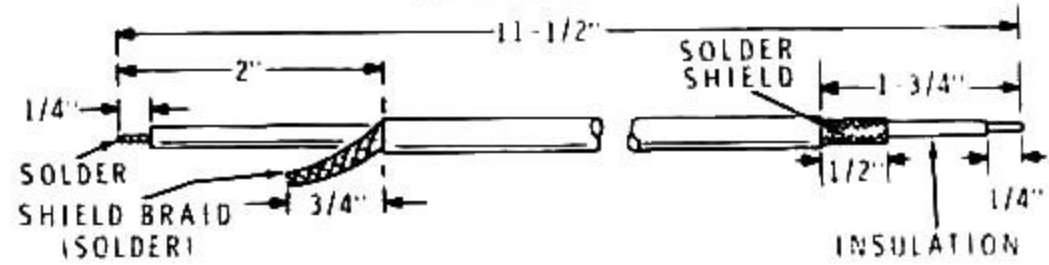
PUSH BACK THE SHIELD. THEN MAKE AN OPENING IN THE SHIELD AND BEND OVER AS SHOWN. PICK OUT THE INNER LEAD.



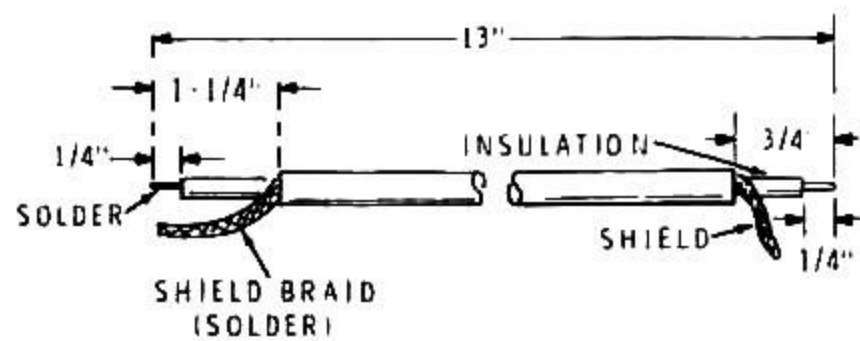
REMOVE THE INNER INSULATION AND STRETCH OUT THE SHIELD. APPLY A SMALL AMOUNT OF SOLDER TO THE END OF THE SHIELD AND THE INNER LEAD. USE ONLY ENOUGH HEAT FOR THE SOLDER TO FLOW.



PART B



PART C



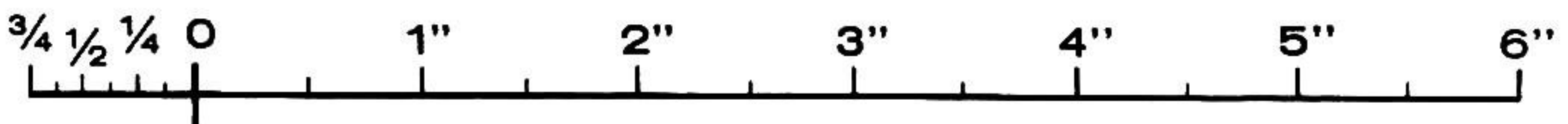
PICTORIAL 2-4

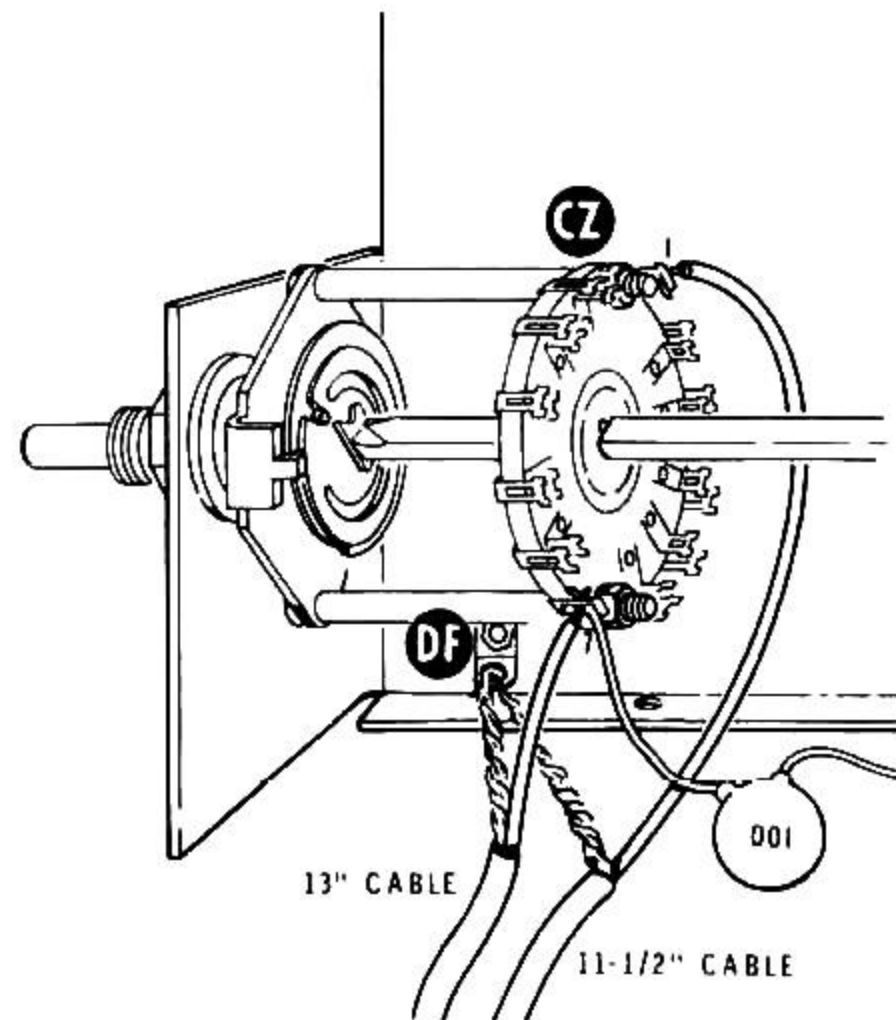
NOTE: When you prepare coaxial cables in the following steps, refer to Part A of Pictorial 2-4 for the method of removing the inside of the cable from the shield braid. Be careful not to melt the inner insulation.

solder to each end to hold the small strands together. In a like manner, twist and solder the end of the shield braid.

() Prepare an 11-1/2" length of RG-58A/U coaxial cable as shown in Pictorial 2-4, Part B. Twist the center conductor wires together and apply a small amount of

() Refer to Pictorial 2-4, Part C, and prepare a 13" length of RG-58A/U coaxial cable as shown.



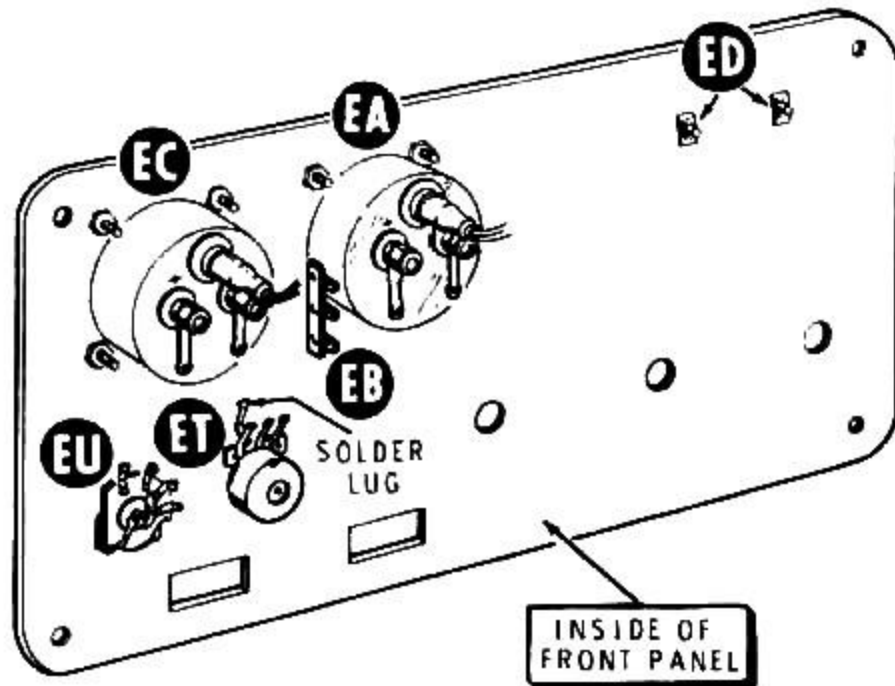


PICTORIAL 2-5

- () Refer to Pictorial 2-5 and connect the 1-1/4" end of the center conductor of the 13" coaxial cable to lug 7 of wafer 1 of switch CZ (NS). Connect the shield braid to solder lug DF (NS).
- () Connect the 2" end of the center conductor of the 11-1/2" coaxial cable to lug 1 of wafer 1 of switch CZ (S-1). Connect the braid to solder lug DF (S-2). **NOTE:** The other ends of the coaxial cables will be connected later.
- () Turn the switch shaft to its stop in each direction and make sure that no wires interfere with the coupling.
- () Cut each lead of a 500 volt (smaller) .001 μ F disc capacitor to a length of 3/4". Connect one lead of this capacitor to lug 7 of wafer 1 of switch CZ (S-2). The other lead will be connected later.

This completes the "Input Coil Assembly."

Set the input coil assembly aside until it is called for later.



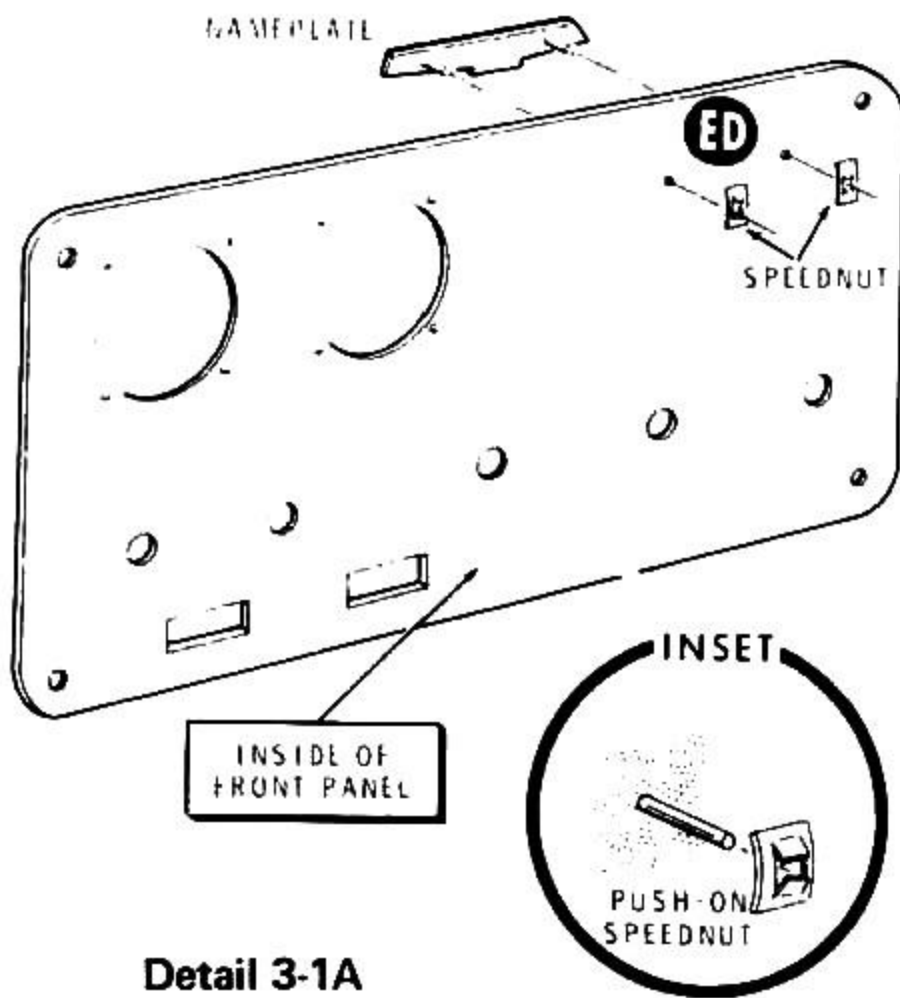
PICTORIAL 3-1

FRONT PANEL

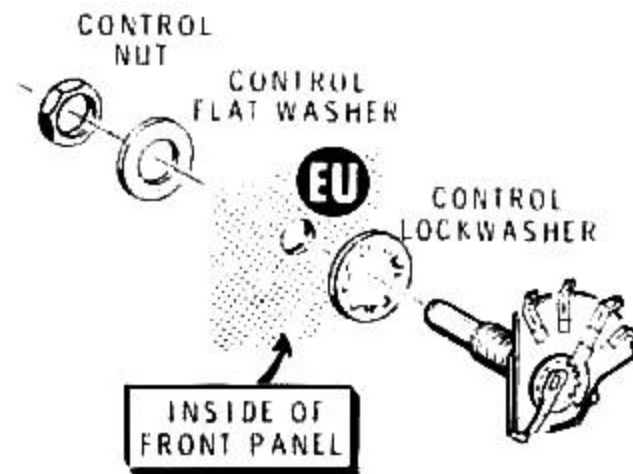
NOTE: To avoid scratching the front panel and meter faces during the following steps, place a soft cloth on your work table.

Refer to Pictorial 3-1 for the following steps.

- () Refer to Detail 3-1A and install the Heathkit nameplate in the two holes marked ED. Use the two speednuts.

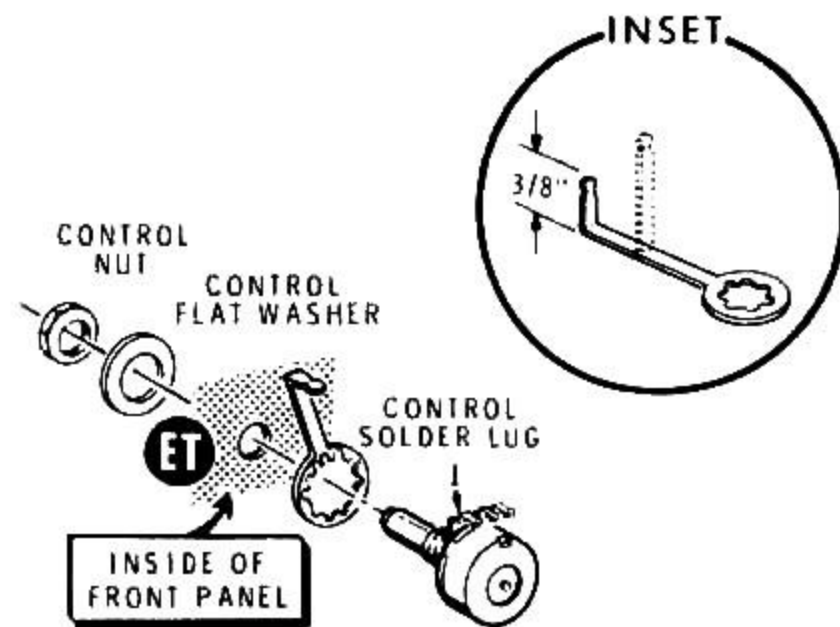


Detail 3-1A

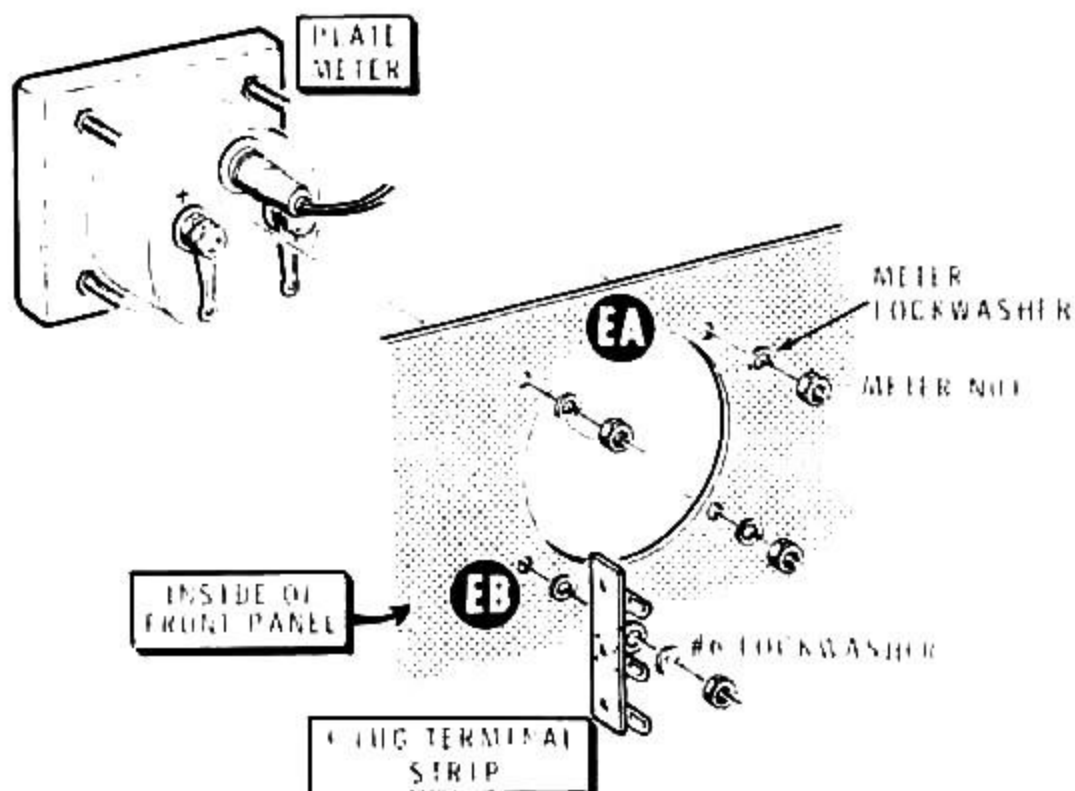


Detail 3-1B

- () Refer to Detail 3-1B and install the 3-position rotary switch (#63-47) at EU. Use a control lockwasher, a control flat washer, and a control nut. Position the switch lugs as shown in the Pictorial.
- () Refer to Detail 3-1C and install the 100 kΩ sensitivity control (#10-12) at ET. Use a control solder lug, a control flat washer, and a control nut. Form the control solder lug as shown. Then align the control solder lug with lug 1 of the control.



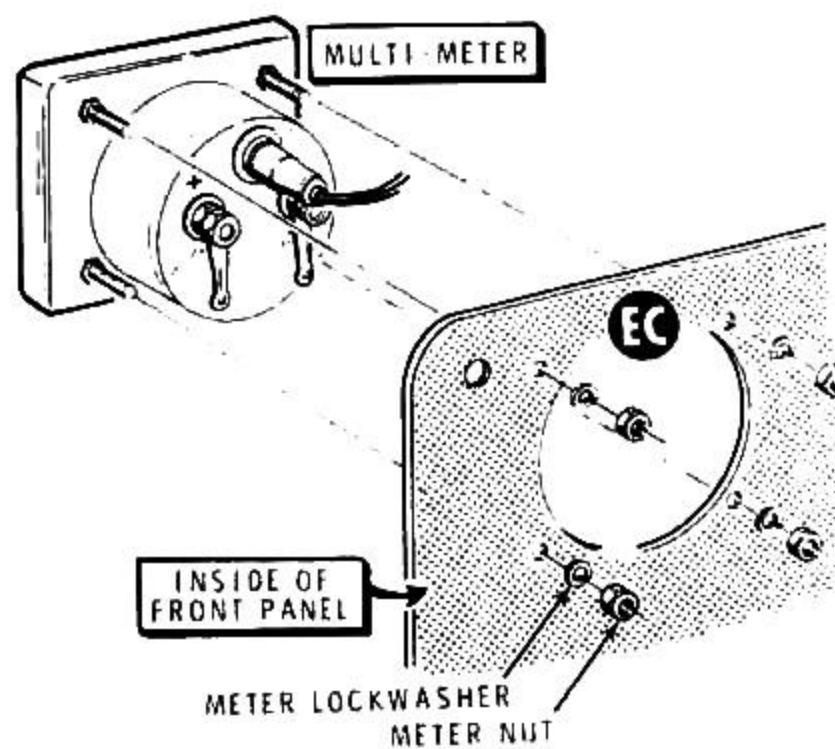
Detail 3-1C



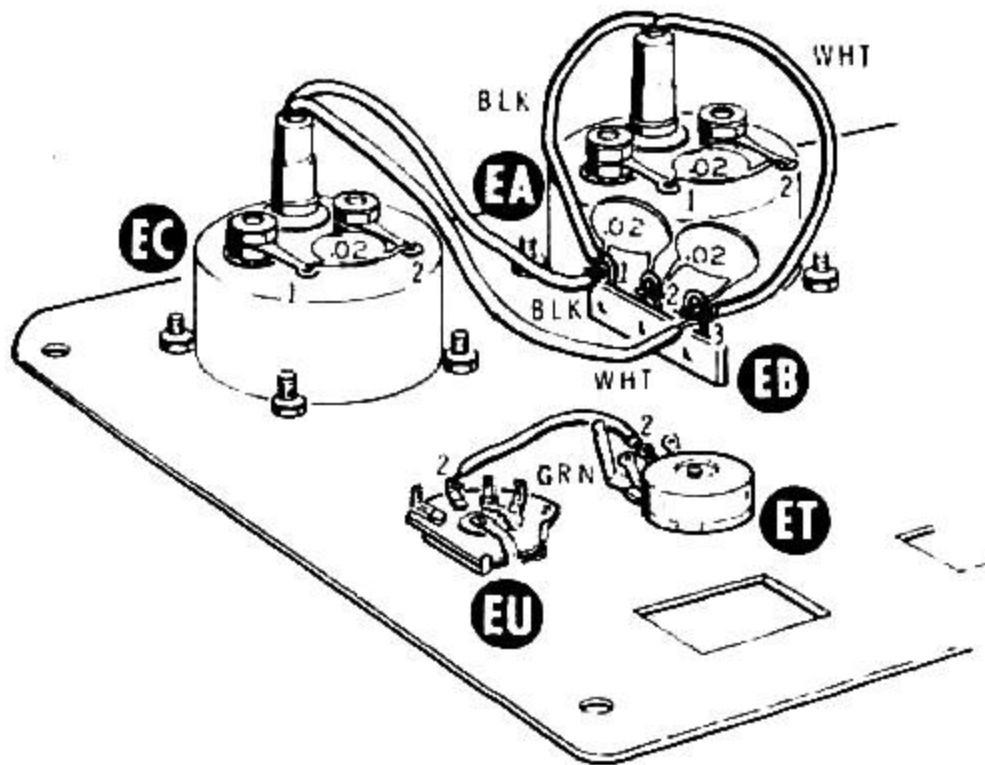
Detail 3-1D

NOTE: Before mounting the terminal strip in the following step, scrape away any paint around hole EB which would prevent the lockwasher and terminal strip foot from making good contact with the panel.

- () Refer to Detail 3-1D and install the plate meter (#407-145) at EA. Use the hardware supplied with the meter. Install a 3-lug terminal strip at EB. Note the lockwashers used. CAUTION: Do not overtighten the meter hardware as the meter case can be damaged.
- () Refer to Detail 3-1E and install the multi-meter (#407-146) at EC. Use the hardware supplied with the meter.
- () Remove and discard the wire jumpers between the meter terminals on each meter.



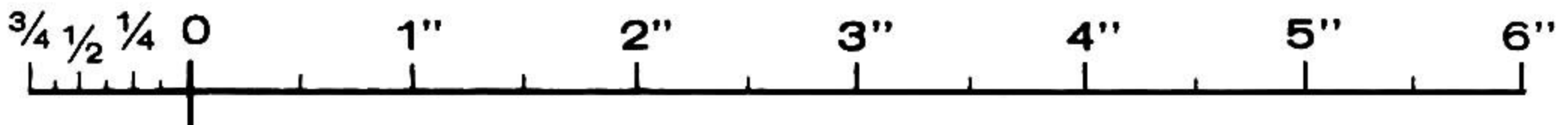
Detail 3-1E

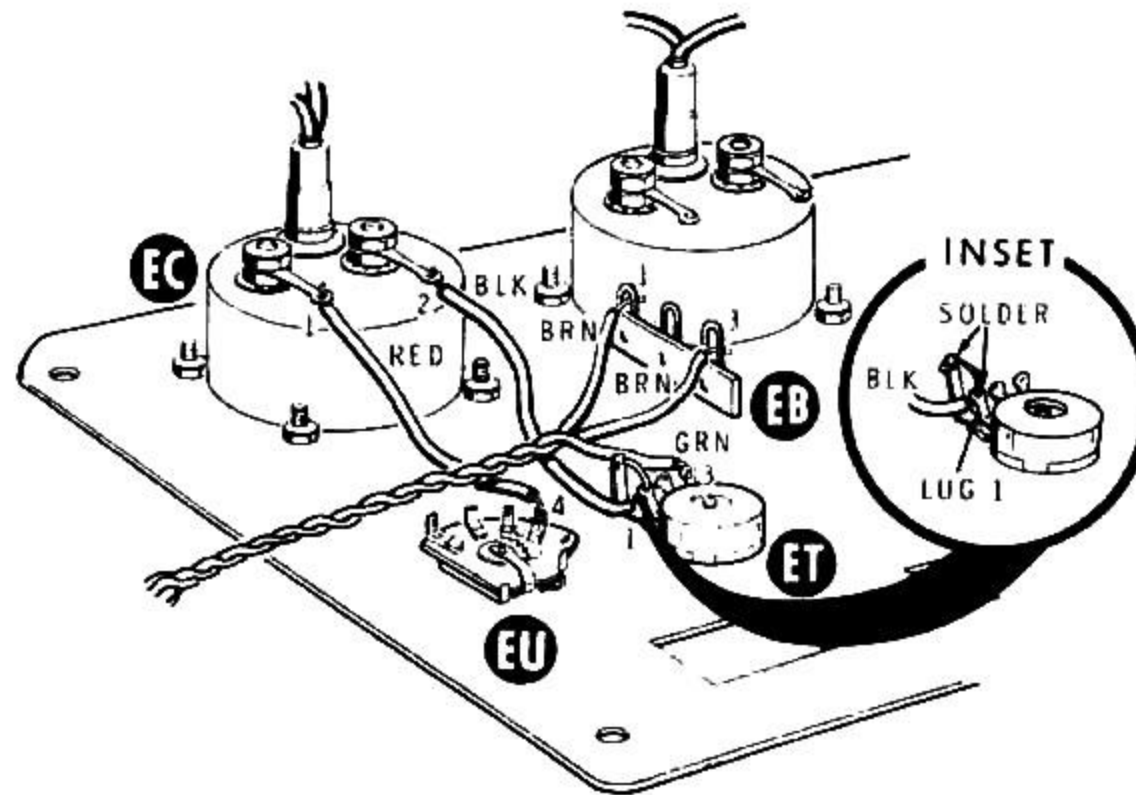


PICTORIAL 3-2

Refer to Pictorial 3-2 for the following steps.

- () Connect a $.02 \mu\text{F}$ disc capacitor between lugs 1 (NS) and 2 (NS) of meter EC.
- () Connect a $.02 \mu\text{F}$ disc capacitor between lugs 1 (NS) and 2 (NS) of meter EA.
- () Cut the leads of two $.02 \mu\text{F}$ disc capacitors to a length of $1/2''$. These capacitors will be used in the next two steps.
- () Install a $.02 \mu\text{F}$ disc capacitor between lugs 1 (NS) and 2 (NS) of terminal strip EB.
- () Install a $.02 \mu\text{F}$ disc capacitor between lugs 2 (S-2) and 3 (NS) of terminal strip EB.
- () Cut the black pilot lamp lead from meter EC to $3-1/2''$ and the white lead to $4''$.
- () Connect the black pilot lamp lead coming from meter EC to lug 1 of terminal strip EB (NS).
- () Connect the white pilot lamp lead coming from meter EC to lug 3 of terminal strip EB (NS).
- () Cut the black pilot lamp lead coming from meter EA to $3''$ and the white lead to $4''$.
- () Connect the black pilot lamp lead coming from meter EA to lug 1 of terminal strip EB (NS).
- () Connect the white pilot lamp lead coming from meter EA to lug 3 of terminal strip EB (NS).
- () Connect a $3-1/2''$ length of green wire from lug 2 of rotary switch EU (S-1) to lug 2 of control ET (S-1).





PICTORIAL 3-3

() Prepare the following lengths of hookup wire:

- | | |
|--------------|-----------|
| 3-1/2" black | 18" brown |
| 3-1/2" red | 18" brown |
| | 30" green |

Refer to Pictorial 3-3 for the following steps.

() Remove an additional 1/2" of insulation from one end of the 3-1/2" black wire. Pass this end through lug 1 of control ET (S-2) and wrap it around the control solder lug (S-1). Connect the other end of this black wire to lug 2 of meter EC (S-2).

() Connect a 3-1/2" length of red wire from lug 1 (marked + on the case) of meter EC (S-2) to lug 4 of rotary switch EU (S-1).

() Connect an 18" length of brown wire to lug 3 of terminal strip EB (S-4).

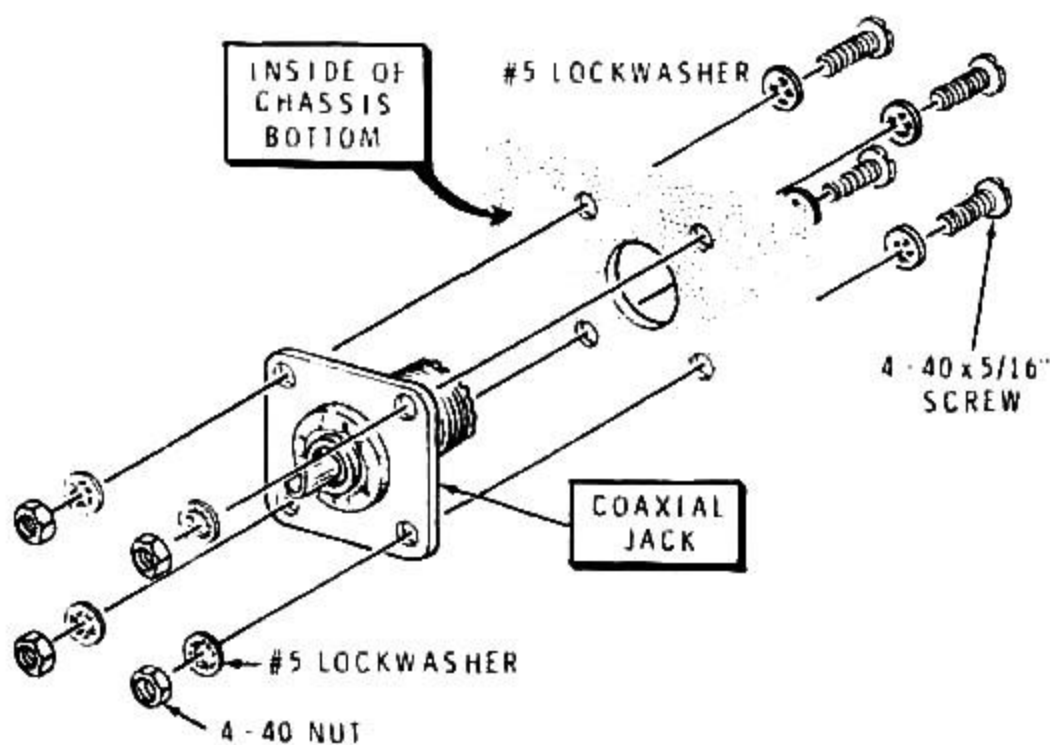
() Connect an 18" length of brown wire to lug 1 of terminal strip EB (S-4).

() Connect a 30" length of green wire to lug 3 of control ET (S-1).

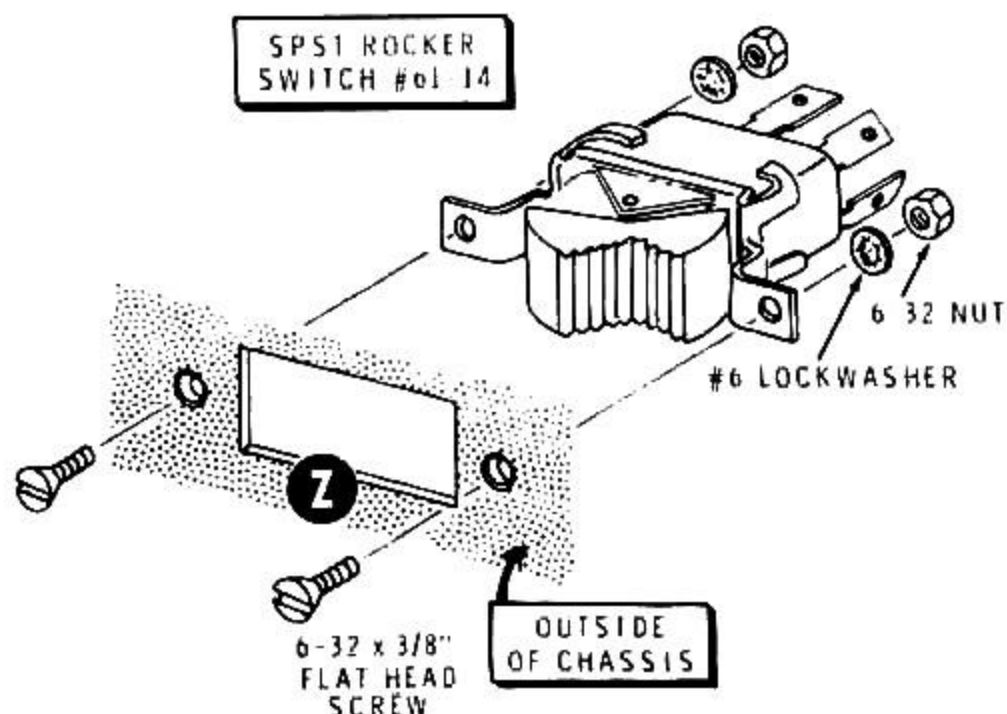
() Gather the green wire and the two brown wires and twist them together approximately one turn per inch.

Set the front panel assembly aside until it is required in later steps.

CHASSIS



Detail 4-1A

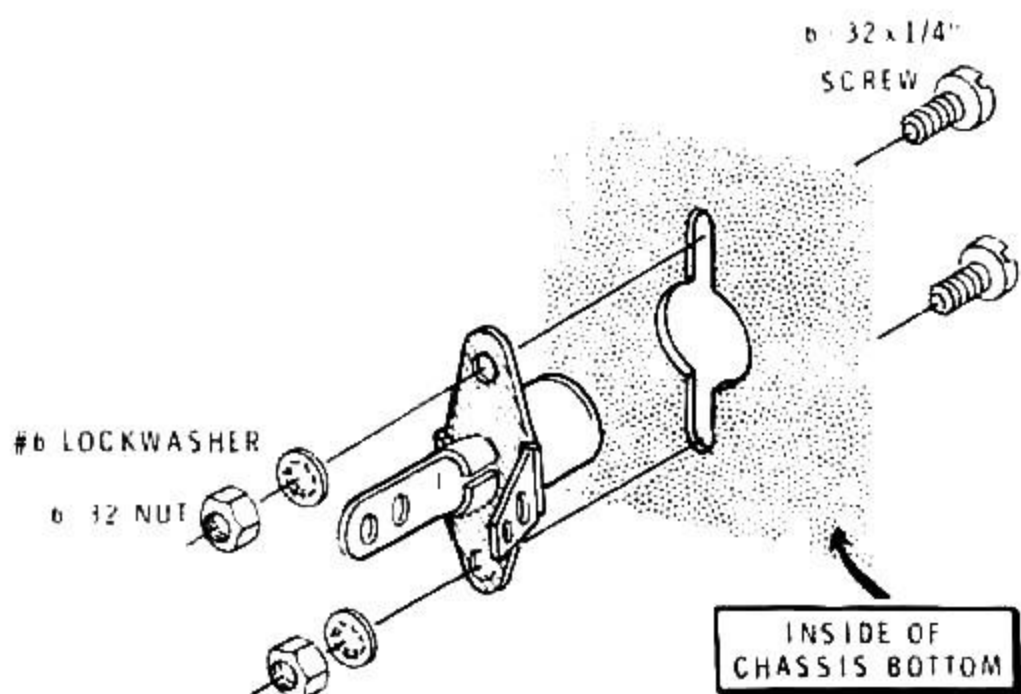


Detail 4-1C

CHASSIS PARTS MOUNTING

Refer to Pictorial 4-1 (fold-out from Page 27) for the following steps.

- () Install 1/2" rubber grommets at Y, T, AK, and AL.
- () Install a 3/4" rubber grommet at AH.
- () Refer to Detail 4-1A and mount a coaxial jack at A on the rear apron of the chassis. Use 4-40 x 5/16" hardware and #5 lockwashers.
- () In the same manner, mount another coaxial jack at L on the rear apron.
- () Refer to Detail 4-1B and mount a phono socket at U on the rear apron. Use 6-32 x 1/4" hardware. Position the ground lug toward the coaxial jack.



Detail 4-1B

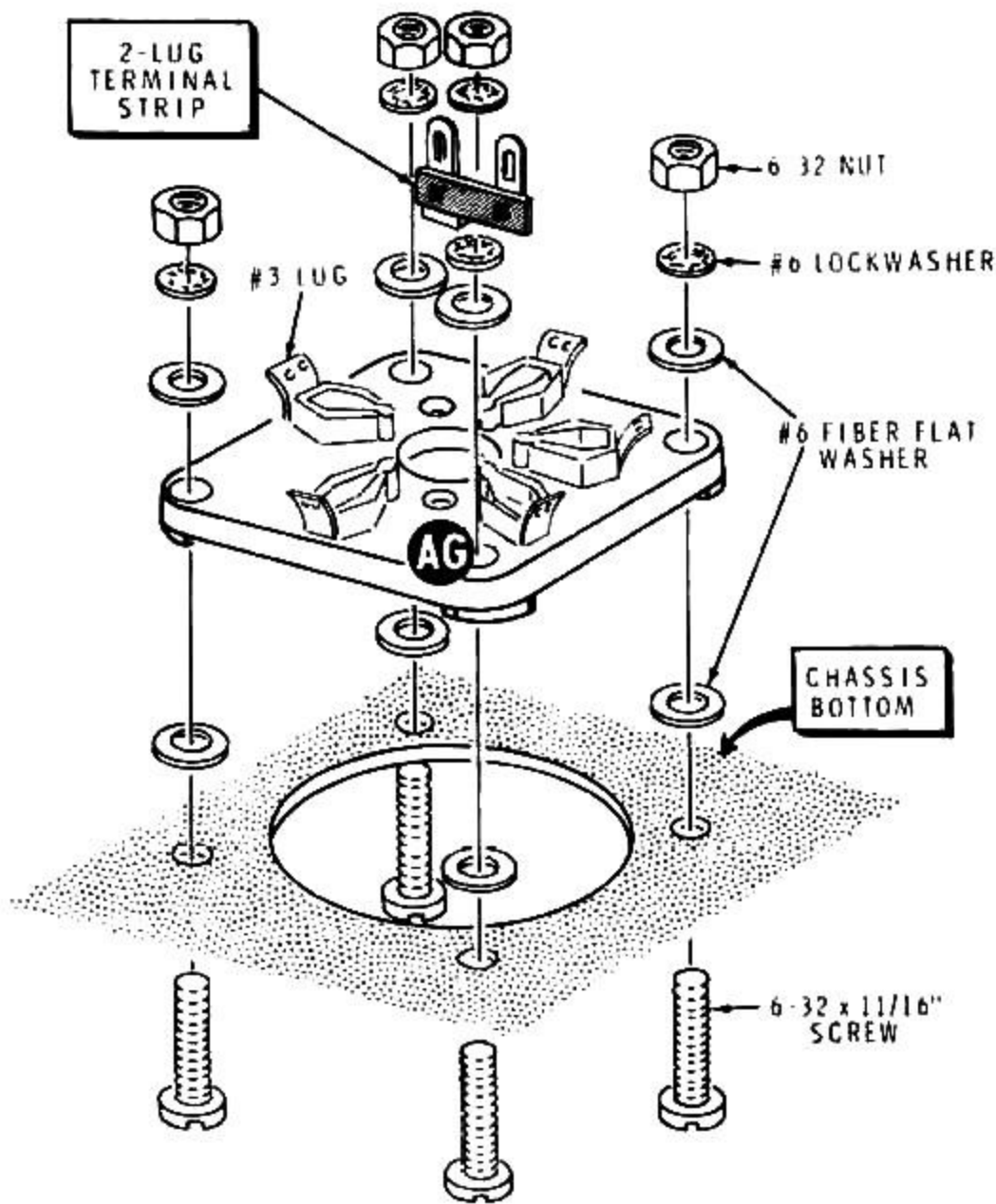
- () Similarly, mount another phono socket at X.

NOTE: In the following steps, the switch mounting holes are off center and fit in one position only.

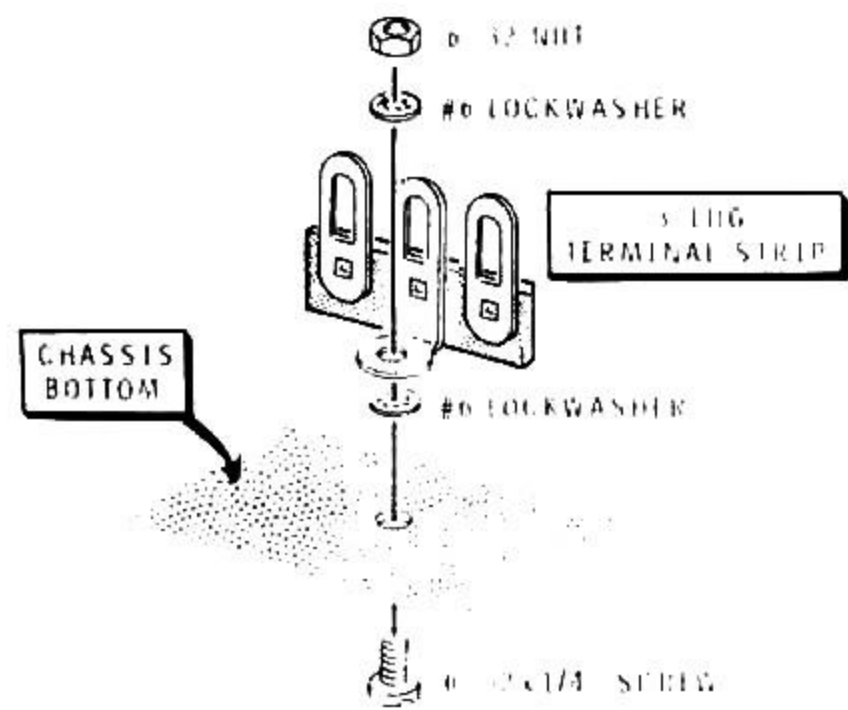
- () Refer to Detail 4-1C and mount the DPST rocker switch (#61-14) at Z on the front apron of the chassis. Use 6-32 x 3/8" flat head screws with lockwashers and nuts. Note the position of the lugs in the Pictorial.
- () Similarly, mount a DPDT rocker switch (#61-15) at AN on the chassis front apron.

NOTE: Discard any loose metal clips you find in the tube socket boxes.

- () Refer to Detail 4-1D and mount a 5-lug ceramic tube socket at N with a 2-lug terminal strip at AG. Use 6-32 x 11/16" hardware and fiber flat washers. Be sure to properly position the socket, and to place a lockwasher under the terminal strip mounting foot.
- () Similarly, mount a 5-lug ceramic tube socket at D. Use 6-32 x 11/16" hardware and fiber flat washers. Do not use a terminal strip on this socket.
- () Refer to Detail 4-1E and mount two #6 solder lugs at C. Use 6-32 x 1/4" hardware. Be sure to position the lugs as shown in the Pictorial.
- () Similarly, mount two #6 solder lugs at M. Position these lugs as shown in the Pictorial.
- () Similarly, mount one #6 solder lug at E.



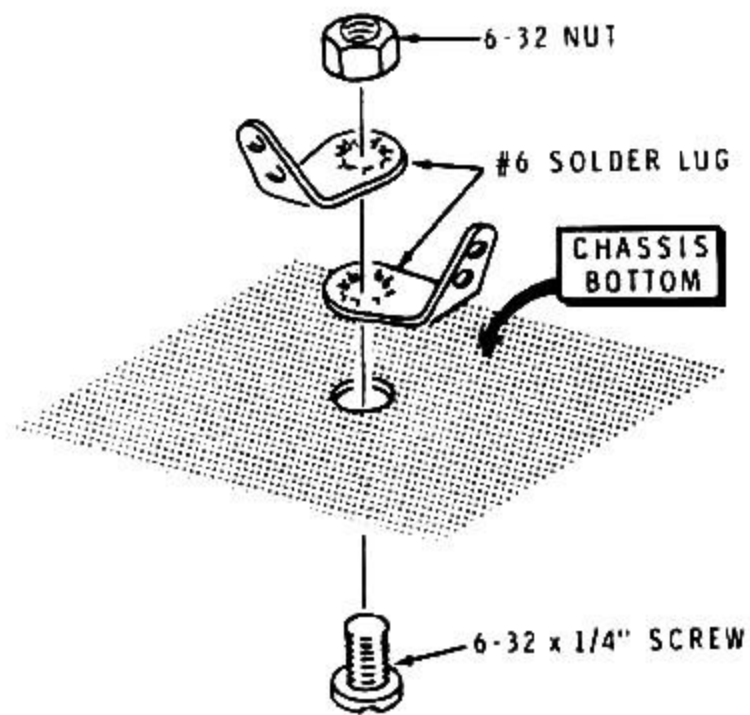
Detail 4-1D



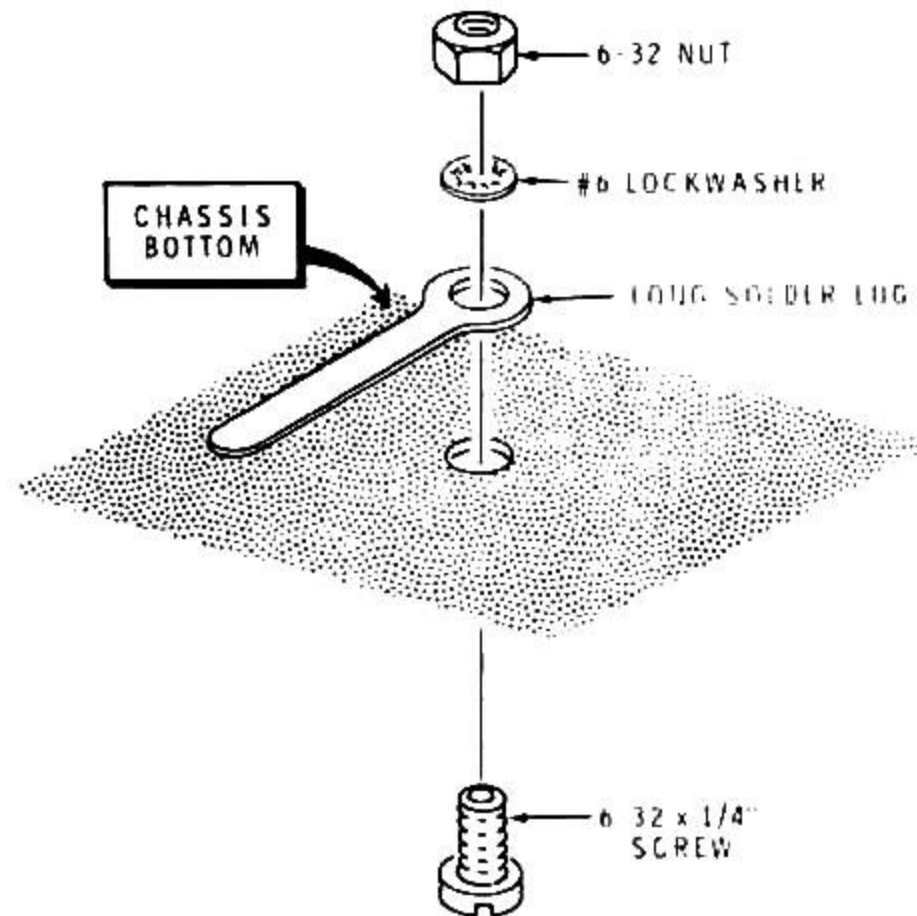
Detail 4-1F

() Refer to Detail 4-1F and mount a 3-lug terminal strip at P. Use 6-32 x 1/4" hardware.

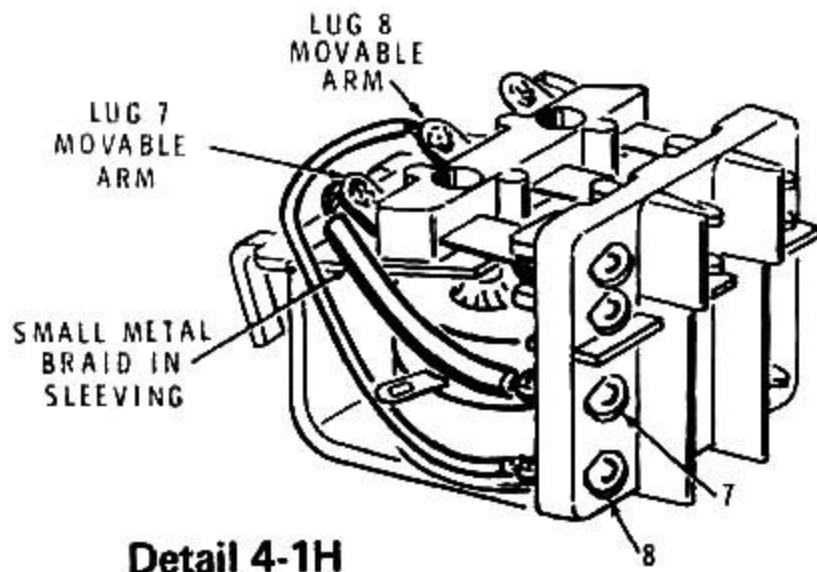
() Refer to Detail 4-1G and mount a long solder lug at R. Use 6-32 x 1/4" hardware.



Detail 4-1E



Detail 4-1G



Detail 4-1H

- () Install a 5/16" rubber grommet at F.

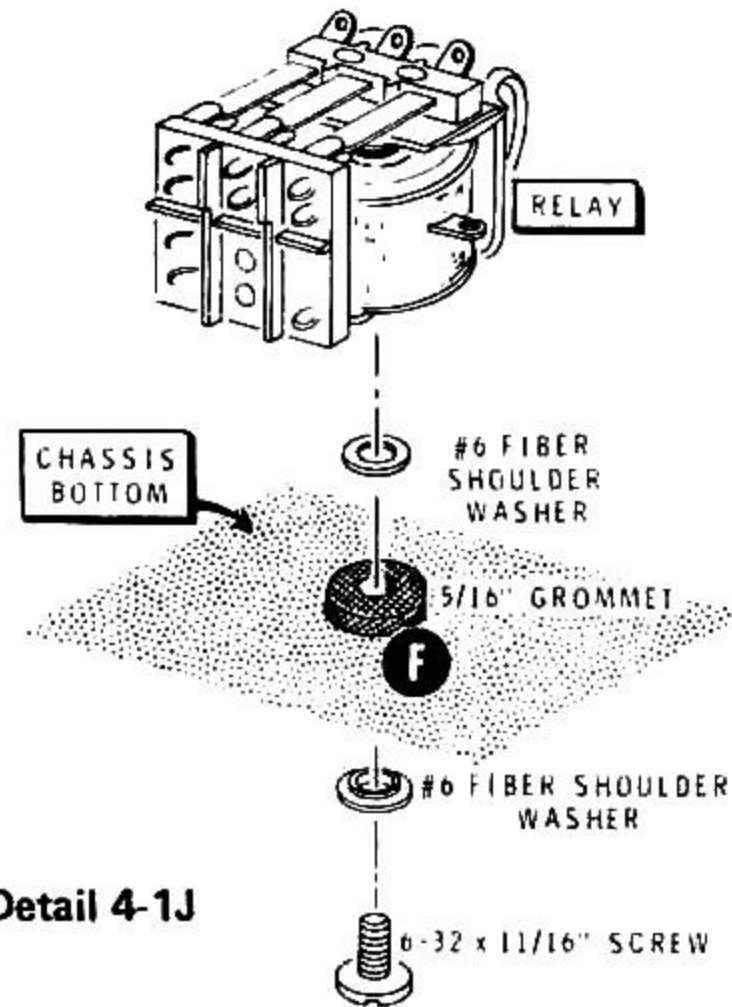
Refer to Detail 4-1H for the following steps.

- () Position the relay (#69-55) with its lugs to the right as shown. Unsolder and discard the black insulated wire between lug 7 and its movable arm.

NOTE: When you solder the small metal braid in the following steps, use the minimum amount of heat necessary to secure a good connection.

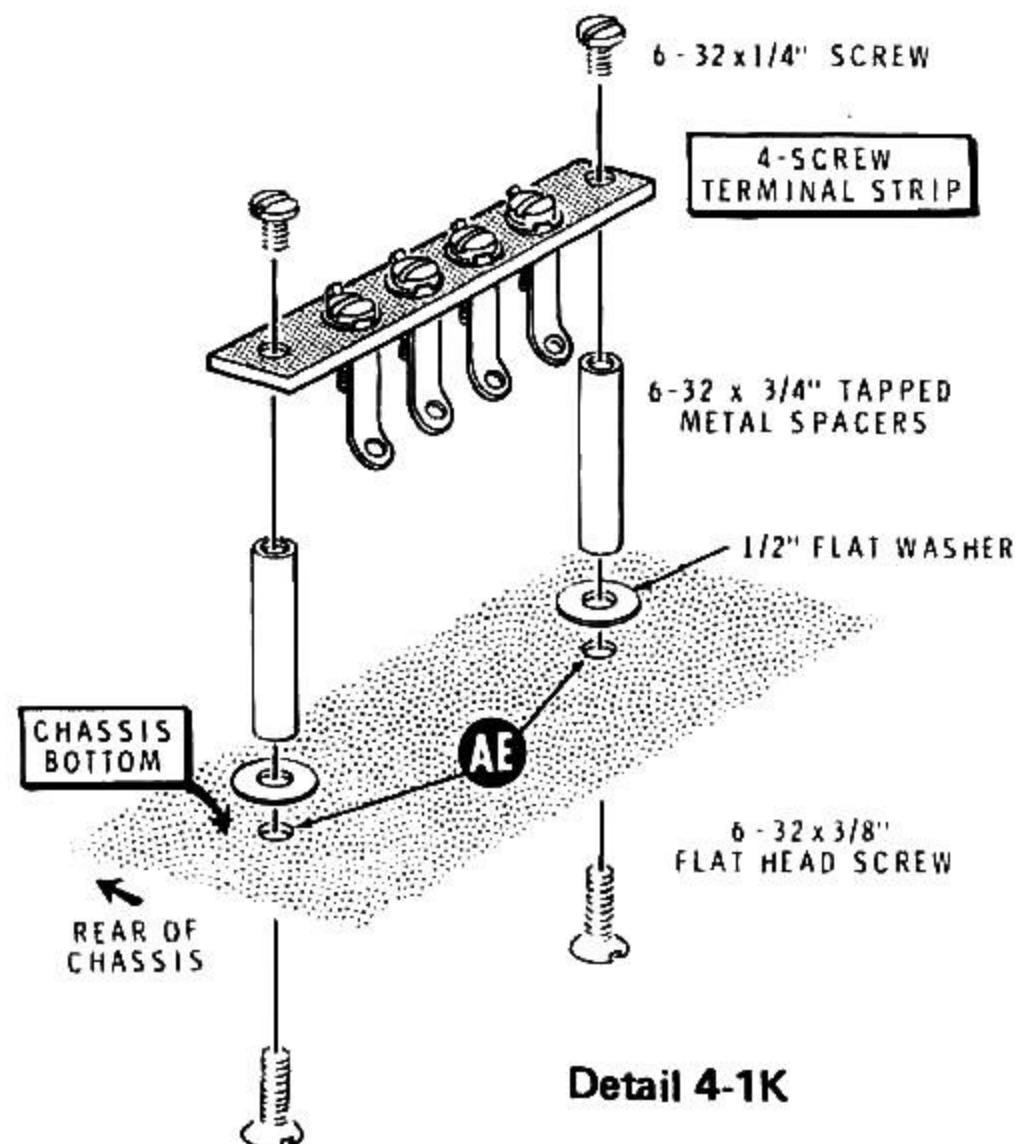
IMPORTANT: Disregard any lug numbers stamped on the relays; refer to the steps and the illustrations for the correct lug numbers.

- () Replace the wire discarded in the previous step with a 3-1/4" length of small metal braid that is folded in the middle and pushed through a 1" length of black sleeving. Solder one end of the braid wires to relay lug 7 and the other end to its movable arm.
- () Unsolder and discard the black insulated wire between lug 8 and its arm.
- () Replace the wire discarded in the previous step with a 5-1/4" length of small metal braid that is folded in the middle and pushed through a 2" length of black sleeving. Solder one end of the braid to lug 8 and the other end to its movable arm.
- () Refer to Detail 4-1J and mount the relay through grommet F. Use a 6-32 x 11/16" screw and two #6 fiber shoulder washers. Do not overtighten this screw. The rubber grommet is used to provide resiliency.

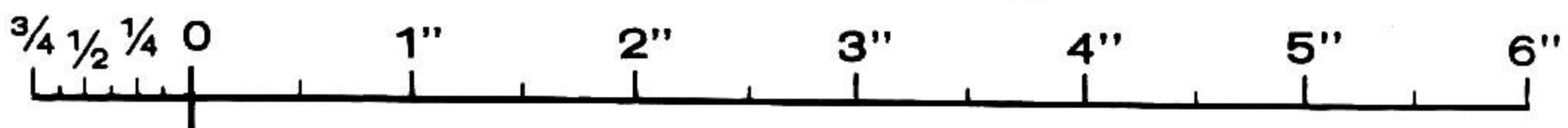


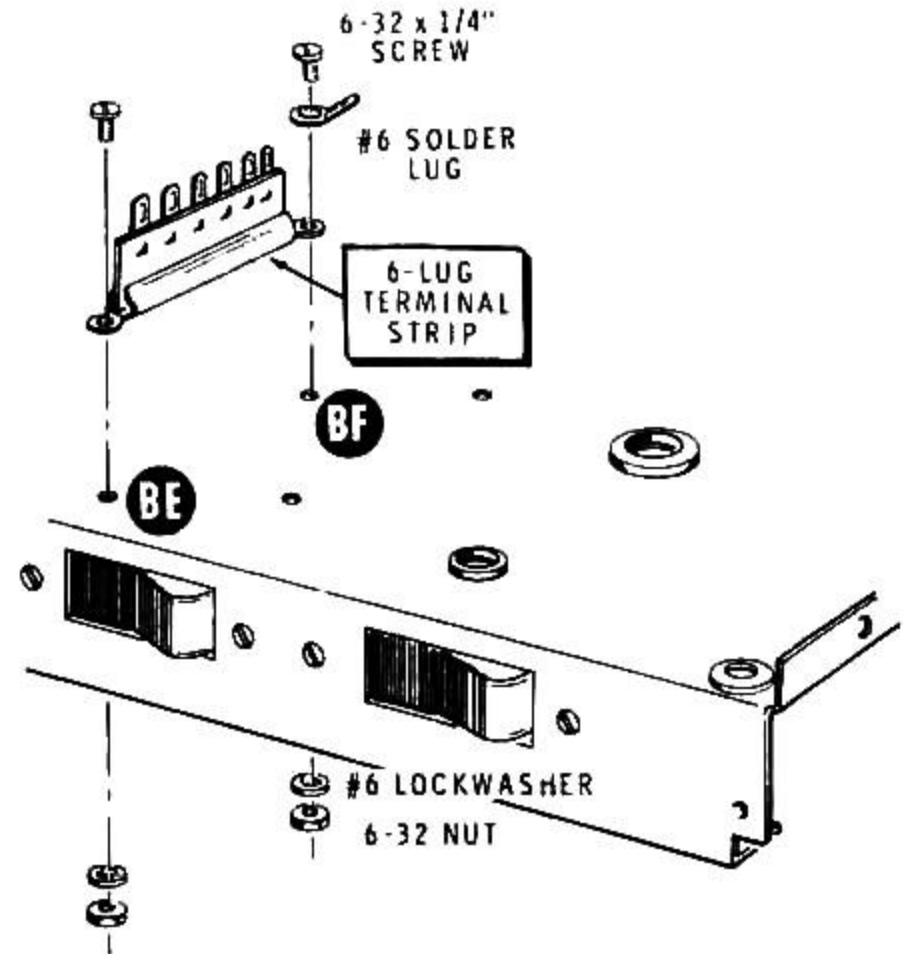
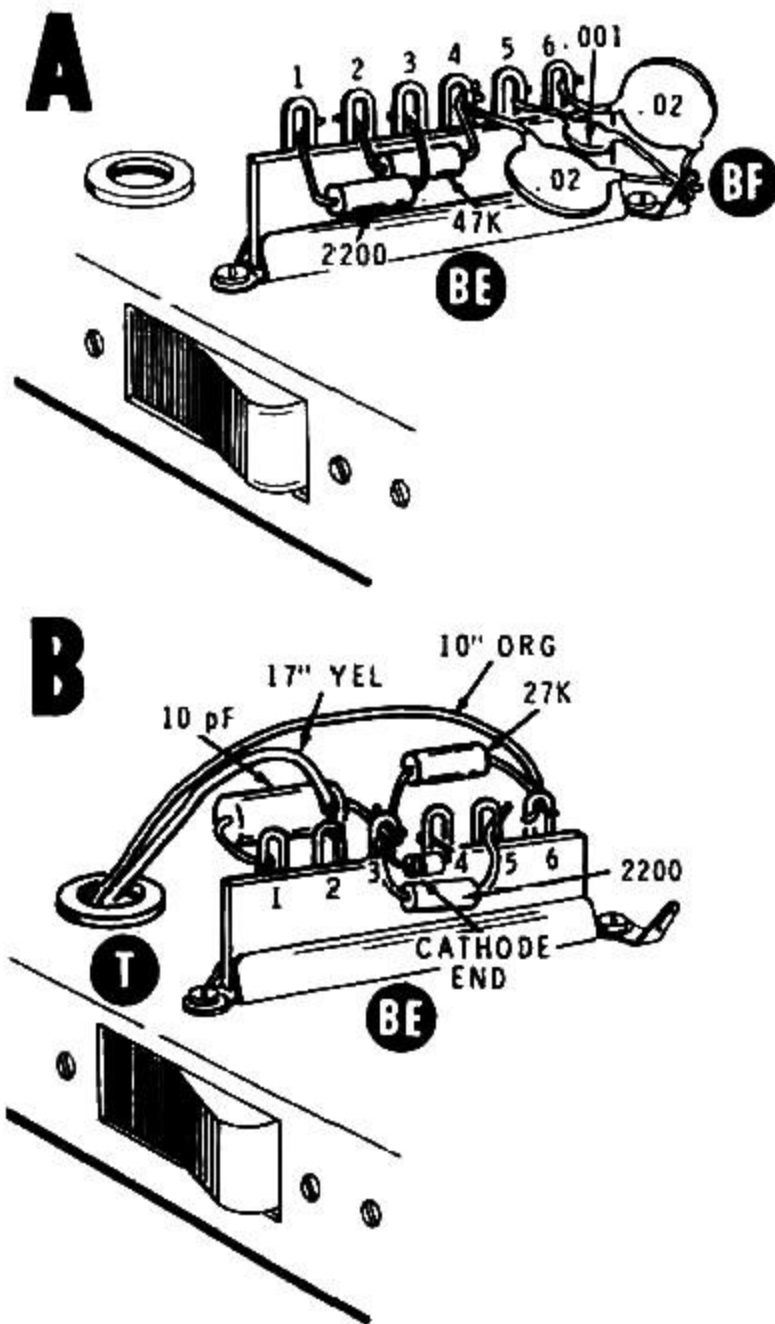
Detail 4-1J

- () Inspect the relay to make sure that neither piece of metal braid can possibly touch the metal frame of the relay.
- () Refer to Detail 4-1K and mount the 4-screw terminal strip at AE. Use two 6-32 x 3/8" flat head screws, two 1/2" flat washers, two 6-32 x 3/4" tapped metal spacers, and two 6-32 x 1/4" binder head screws.



Detail 4-1K





Detail 4-2A

PICTORIAL 4-2

ALC WIRING

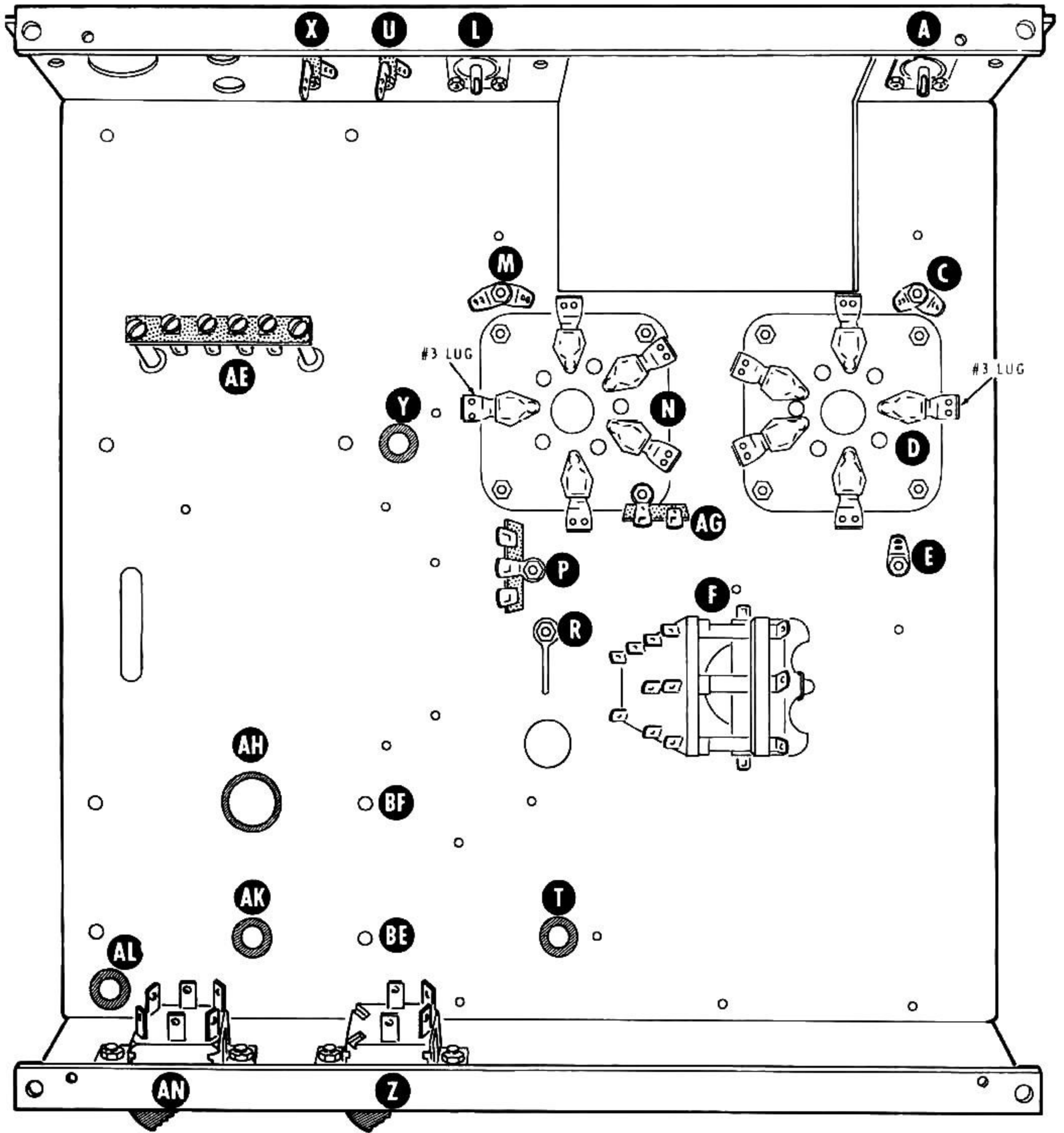
Refer to Pictorial 4-2 for the following steps.

- () Refer to Detail 4-2A and mount a 6-lug terminal strip on the top of the chassis at holes BE and BF with 6-32 x 1/4" hardware. Use a #6 solder lug at BF only.
- Refer to Part A of the Pictorial for the next five steps. Note the positions of the components.
- () Connect a 47 kΩ (yellow-violet-orange) resistor from lug 2 (NS) to lug 4 (NS) of terminal strip BE.
- () Connect a 2200 Ω (red-red-red) resistor from lug 1 (NS) to lug 3 (NS) of terminal strip BE.
- () Connect a .02 μF disc capacitor from lug 4 of terminal strip BE (NS) to solder lug BF (NS).
- () Connect a 500 volt (smaller) .001 μF disc capacitor from lug 5 of terminal strip BE (NS) to solder lug BF (NS).

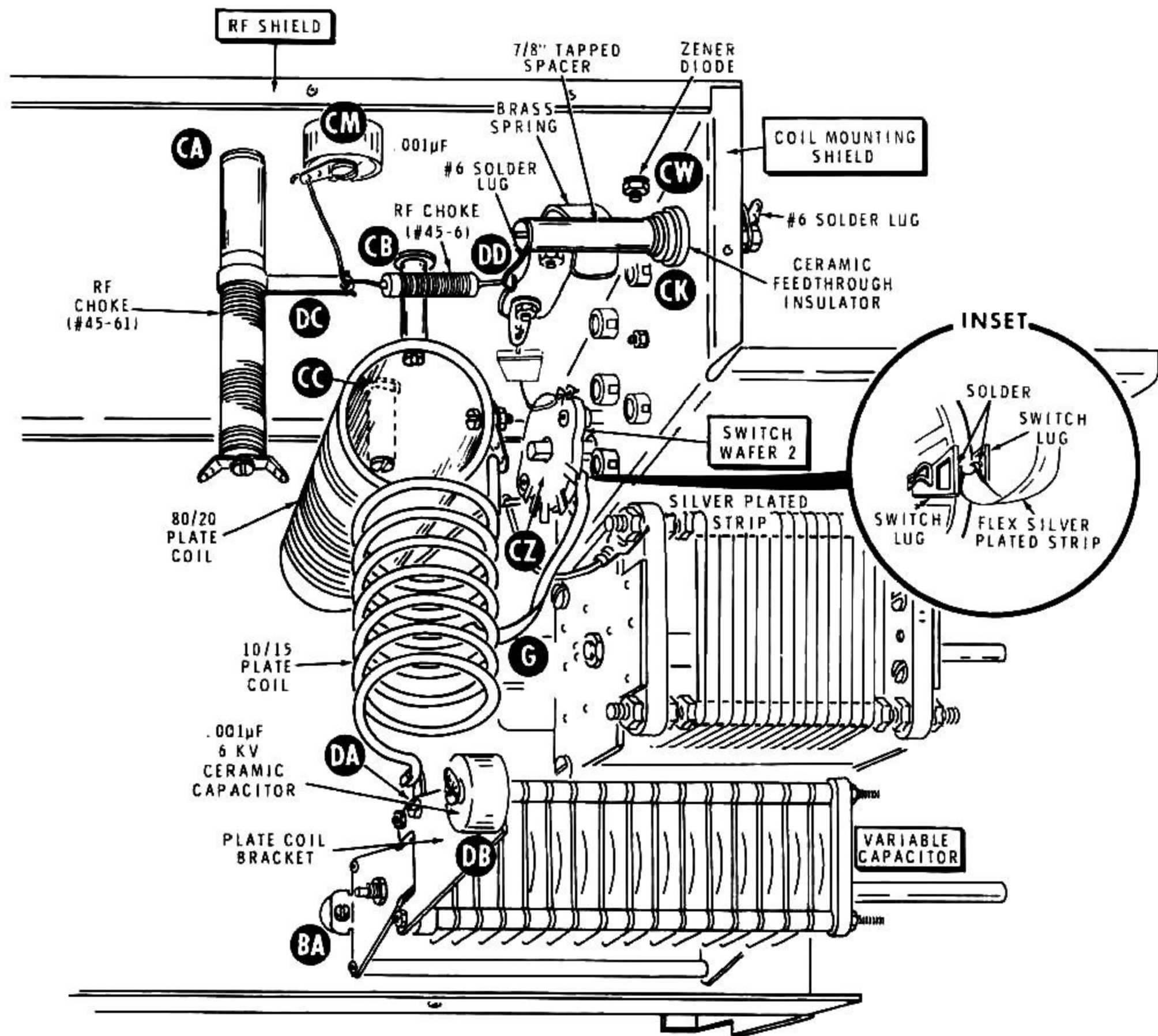
- () Connect a .02 μF disc capacitor from lug 6 of terminal strip BE (NS) to solder lug BF (S-3).

Refer to Part B of the Pictorial for the next eight steps.

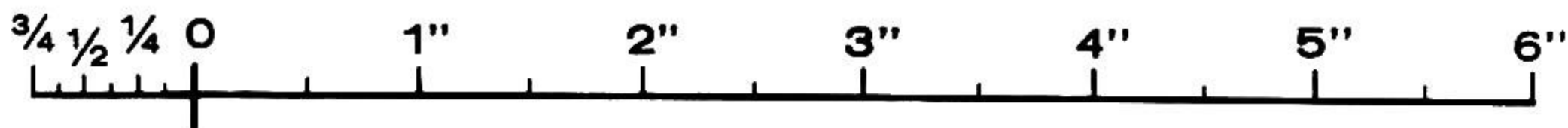
- () Prepare a 10" length of orange hookup wire and a 17" length of yellow hookup wire.
- () Connect one end of the orange wire to lug 6 of terminal strip BE (NS).
- () Connect one end of the yellow wire to lug 2 of terminal strip BE (S-2).
- () Pass the free ends of the yellow and the orange wires down through grommet T. To temporarily secure the ends of these wires, they can be passed up through some other hole in the chassis.
- () Connect a 2200 Ω (red-red-red) resistor from lug 3 (NS) to lug 5 (S-2) of terminal strip BE.
- () Connect a 27 kΩ (red-violet-orange) resistor from lug 3 (NS) to lug 6 (S-3) of terminal strip BE.
- () Connect the cathode lead of a silicon diode (#56-24, yellow-green-gray) to lug 3 (NS), and the anode lead to lug 4 (S-3) of terminal strip BE.
- () Connect a 10 pF (may be marked 10 μμF) tubular ceramic capacitor from lug 3 (S-5) to lug 1 (NS) of terminal strip BE.

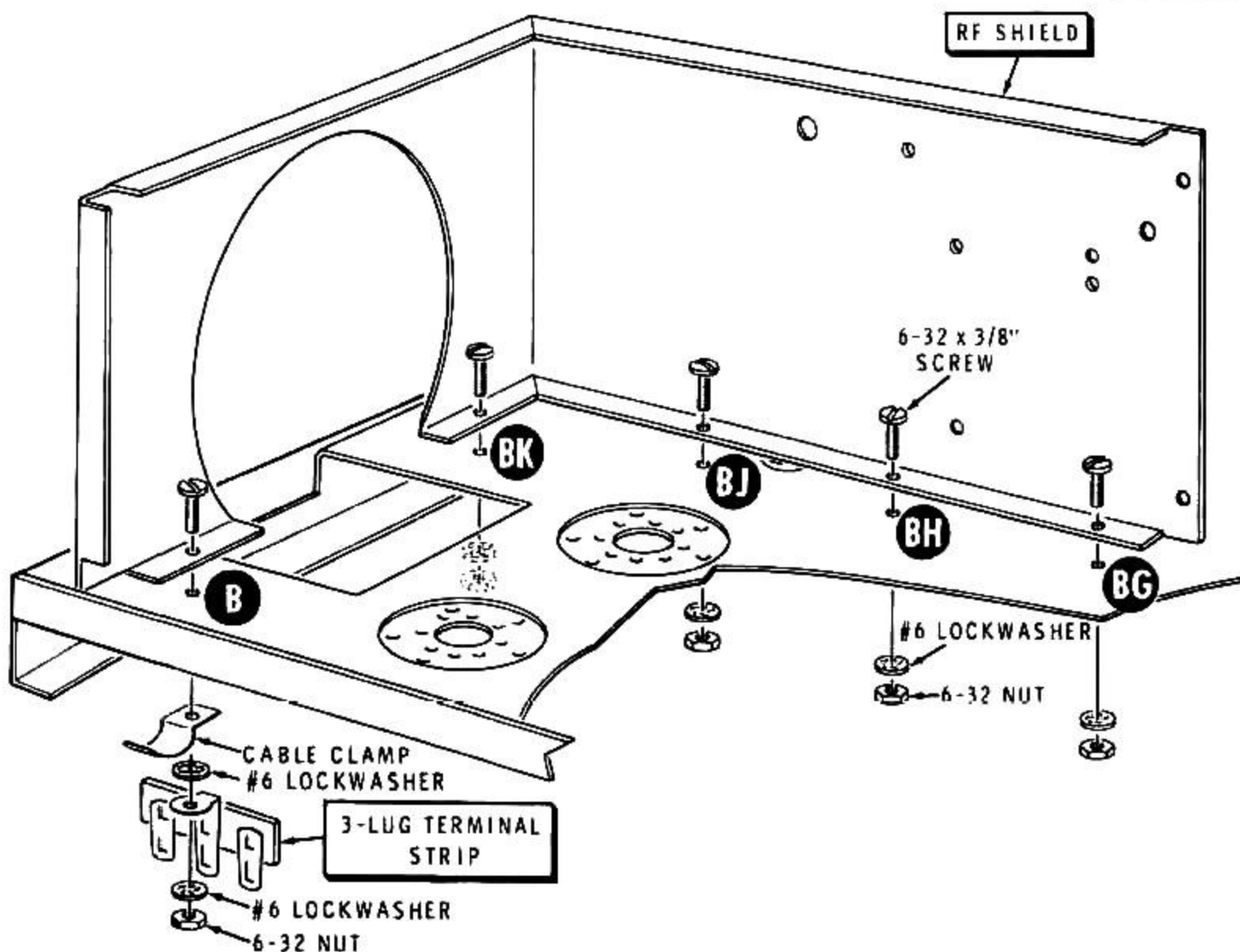


PICTORIAL 4-1



PICTORIAL 4-5





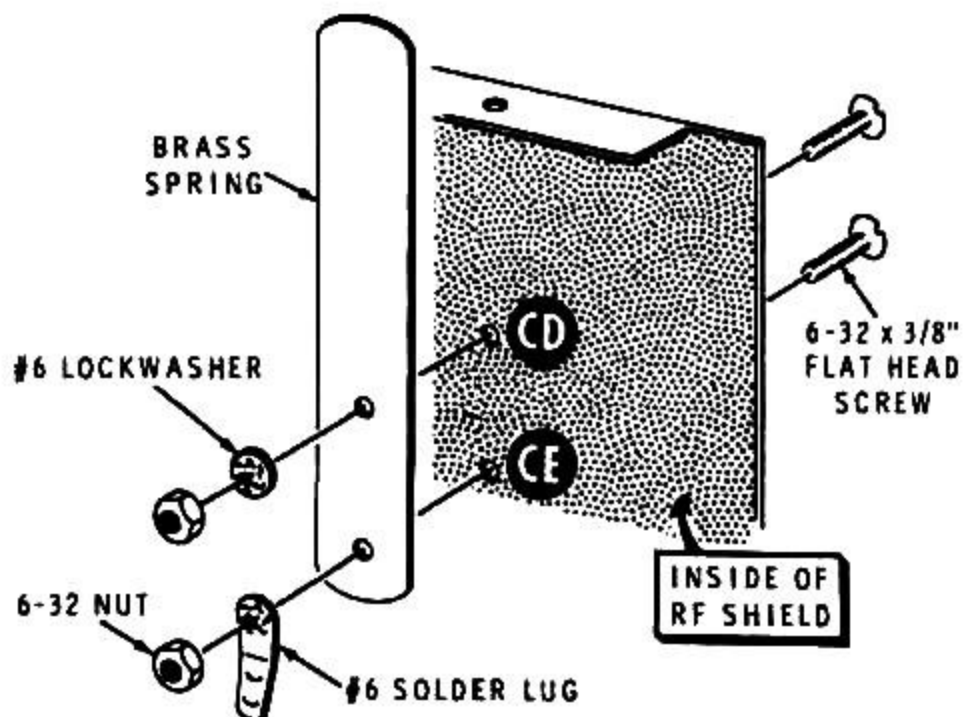
Detail 4-3A

TOP-CHASSIS ASSEMBLY

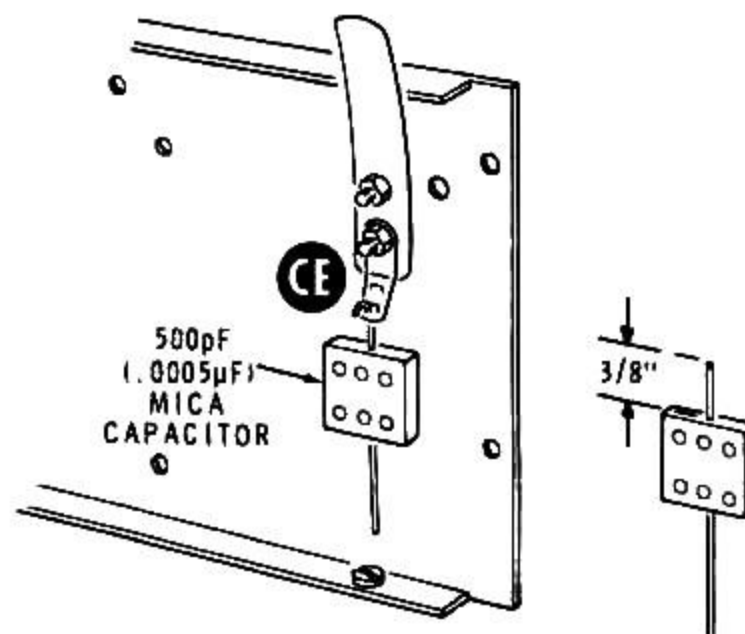
Refer to Pictorial 4-3 for the following steps.

- () Refer to Detail 4-3A and mount the RF shield (#206-493) on the top of the chassis. At BG, BH, BJ, and BK, use 6-32 x 3/8" screws. At B, use a 6-32 x 3/8" binder head screw with a 3-lug terminal strip, a cable clamp, two #6 lockwashers, and a 6-32 nut.

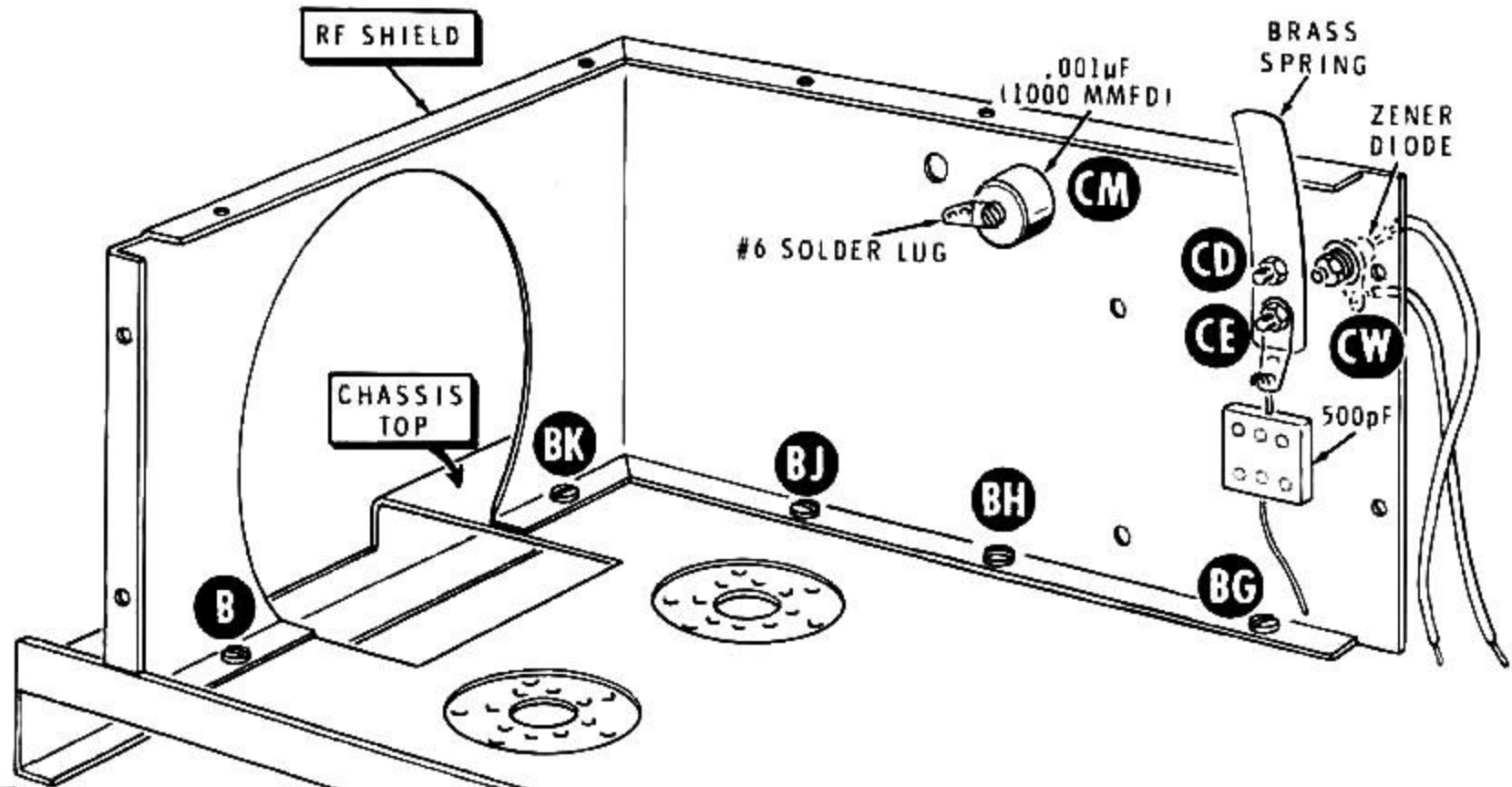
- () Refer to Detail 4-3B and mount the brass spring (#258-115) at CD and CE on the RF shield. Use 6-32 x 3/8" flat head hardware with a #6 solder lug at CE. When the hardware is tightened, the end of the brass strip will contact the upper lip of the RF shield.
- () Refer to Detail 4-3C and cut one lead of a 500 pF mica capacitor (may be marked ".0005") to a length of 3/8". Connect this lead to the solder lug at CE (S-1). The other lead will be connected later.



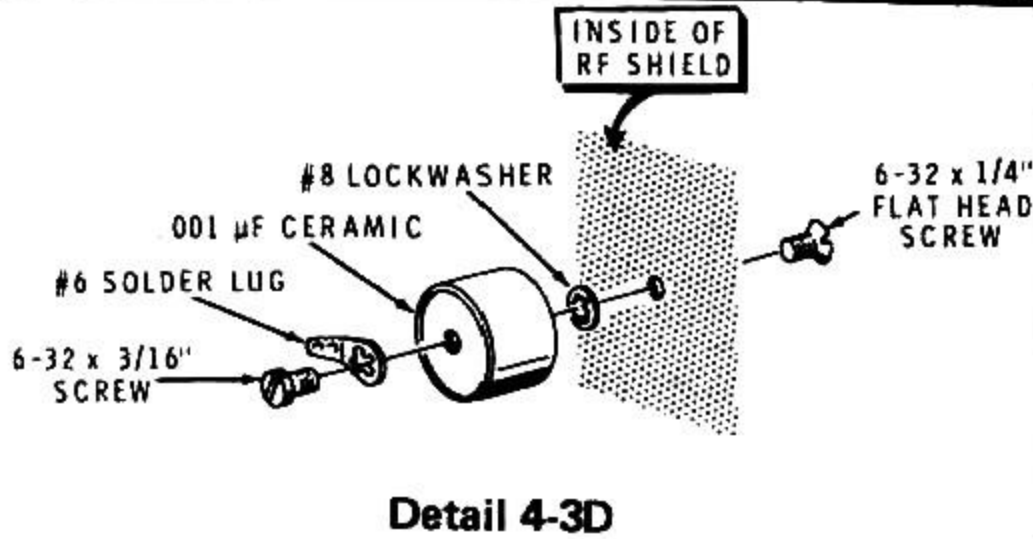
Detail 4-3B



Detail 4-3C



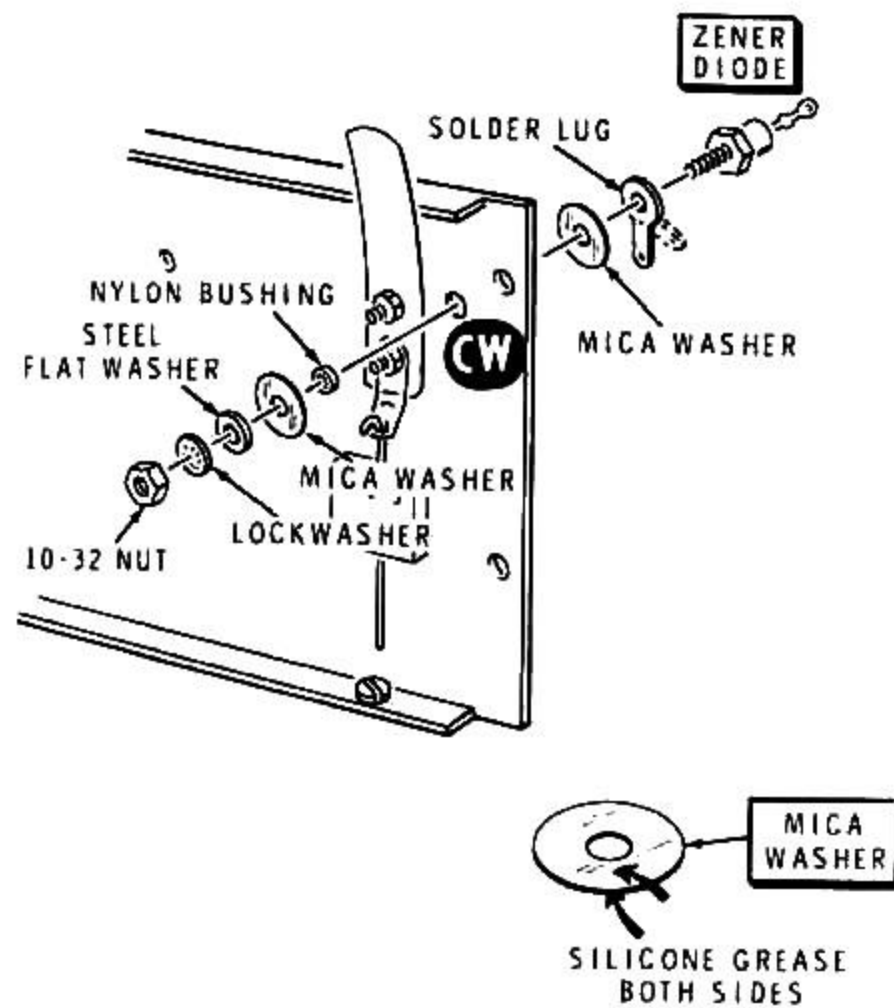
PICTORIAL 4-3



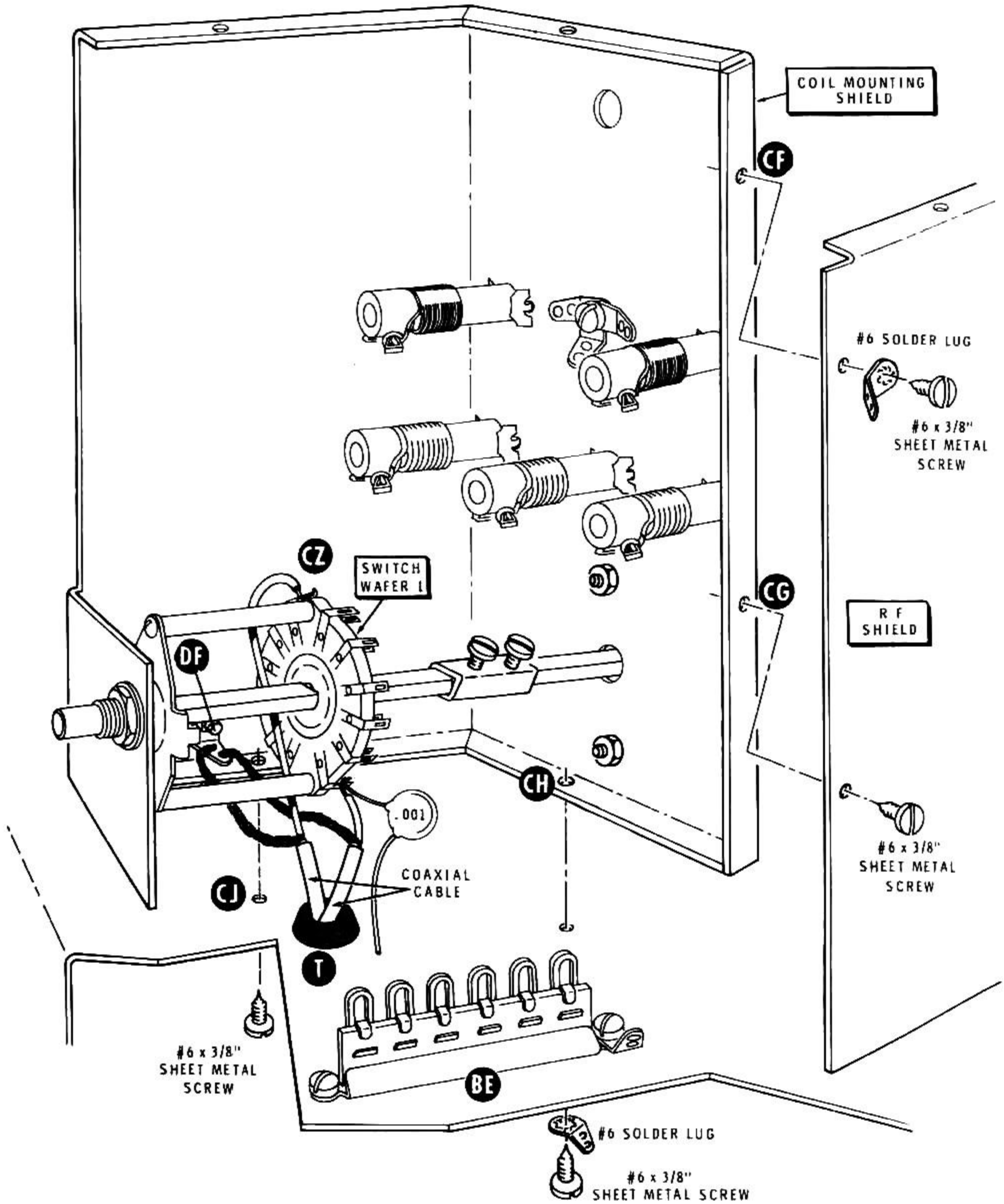
Detail 4-3D

- () Bend the end of the solder lug up away from the chassis at an angle of approximately 45 degrees.
- () Prepare two 3" lengths of small black stranded wire. Connect one end of one wire to the solder lug at CW (S-1). Connect one end of the other 3" wire to the solder terminal on the zener diode (S-1). The other ends of these wires will be connected later.

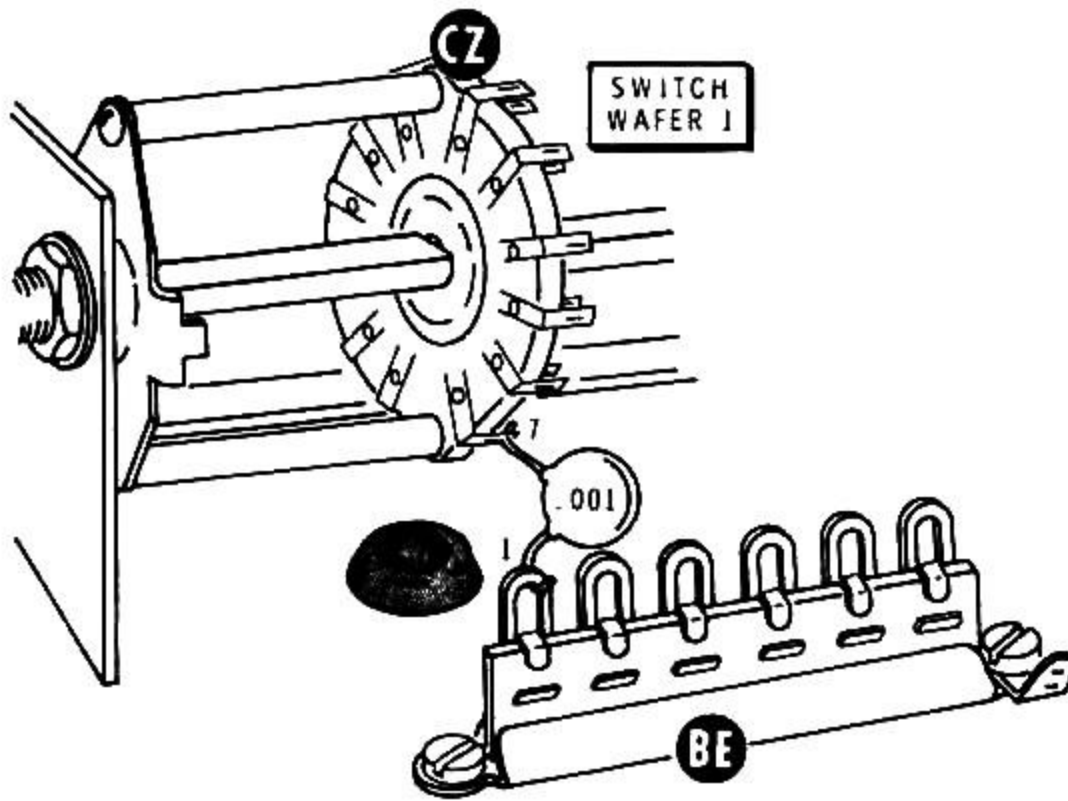
- () Refer to Detail 4-3D and mount a .001 µF ceramic capacitor (#21-165) at CM on the inside of the RF shield (this capacitor may be marked 1000 MMFD). Use a 6-32 x 1/4" flat head screw with a #8 lockwasher between the capacitor and the RF shield.
- () Install a #6 solder lug on the other terminal of the capacitor with a 6-32 x 3/16" screw. Position the solder lug as shown.
- () Refer to Detail 4-3E and install the zener diode at CW on the outside of the RF shield with the mounting stud and nut on the same side of the shield as the brass spring, as shown in the Pictorial. Coat both sides of each mica washer with silicone grease before you install it. Make sure the nylon bushing is centered in the hole and that the solder lug points toward the chassis. Tighten the nut firmly, but do not overtighten.



Detail 4-3E



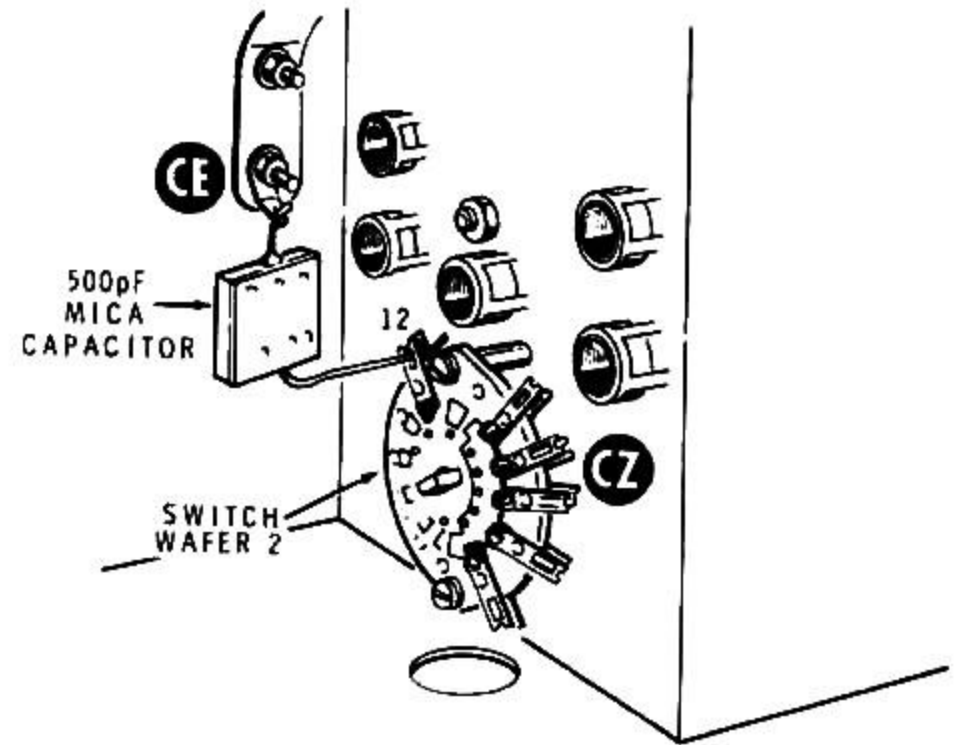
PICTORIAL 4-4



Detail 4-4A

Refer to Pictorial 4-4 for the following steps. For clarity, only the coil mounting shield is shown.

- () Start the ends of the two coaxial cables coming from wafer 1 of switch CZ down through grommet T, and lower the input coil assembly down onto the chassis. Pull the two coaxial cables through the grommet as you lower the assembly.
- () From the bottom of the chassis, install a #6 sheet metal screw and a #6 solder lug at CH in the coil mounting shield.
- () From the bottom of the chassis, install a #6 sheet metal screw at CJ in the coil mounting shield.
- () Make sure none of the parts on terminal strip BE contact any part on switch CZ.
- () Install a #6 sheet metal screw and a #6 solder lug at CF. Note the position of the solder lug.
- () Install a #6 x 3/8" sheet metal screw at CG.
- () Refer to Detail 4-4A and connect the free lead of the .001 disc capacitor from lug 7 of the switch wafer to lug 1 of terminal strip BE (S-3).



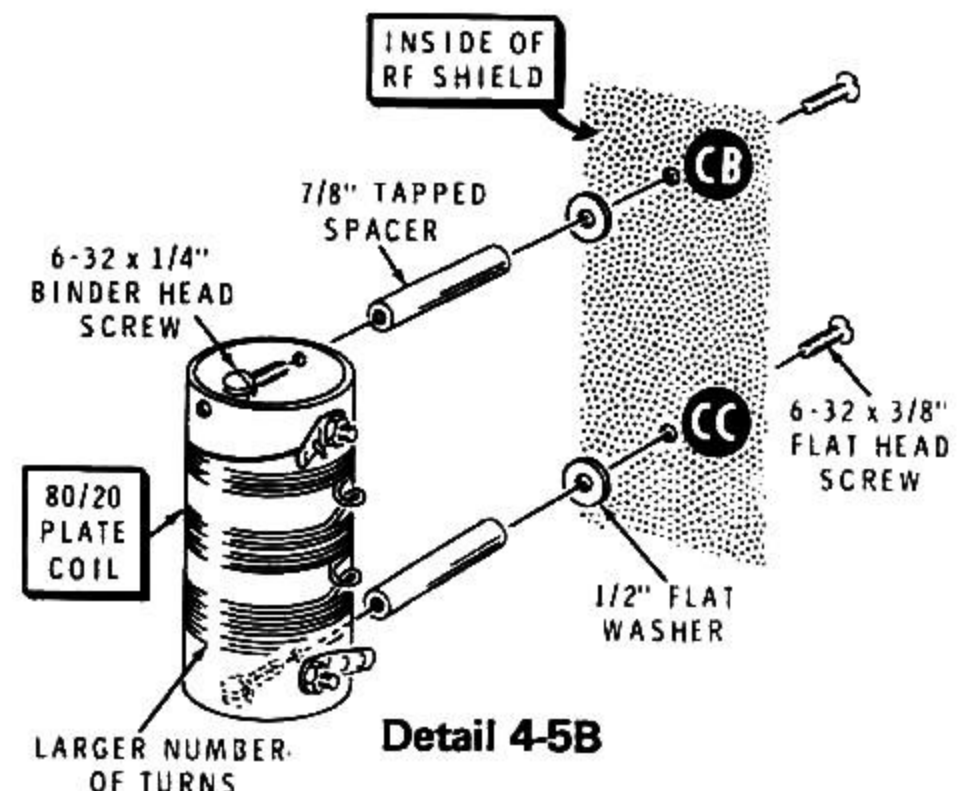
Detail 4-5A

Refer to Pictorial 4-5 (fold-out from Page 28) for the following steps.

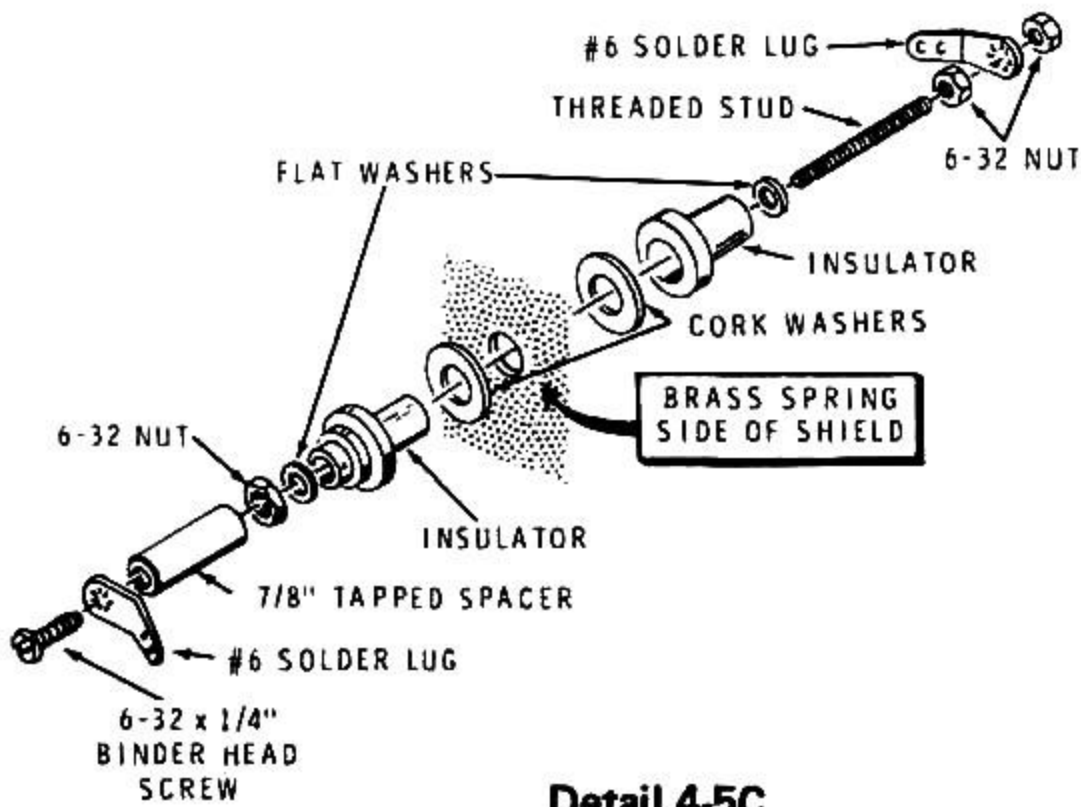
- () Refer to Detail 4-5A and connect the free end of the 500 pF mica capacitor at CE to lug 12 of rotary switch CZ wafer 2 (S-3). Be sure the capacitor lead is soldered to both lugs.

Refer to Detail 4-5B for the next two steps.

- () Install two 7/8" tapped spacers on the 80/20 plate coil (#40-1666). Use 6-32 x 1/4" binder head screws.
- () Mount the plate coil assembly at CB and CC on the inside of the RF shield. Be sure to position the coil so the taps are on the side toward the brass spring, and so the winding with the larger number of turns is toward CC. Use 1/2" flat washers and 6-32 x 3/8" flat head screws.



Detail 4-5B



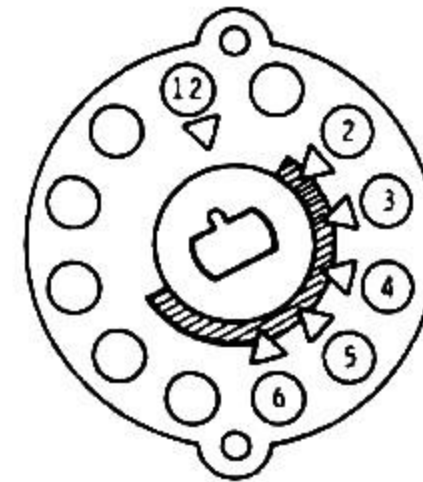
Detail 4-5C

() Refer to Detail 4-5C and install a ceramic feedthrough insulator (#71-2) at CK. In addition to the parts in the plastic bag, use a 7/8" tapped spacer, two #6 solder lugs, and a 6-32 x 1/4" binder head screw. Before the spacer is screwed onto the threaded stud running through the insulator, hold the brass spring down so it will bear against the under side of the installed spacer as shown in the Pictorial. Discard the unused nut.

NOTE: In the following steps, wires will be connected between wafer 2 of switch CZ and the taps on the plate coil. Each wire should be fitted before it is soldered in place. The end of each wire going through the switch lugs must first be flattened as shown in the inset drawing of Detail 4-5E. **DO NOT** use the switch lugs to hold one end of the wire when forming it, as the switch lugs and the ceramic switch wafer can be damaged.

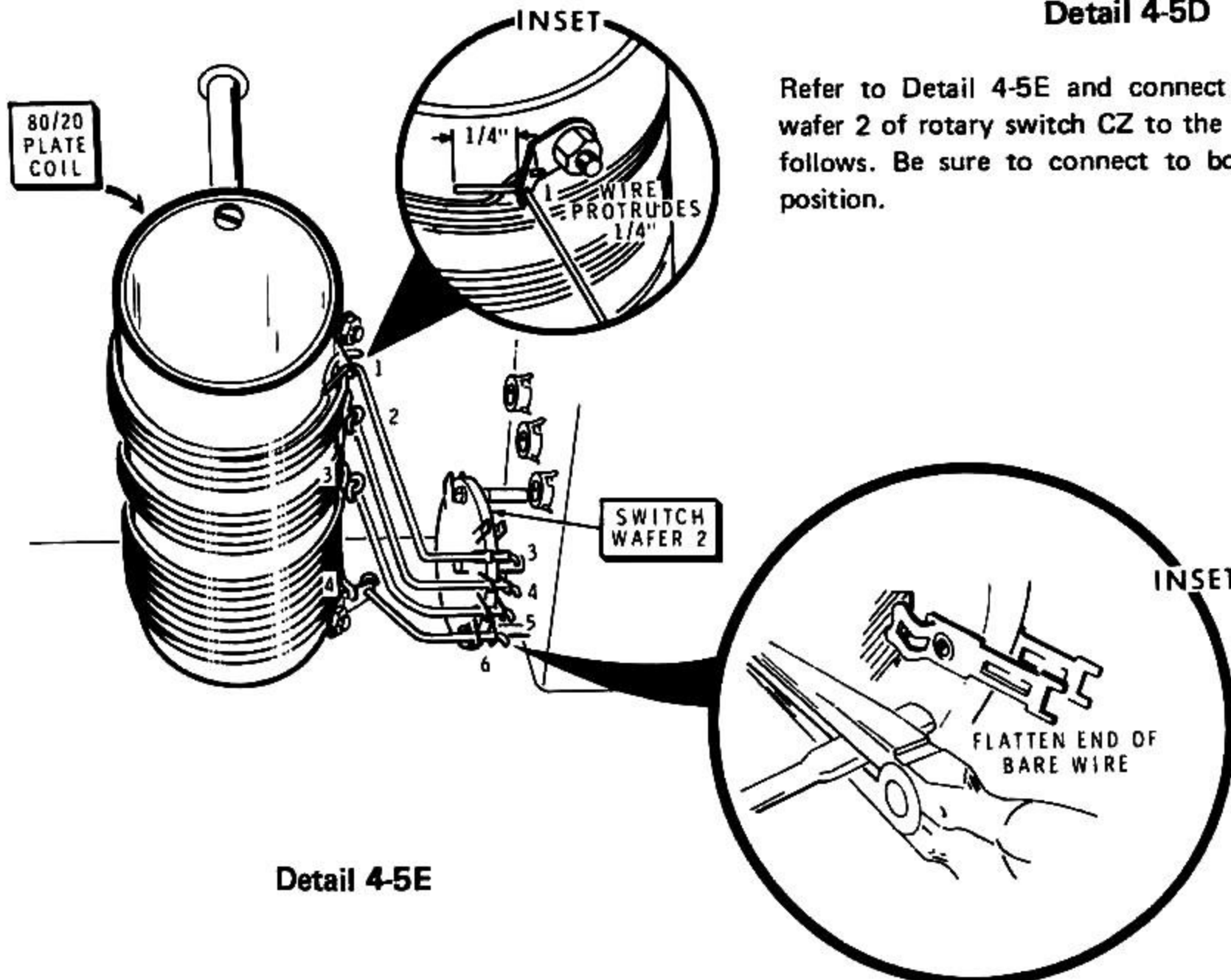
When soldering wires to the switch, make sure the wire is soldered to both switch lugs. After you fit the wires, cut off any excess wire lengths.

Refer to Detail 4-5D for the switch lug numbering system. The Detail shows the switch rotor as it was positioned when the shaft was installed (viewed from the rear).



Detail 4-5D

Refer to Detail 4-5E and connect small bare wires from wafer 2 of rotary switch CZ to the taps on the plate coil as follows. Be sure to connect to both lugs at each switch position.

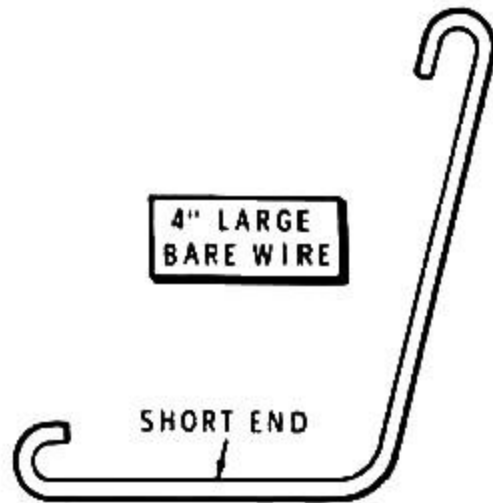


Detail 4-5E

Wire Length	Switch Lug No.	Coil Tap
() 1-1/2"	6 (S-3)	4 (S-1)
() 2-1/2"	5 (S-3)	3 (S-1)
() 3"	4 (S-3)	2 (S-1)
() 3-1/2"	3 (S-3)	1 (NS)*

*Extend the wire 1/4" through the solder lug as shown in the upper inset.

() Refer to Detail 4-5F and bend a 4" length of large bare wire. Use the illustration as a template to form the wire.

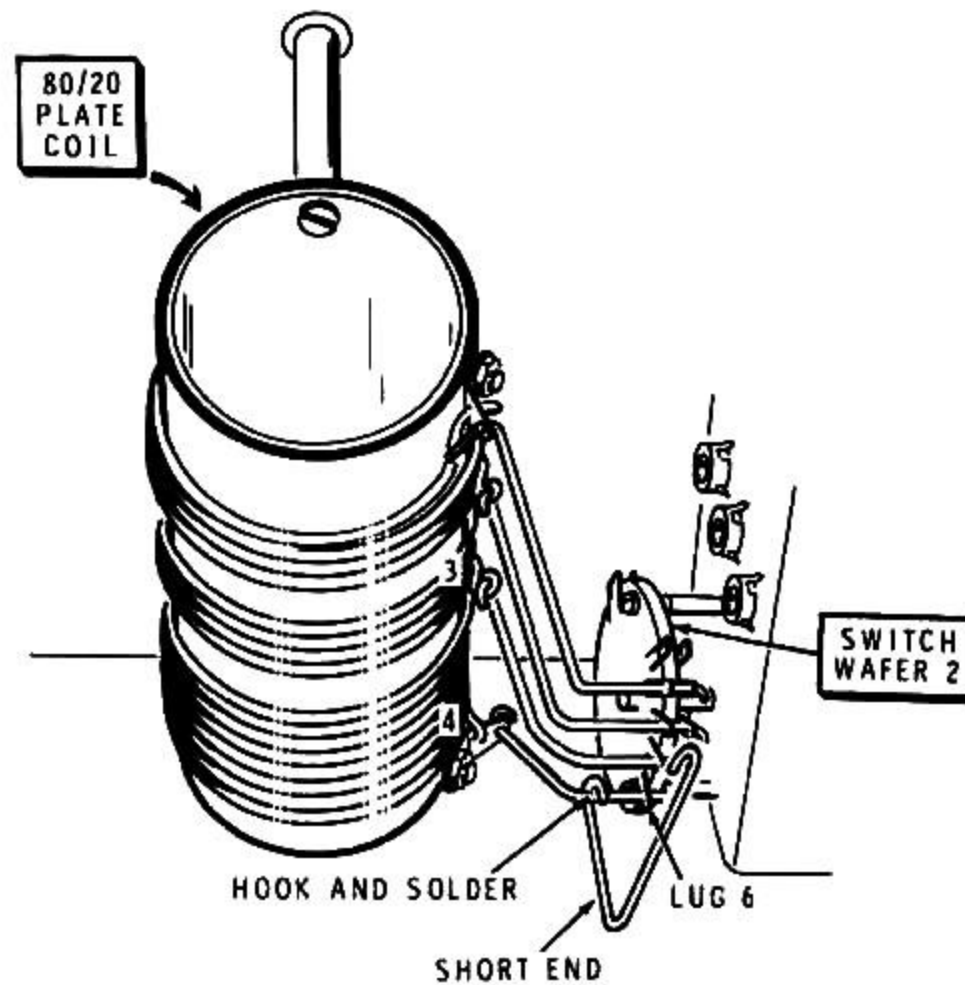


Detail 4-5F

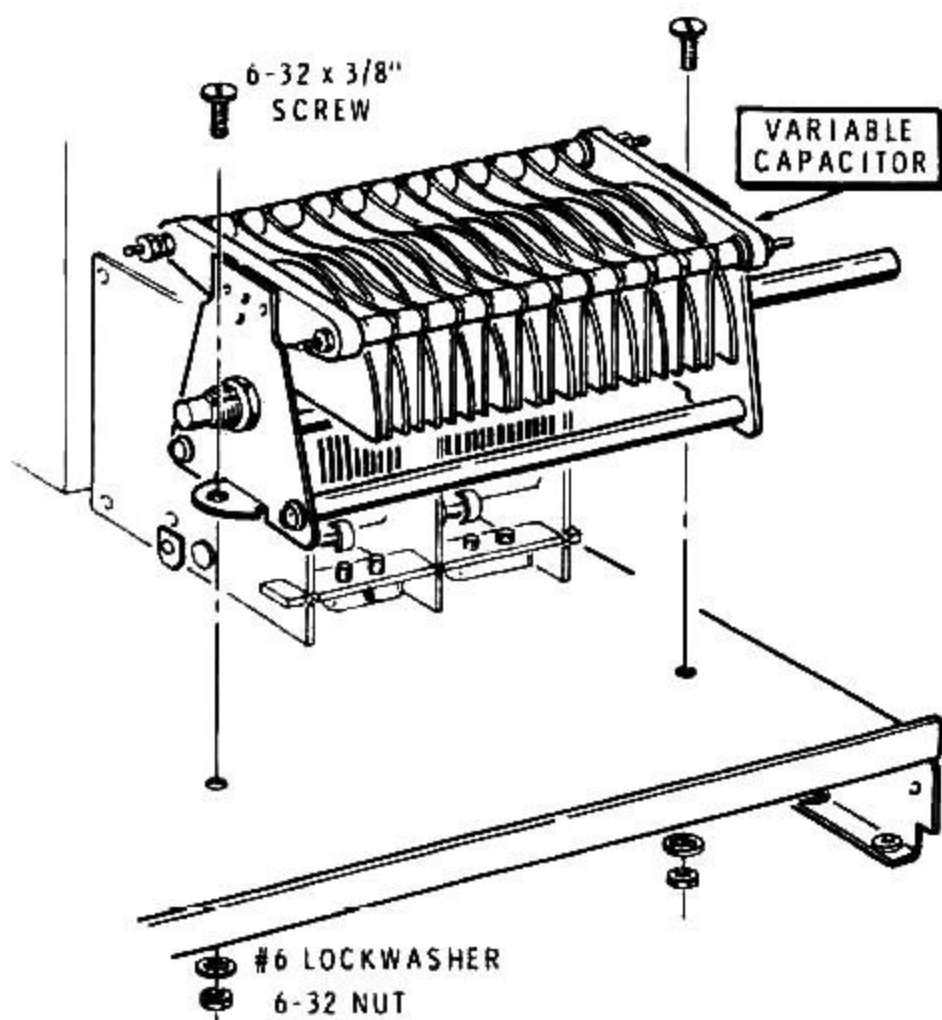
() Refer to Detail 4-5G and hook the short end of the bare wire around the switch wire at lug 4 of the 80/20 plate coil. Position the wire as shown. Then crimp and solder the hook to the wire.

Refer to Detail 4-5H Part 1 (fold-out from Page 35) for the following numbered steps.

- () 1. Close the end of the spade lug with a pair of pliers as shown in inset drawing # 1.
- () 2. Loosen the 10-32 nut on the 840 pF variable capacitor (#26-145) at screw DP. Position the spade lug as shown and mount the lug on the screw. Retighten the nut.
- () 3. Refer to inset drawing #2 and bend the spade lug over the edge of the capacitor 90° as shown.
- () 4. Mount the prepared 840 pF variable capacitor on the chassis. Use 6-32 x 3/8" hardware at BB. Use a cable clamp and 6-32 x 3/8" hardware at G. You will loosen the cable clamp later to install a coaxial cable.
- () Refer to Detail 4-5H Part 2 and hook the remaining end of the 4" large bare wire around the spade lug on the variable capacitor at DP. Crimp and solder the connection. Make sure the wire is positioned away from the capacitor body and any adjacent wiring.

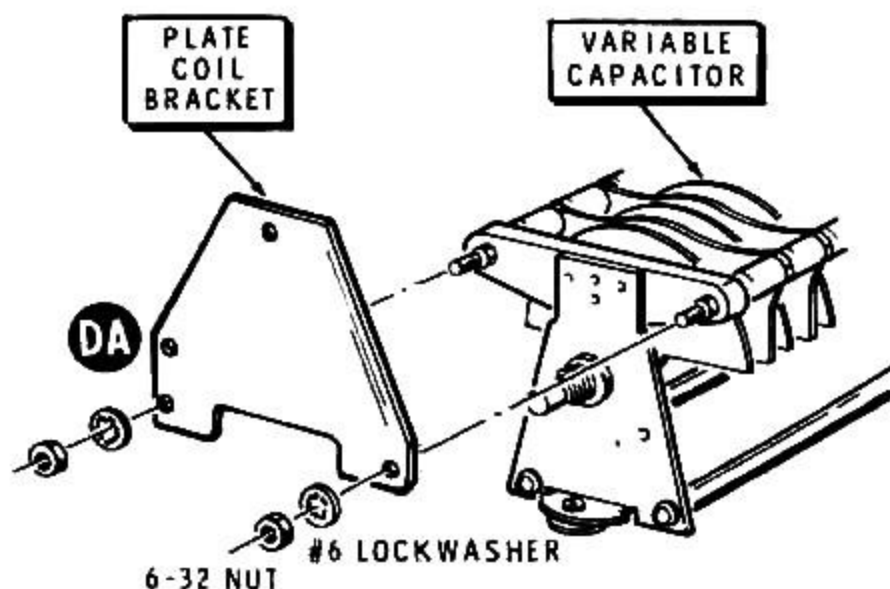


Detail 4-5G



Detail 4-5J

- () Refer to Detail 4-5J and mount variable capacitor #26-131 at holes BA. Use 6-32 x 3/8" hardware.
- () Refer to Detail 4-5K and install the plate coil bracket (#204-2102) on the rear of variable capacitor BA. Use the two extra nuts and lockwashers supplied with the capacitor. Be sure to position the bracket with hole DA as shown.



Detail 4-5K

Refer to Detail 4-5L for the following steps.

- () Position the 15/10 plate coil (#40-968) with the silver plated strip located as shown.

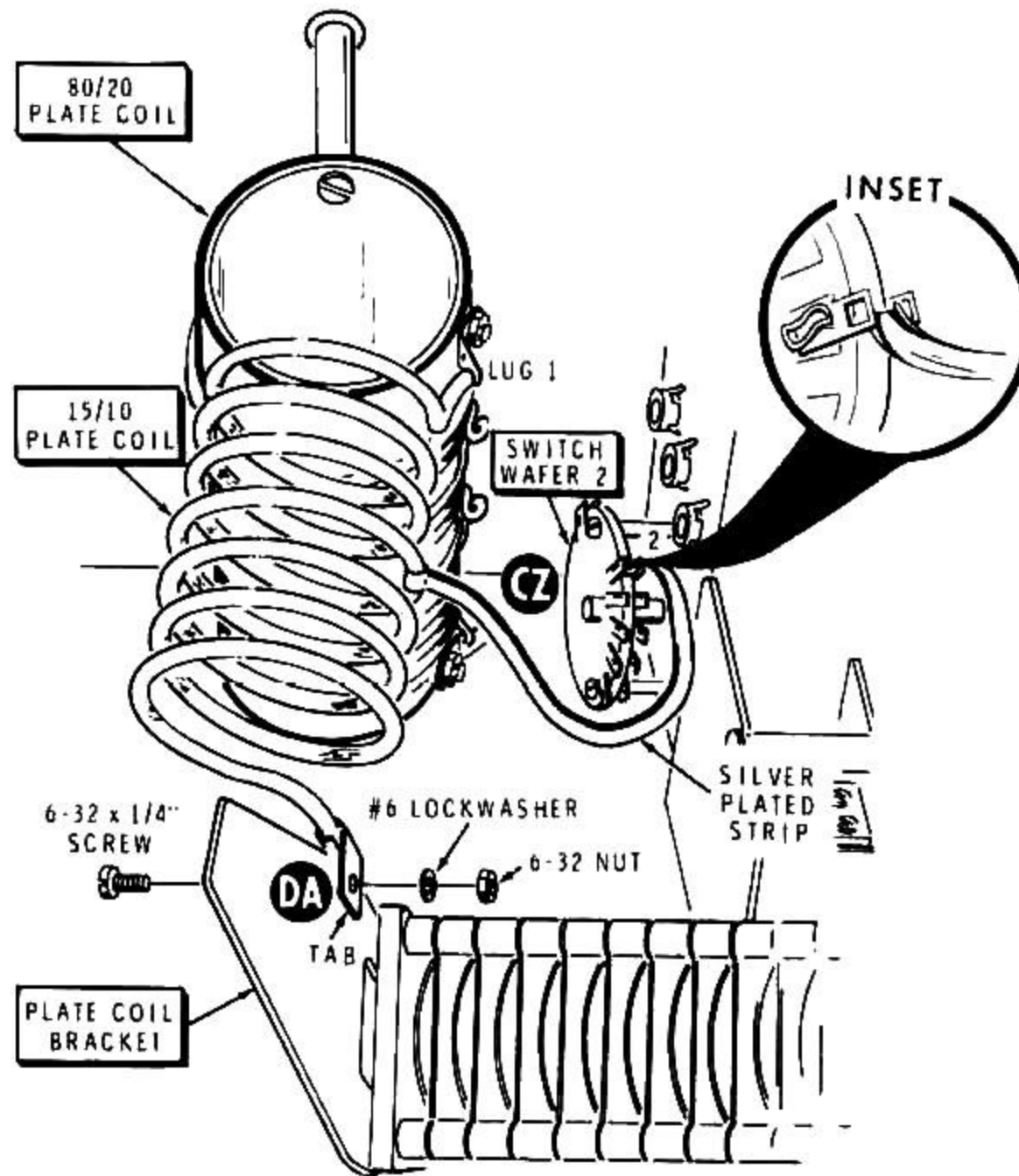
- () Place the open end of the coil tubing over the wire projecting from lug 1 of the 80/20 plate coil. Form the solder lug so the coil tubing will butt snugly against it.
- () Connect the tab on the coil to hole DA in the plate coil bracket. Use 6-32 x 1/4" hardware.
- () Solder the coil tubing and the wire lead from the switch wafer to lug 1 of the 80/20 plate coil. Make sure the end of the tubing is against the solder lug and that this connection is well soldered.
- () Connect the free end of the silver plated strip to lug 2 of wafer 2 of switch CZ. Flex the end of the strip and place it between the switch lugs as shown in the inset drawing of the Detail (S-2).

Refer to Detail 4-5M for the following steps.

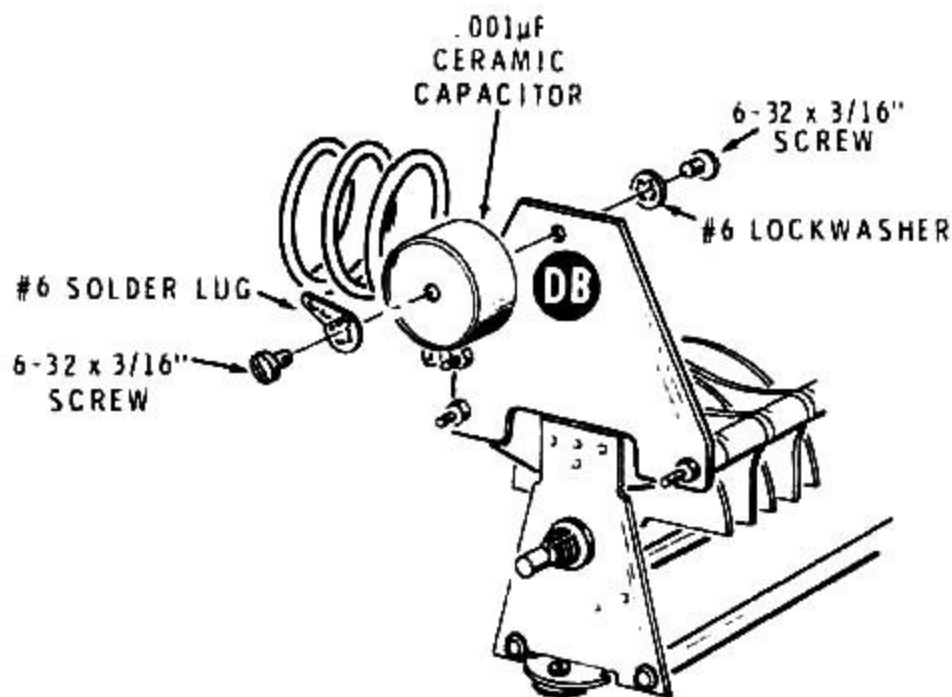
- () Install a #6 solder lug on one end of a .001 μ F capacitor (#21-165). Use a 6-32 x 3/16" screw.
- () Mount this capacitor at DB on the plate coil bracket. Use a 6-32 x 3/16" screw and a #6 lockwasher. Before tightening the screw, position the solder lug as shown.
- () Refer to Detail 4-5N and mount an RF choke (#45-61) at CA on the RF shield. Use a 1-3/8" spacer (8-32), two 1/2" flat washers, a #6 lockwasher, a #6 fiber flat washer, and 6-32 x 2" flat head screw. Do not overtighten the screw as the threads in the ceramic choke form can be damaged. Position the choke so solder lug DC points toward spacer DD.

Refer to the Pictorial for the next two steps.

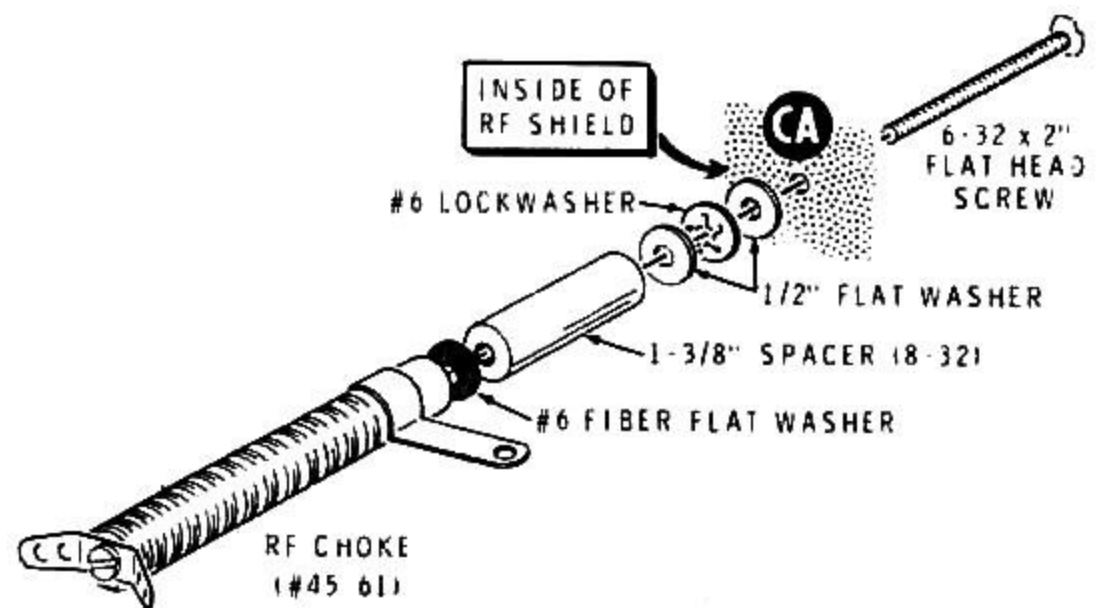
- () Connect a 1-1/2" small bare wire from the solder lug on capacitor CM (S-1) to RF choke solder lug DC (NS).
- () Cut each lead of RF choke #45-6 to a length of 3/8". Connect one lead to choke lug DC (S-2) and the other lead to solder lug DD (S-1).



Detail 4-5L

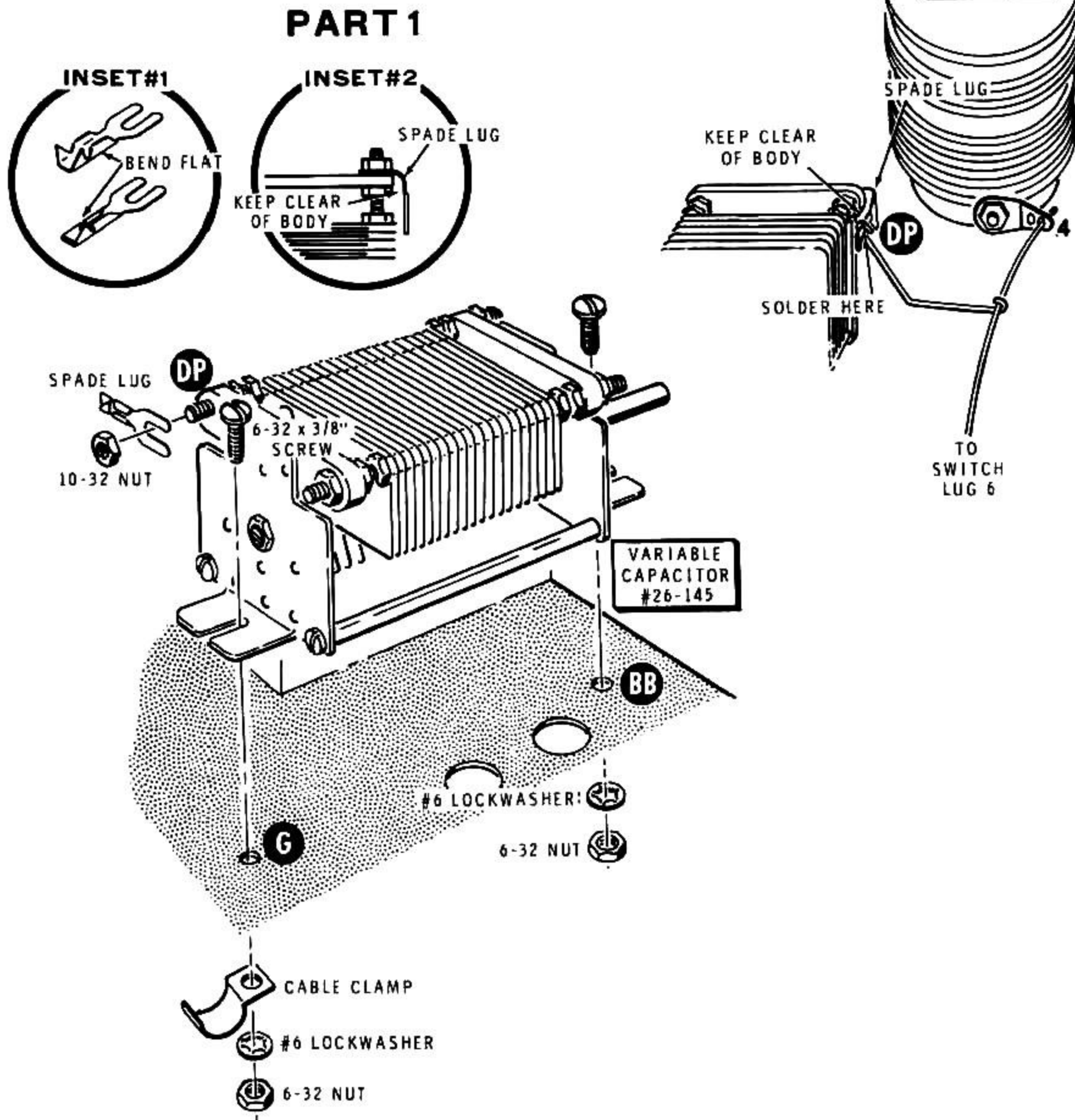


Detail 4-5M

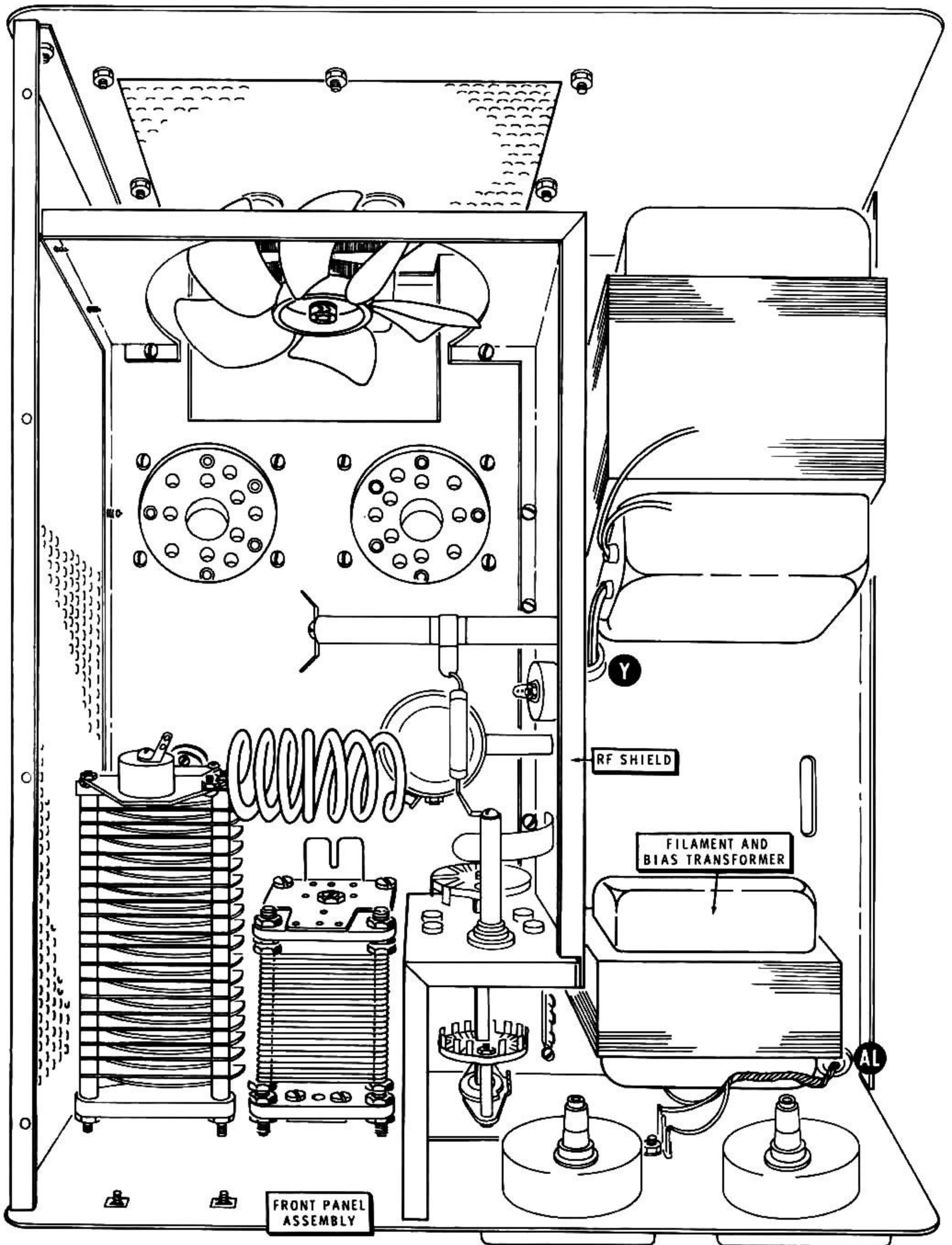


Detail 4-5N

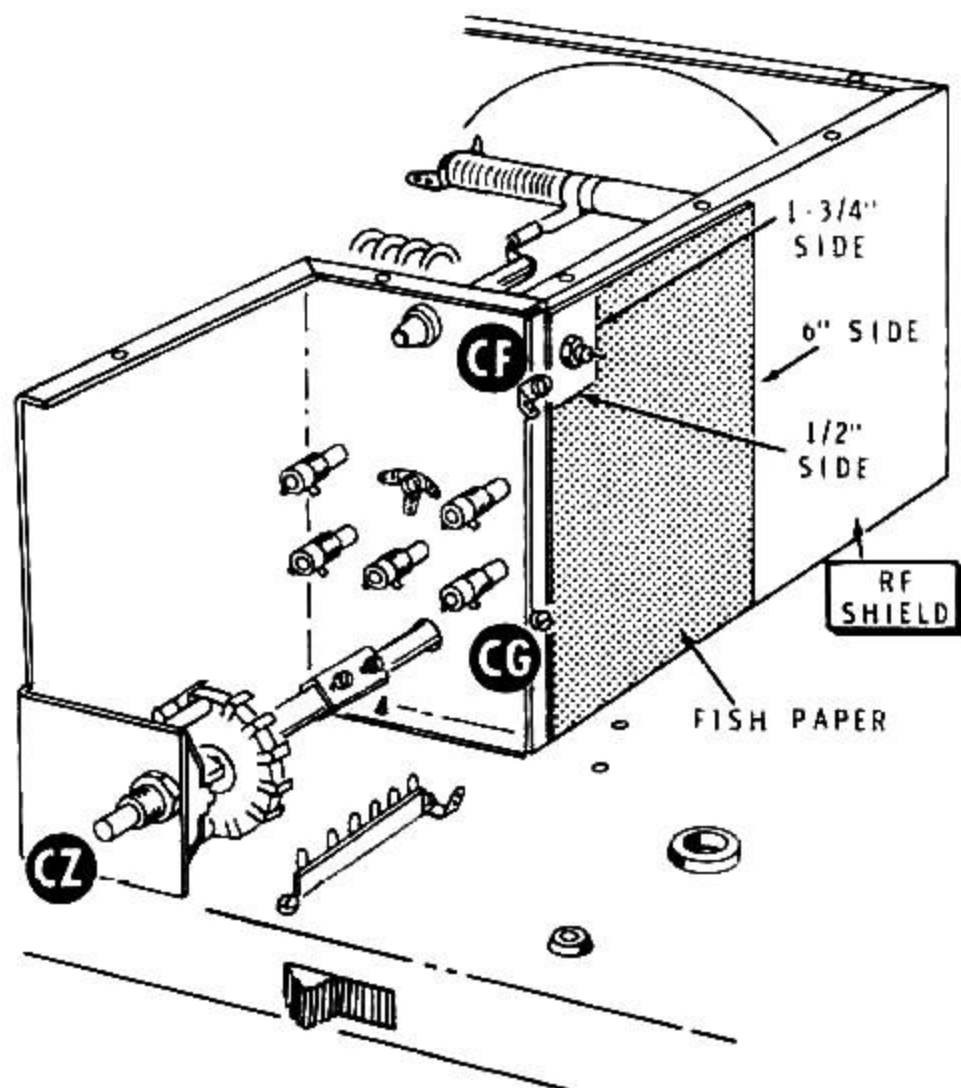
PART 2



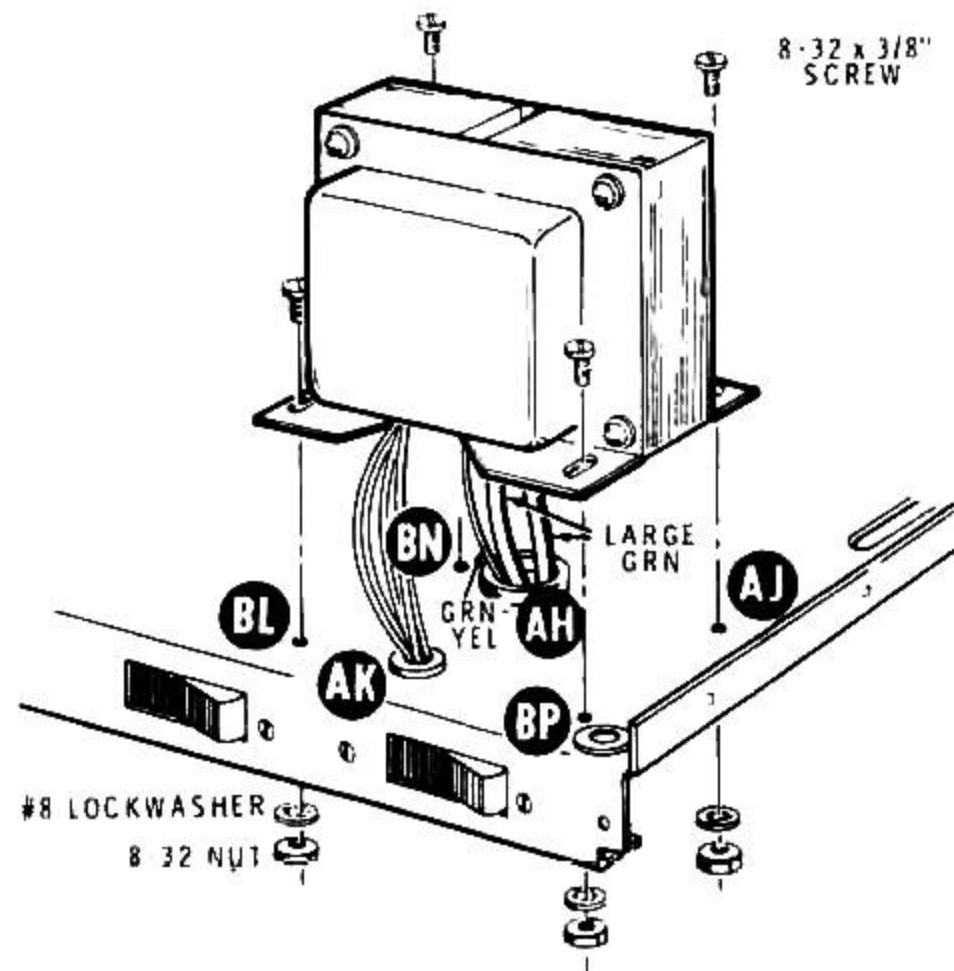
Detail 4-5H



PICTORIAL 4-6



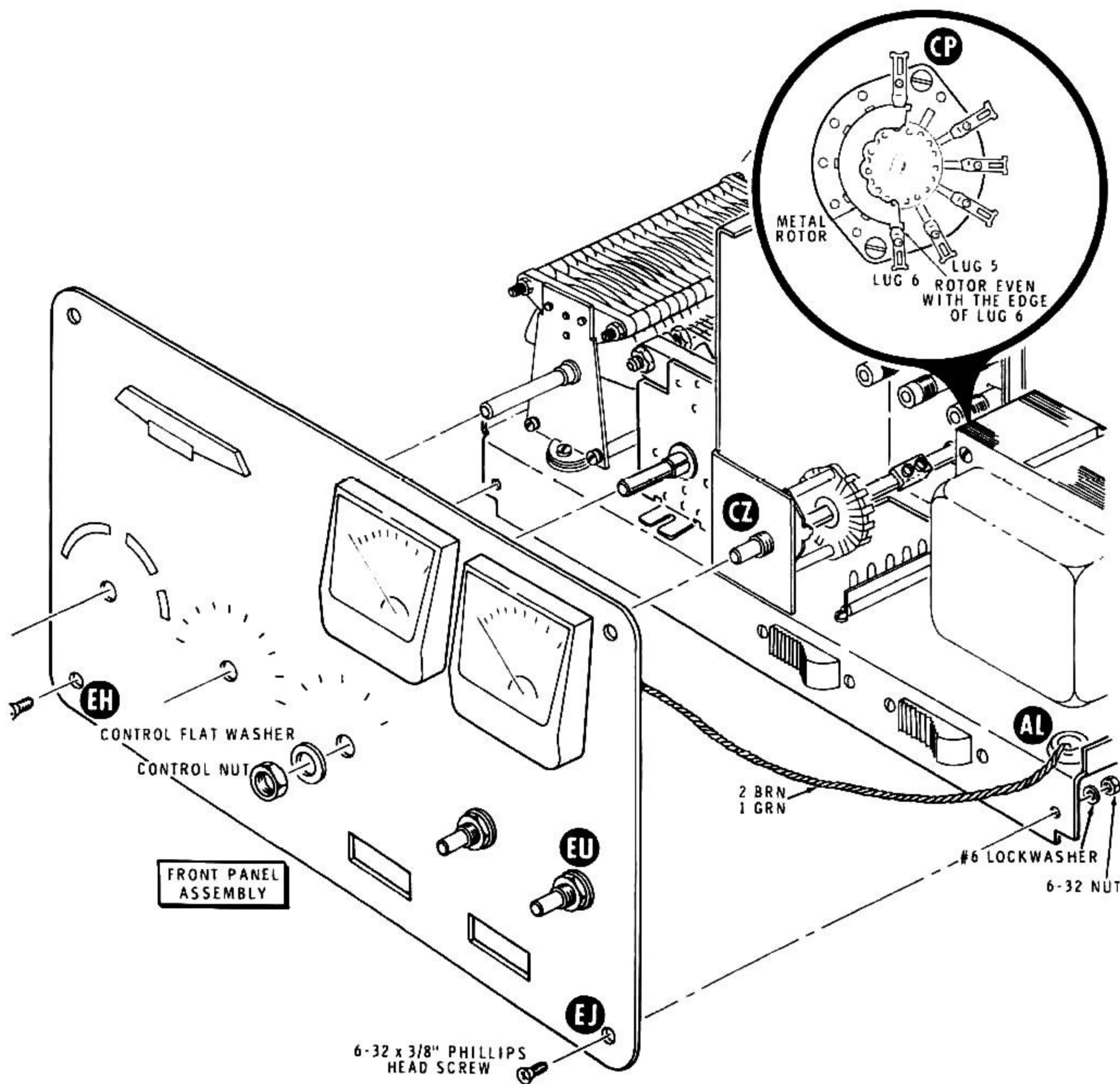
Detail 4-6A



Detail 4-6B

Refer to Pictorial 4-6 (fold-out from Page 36) for the following steps.

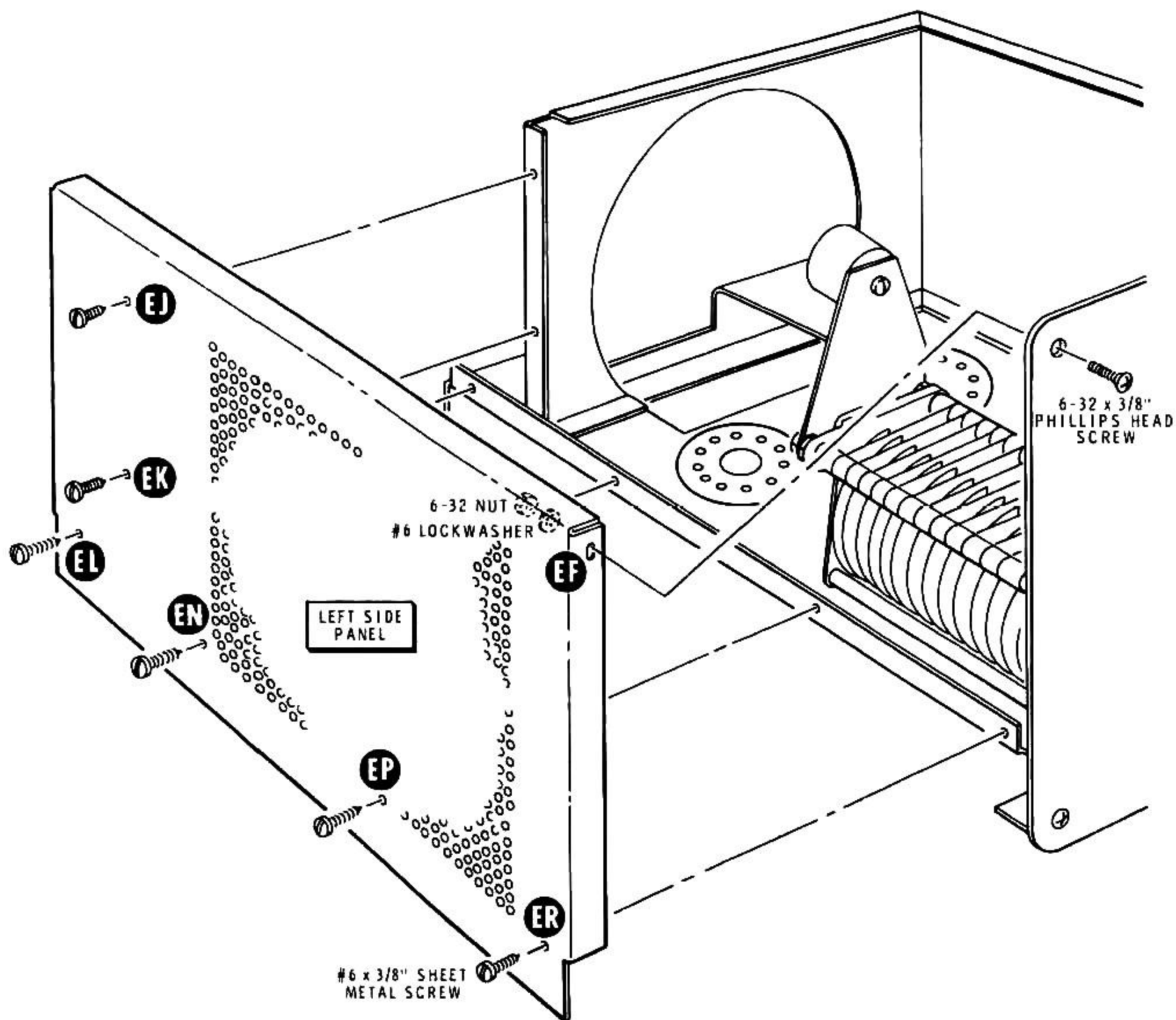
- () Refer to Detail 4-6A and notch out one corner of the 4-1/2" x 6" fish paper insulator as shown. Make sure the 1-3/4" side of the notch is along the 6" side of the fish paper.
- () Position the fish paper with the 6" side vertical and with the adhesive side against the RF shield. Make sure the fish paper clears the zener diode and the sheet metal screw at CG. Rub the paper firmly into place.
- () Refer to Detail 4-6B and mount the filament and bias transformer (#54-238) on the top of the chassis. As you position the transformer, insert the two large green leads and the green-yellow lead down through grommet AH. Insert the other leads through grommet AK. Use 8-32 x 3/8" hardware at AJ, BL, BN, and BP. Push the transformer toward the front of the chassis as far as possible before you tighten the hardware.
- () Temporarily remove the control nut and the control flat washer from rotary switch CZ. (Detail 4-6A).



Detail 4-6C

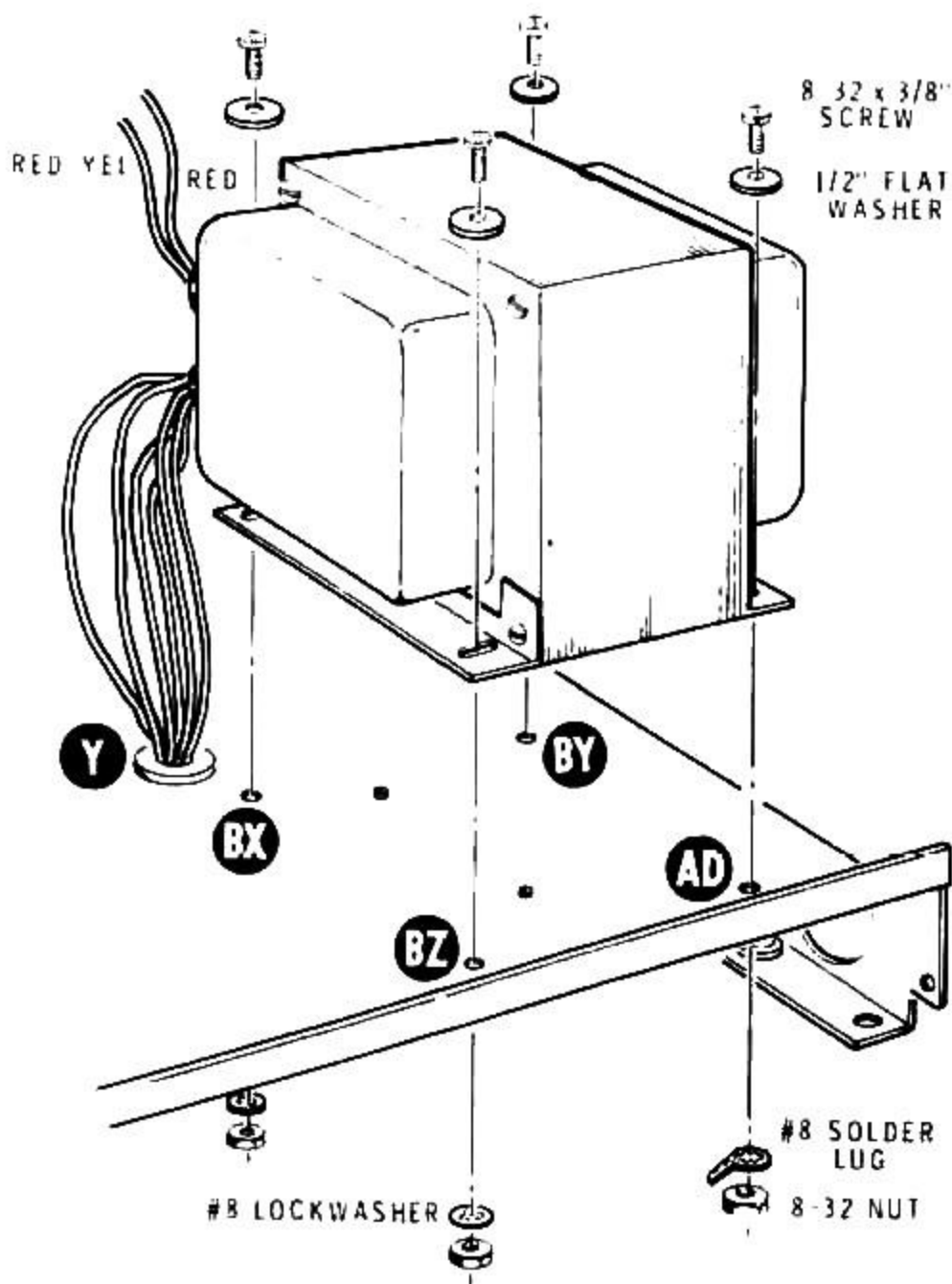
() Refer to Detail 4-6C and mount the front panel assembly on the front of the chassis. Insert the twisted hookup wires (two brown and one green) down through grommet AL. Use 6-32 x 3/8" phillips head hardware at EH and EJ.

() Replace the control flat washer and the control nut on switch CZ. Refer to the inset drawing and check the metal rotor of switch wafer CP again. If the metal rotor extends past lug 6, arcing can occur between the rotor and lug 5.

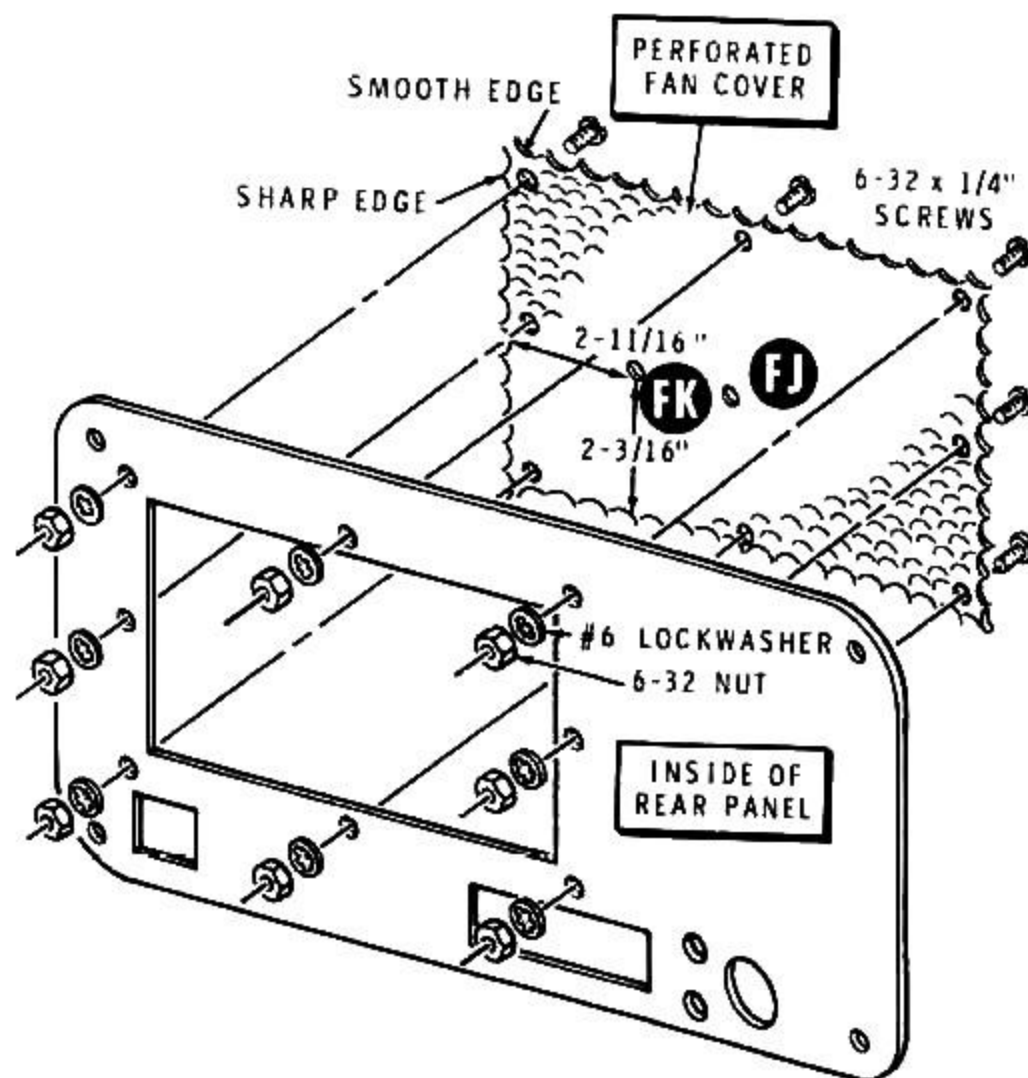


Detail 4-6D

- () Adjust the position of the filament and bias transformer to insure approximately 1/16" clearance between the transformer end bell and any connections to the lugs of switch EU.
- () Refer to Detail 4-6D and install the left side panel (#203-646). Use 6-32 x 3/8" phillips hardware at EF. Use #6 x 3/8" sheet metal screws at EJ, EK, EL, EN, EP, and ER.



Detail 4-6E

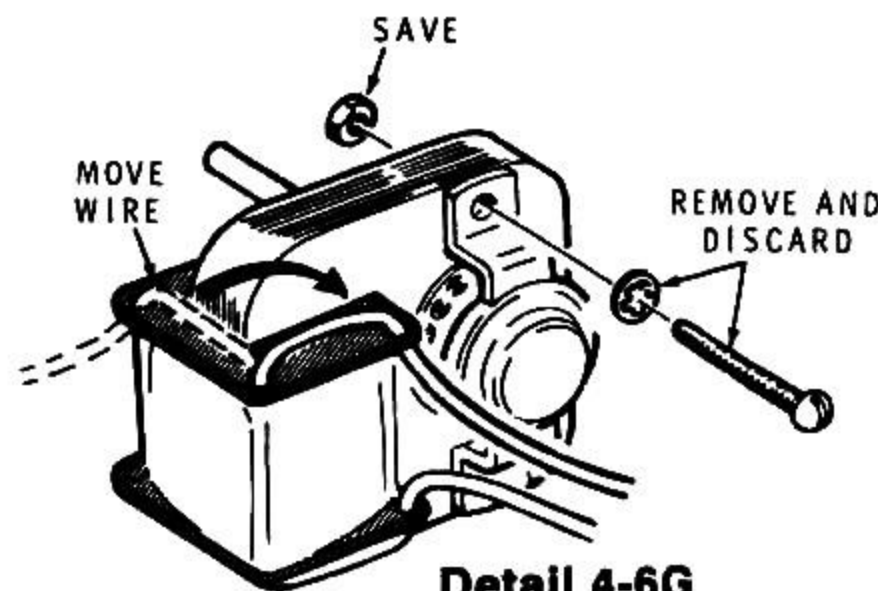


Detail 4-6F

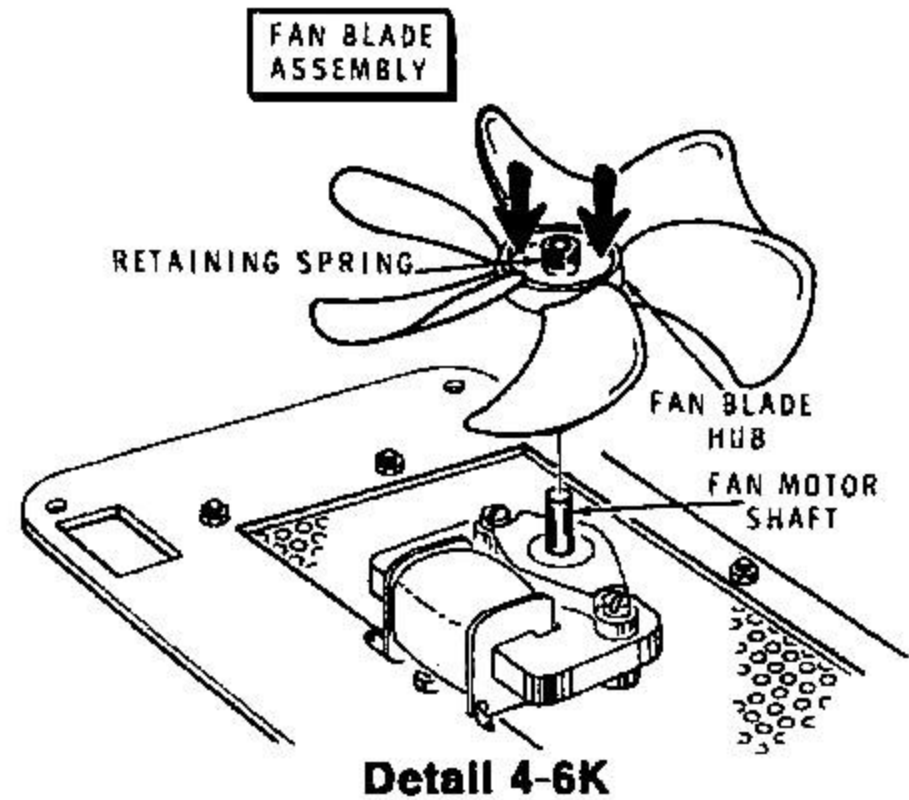
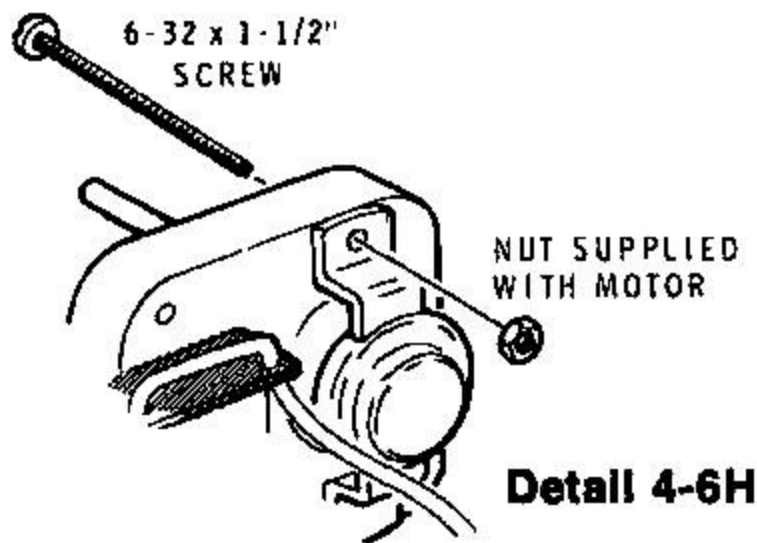
Refer to Detail 4-6G for the following steps.

- () Refer to Detail 4-6E and mount the HV transformer. Position the wires from the end bell so they are above grommet Y. Insert all leads except the red and the red/yellow leads down through grommet Y. Use an 8-32 x 3/8" screw, a 1/2" flat washer, a #8 solder lug and an 8-32 nut at AD. At BX, BY and BZ, use 8-32 x 3/8" hardware with a 1/2" flat washer at each location. Before you tighten the hardware, make sure the transformer end bell does not protrude beyond the chassis rear apron.
- () Refer to Detail 4-6F and locate the perforated fan cover (#205-874) and the rear panel (#203-644). The edges of the fan cover are smooth on one side and sharp on the other. Before placing the sharp edge against the rear panel, check the two off-center holes (FK and FJ) which, if viewed as shown in the Detail, must be closest to the bottom left-hand corner.
- () Fasten the perforated fan cover to the rear panel with 6-32 hardware. The sharp edge of the fan cover should be turned toward the rear panel.

- () 1. Position the motor as shown. Then move one of the motor leads to the indicated hole in the plastic frame (away from the motor shaft).
- () 2. Similarly, move the other motor lead to the indicated hole in the plastic frame.
- () 3. Carefully remove the mounting hardware from one side of the motor as shown. Discard the screw and the lockwasher.

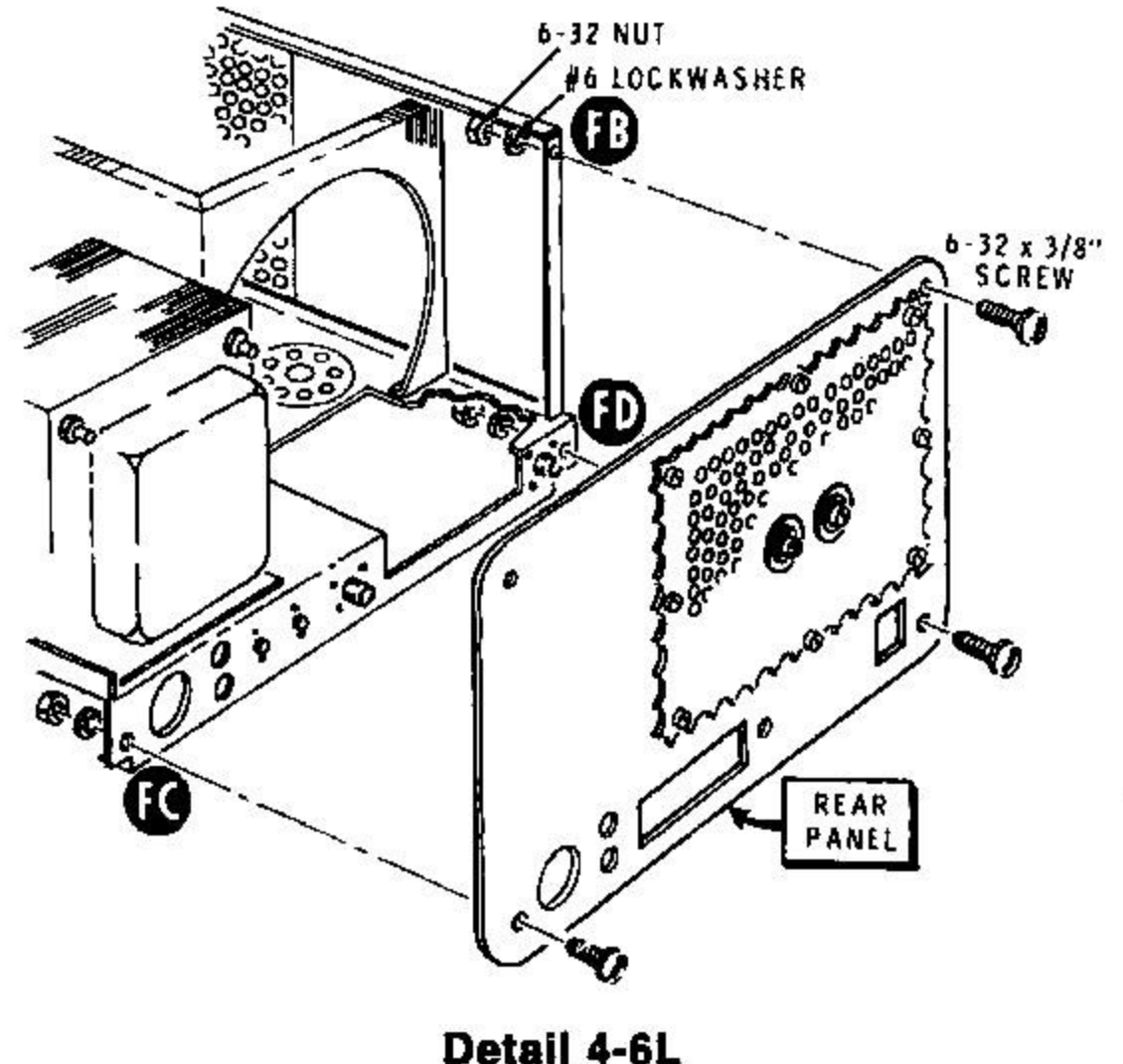
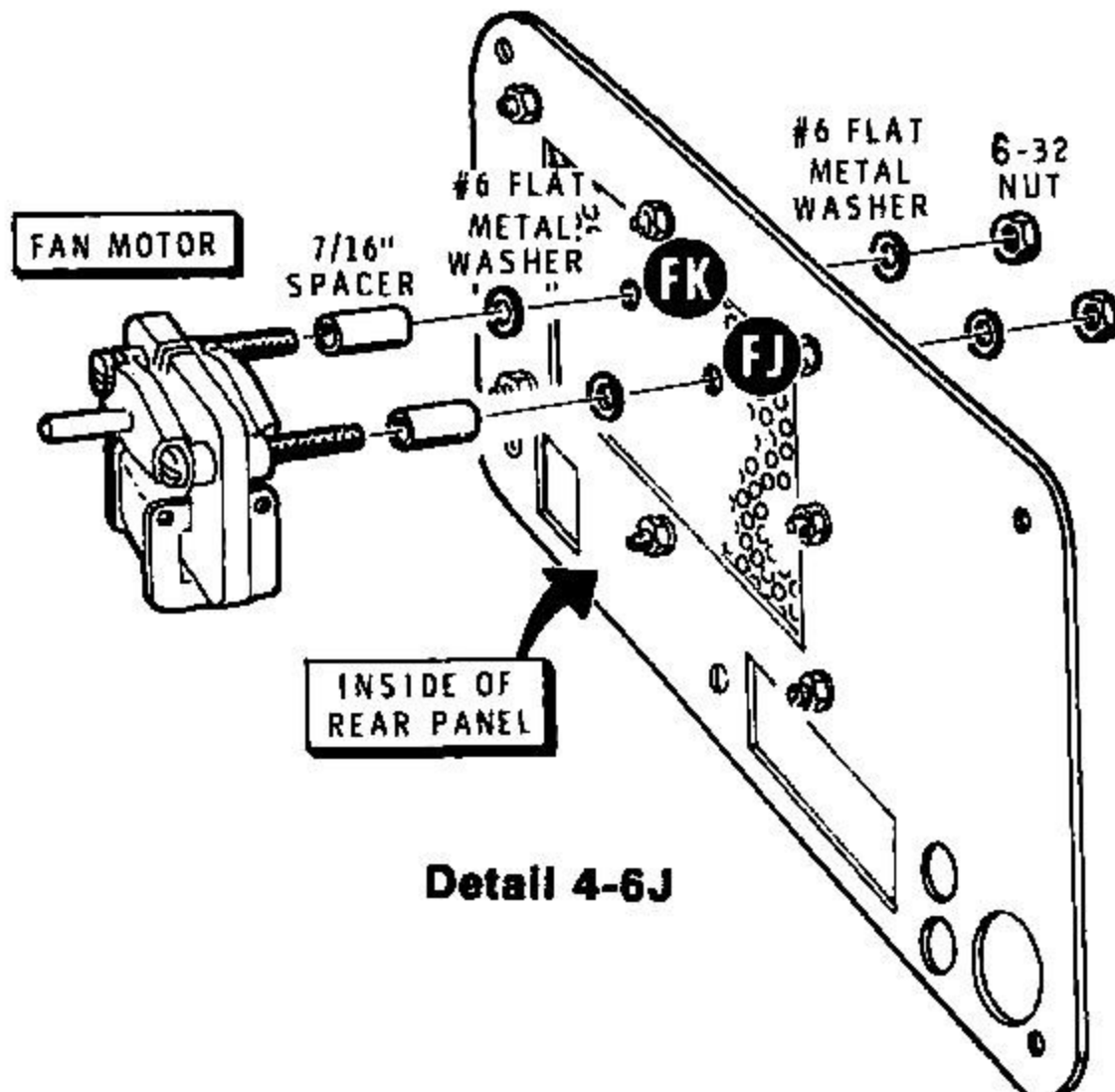


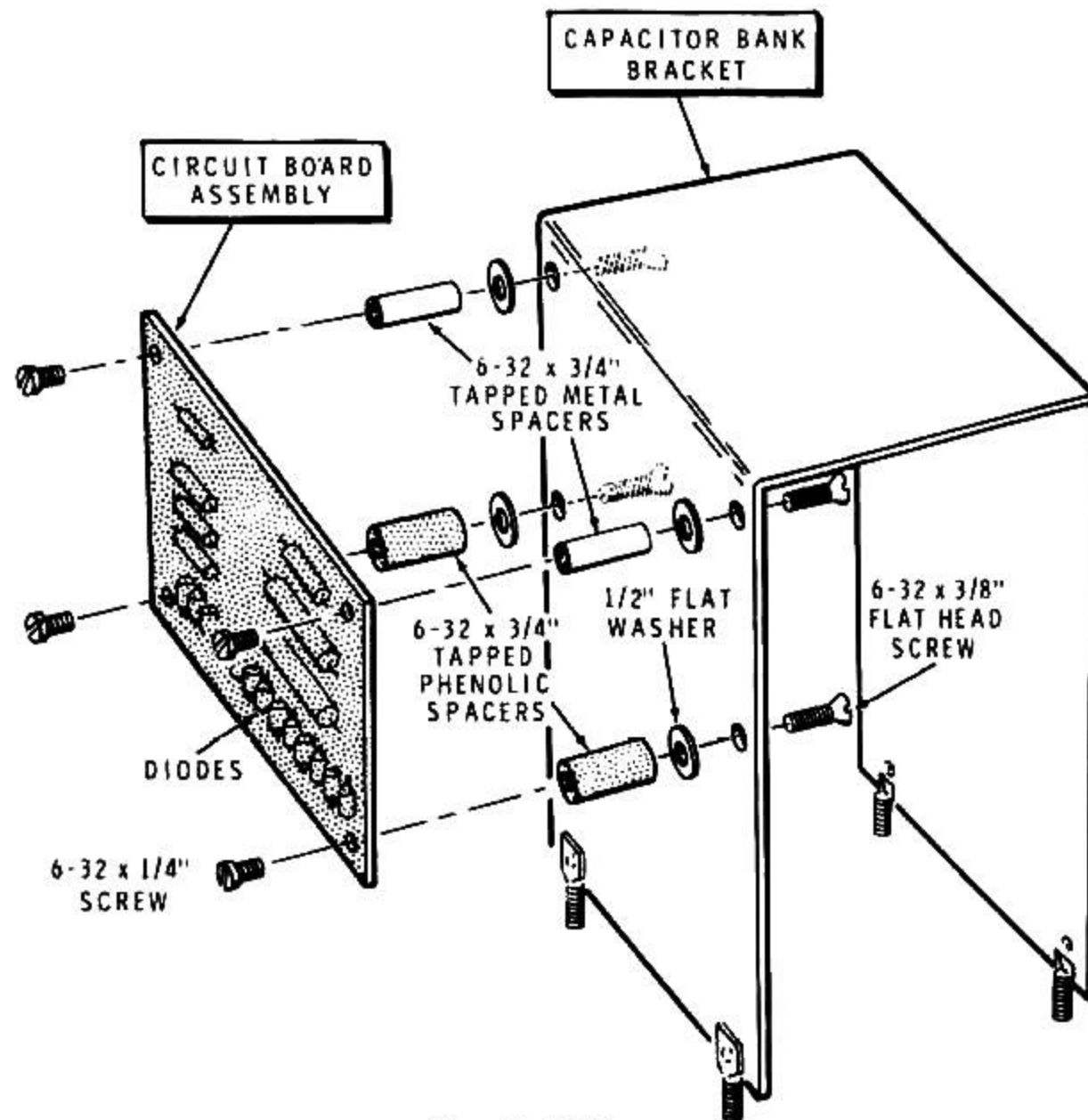
Detail 4-6G



- () Refer to Detail 4-6H and, from the shaft side of the motor, insert the 6-32 x 1-1/2" screw (supplied with the motor assembly) through the mounting hole. Then secure the screw with the nut you removed in step 3 above.
- () Similarly modify the hardware on the other side of the motor. Be sure to install the new screw from the shaft side of the motor.
- () Refer to Detail 4-6J and mount the fan motor on the perforated fan cover at holes FJ and FK. Use two 7/16" spacers, four #6 flat metal washers, and two 6-32 nuts as shown.

- () Refer to Detail 4-6K and install the fan blade assembly (# 266-296) on the fan motor shaft. Position the fan motor and the blade assembly as shown, and apply firm downward pressure with both thumbs on the fan blade hub. A slight rocking motion will help. Push the fan blades onto the motor shaft until there is 1/16" to 1/32" clearance between the fan blade hub and the motor frame.
- () Refer to Detail 4-6L and mount the rear panel to the chassis rear apron at FC and FD, and to the left side panel at FB. Use 6-32 x 3/8" hardware.

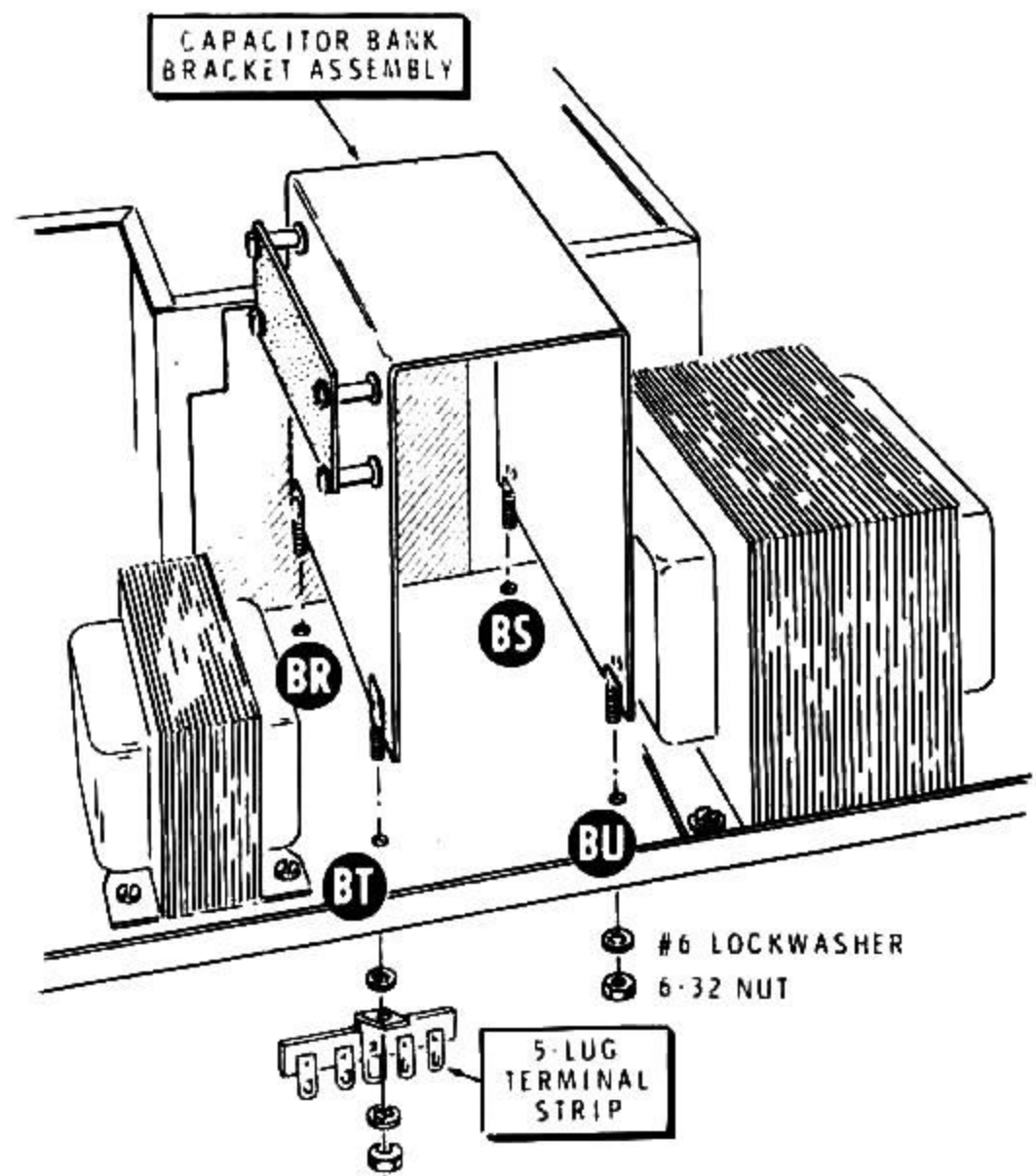




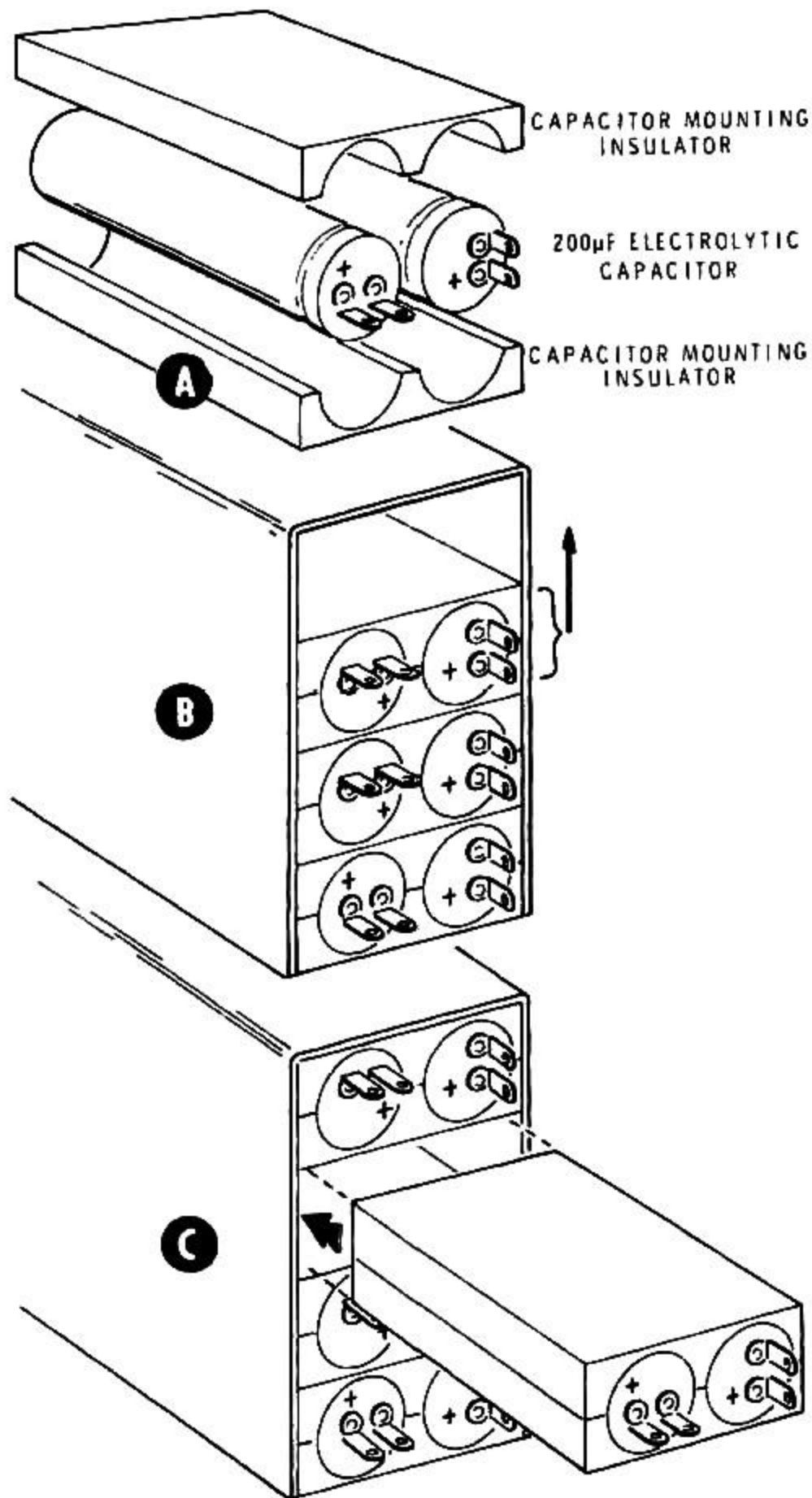
Detail 4-7A

Refer to Pictorial 4-7 (fold-out from Page 43) for the following steps.

- () Refer to Detail 4-7A and mount the circuit board assembly on the capacitor bank bracket. Use 6-32 x 1/4" screws, 6-32 x 3/4" tapped metal spacers, 6-32 x 3/4" tapped phenolic spacers, 1/2" flat washers, and 6-32 x 3/8" flat head screws. Note that the diodes, and the phenolic spacers, are along the lower edge of the circuit board.
- () Refer to Detail 4-7B and mount the capacitor bank bracket with one spade bolt entering each of holes BR, BS, BT, and BU. Use #6 lockwashers and 6-32 nuts only on spade bolts BR, BS, and BU. Leave the nuts flush with the ends of the spade bolts.
- () Mount a 5-lug terminal strip (#431-42) on spade bolt BT. Use two #6 lockwashers and a 6-32 nut. Leave the face of the nut flush with the end of the spade bolt.



Detail 4-7B

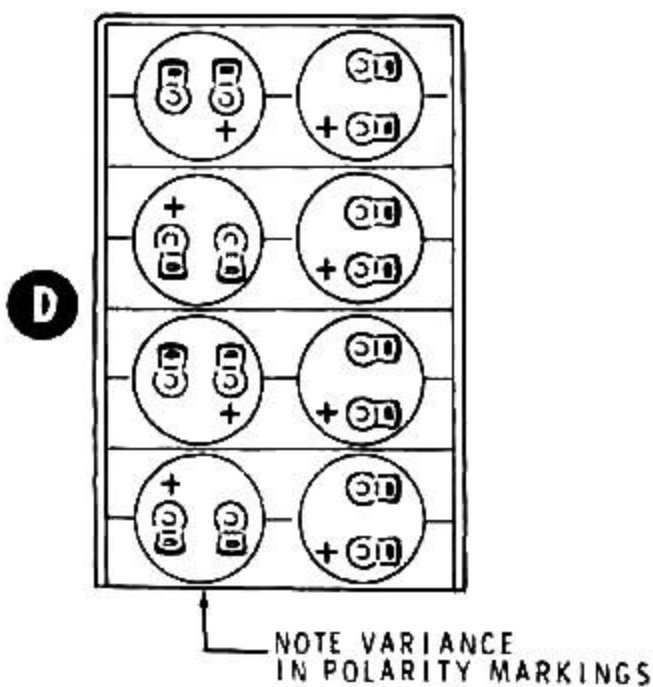


Refer to Detail 4-7C for the steps covering the capacitor bank assembly.

- () **Part A:** Assemble four capacitor sections, each composed of two capacitor mounting insulators (#75-125) and two 200 μ F electrolytic capacitors (#25-224).
- () **Part B:** Stack three capacitor sections in the capacitor bank bracket. Then lift up the top section to the top of the bracket.
- () **Part C:** Insert the fourth capacitor section into the vacated space in the bracket.
- () **Part D:** Align the capacitor lugs and the positive (+ or red dot) polarity markings as shown. Then push the capacitors snugly against the fish paper and tighten the spade bolt nuts on the bottom of the chassis just to the point where you can no longer rotate the capacitors with your fingers. Do not overtighten. Note the position of the terminal strip mounting foot in Detail 4-7B.

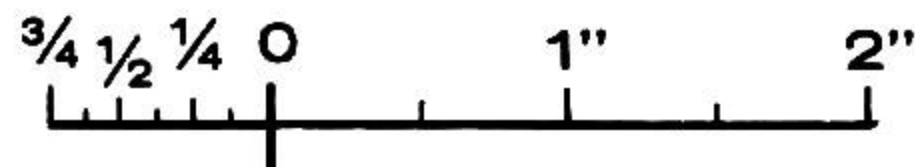


Detail 4-7D



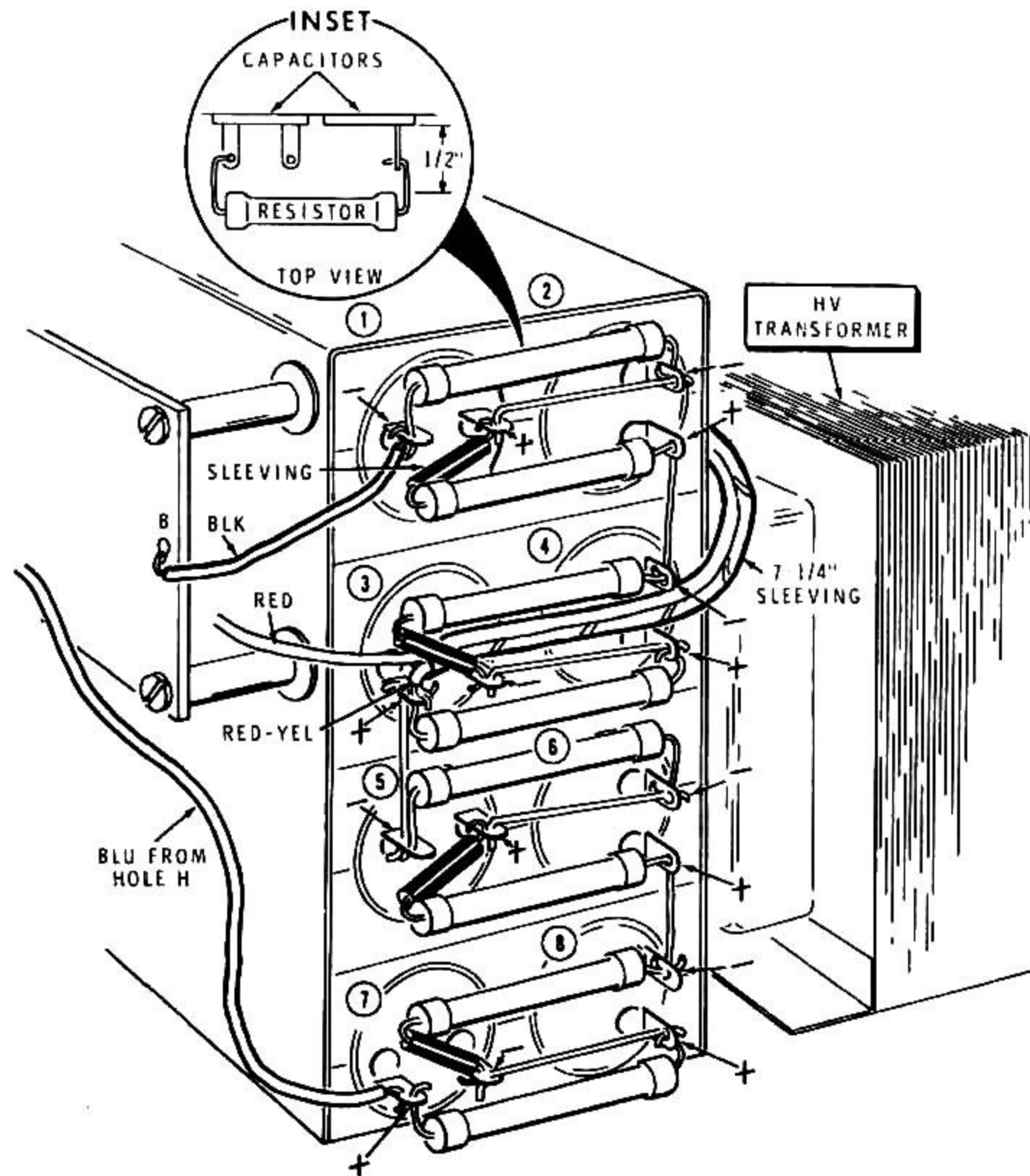
Detail 4-7C

- () Refer to Detail 4-7D and cut four pieces of small bare wire 1-5/8" long and one piece 1-3/8" long. Bend down 1/8" at one end of each. These wires will be used in the capacitor bank wiring.
- () Cut four pieces of small black sleeving 3/4" long for use in wiring the capacitor bank.



NOTE: When you connect resistors in the following steps, align them as shown in the Pictorial. Space the resistors 1/2" from the capacitors as shown in the inset drawing. After fitting and soldering the resistors, cut off and discard any excess lead lengths. No resistor should be closer than 1/4" to any metallic object to which it is not intentionally connected.

- () Refer to the Pictorial and place one of the 3/4" lengths of sleeving on one lead of a 30 k Ω resistor. Connect this lead to the positive (+ or red dot) lug of capacitor 1 (NS). Pass the other resistor lead through the positive lug of capacitor 2 (S-2) to the negative lug of capacitor 4 (NS).
- () Place one of the 3/4" lengths of sleeving on one lead of a 30 k Ω resistor and connect this lead to the positive lug of capacitor 5 (NS). Pass the other lead through the positive lug of capacitor 6 (S-2) to the negative lug of capacitor 8 (NS).
- () Pass the straight end of one of the 1-5/8" bare wires through the negative lug of capacitor 2 (NS). Place the bent end of the wire into the positive lug of capacitor 1 (S-2).
- () Connect the black hookup wire coming from hole B on the circuit board to the negative lug of capacitor 1 (NS).
- () Connect a 30 k Ω resistor from the negative lug of capacitor 1 (S-2) to the negative lug of capacitor 2 (S-2).
- () Connect the bent end of one of the 1-5/8" bare wires to the negative lug of capacitor 3 (NS) and the straight end to the positive lug of capacitor 4 (NS).
- () Place a 3/4" length of sleeving on one lead of a 30 k Ω resistor and connect this lead to the negative lug of capacitor 3 (S-2). Connect the other lead to the negative lug of capacitor 4 (S-2).
- () Place the bent end of a 1-5/8" bare wire in the positive lug of capacitor 5 (S-2), and the straight end in the negative lug of capacitor 6 (NS).
- () Connect a 30 k Ω resistor from the negative lug of capacitor 5 (NS) to the negative lug of capacitor 6 (S-2).
- () Place the bent end of a 1-5/8" bare wire in the negative lug of capacitor 7 (NS) and the straight end in the positive lead of capacitor 8 (NS).
- () Place a 3/4" length of sleeving on one lead of a 30 k Ω resistor and connect this lead to the negative lug of capacitor 7 (S-2). Connect the other lead to the negative lug of capacitor 8 (S-2).
- () Connect the blue wire from hole H of the circuit board to the positive lug of capacitor 7 (NS).
- () Connect one lead of a 30 k Ω resistor to the positive lug of capacitor 7 (S-2). Connect the other lead to the positive lug of capacitor 8 (S-2).
- () Connect one lead of a 30 k Ω resistor to the positive lug of capacitor 3 (NS). Connect the other lead to the positive lug of capacitor 4 (S-2).
- () Connect the bent end of the 1-3/8" length of bare wire to the positive lug of capacitor 3 (NS) and the straight end to the negative lug of capacitor 5 (S-2).
- () Pass a 7-1/4" length of clear sleeving over the red and the red-yellow wires coming from the HV transformer. Slide the sleeving on the wires as far as it will go.
- () Cut off the red-yellow wire 1/2" beyond the end of the sleeving. Remove 1/4" of insulation.
- () Connect the red-yellow wire to the positive lug of capacitor 3 (S-3).
- () Carefully compare your work in the foregoing steps to the Pictorial (and the Details) for wiring errors and for proper capacitor polarity. Incorrect connections in this high-voltage circuit area can cause serious damage.



PICTORIAL 4-7

Refer to Pictorial 4-8 for the following steps.

NOTE: In the following step, if solder on the bare end of the red wire prevents its entry into hole D, carefully cut off just enough of the soldered wire end to allow it to fit into the hole. Be careful not to cut the wire too short.

- () Connect the red wire coming from the HV transformer to hole D on the circuit board (S-1). Reach in between the circuit board and the capacitor bracket to solder this connection. Make sure this connection is well soldered.
- () Pass one lead of a .001 μ F, 6 kV, capacitor through solder lug CF (S-2) to hole K in the circuit board (S-1). Connect the other lead of this capacitor to solder lug CK (NS).

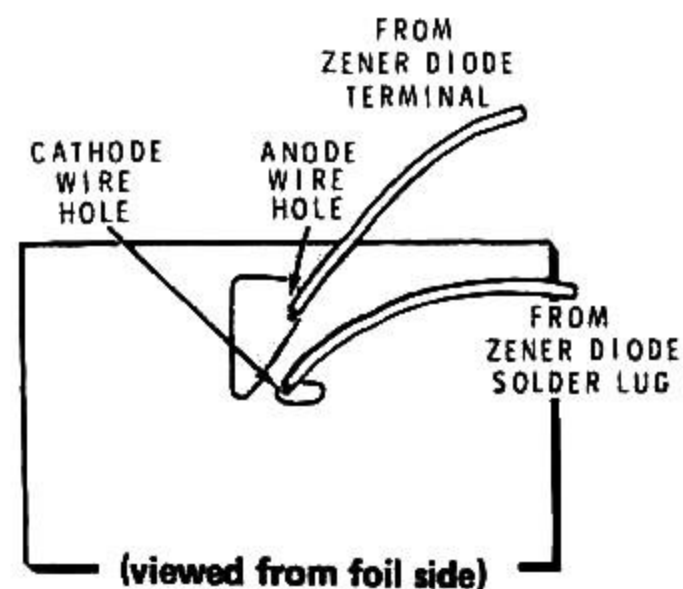
Refer to the inset drawing of Pictorial 4-8 and Detail 4-8A for the next two steps.

- () Connect the black cathode wire, coming from the solder lug of zener diode CW, to the foil side of the circuit board (S-1). Detail 4-8A shows the foil pattern.
- () Connect the other black wire, coming from the anode of zener diode CW, to the foil side of the circuit board (S-1). Refer to Detail 4-8A for the foil configuration.

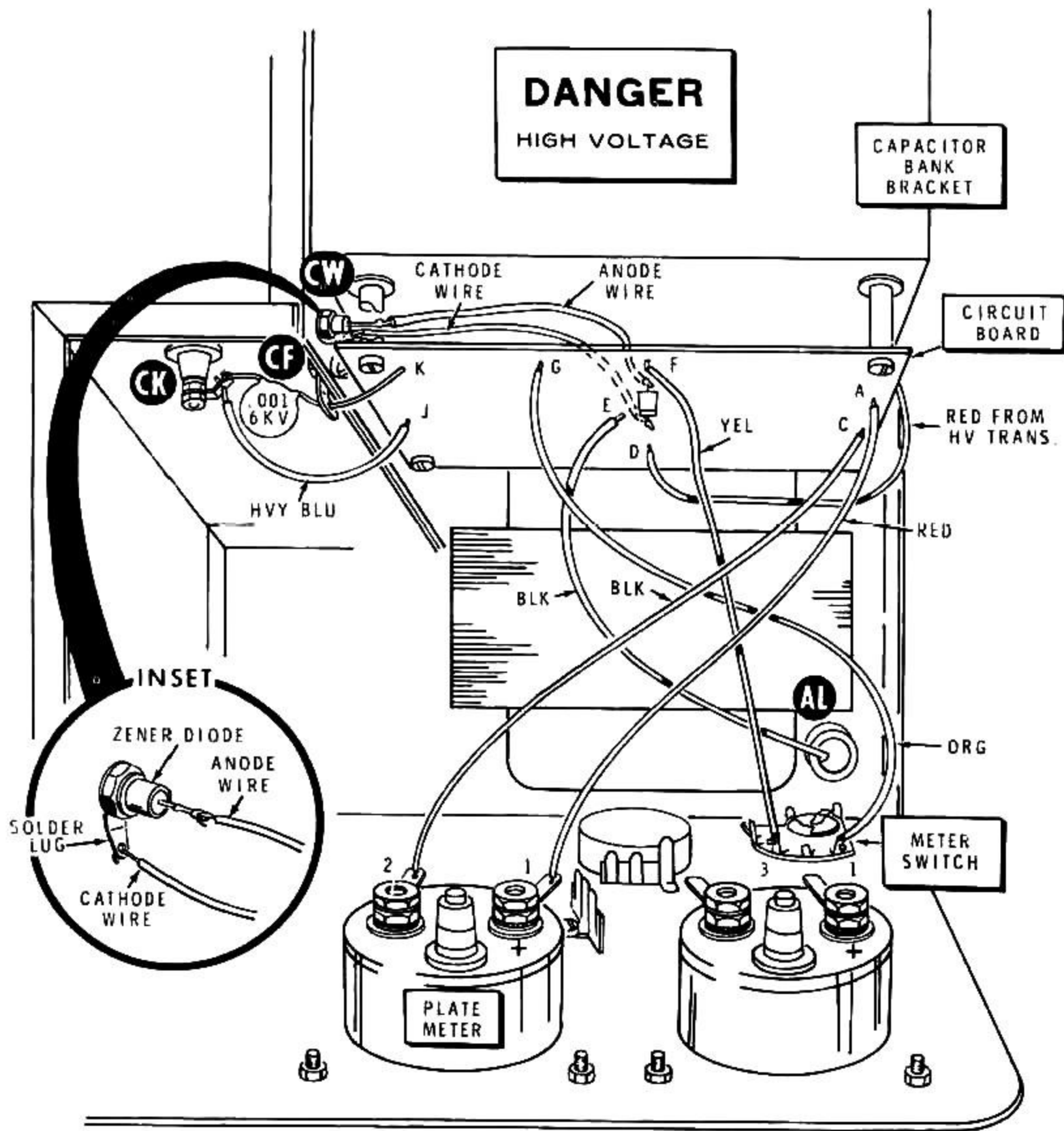
Connect the wires coming from the component side of the circuit board as follows:

Wire Color	From Hole	Connect to
() HVY Blue	J	Solder lug CK (S-2).
() Yellow	F	Lug 3 of meter switch (S-1).
() Orange	G	Lug 1 of meter switch (S-1).
() Black	C	Lug 2 of plate meter (S-2).
() Red	A	Lug 1 of plate meter (S-2).

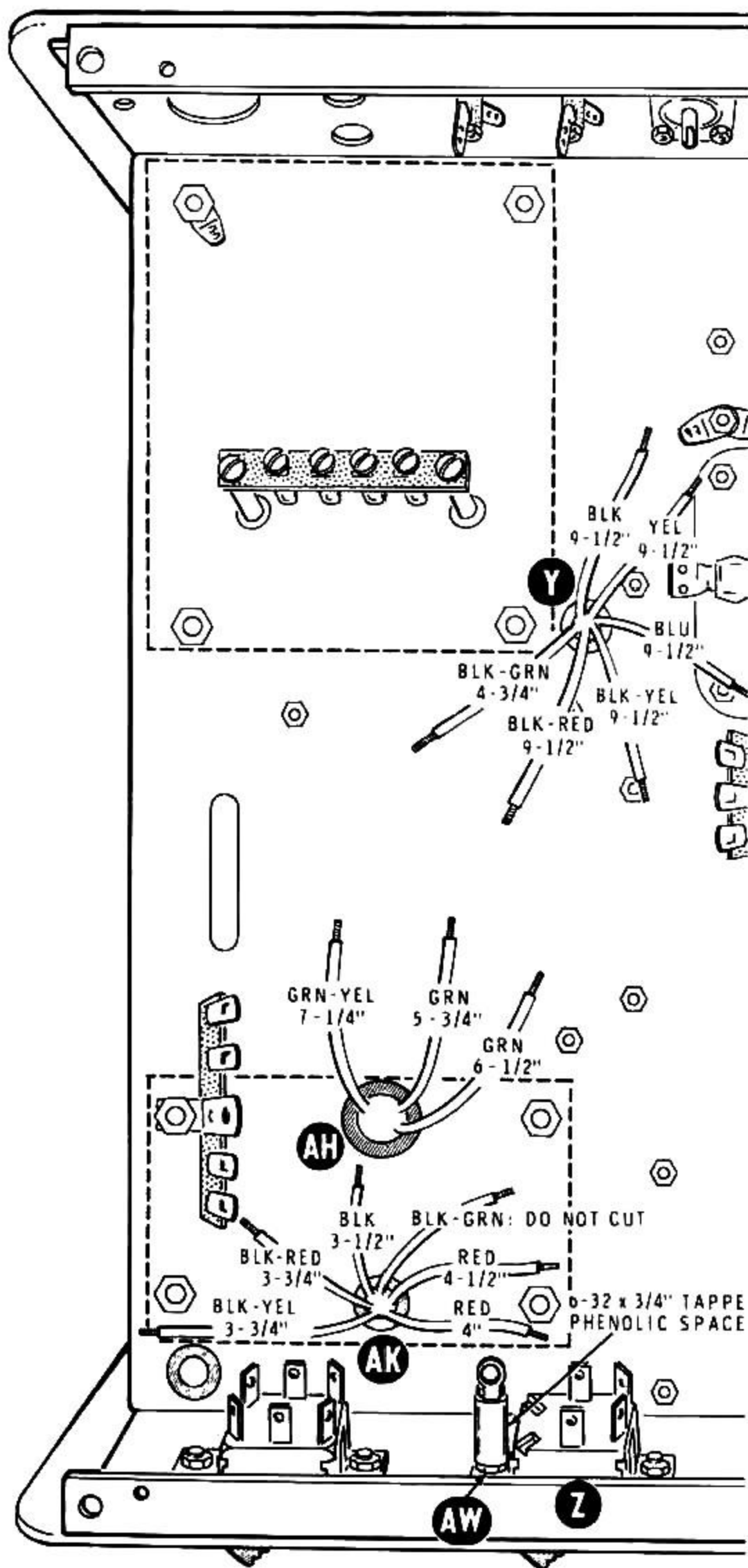
- () Insert the black stranded wire coming from hole E in the circuit board down through grommet AL.
- () Peel off the backing paper from the DANGER label and press it into place on the top of the capacitor bank bracket.



Detail 4-8A



PICTORIAL 4-8



PICTORIAL 4-9

UNDER-CHASSIS WIRING

Refer to Pictorial 4-9 and cut the transformer leads coming through the chassis at Y, AH and AK to the indicated lengths. Be sure you have selected the proper location before you cut. Measure the length of each lead from the chassis.

() At grommet Y, cut the transformer leads as follows:

Blue	9-1/2"
Yellow	9-1/2"
Black	9-1/2"
Black-red	9-1/2"
Black-Yellow	9-1/2"
Black-Green	4-3/4"

() At grommet AH, cut the transformer leads as follows:

Green	6-1/2"
Green-Yellow	7-1/4"
Green	5-3/4"

() At grommet AK, cut the transformer leads as follows:

One red	4-1/2"
Other red	4"
Black-Red	3-3/4"
Black-Yellow	3-3/4"
Black	3-1/2"
Black-Green	Do not cut

NOTE: When you remove insulation from transformer leads in the following steps, grasp the wires where they emerge from the chassis so no strain will be placed on the connections at the transformer end of the leads.

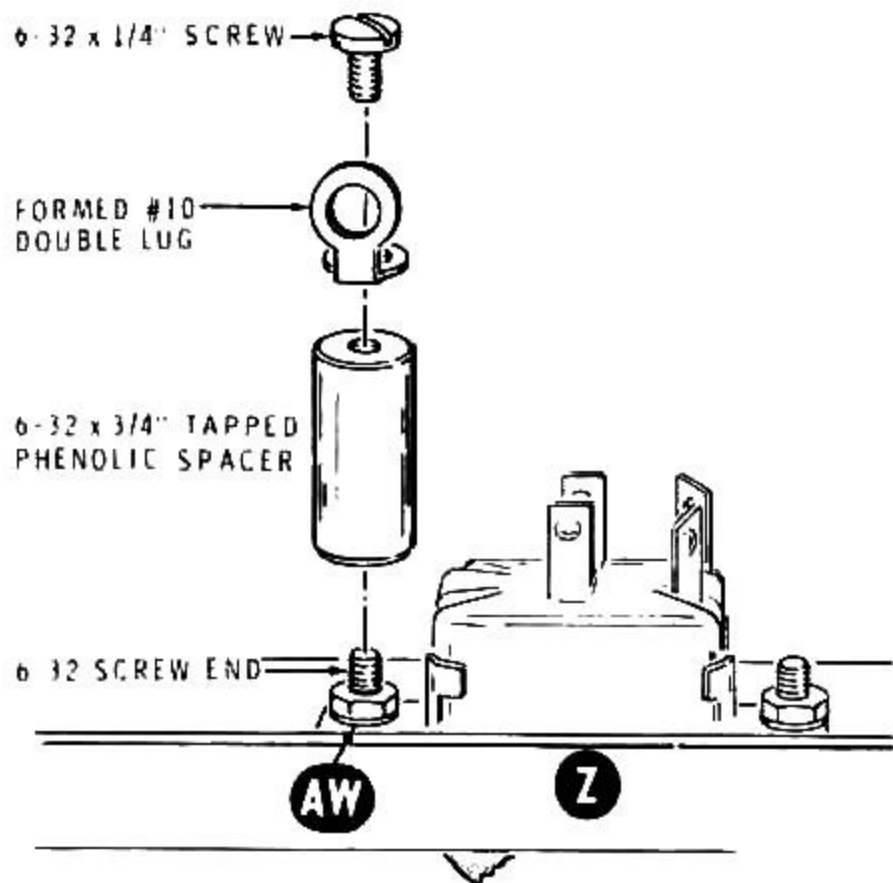
() Remove 1/4" of insulation from the cut ends of the two heavy green leads coming from AH. Melt a small amount of solder on the bared wire ends.

() Remove 1/4" of insulation from the end of each remaining transformer lead. Twist the fine wire strands together and melt a small amount of solder on each bared end.



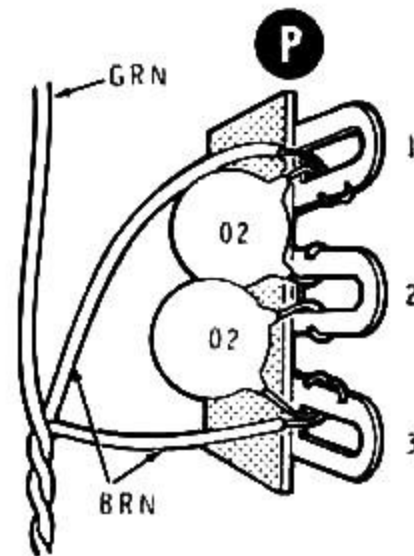
Detail 4-9A

- () Refer to Detail 4-9A and form a #10 double lug (#259-25) as shown.
- () Refer to Detail 4-9B and screw a 6-32 x 3/4" tapped phenolic spacer onto screw AW. Then install the formed lug on the inner end of the phenolic spacer with a 6-32 x 1/4" screw. Position the lug as shown.



Detail 4-9B

NOTE: Before starting the wiring in the following steps, look ahead to the under-chassis photograph on Page 86. Observe how wires are routed down the center of the chassis and are then bound together by ties to form a cable. As an aid in forming a neat cable, you can mark the main wiring guide lines on the under side of the chassis with a magic marker or china marking pencil. Then follow these guide lines when routing the individual wires.



Detail 4-10A

Refer to Pictorial 4-10 (fold-out from Page 49) for the following steps.

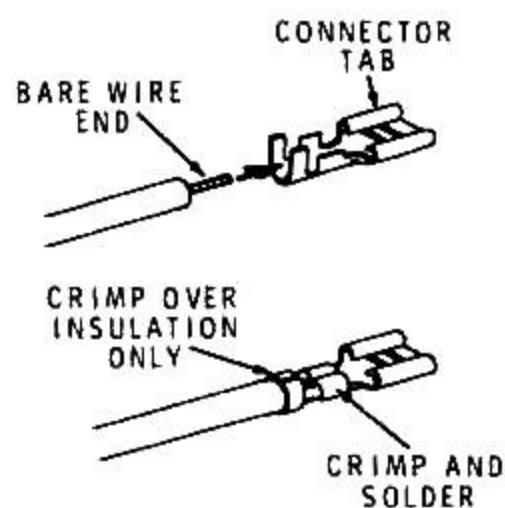
- () Route the twisted green and brown wires from grommet AL between grommet AH and grommet AK. Refer to Detail 4-10A and connect one of the brown wires to lug 1 (NS) and the other brown wire to lug 3 (NS) of terminal strip P.
- () Connect a .02 μ F disc capacitor from lug 1 (NS) to lug 2 (NS) of terminal strip P.
- () Connect a .02 μ F disc capacitor from lug 3 (NS) to lug 2 (S-2) of terminal strip P.
- () Connect the green wire from grommet AL to lug 1 of terminal strip B (NS).

Connect the transformer leads from grommet AK as follows:

Lead	Connect to
() 4-1/2" Red	Terminal strip BT, lug 3 (NS).
() 4" Red	Terminal strip BT, lug 4 (NS).
() Black-green	Terminal strip AE, lug 3 (NS).

Connect the following transformer leads coming from grommet Y to switch AN:

Lead	Lug of Switch AN
() Black-yellow	1 (S-1).
() Yellow	5 (S-1).
() Blue	6 (S-1).
() Black-red	2 (S-1).
() Connect a 2" black hookup wire from lug 3 (S-2) to lug 1 (NS) of terminal strip BT.	
() Connect the yellow hookup wire from grommet T to lug 1 of phono socket U (NS).	
() Connect the orange wire from grommet T to lug 2 of terminal strip BT (NS).	
() Prepare a 4-1/4" length of large black stranded wire.	



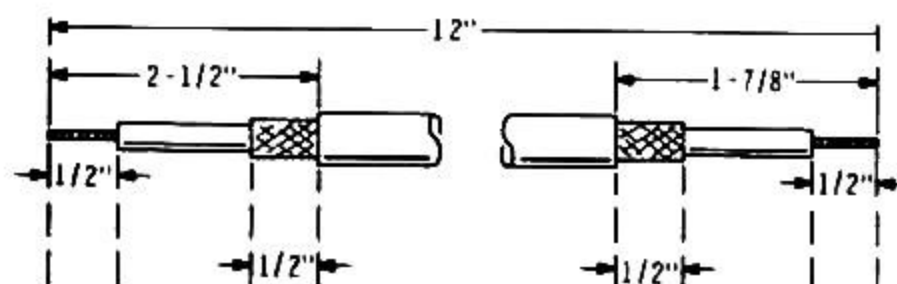
Detail 4-10B

Refer to Detail 4-10B for the next two steps.

- () Locate the large connector tabs (#432-137). If these tabs are connected to one another, cut the strip of tabs into six individual tabs as shown.
- () Install one of these large connector tabs (#432-137) on one end of the 4-1/4" wire (S-1).

Refer to the Pictorial for the following steps.

- () Push the connector tab from the preceding step onto lug 3 of switch Z. Connect the other end of this wire to double lug AW (NS).
- () Connect the black lead from grommet AK to double lug AW (NS).
- () Connect the black lead from grommet Y to double lug AW (NS).
- () Connect the center conductor of the coaxial cable coming from lug 7 of switch CZ to lug 1 (NS) and the shield wires to lug 2 (S-1) of terminal strip AG.



Detail 4-10D

- () Refer to Detail 4-10D and prepare a 12" length of RG-8/U coaxial cable. Tin the exposed braid at each end, being careful not to melt the inner insulation.
- () Loosen the cable clamp at G, place the shield braid at the 2-1/2" end under the clamp, and connect the center conductor to lug 8 of relay F (S-1).
- () Similarly, place the shield braid at the other end of the cable under cable clamp B and connect the center conductor to coaxial fitting A (S-1).
- () Tighten both cable clamps and solder the shield braid at each end of its cable clamp. Be careful not to melt the inner insulation.

Refer to Pictorial 4-11 for the following steps.

- () Prepare the following lengths of large black stranded wire:

4-1/2"

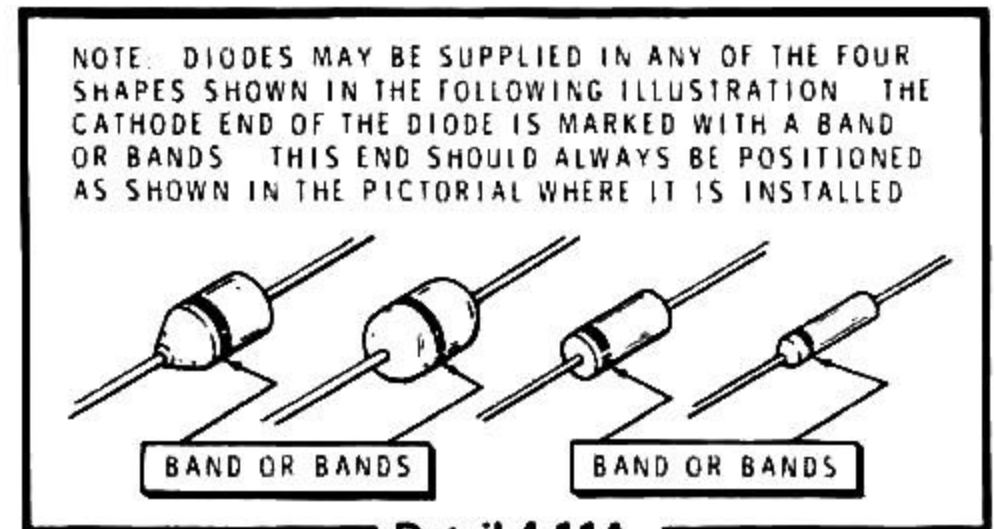
13-1/2"

13-1/2"

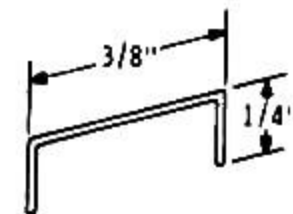
- () Install a large connector tab (#432-137) on one end of each of the three wires.
- () Push the tab on the 4-1/2" wire onto lug 4 of switch AN.
- () Push the connector tab on one of the 13-1/2" wires onto lug 1 of switch Z, and the connector tab on the other 13-1/2" wire onto lug 2.
- () Prepare a 12-1/2" length of large black stranded wire.
- () Connect the free end of the black-yellow wire coming from grommet AK and one end of the 12-1/2" wire in the preceding step to one large tab connector (S-2). Then push this connector tab onto lug 3 of switch AN.
- () Connect the free end of the black-red lead coming from grommet AK and the free end of the black wire coming from lug 4 of switch AN to one large tab connector (S-2). Push this tab onto lug 4 of switch Z.

The free ends of the "tabbed" wires in the preceding steps will be connected later.

- () Refer to Detail 4-11A and connect the cathode lead of a silicon diode (#57-27) to lug 5 (NS) and the anode lead to lug 4 (S-2) of terminal strip BT.

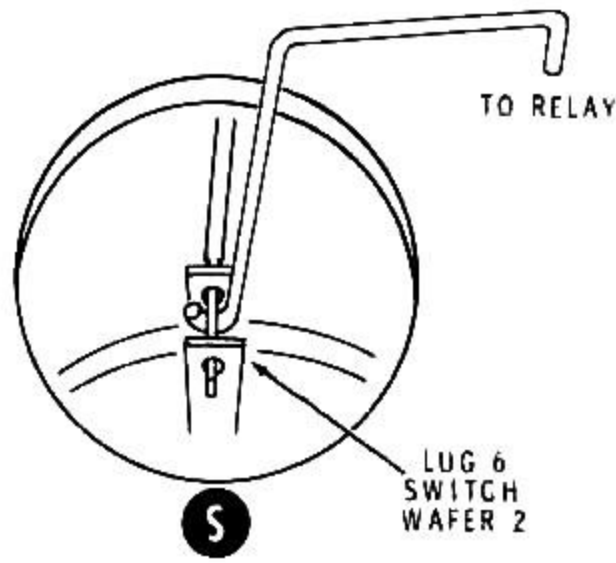


- () Connect a 33 k Ω (orange-orange-orange) resistor from lug 1 (NS) to lug 2 (NS) of terminal strip BT.
- () Connect a 22 k Ω (red-red-orange) resistor from lug 2 (S-3) to lug 5 (NS) of terminal strip BT.
- () Connect the positive lead (marked +) of a 20 μ F electrolytic capacitor to lug 5 (NS) and the other lead to lug 1 (S-3) of terminal strip BT.
- () Connect the black stranded wire coming from grommet AL to lug 6 of relay F (S-1).
- () Connect a 2" red hookup wire from lug 3 (NS) to lug 11 (S-1) of the relay.
- () Connect a 9-1/2" length of red hookup wire from lug 5 of terminal strip BT (S-4) to lug 3 of the relay (NS).

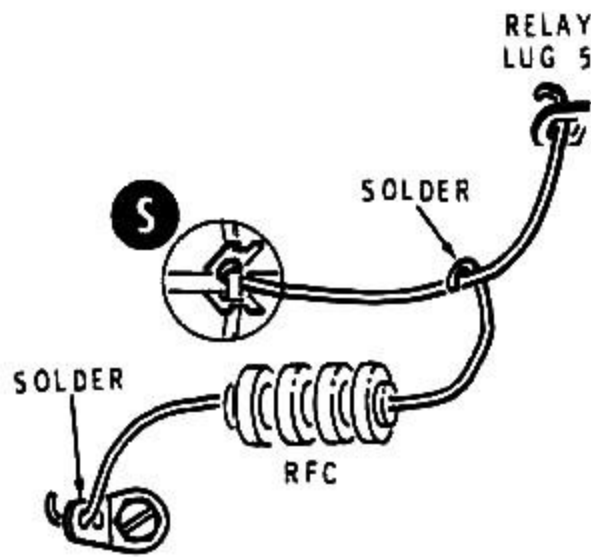


Detail 4-11B

- () Refer to Detail 4-11B and form a 7/8" length of bare wire as shown.
- () Connect the bare wire from lug 1 (S-1) to lug 2 (S-1) of relay F.
- () Connect the black-green transformer lead from grommet Y to lug 3 of terminal strip AE (S-2).

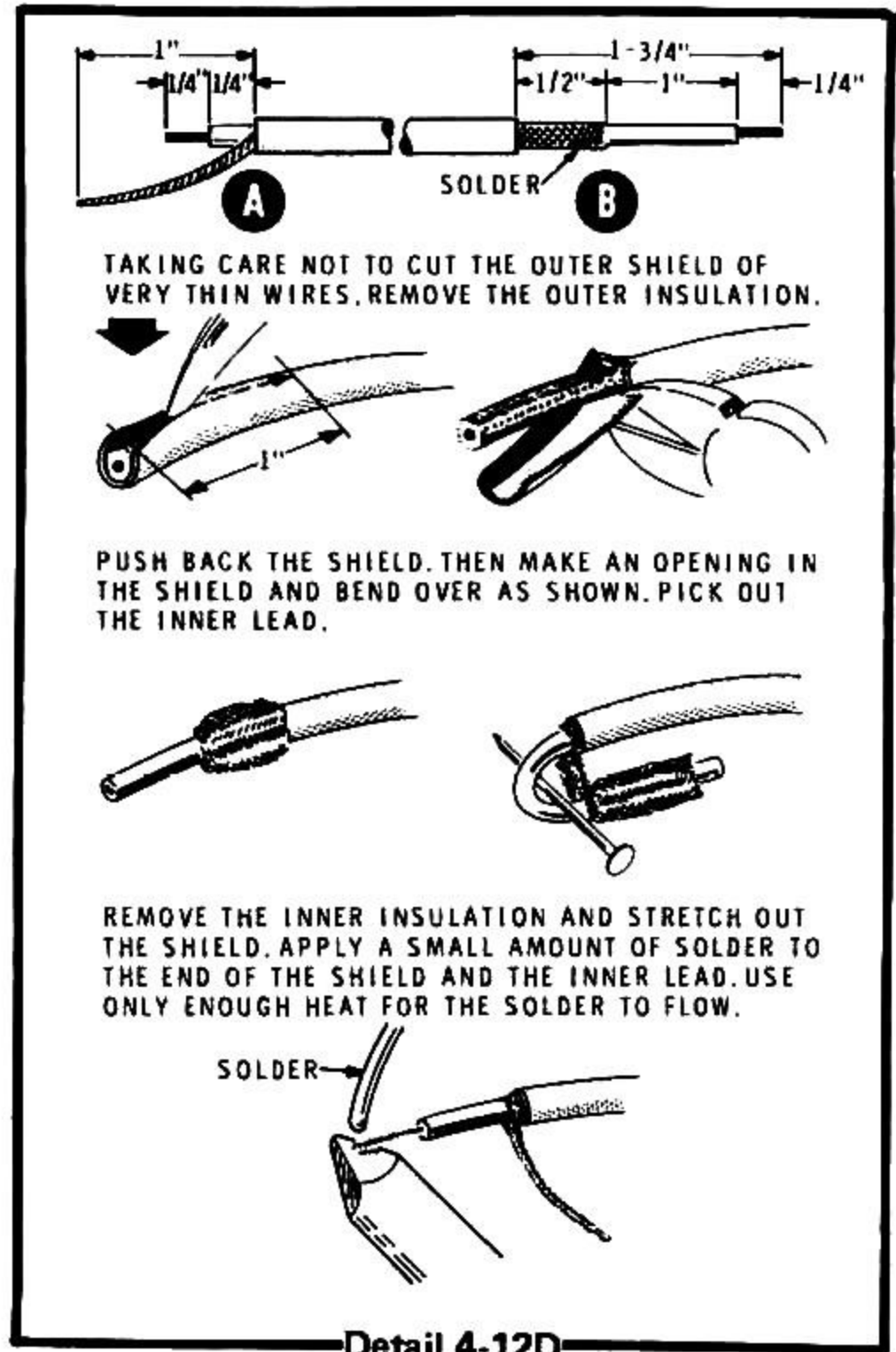


Detail 4-12B



Detail 4-12C

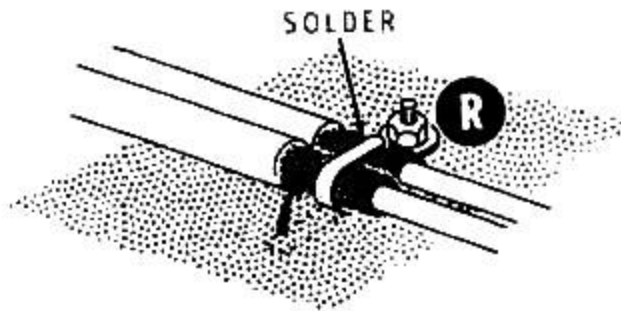
- () Refer to Detail 4-12B and connect the hook on the end of the formed wire through hole S to lug 6 of wafer 2 of switch CZ (S-4). Connect the other end of this wire to lug 5 of relay F (S-1) as shown in the Pictorial.
- () Refer to Detail 4-12C and connect one lead of a 1 MH RF choke to solder lug CH (S-1). Wind the other lead around the bare wire coming from relay lug 5 (S-1). Position the choke parallel to the chassis with a clearance of approximately 1/2".



- () Refer to Detail 4-12D and prepare an 11-1/2" length of RG-58A/U coaxial cable. Note that 1" of outer insulation is first removed from end A, and that the center conductor and inner insulation are then cut back as shown.

- () Tin the shield braid on end B. Use a minimum amount of heat and avoid melting the inner insulation.
- () Connect the coaxial cable center conductor at end B to lug 7 of relay F (S-1).
- () Connect the center conductor of the remaining coaxial cable coming from grommet T to lug 4 of relay F (S-1). Be sure this lead does not touch any other lug of the relay.

Detail 4-12E

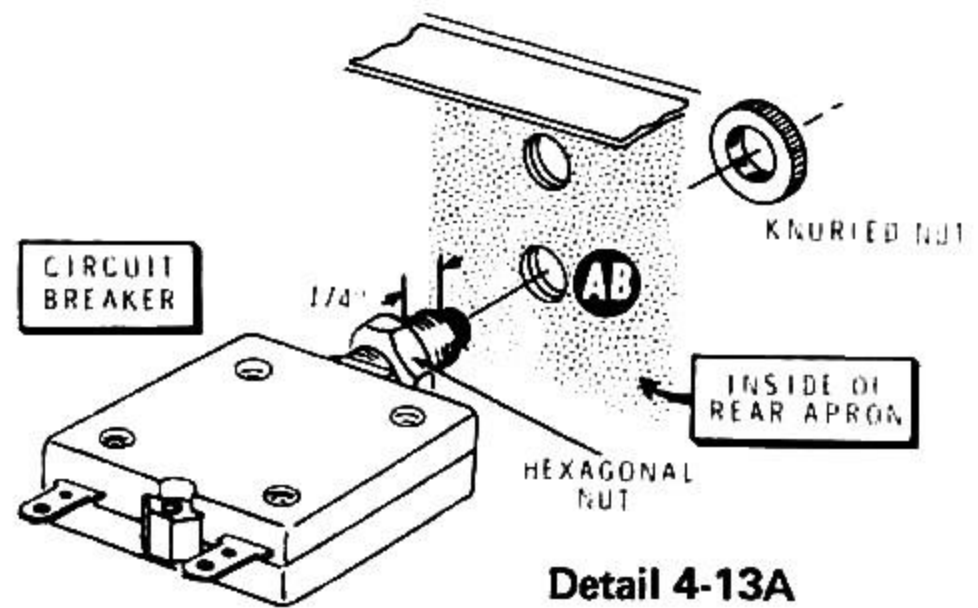


- () Refer to Detail 4-12E and position the exposed shields of the coaxial cables connected in the two preceding steps, over the long solder lug at R. Bend the solder lug back over both shield braids and solder. Use a minimum, but adequate, amount of heat.
- () Connect the center conductor at the free end of the coaxial cable to the center conductor of the coaxial fitting at L (S-1). Connect the shield wires to lug 2 of phono socket U (S-1).
- () Cut each lead of a 100 kΩ resistor (brown-black-yellow) to 1/2".
- () Connect the 100 kΩ resistor from lug 9 (S-2) to lug 3 (S-3) of relay F as shown in inset drawing 2 of the Pictorial.

Refer to Pictorial 4-13 (fold-out from Page 50) for the following steps.

Refer to Detail 4-13A for the following three steps.

- () Remove a knurled nut from each of the two circuit breakers (#65-28).
- () Position the face of each hexagonal nut 1/4" from the end of the mounting bushing.
- () Mount a circuit breaker on the chassis rear apron at AB. Use the knurled nut provided. NOTE: For convenience in wiring, position the solder lugs to provide the maximum distance between the chassis and the lugs.
- () Similarly, mount the other circuit breaker at AA.

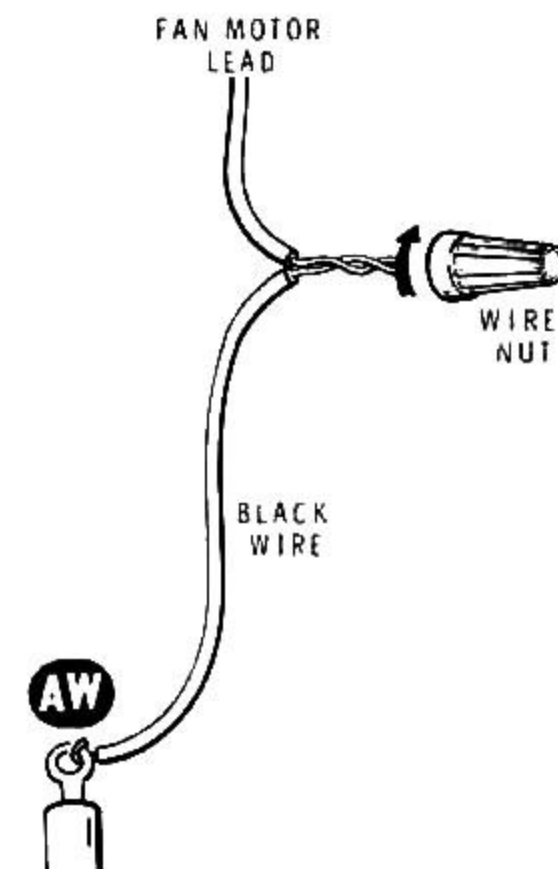


Detail 4-13A

NOTE: In the following steps, you will connect the fan motor. Be careful not to tear the motor leads out of their plastic frame.

- () Route one of the fan motor leads to terminal strip AE as shown. Cut off the excess lead lengths.
- () Connect the prepared lead to lug 2 of terminal strip AE (NS).
- () Remove 1/4" of insulation from the end of the other fan motor lead.
- () Locate the remaining small black stranded wire, and remove 1/4" of insulation from one end.

- () Twist together (clockwise) the bare end of the black wire and the bare end of the fan motor lead. Then twist the wire nut clockwise onto the wire ends until it is tight. Make sure there are no bare wires exposed around the wire nut.

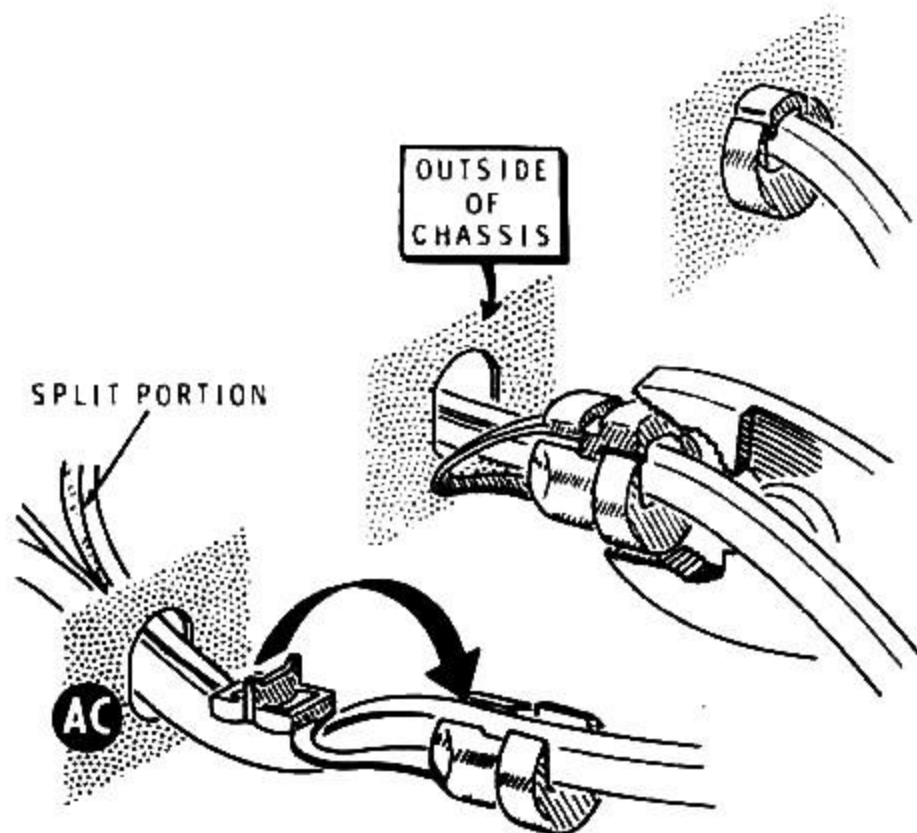


- () Route the black wire to lug AW (refer to Pictorial 4-13) then cut the wire to the proper length. Remove 1/4" of insulation from the end of the wire, and connect it to double lug AW (S-4).

Connect the wires from switches AN and Z as follows:

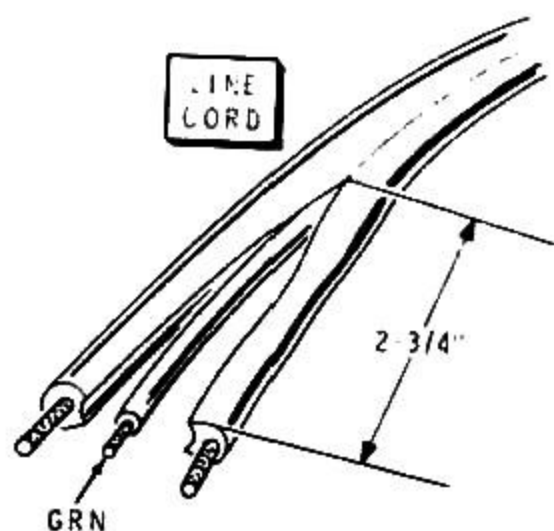
Wire Coming from	Connect to
Lug 3, switch AN	Lug 2, terminal strip AE (S-2).
Lug 1, switch Z	Lug 1, circuit breaker AB (S-1).
Lug 2, switch Z	Lug 1, circuit breaker AA (S-1).

- () Prepare a 3" and 3-1/2" large black stranded wire by cutting to length and removing 1/4" of insulation from each end of each wire.
- () Connect one end of the 3" wire to lug 4 of terminal strip AE (S-1). Connect the other end of this wire to lug 2 of circuit breaker AB (NS). Use the hole next to the circuit breaker body.
- () Similarly, connect the 3-1/2" wire from lug 1 of terminal strip AE (S-1) to lug 2 of circuit breaker AA (NS).
- () Connect a .01 μ F, 1.4 kV, disc capacitor from solder lug AD (NS) to lug 2 of circuit breaker AB (NS).
- () Connect a .01 μ F, 1.4 kV, disc capacitor from solder lug AD (NS) to lug 2 of circuit breaker AA (NS).
- () Refer to Detail 4-13B and prepare the end of the line cord as shown. Remove 3/8" of insulation from the end of each of the three conductors. Melt a small amount of solder on the end of each.

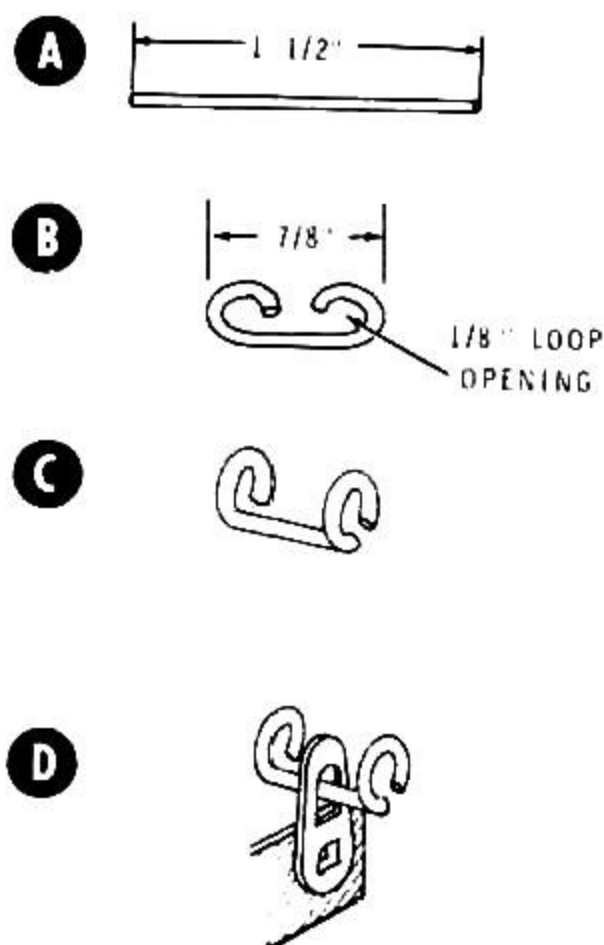


Detail 4-13C

- () Refer to Detail 4-13C and place the strain relief on the line cord just beyond the split portion of the cord, as shown. Use a pair of gas pliers to compress the strain relief, and then insert it into hole AC from the outside of the chassis.
- () Connect the green line cord wire to solder lug AD (S-3).
- () Connect one line cord conductor to lug 2 of circuit breaker AB (S-3).
- () Connect the other line cord conductor to lug 2 of circuit breaker AA (S-3).



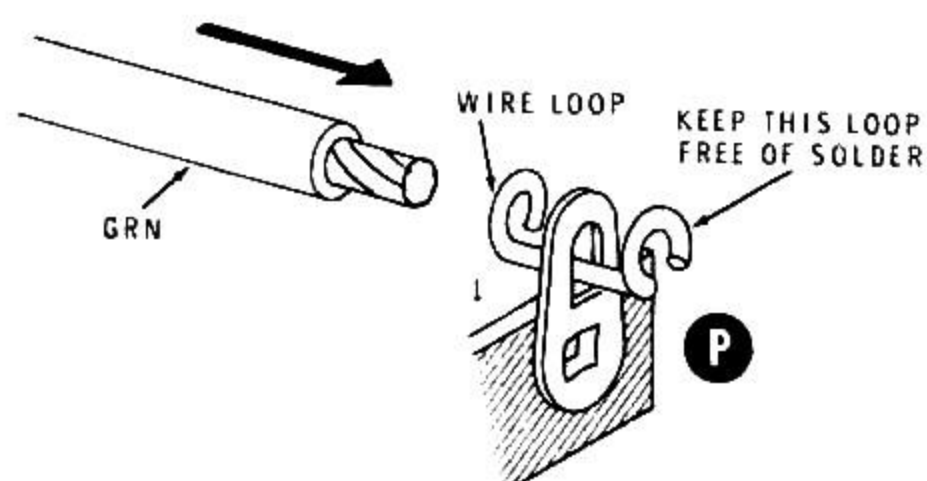
Detail 4-13B



Detail 4-13D

Refer to Detail 4-13D for the following steps.

- () **Part A.** Cut a 1-1/2" length of bare wire.
- () **Part B.** On each end of the bare wire, form a loop having an inside diameter of approximately 1/8". Adjust the size of the loops so they will just slide onto the tinned end of one of the large green transformer leads from hole AH.
- () **Part C.** Bend the two wire loops up as shown.
- () **Part D.** Pass the formed wire through lug 1 of terminal strip P.
- () Form another bare wire in the same manner, except pass this wire through lug 3 of terminal strip P.

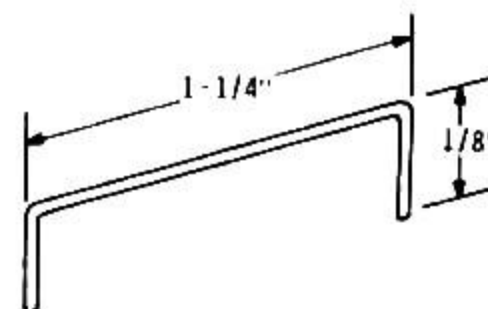


Detail 4-13E

- () Refer to Detail 4-13E and position the wire loops at lug 1 of the terminal strip so they point up away from the chassis. Then insert the end of the 6-1/2" green

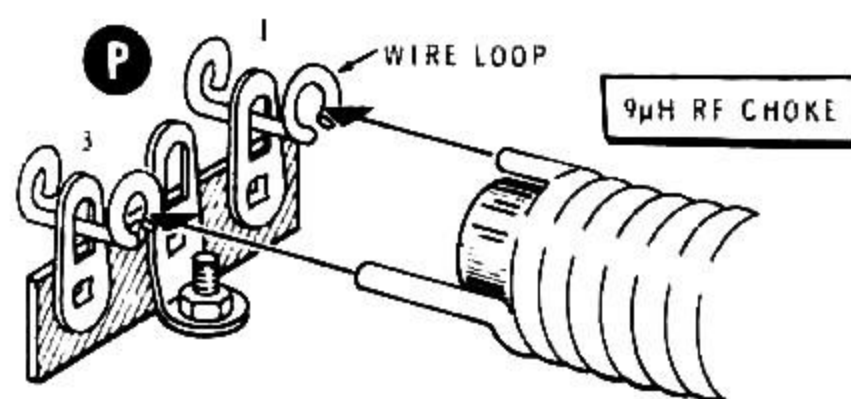
lead from hole AH all the way into the wire loop. Be careful to keep the two wire loops equally distant from the terminal strip solder lug. Then use pliers to compress the wire loop on the green wire. Solder the green lead to the wire loop and the wire loop to the solder lug, but be sure to keep the other wire loop free of solder. Also solder the lead from the .02 μ F disc capacitor and the brown wire to lug 1 at this time.

- () Repeat the preceding step at lug 3 of terminal strip P for the 5-3/4" green lead.



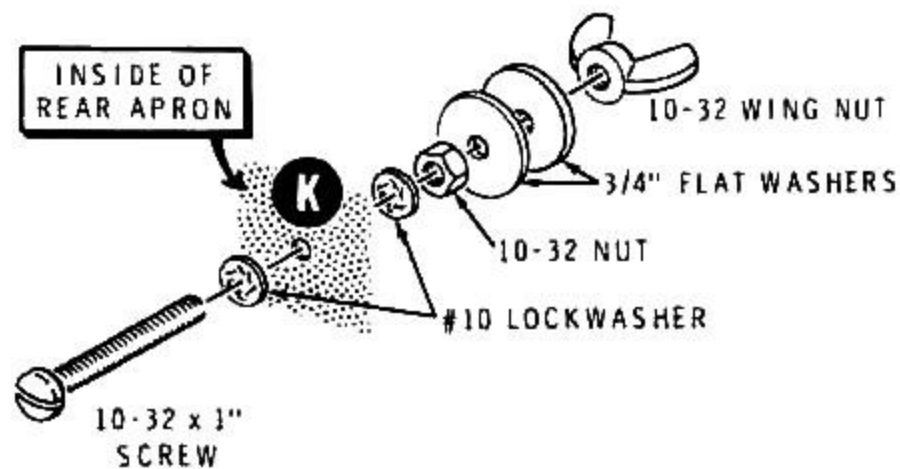
Detail 4-13F

- () Refer to Detail 4-13F and form two 1-1/2" lengths of bare wire. Then, fit one wire from lug 1 of tube socket D (S-1) to lug 5 of tube socket N (NS).
- () Fit the other 1-1/2" wire from lug 5 of tube socket D (S-1) to lug 1 of tube socket N (NS).
- () Connect a .02 μ F disc capacitor from lug 5 (S-2) to lug 1 (NS) of tube socket N.
- () Connect a .01 μ F, 1.4 kV, disc capacitor from lug 1 of tube socket N (S-3) to lug 1 of terminal strip AG (S-2).



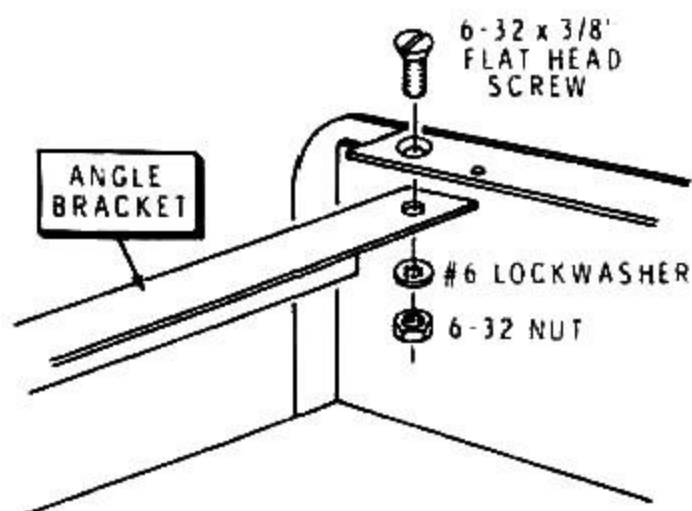
Detail 4-13G

- () Refer to Detail 4-13G and fit the 9 μ H RF choke (#45-78) so the two short leads at one end fit into the two wire loops on terminal strip P. At the other end of the choke, form the two leads so they loop around the bare wire filament leads between the two tubes as shown. Make sure the RF choke leads clear the chassis by at least 1/8". Solder the four RF choke leads carefully as these leads carry heavy current.



Detail 4-13H

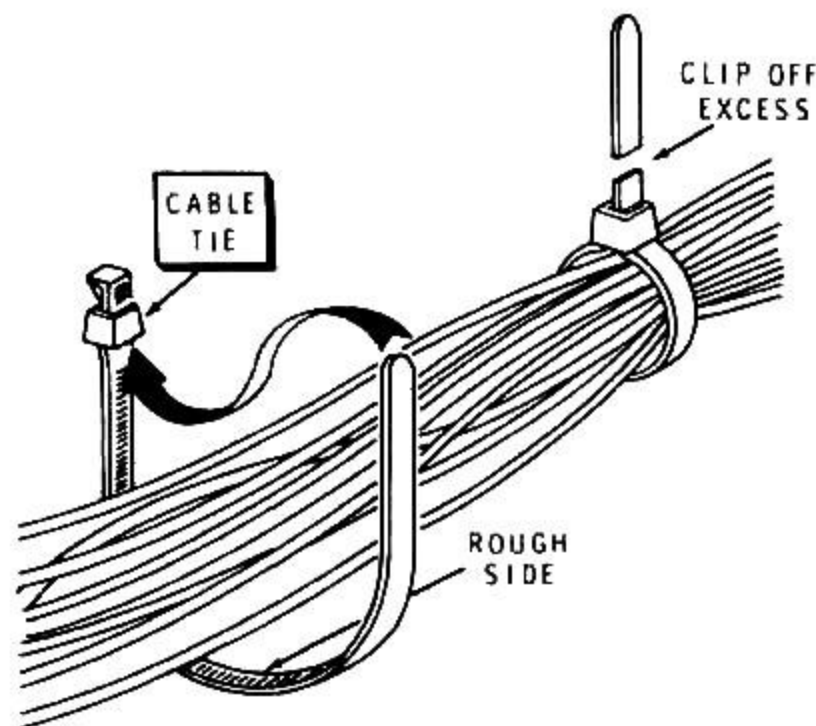
- () Refer to Detail 4-13H and install the ground post at K on the chassis rear apron. Use a 10-32 x 1" screw, two #10 lockwashers, a 10-32 nut, two 3/4" flat washers, and a 10-32 wing nut.



Detail 4-14A

Refer to Pictorial 4-14 for the following steps.

- () Refer to Detail 4-14A and install an angle bracket (#204-1041) on the chassis at AS and AT. Use 6-32 x 3/8" flat head hardware.
- () Similarly, install the other angle bracket between AP and AR.



Detail 4-14B

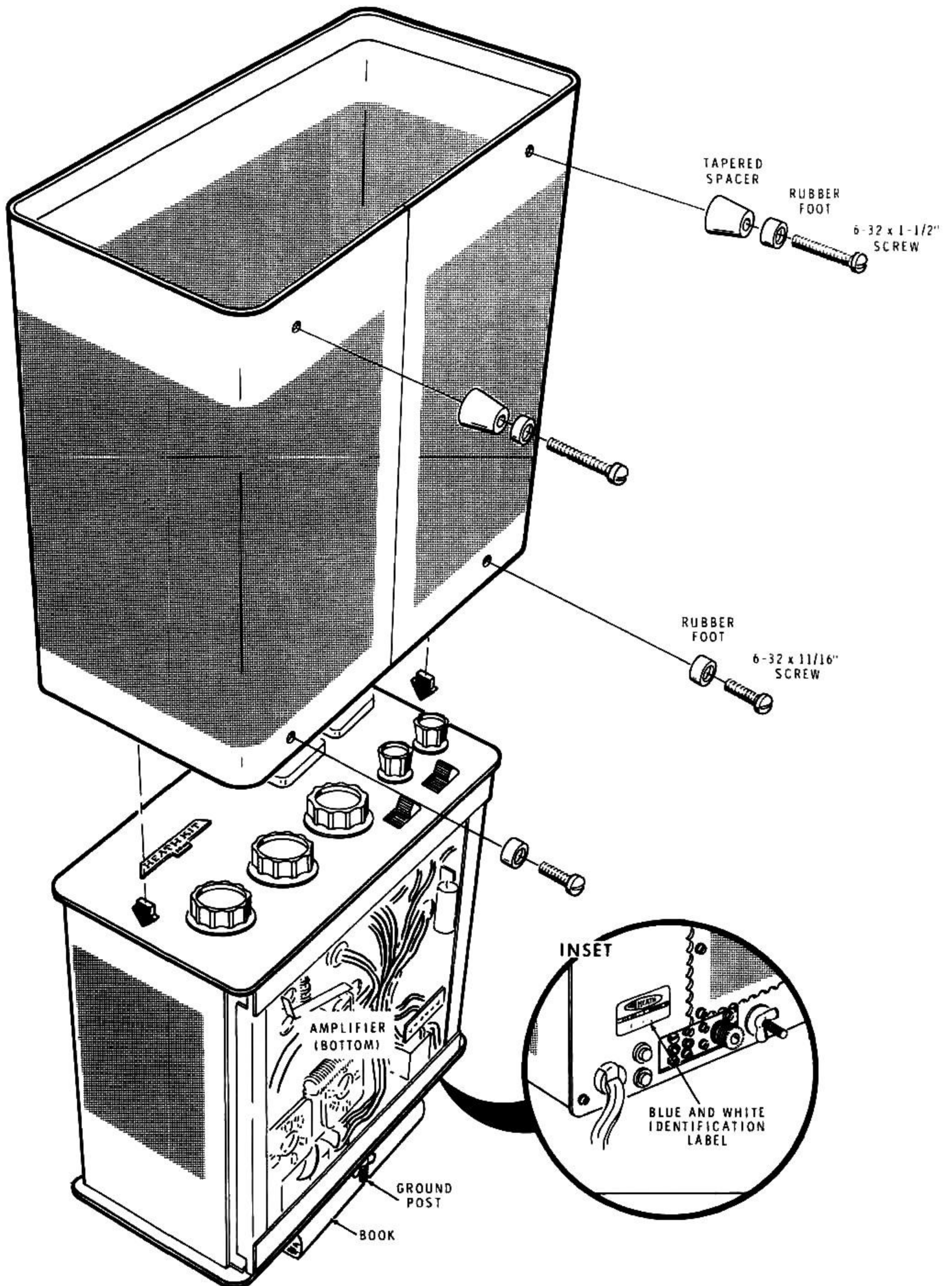
- () Refer to Detail 4-14B and pass a cable tie (#354-5) around all of the wires at each of the six points shown in the Pictorial to form a neat cable. Equalize any slack in each wire between the ends of the wire. Then pull each cable tie snug and clip off the excess length of the tie.

120-240 VOLT WIRING

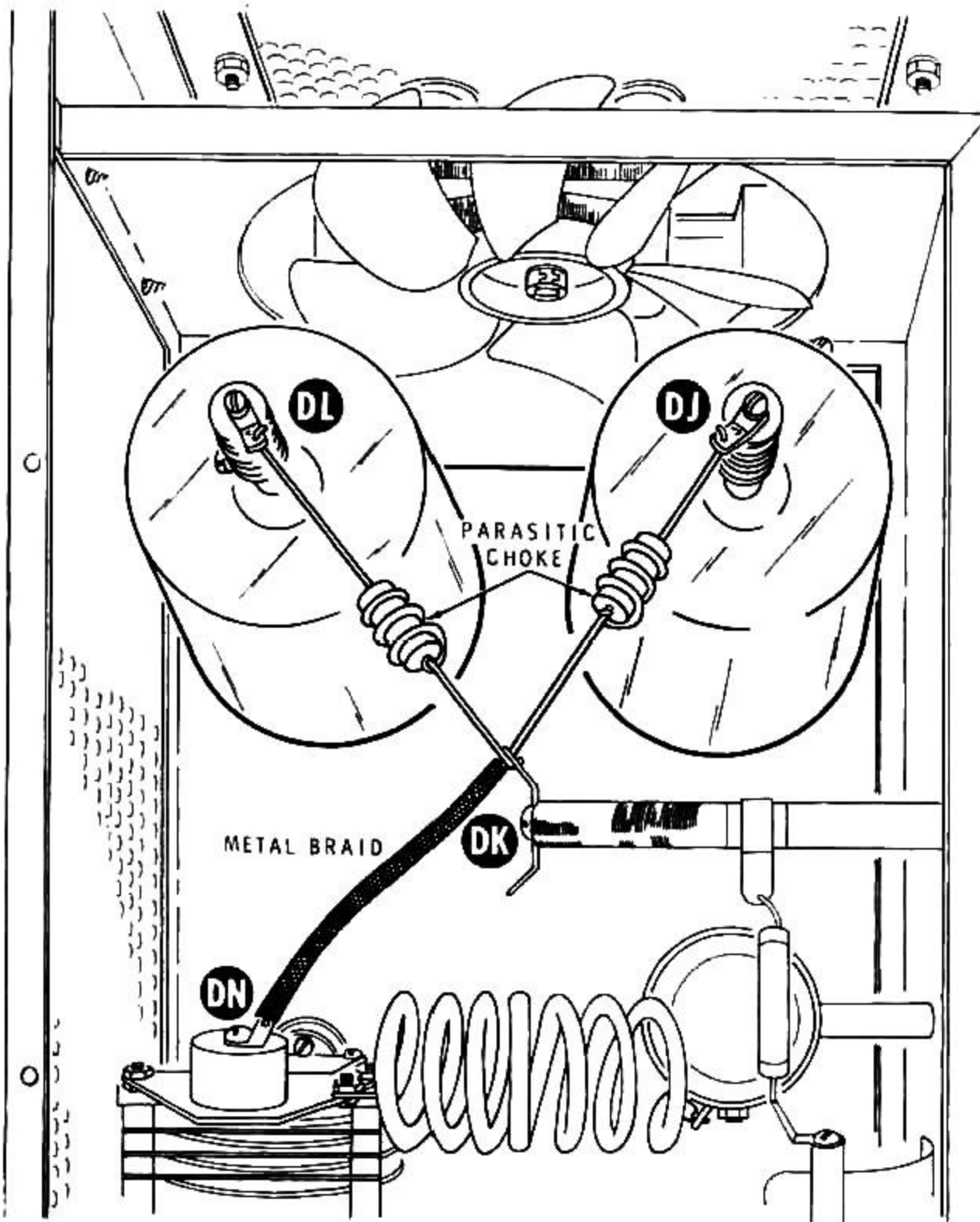
This amplifier can be operated from 120 or 240 volts, 50/60 Hertz, alternating current.

Make the proper connections on terminal strip AE for the supply voltage you will use. Refer to the inset drawing of Pictorial 4-14 and perform one of the following steps, depending on the line voltage to be used.

- () For 120 VAC operation, connect a bare wire between terminals 1 and 2 and another bare wire between terminals 3 and 4 of terminal strip AE.
- () For 240 VAC operation, connect a bare wire between terminals 2 and 3 of terminal strip AE.



PICTORIAL 4-20



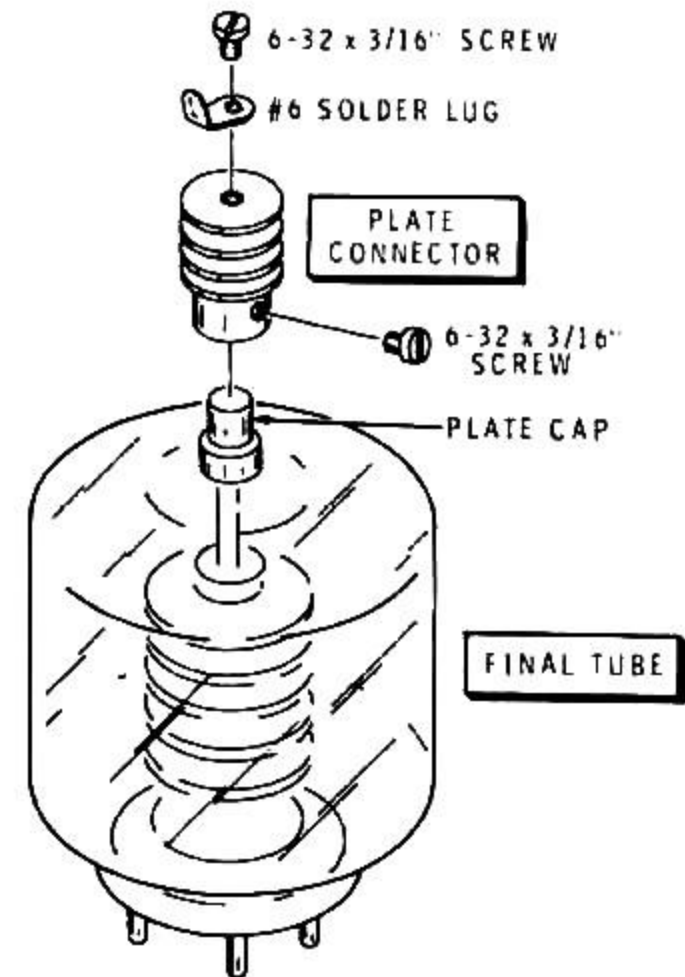
PICTORIAL 4-15

FINAL TOP-CHASSIS WIRING

Refer to Pictorial 4-15 for the following steps.

Refer to Detail 4-15A for the following three steps.

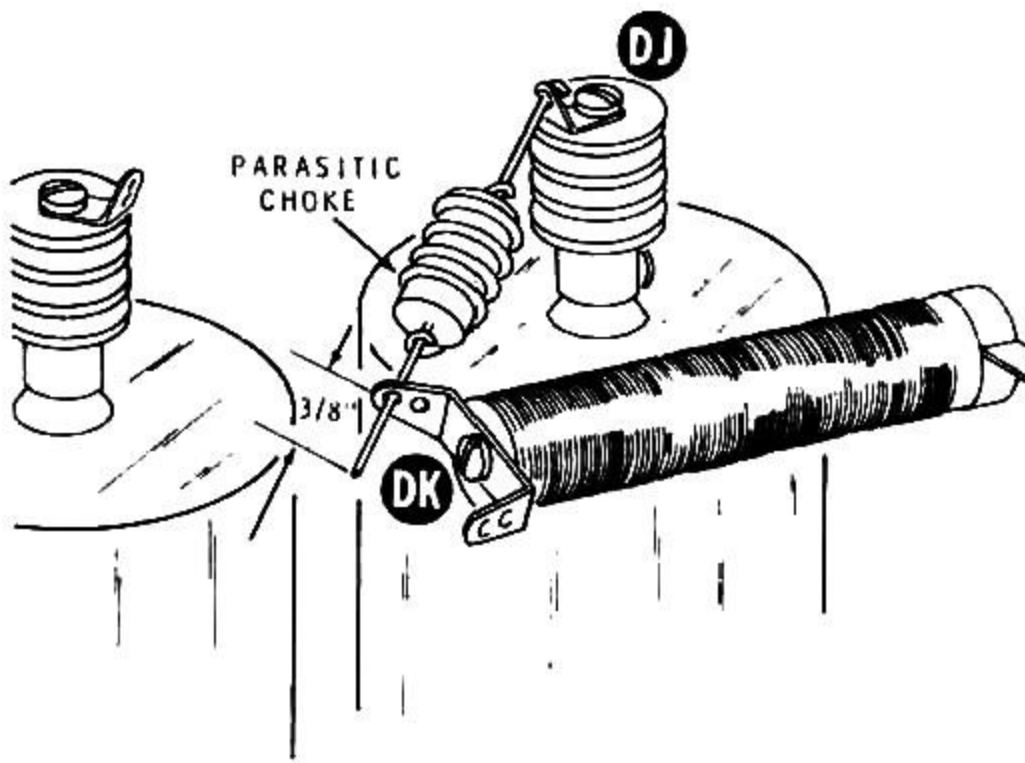
- () Install a #6 solder lug on the top end of each plate connector (#260-12). Use a 6-32 x 3/16" screw, but leave it loose.
- () Start a 6-32 x 3/16" screw into the side of each plate connector.



Detail 4-15A

- () Place each plate connector on the plate cap of a final tube (3-500Z) and tighten the screw on the side of each connector.

- () Place a final tube in each tube socket. **CAUTION:** Use extreme care when you install a final tube (3-500Z). Without rocking, gently push the tube into its socket. Too much pressure or lateral force (from rocking) may crack the glass beads around the socket pins, and damage the tube. Heath Company cannot be held responsible for any damage sustained through improper installation.

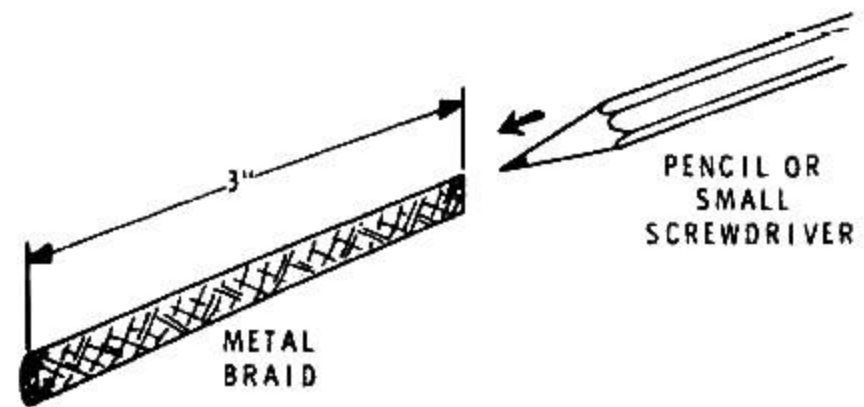


Detail 4-15B

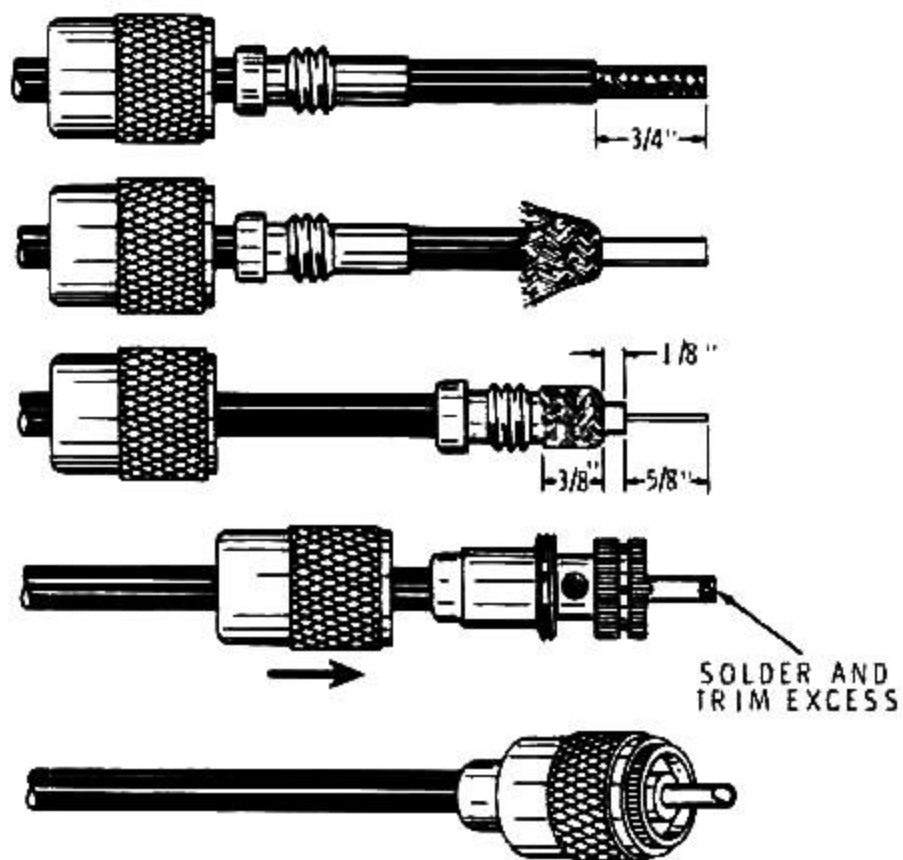
NOTE: When you install parasitic chokes in the following steps, center the chokes between the solder lugs.

- () Cut each lead of the two parasitic chokes (#45-53) to a length of 7/8".
- () Refer to Detail 4-15B and install a parasitic choke from solder lug DJ (S-1) to solder lug DK (NS). Note that the lead of the parasitic choke extends through solder lug DK for approximately 3/8". Leave this lead straight as shown in the Detail.

- () Install the other parasitic choke from solder lug DL (S-1) to solder lug DK (NS).
- () Tighten the screws in the tops of the two plate connectors.
- () Refer to Detail 4-15C and open up the ends of a 3" length of metal braid with a pencil. (Note that the metal braid is actually flattened tubular braid.) Push one end onto the 3/8" projecting end of the parasitic choke at DK (S-3). Push the other end over the solder lug on the capacitor at DN (S-1).



Detail 4-15C

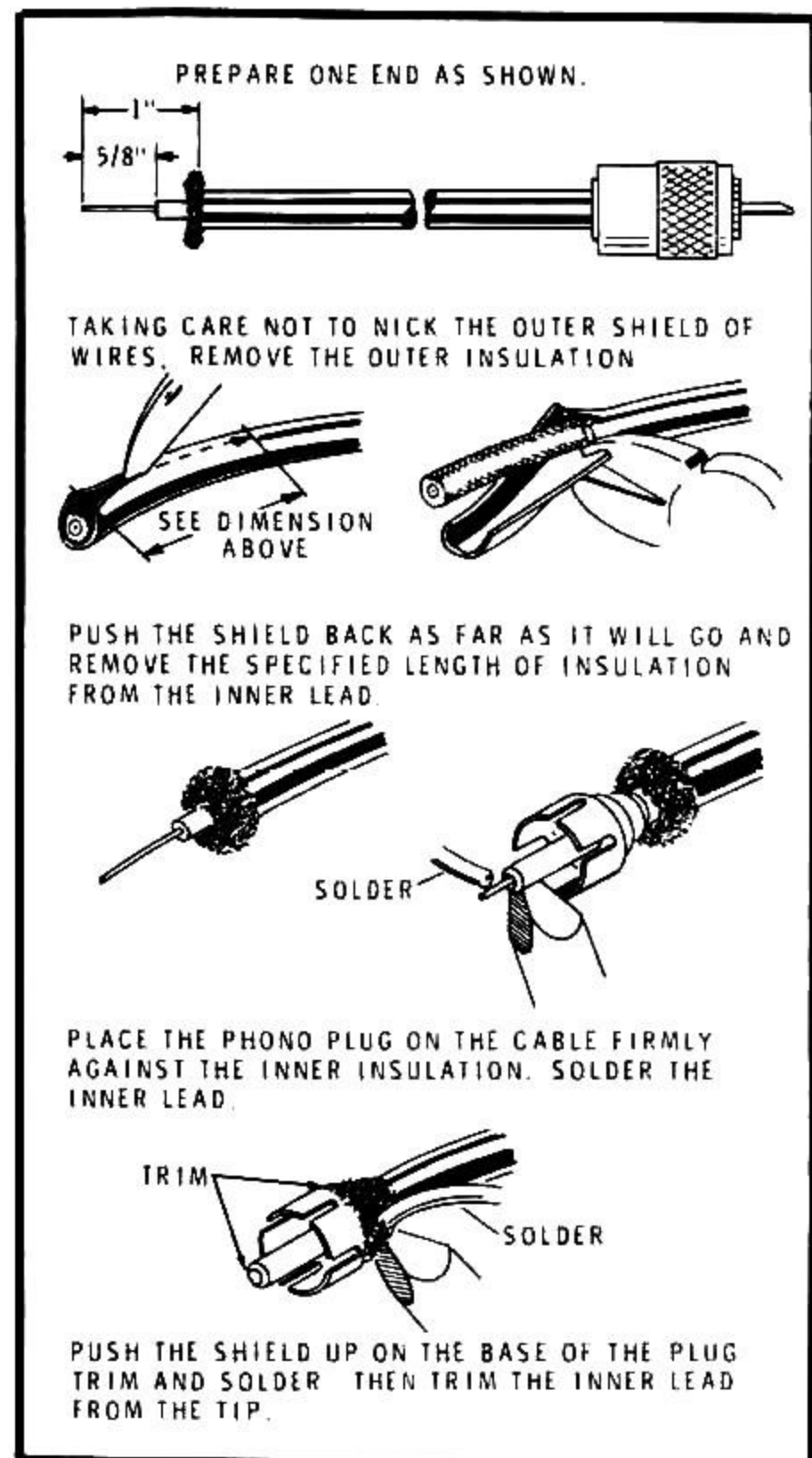


PICTORIAL 4-16

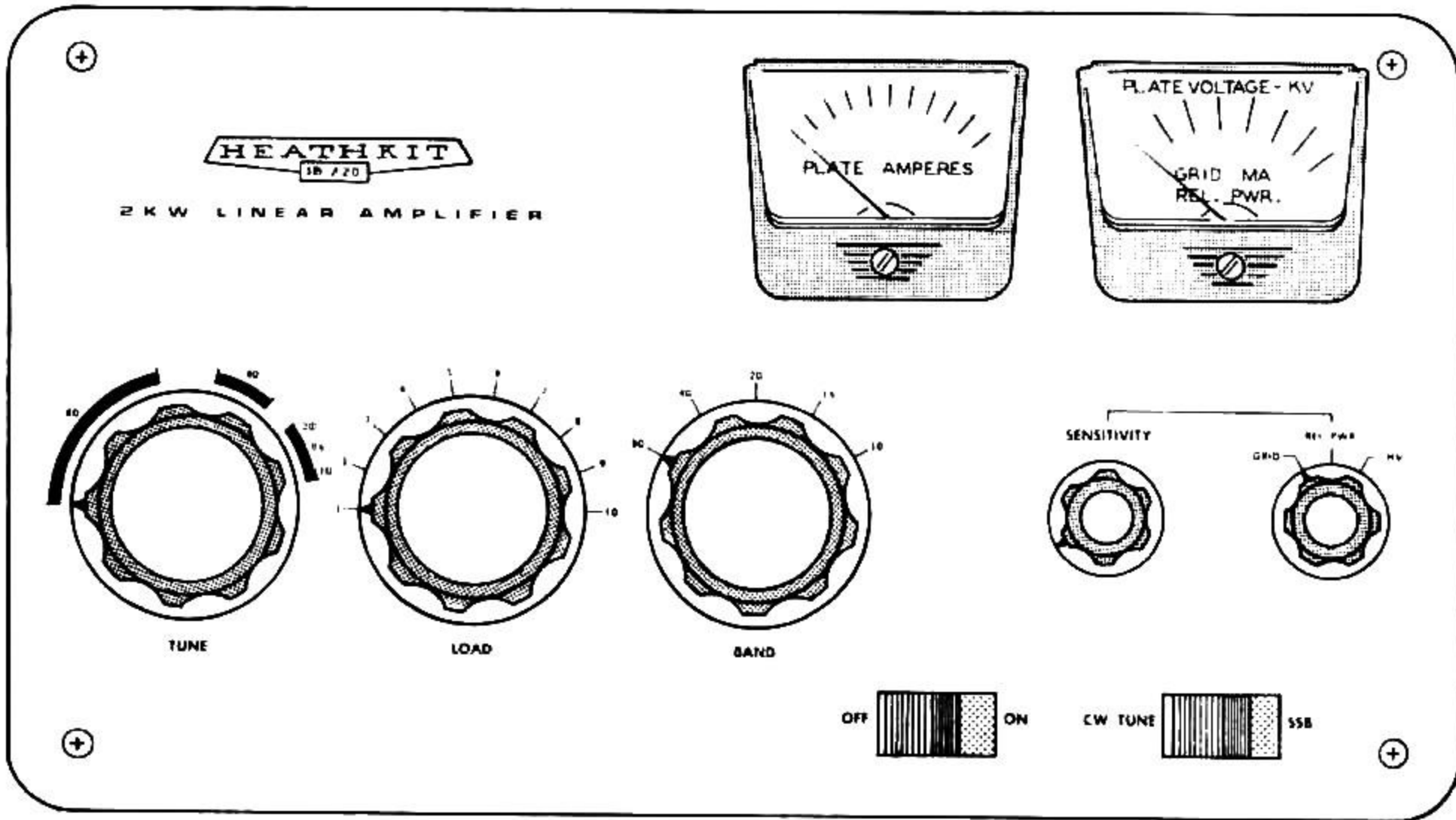
CABLE PREPARATION

- () Cut a length of RG-58A/U coaxial cable which will conveniently reach from the output of your exciter to the RF Input connector on the rear panel of the Amplifier (4' maximum recommended).
- () Refer to Pictorial 4-16 and install a coaxial plug (#438-9) and a coaxial plug insert (#438-12) on one end of the coaxial cable.
- () On the other end of the coaxial cable, install a connector (not furnished) which will mate with the output connector of your exciter. Refer to Pictorial 4-16 or Pictorial 4-17, as appropriate.

Lay the cable aside for use later.



PICTORIAL 4-17



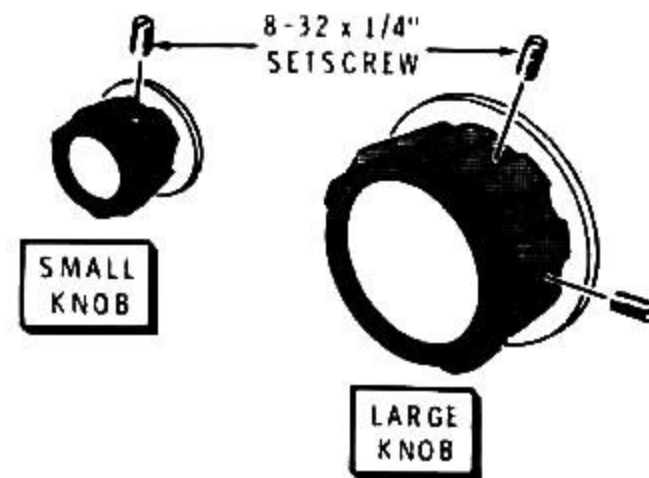
PICTORIAL 4-18

KNOB INSTALLATION

Refer to Pictorial 4-18 for the following steps.

- () Refer to Detail 4-18A and start two 8-32 x 1/4" setscrews into each of the three large knobs. Start a single setscrew into each of the two small knobs.
- () Turn the shafts of the Tune and Load capacitors so the plates of each are fully meshed.
- () Turn the three other shafts fully counterclockwise.
- () Install the knobs on the shafts so the index marks are positioned as shown in the Pictorial, and tighten the setscrews.

Proceed to "Test and Final Assembly."



Detail 4-18A

TEST AND FINAL ASSEMBLY

The input coils are factory adjusted and do not require any further alignment.

The brass spring and the metal spacer form a safety "interlock" which grounds the high voltage power supply and removes the high voltage from points which are exposed when the perforated cover is removed.

Refer to the chassis photographs for the location of the interlock and the resistance test points.

RESISTANCE CHECK

- () **IMPORTANT:** Refer to Figure 1, push down the brass spring of the interlock, and temporarily insert a rubber foot between the brass spring and the metal spacer. If you fail to do this, the high voltage circuit will be short-circuited, you will be unable to obtain a plate connector resistance reading, and damage will result if power is applied.
- () The resistance between the plate connectors and the chassis should measure approximately $200\text{ k}\Omega$ after the meter stabilizes.
- () The resistance between lug 3 of each tube socket and the chassis (Pictorial 4-14) should measure approximately $20\ \Omega$.

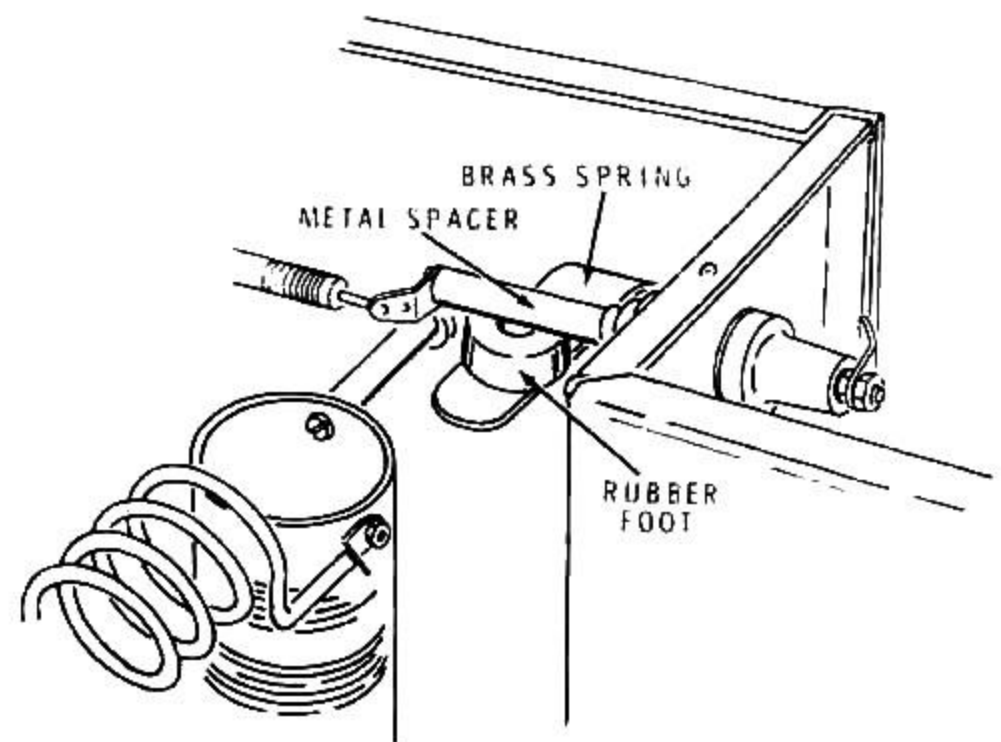
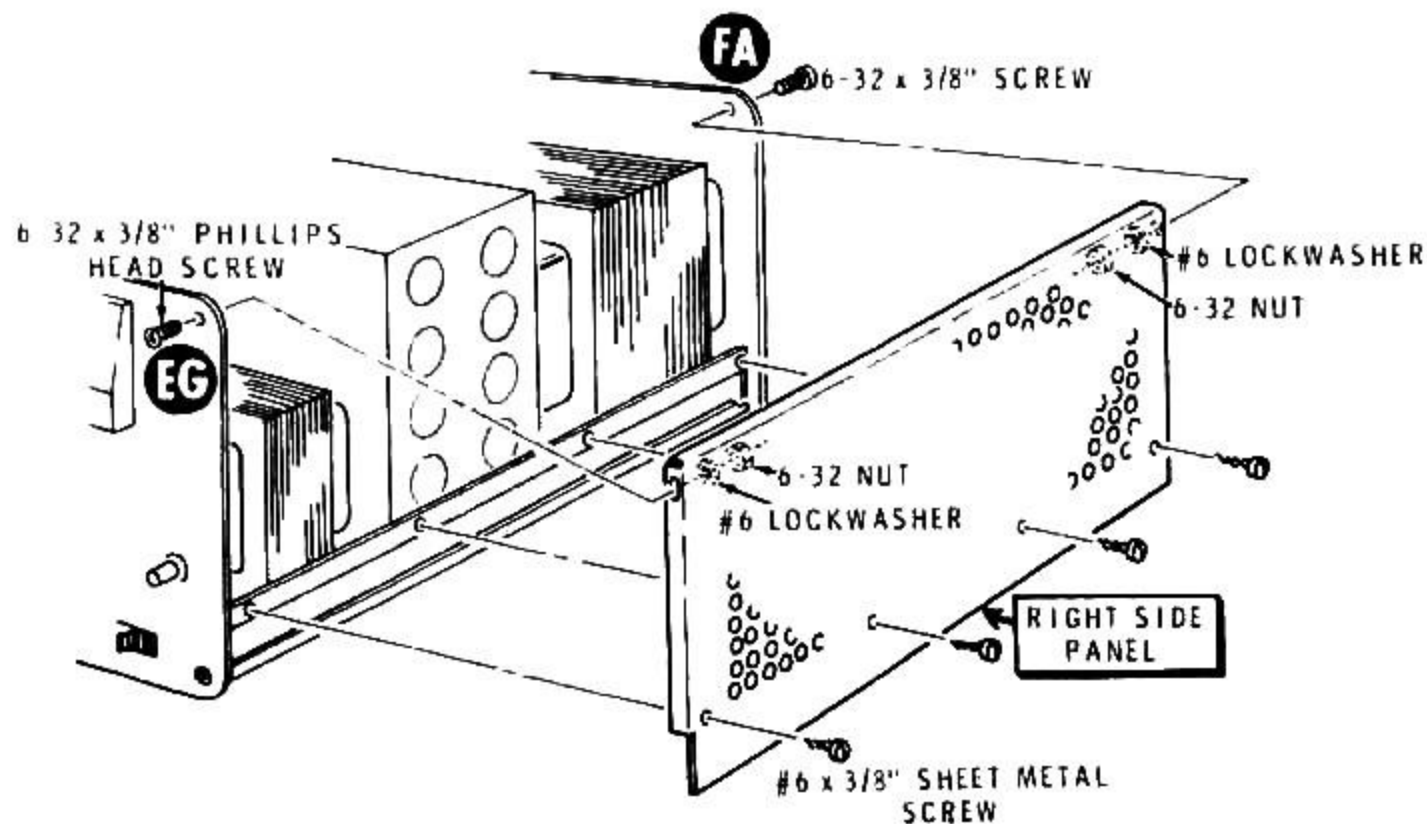


Figure 1

If any difficulty is encountered in obtaining either of these resistance readings, refer to the "In Case of Difficulty" section of the Manual on Page 75.

- () Remove the rubber foot from the interlock.



Detail 4-19A

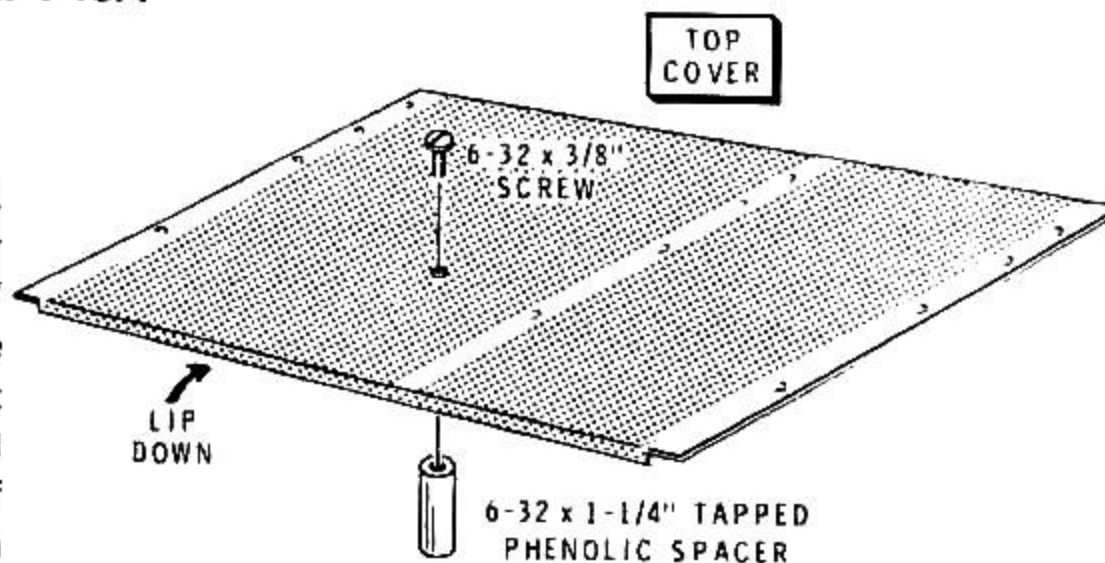
Refer to Pictorial 4-19 for the following steps.

() Refer to Detail 4-19A and install the right side panel. Use #6 x 3/8" sheet metal screws along the lower edge, 6-32 x 3/8" hardware at FA, and 6-32 x 3/8" phillips head hardware at EG. CAUTION: After the panel is installed, check to make sure there is at least 1/4" clearance between the point of the sheet metal screw and any connections to the positive (+) lug of filter capacitor #7. (See Pictorial 4-7, fold-out from Page 43.)

() As shown in the Pictorial, place the perforated top cover (#205-724) on the top of the Amplifier with the lip against the front panel pointing down. Align the mounting screw holes. Then mark the hole in the cover which is directly over that portion of the brass spring which protrudes beyond the metal spacer.

() Refer to Detail 4-19B and install a 6-32 x 1-1/4" tapped phenolic spacer (#255-39) on the underside of the perforated cover at the marked hole. Use a 6-32 x 3/8" screw.

() Install the perforated top cover and the top rear plate cover (#205-723) on the top of the amplifier. Use #6 x 3/8" sheet metal screws. First, install a screw near each corner of the top cover and then check visually to make sure that the phenolic spacer on the underside of the top cover pushes the interlock spring down away from the metal spacer mounted on the feedthrough insulator. Any required repositioning of the phenolic spacer should be accomplished before completing the top cover installation. Then install the rest of the sheet metal screws.



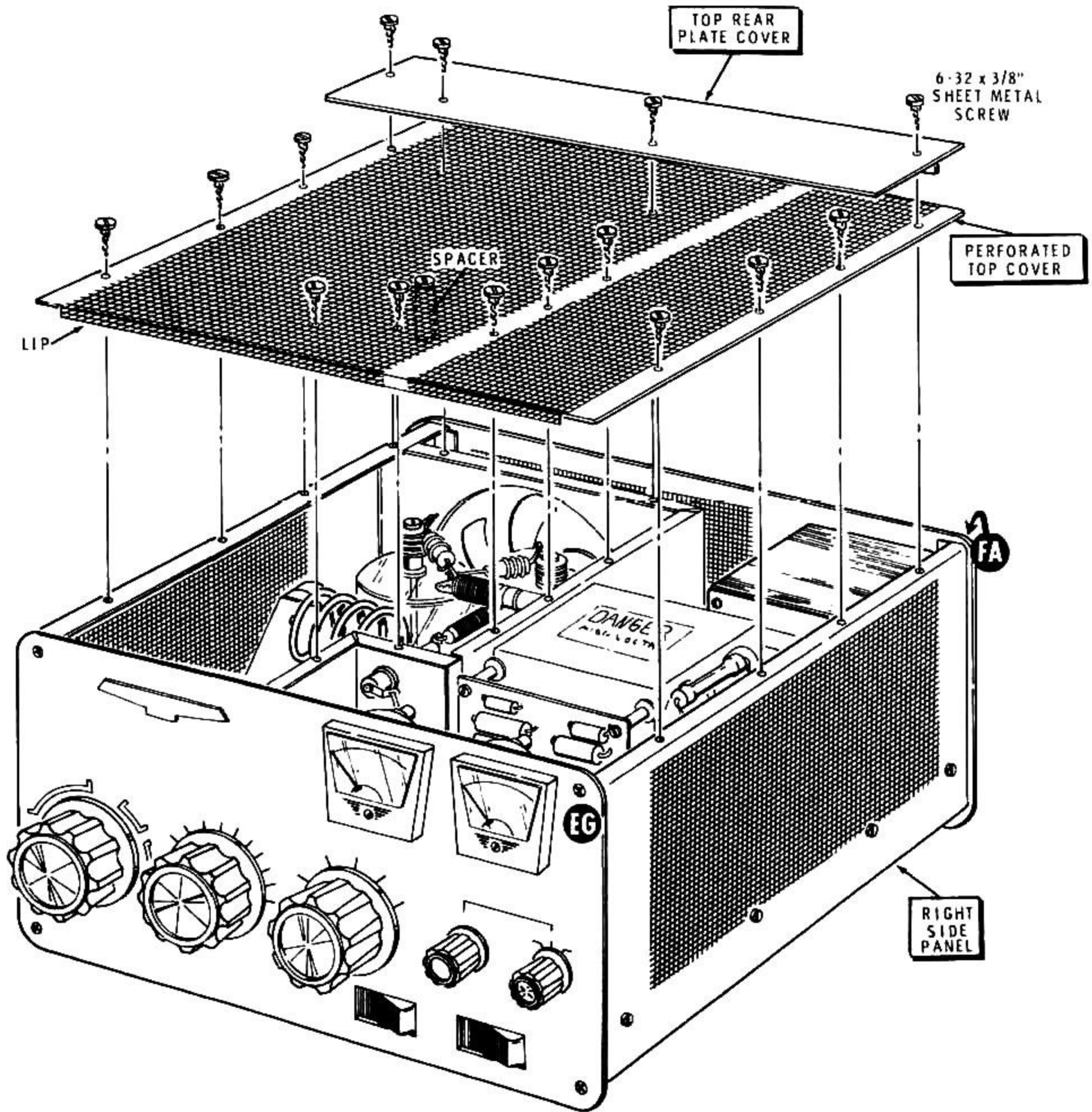
Detail 4-19B

() If necessary, adjust each meter pointer to "0" with the meter adjusting screw (see Figure 3-1 fold-out from Page 68).

NOTE: If at any time during the testing and operation the Linear Amplifier does not perform as described, unplug the Linear Amplifier line cord and refer to the "In Case of Difficulty" section of the Manual.

Position the switches and controls as follows:	
TUNE	9 o'clock
LOAD	9 o'clock
BAND	Any
SENSITIVITY	12 o'clock
METER SWITCH	HV
POWER SWITCH	OFF
MODE SWITCH	CW/TUNE

() Plug the line cord into the power source for which the unit is wired, either 120 volts or 240 volts AC.



PICTORIAL 4-19

CAUTION: LETHAL VOLTAGES ARE PRESENT IN THIS UNIT. USE EXTREME CARE WHEN MAKING ANY TESTS.

- () Push the POWER switch to ON.
- () Check to see that the tube filaments and meter pilot lamps light, and that the fan operates. The right-hand meter should read approximately 2500 volts.
- () Push the MODE switch to SSB. The meter should read approximately 3000 volts.

NOTE: There should be no indication on either panel meter except when the METER SWITCH is at the HV position.

- () Push the POWER switch to OFF and unplug the line cord.



NOTE: Read through the following steps and decide whether you want your amplifier to sit level, or whether you wish the front of the chassis elevated. Then select the feet and mounting hardware so the parts will be immediately available as you install the cabinet. The screws for the mounting feet will be inserted through the four holes in the cabinet bottom and screwed into the captive nuts in the flange of the chassis.

Refer to Pictorial 4-20 (fold-out from Page 56) for the following steps.

- () Place a book on a flat surface and balance the amplifier chassis on the book, front panel uppermost.
- () Lower the cabinet onto the chassis so the captive nuts in the chassis bottom flange are aligned with the four holes in the cabinet.

Perform only one of the following two steps, depending upon how you wish the amplifier cabinet positioned.

- () If you wish to have the amplifier cabinet sit level, install a rubber foot at each corner of the cabinet. Use 6-32 x 11/16" screws.

- () If you wish the front of the cabinet to be elevated, install a rubber foot on each rear corner with 6-32 x 11/16" screws. Then, install a tapered spacer and a rubber foot at each front corner of the cabinet with 6-32 x 1-1/2" screws.

NOTE: The blue and white identification label shows the Model Number of your kit. Refer to these numbers in any communications with the Heath Company.

- () Install the identification label in the following manner.
 1. Select a location for the label where it can easily be seen when needed, but will not show when the unit is in operation, such as on the rear panel (see the inset drawing in Pictorial 4-20).
 2. Carefully peel away the backing paper. Then press the label into position. You will avoid smearing the numbers on the label if you will put the piece of waxed backing paper on top of the label and then rub on it instead of directly on the label.

This completes the assembly of your Linear Amplifier. Proceed to "Installation."

INSTALLATION

LOCATION

The amplifier should not be operated in excessively warm locations or near heating vents or radiators. Free air circulation around and through the amplifier cabinet, and an unobstructed air inlet for the blower should be provided. No books, magazines, or equipment should be placed on top of the cabinet to impede the free flow of air.

POWER CONSIDERATIONS

Because of the power involved, this Amplifier should preferably be served by its own 240 VAC electric service line, having three 12 gauge conductors and fused in each "hot" wire for 10 amperes. However, if a single 240 VAC line must serve the entire station, make an effort to connect your equipment so the load will be balanced between the two "hot" wires as nearly as possible.

If only 120 VAC can be provided, use a separate line having 10 gauge conductors and 20 ampere fuses.

DO NOT use this Amplifier at its full ratings on a regular house wiring circuit, as the ratings of the wire will almost certainly be exceeded.

Avoid excessively long runs of wire from your service entrance. A heavy flow of current in such a line results in a voltage drop which can affect the performance of your equipment.

The plug on the power cord for this kit is for standard 120 VAC outlets. For 240 VAC operation in the U.S.A., cut off and replace this plug with a permanent plug that matches your 240 VAC receptacle in a manner such that your power connection conforms with section 210-21 (b) of the National Electric Code, which reads, in part:

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

When you install the new plug, make sure it is connected according to your local electrical code. Keep in mind that the green line cord wire is connected to the amplifier chassis.

For your convenience in identifying conductors, one edge of the heavy line cord is beaded. The other edge is smooth.

ANTENNA

The output circuit of the Amplifier is designed for connection to an unbalanced transmission line of 50 Ω characteristic impedance. Lines of other characteristic impedance may be used providing the SWR (standing wave ratio) does not exceed 2:1.

The antenna connector is a UHF type SO-239. A mating PL-259 plug is furnished for your transmission line. See "Equipment Interconnections" for information on how to install this plug.

Coaxial cables RG-8/U, RG-11/U, or similar types, should be used for the transmission line. The smaller types RG-58/U and RG-59/U are not recommended because of the power level.

The "A.R.R.L. Antenna Book" is commonly available and includes comprehensive reference work on transmission lines and antennas. Other similar handbooks for the amateur are offered for sale and can often be found in a public library.

GROUNDING

A good earth or water pipe ground should be connected to the ground post on the rear apron of the Amplifier. Use the heaviest and shortest connection possible.

Before using a water pipe ground, inspect the connections around your water meter and make sure that no plastic or rubber hose connections are used which interrupt electrical continuity to the water supply line. Install a jumper around any insulating water connectors found. Use heavy copper wire and pipe clamps. It is best to ground all equipment to one point at the operating position and then ground this point as discussed above.

EQUIPMENT INTERCONNECTIONS

Interconnections between this Amplifier and other Heath equipment are shown in the Figure 2 series of illustrations. Other makes of equipment will usually follow the same general pattern.

CABLES FURNISHED

Two phono cables are furnished. These are shielded cables which have a phono plug molded at each end. Use one cable to connect the amplifier ALC output to the exciter ALC input. Use the second cable to connect the amplifier antenna relay socket to the exciter antenna relay socket.

An RG-58A/U coaxial cable was made up earlier. This cable is used to connect the exciter RF output to the amplifier RF input.

Antenna Relay

OPERATION

The antenna relay circuit in the Amplifier must be grounded in the transmit mode. Heath exciters contain a provision to accomplish this action. If a relay terminal, or other

switching provision is not available, this function must be provided by other means. If a separate coaxial send-receive relay is used in your station, it may have external contacts available. A separate switch can also be used.

HEATH TRANSCEIVERS WITH 11-PIN POWER PLUGS

If you will use your Amplifier with a Heath transceiver which has an 11-pin power plug on the rear panel, refer to Pictorial 5 and perform the following steps to accomplish the Antenna Relay connection.

However, if you have previously changed the interior wiring of the transceiver to use one of the spare phono sockets to bring out the exterior antenna relay connection, disregard the following steps and proceed to the "Operations" section.

- () Cut off and discard the phono plug from one end only of one of the phono cables furnished.
- () Remove 3/4" of the gray outer insulation of the cable.
- () Unwind the shield wires from the inner insulation. Then twist the shield wires tightly together and melt a small amount of solder on the ends of the wires.
- () Remove 1/4" of insulation from the inner conductor, twist the exposed bare wires tightly, and melt a small amount of solder on the wire ends.
- () Remove the transceiver power cable socket cap and slide it back on the power cable. Then push the prepared end of the phono cable through the socket cap as shown in the Pictorial.

NOTE: When soldering the power socket in the following steps, be very careful that you do not get the hot soldering iron against the clear sleeving already installed on the adjacent lugs.

- () Connect the center conductor of the phono cable to lug 11 (S-1), and the shield wires to lug 5 (S-1) of the power socket.
- () Snap the power socket cap back into place.

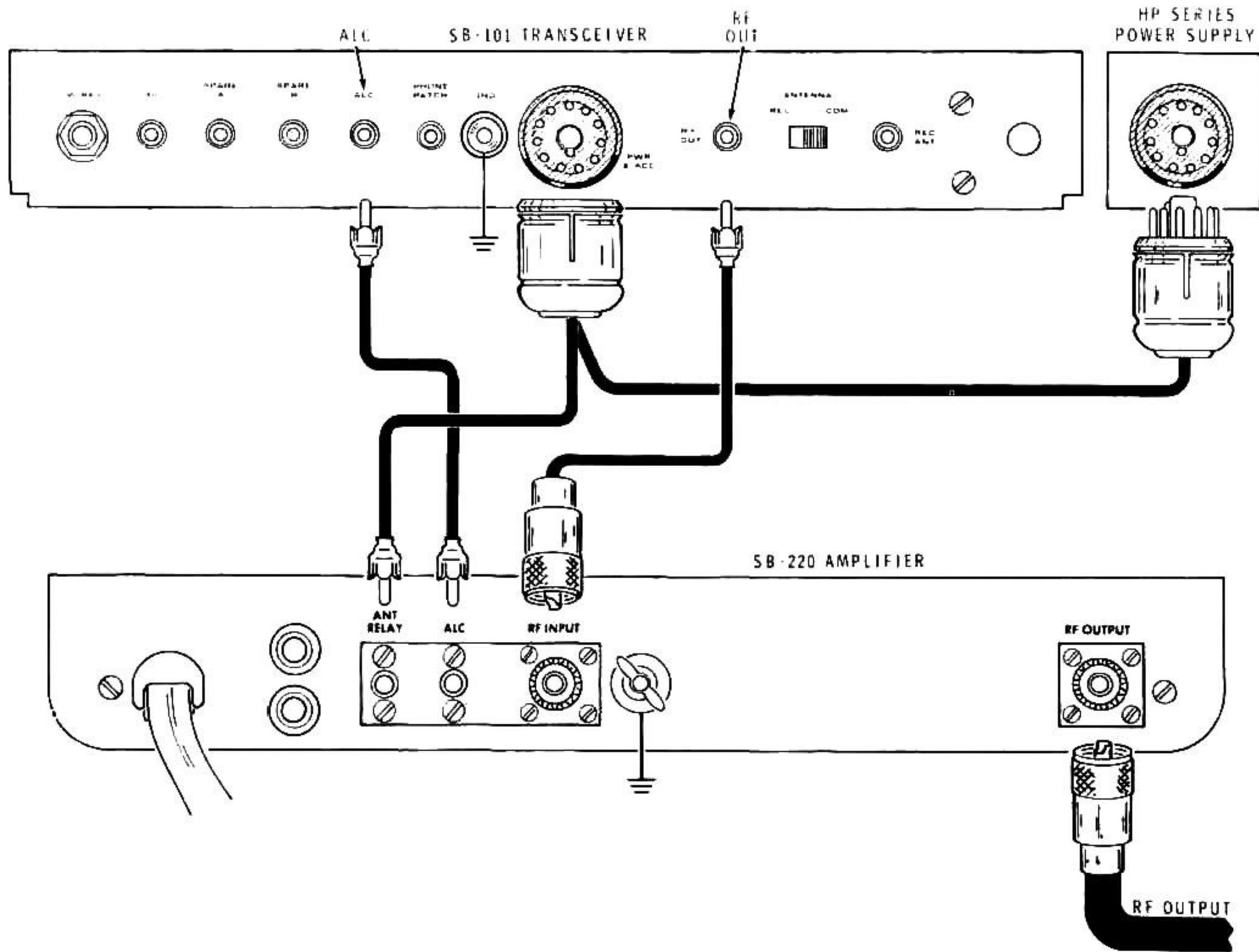
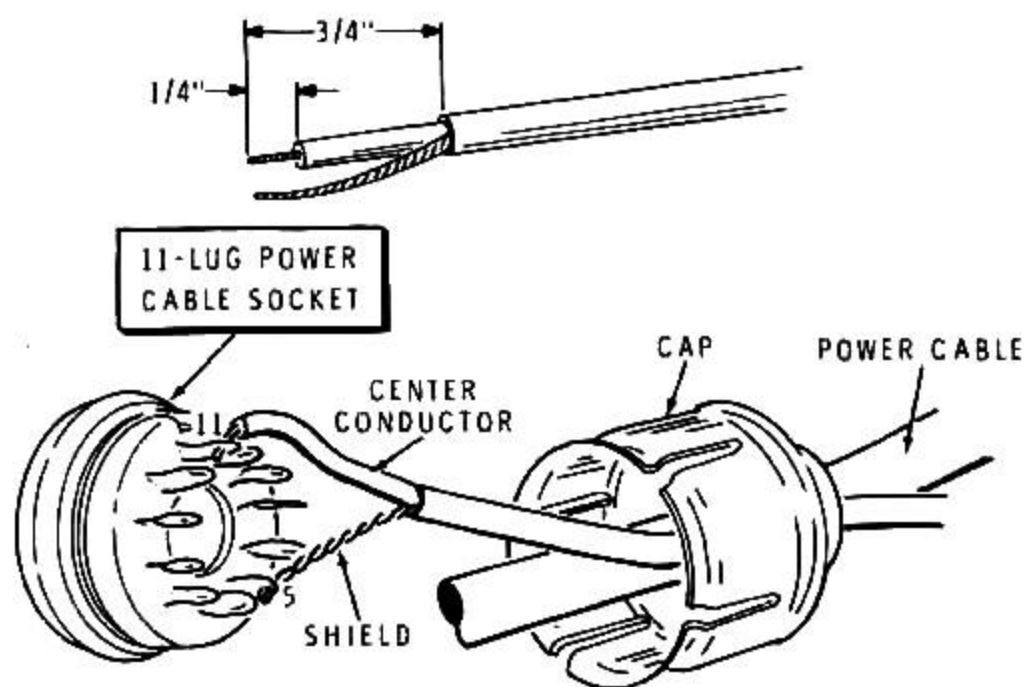


Figure 2-1



PICTORIAL 5

OPERATION

CONTROLS, CONNECTORS, AND METERS

Refer to Figure 3-1 (fold-out from Page 68) for identification of the front panel controls and a concise description of the functions of each.

Refer to Figure 3-2 for rear panel connections.

READING THE METER

Refer to Figure 3-3 for illustrations of the two panel meters.

Plate Meter

The Plate Meter is calibrated from 0 to 1 ampere. Note that by adding the proper number of zeros and dropping the decimal point, each scale number may be read as milliamperes. Thus .5 amperes would become 500 milliamperes.

Multi-Meter

Read the Multi-Meter scale which corresponds to the setting of the METER SWITCH:

METER SWITCH POSITION	MEASURES	SCALE READING
GRID	Grid current	0-350 milliamperes (lower scale)
REL PWR	Relative power output	0-350 (lower scale) (Adjust needle deflection to full scale with SENSITIVITY control after tune-up)
HV	High voltage	0-3.5 kilovolts (upper scale)

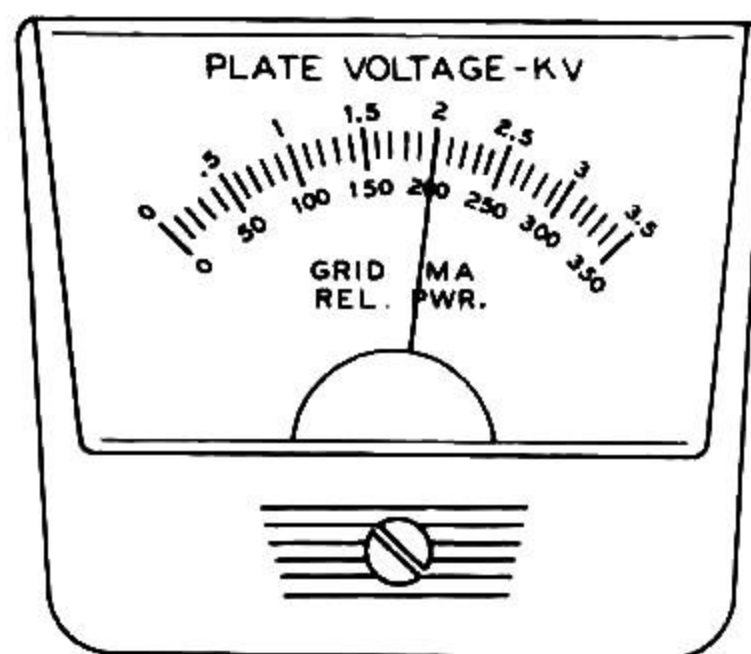
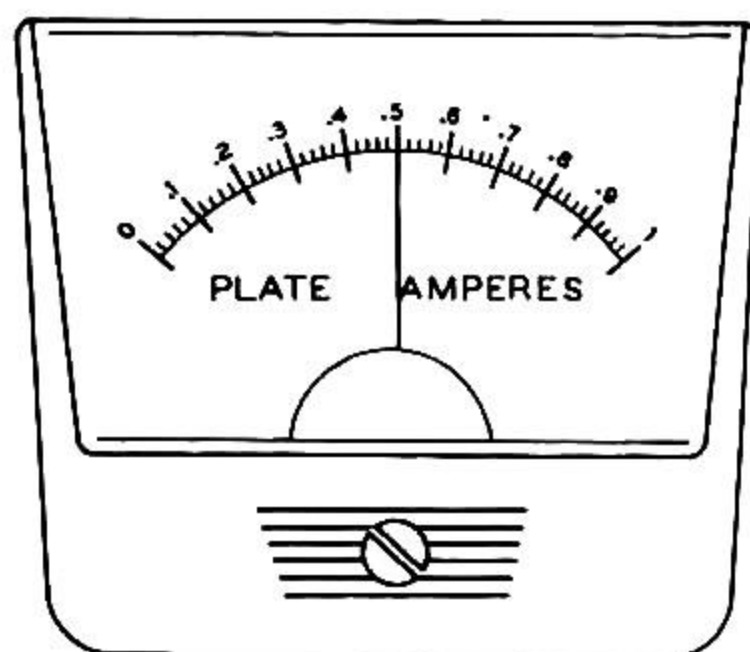


Figure 3-3

GENERAL

SAFETY INTERLOCK

Refer to the Chassis Photograph (Page 87) for the location of the interlock. When the amplifier top cover is in place, the insulator on the underside of the cover opens the interlock, and the high voltage circuit is operational. When the top cover is removed, the interlock closes and connects the high voltage circuit to chassis. This connection will discharge the filter capacitor bank and eliminate a shock hazard.

WARNING: *If the Amplifier is turned ON when the amplifier cover is removed, the high voltage power supply will be short circuited and may be damaged. If this occurs, DO NOT touch any part of the high voltage supply with your hands until all possible high voltage points have been checked with a separate voltmeter.*

CIRCUIT BREAKERS

Push in the red buttons on the two circuit breakers and note their position. When a circuit breaker opens, the red buttons will protrude farther and will be easily noticed.

If one or both circuit breakers open during operation of the Amplifier, turn the amplifier POWER switch OFF; then push the red buttons in to their former position, wait a few seconds, and push the POWER switch to ON. If the breakers will not stay closed, push the POWER switch OFF and locate the reason for the overload.

TUBES

The Amplifier uses "instant heating" type tubes. Therefore, after tune-up, you can use the Amplifier immediately after it is turned on.

It is not abnormal for the tube plates to show a dull red color. If the plates show a bright orange or yellow color, tuning and drive conditions should be investigated immediately, and necessary corrections should be made.

After prolonged usage, let the Amplifier run for several minutes without excitation, so the fan will cool the tubes before the Amplifier is turned off.

DC INPUT POWER

In grounded grid amplifier operation, a considerable portion of the driving power is fed through the amplifier tube. The Amplifier output is the approximate sum of the driver output and the power added by the Amplifier. Both the driver and amplifier input powers must therefore be considered when calculating DC input power.

DRIVING POWER

This Amplifier is designed to operate at full ratings (see Specifications) when driven by an exciter delivering approximately 100 watts of RF output. An exciter of lower power output may be used as a driver, but the Amplifier's output will be less. If you use an exciter that delivers more than 100 watts, carefully adjust the driving power to avoid "over-drive" and the creation of spurious signals which create needless interference to others. The use of the Heathkit Model 610 Monitor Scope is highly recommended for continuous output monitoring. The display on an oscilloscope is the best readily available way of determining the amplitude of the voice peaks which, if excessive, can cause "flat topping" and the radiation of distortion products.

IMPORTANT: In no case should the MIC/CW Level of your exciter be advanced beyond the point where the Amplifier REL. PWR. indication ceases to increase. If the level control is turned past this point, nonlinear operation may be produced.

ALC (Automatic Level Control)

When the Amplifier is overdriven, the ALC circuitry creates a negative voltage which is fed back to the exciter to reduce its gain and help prevent "flat topping."

Protective circuitry of this nature is a valuable circuit element, but it is not a substitute for proper adjustment of the exciter drive.

TUNE-UP

The current and voltage figures given in this section are approximations. Actual readings will vary at each installation with such factors as line voltage, exciter drive, and load impedance.

The following procedure for tuning the Amplifier should take only a few seconds after you go through it a few times. Note the LOAD control position so it can be preset the next time a particular band is used.

CW AND RTTY PROCEDURE

Make sure the Amplifier has been installed as described and illustrated in the "Installation" section. **IMPORTANT:** Before proceeding, make sure you have a dummy load (such as the Heathkit Antenna) or an appropriate antenna connected to the Amplifier output.

() Set the Amplifier controls as follows:

SWITCH OR CONTROL	POSITION	COMMENTS
TUNE	Desired band segment	
LOAD	1 (80 and 40 bands) 4 (20, 15, and 10 bands)	After tune-up, note position so control can be preset in the future.
BAND	Desired band	
SENSITIVITY	12 o'clock	Keep needle on scale with SENSITIVITY control. After tune-up, adjust as desired.
METER	REL. PWR.	
POWER	OFF	
MODE	CW/TUNE	

- () Tune your exciter for full CW output at the desired frequency. The MULTI-METER on the Amplifier, when switched to indicate REL. PWR., will show the relative power output of the exciter and may be used even though the Amplifier is off.
- () Reduce the exciter output to 0 by placing its controls in the receive mode; also turn its MIC/CW Level control fully counterclockwise.
- () Turn the Amplifier on.
- () Place the exciter in the tune mode. The amplifier plate meter should read approximately .12 ampere resting plate current. Then advance the Level control until the PLATE METER shows .3 ampere.
- () Peak (adjust) the amplifier TUNE and LOAD controls for maximum REL. PWR. meter indication.
- () Advance the drive to .4 ampere plate current and repeak the TUNE and LOAD controls. The Meter readings should then be approximately:

Plate amperes = .35
 High voltage = 2100
 Grid mA = 110

- () Alternately adjust the TUNE, LOAD, and exciter drive controls for the desired input. Refer to Figure 3-4. The meter readings at 1 kw input will be approximately:

Plate amperes = .5
 High voltage = 2000
 Grid mA = 100-200

- () Advance the SENSITIVITY control for the desired REL. PWR. meter reading.

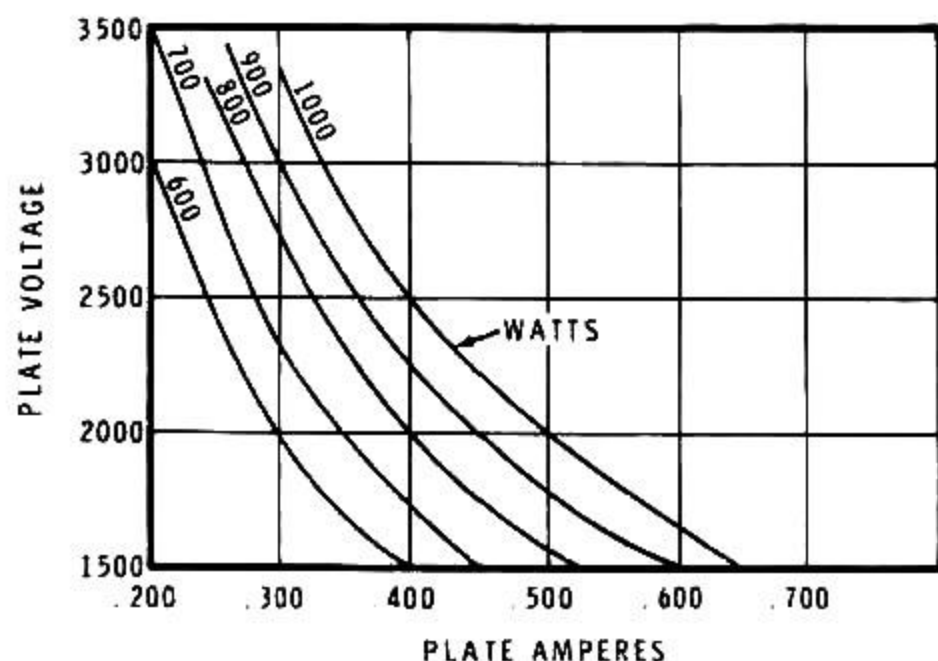


Figure 3-4

- () Turn the exciter Mode switch to Standby or the desired transmission mode.

The Linear Amplifier is now loaded for operation on CW or RTTY. If an oscilloscope is being used for monitoring, a display similar to that shown in Figure 3-5 should be obtained. If you have a Heathkit Model 610 Monitor Scope, you may find that its optional trapezoid display pattern is more easily interpreted for voice patterns.

CAUTION: While actually transmitting, DO NOT switch between CW/TUNE and SSB modes.

SSB PROCEDURE

- () Tune up the exciter and Amplifier as for CW operation. NOTE: In the absence of the recommended oscilloscope monitor, either the PLATE METER or the REL. PWR. indication can be used to monitor SSB transmission. The PLATE METER indications are easier to follow.

Low Power SSB

- () For 1000 watts P.E.P. operation, switch the exciter only to the SSB mode. Leave the amplifier MODE switch at CW/TUNE.
- () Adjust the exciter drive control so the PLATE METER will indicate between .12 and .2 ampere with average speech. Hard voice peaks should not exceed .250 ampere.

High Power SSB

- () For 2000 watts P.E.P. operation, switch both the exciter and the amplifier MODE switch to SSB.
- () Advance the exciter drive level until the PLATE METER reads from .2 to .3 ampere with average speech and no higher than .33 ampere on hard voice peaks. A higher drive level will cause "flat topping."

An example of a proper SSB oscilloscope pattern is shown in Figure 3-6. Note that there are sharp, distinct peaks. The number of patterns or "christmas trees" will depend upon the operator's voice characteristics and the scope sweep speed. Set the scope for approximately 30 Hz sweep.

Note that the meter reading on voice peaks will not be high, due to meter inertia and voice characteristics; however, the height of the oscilloscope pattern is greater than that shown in Figure 3-5.

Figure 3-7 shows the same voice pattern but with extreme "flat topping." The oscilloscope shows that no more useful power is being developed. When the drive level is too high the meter reads higher, but only distortion is developed.

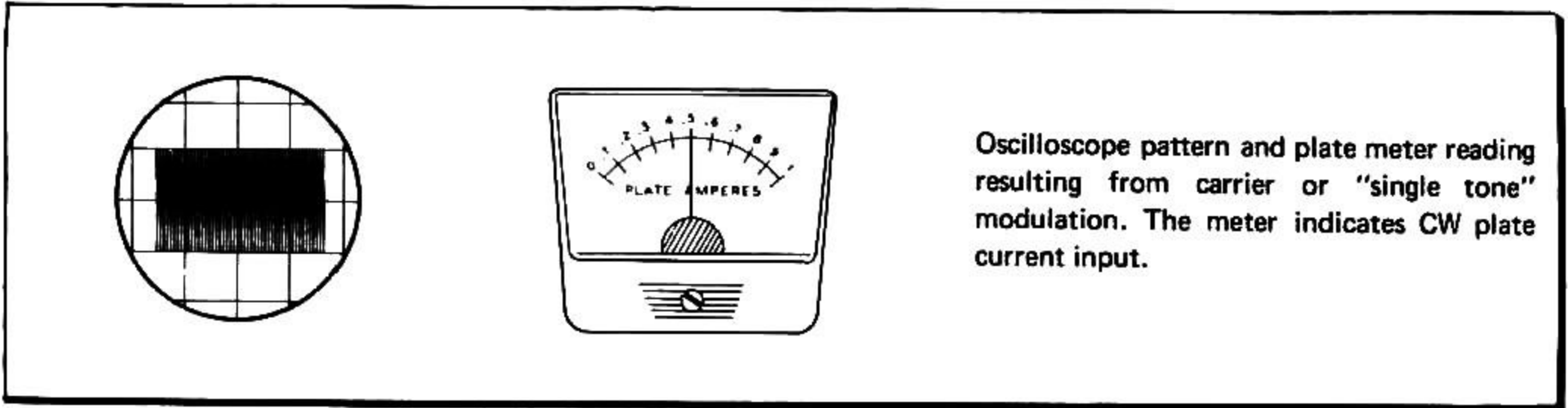


Figure 3-5

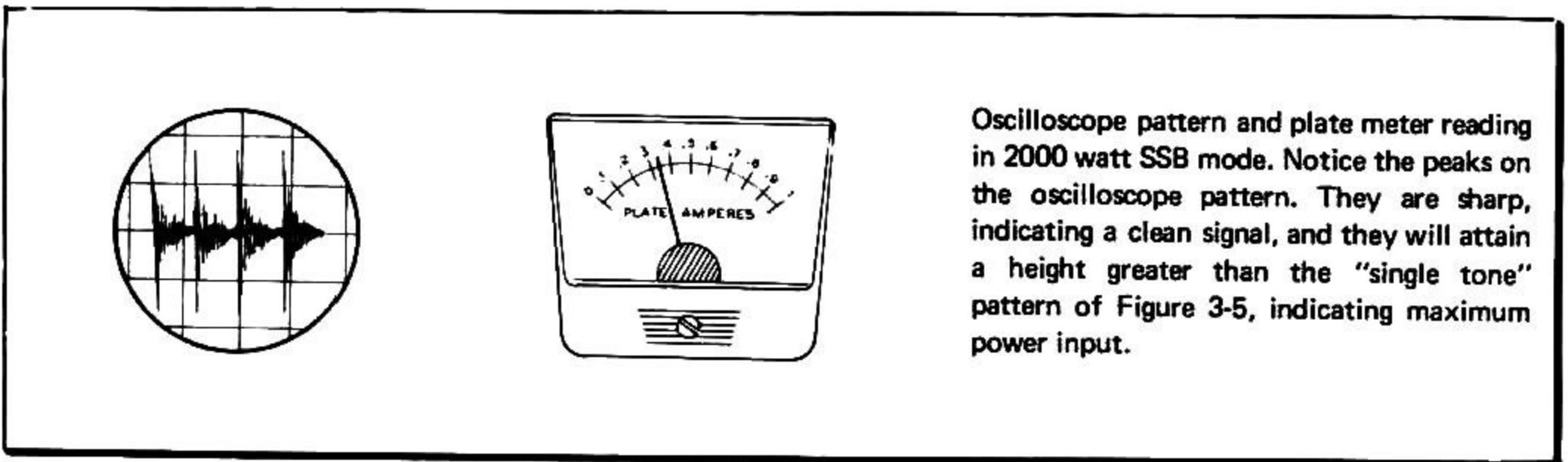


Figure 3-6

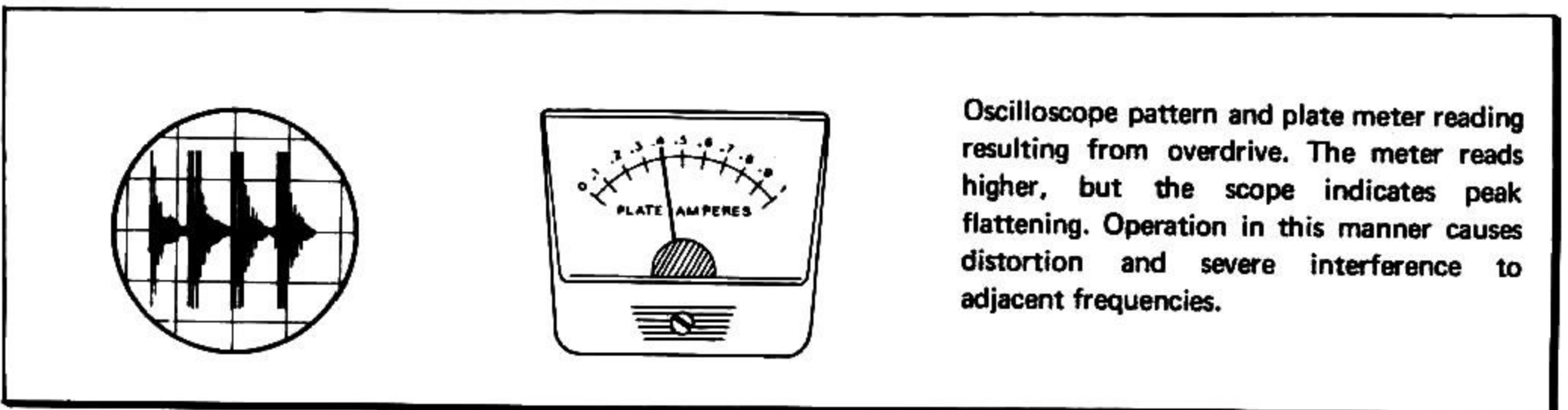


Figure 3-7

PERIODIC MAINTENANCE

Remove the top cover of the Amplifier and remove the dust at least once a year. This can be done by using the blower connection on a vacuum cleaner, or by a soft bristle brush.

While the top cover is removed, add one drop of light machine oil to each fan bearing.

IN CASE OF DIFFICULTY

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

NOTE: Operating the Amplifier outside the specified power or frequency range (or both) may damage components. Such damage is not covered by the Heath warranty.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. The majority of the kits that are returned for repair, do not function properly due to poor connections and soldering. Many troubles can be eliminated by carefully reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of the "Kit Builders Guide."
3. Make sure that the tubes light up properly. If they do not, remove the tubes from their sockets and check for continuity between pins 1 and 5 with an ohmmeter. An infinite resistance will indicate a faulty tube filament.
4. Check the values of the parts. Be sure that the proper part has been wired into the circuit as shown in the Pictorial Diagrams and as called out in the wiring instructions.
5. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.
6. A review of the Circuit Description will prove helpful in indicating where to look for trouble.

TROUBLESHOOTING CHART

DIFFICULTY	POSSIBLE CAUSE
1. No AC power	<ul style="list-style-type: none"> A. Circuit breakers open. B. Jumpers missing on terminal strip AE. C. Terminal strip AE wired wrong.
2. Meter inoperative in one position: <ul style="list-style-type: none"> A. GRID. B. REL. PWR. C. HV. 	<ul style="list-style-type: none"> A. Resistor R1, R3. B. D17, R25, R24, C54, R26. C. R6, R7, R8, R9. D. Meter switch.
3. Meter circuits inoperative	<ul style="list-style-type: none"> A. Meter jumper wire not removed. B. R2, C3, C8. C. Meter switch.
4. Idle current over .15A in CW/TUNE position.	<ul style="list-style-type: none"> A. ZD1.
5. No idle current	<ul style="list-style-type: none"> A. Relay. B. ZD1. C. V1 - V2.
6. No high voltage	<ul style="list-style-type: none"> A. D1 - D14. B. C10 - C17. C. R12 - R19. D. T1. E. R1 or R3. F. C29. G. Top cover off (interlock).
7. Relay will not activate	<ul style="list-style-type: none"> A. D16. B. C4. C. Ant-Relay jack. D. T2. E. RL-1.
8. Final tune has no effect	<ul style="list-style-type: none"> A. Bandswitch wafer #2 180 degrees out of position. B. L7 installed wrong. C. Improper load on the Linear Amplifier. D. V1, V2.

DIFFICULTY	POSSIBLE CAUSE
9. No RF output	A. Relay wired wrong. B. L7 installed wrong. C. Coax shorted. D. C29.
10. ALC inoperative	A. Wiring error or component failure on terminal strip BE. B. ALC jack.
11. Amplifier hard to drive.	A. Coaxial leads to the input bandswitch reversed.

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

SPECIAL SHIPPING INSTRUCTIONS FOR U.S. AND CANADA

DO NOT ship an assembled Model SB-220 amplifier unless it is packed in the Model 220 Service Pack. Due to the weight of the transformers, shipment without special packaging will almost certainly result in damage.

OVERSEAS SHIPMENT NOTE: Shipment from overseas sources with the transformers mounted is not recommended.

SPECIFICATIONS

Band Coverage	80, 40, 20, 15 and 10 meter amateur bands.
Driving Power Required	100 watts.
Maximum Power Input	SSB: 2000 watts P.E.P. CW: 1000 watts. RTTY: 1000 watts.
Duty Cycle	SSB: continuous voice modulation. CW: Continuous (maximum key-down 10 minutes). RTTY: 50% (maximum transmit time 10 minutes).
Third Order Distortion	-30 dB or better.
Input Impedance	52 Ω unbalanced.
Output Impedance	50 Ω unbalanced; SWR 2:1 or less.
Front Panel	Tune. Load. Bandswitch. Sensitivity. Meter switch. Power. CW/Tune – SSB. Plate meter. Multi-meter (Grid mA, Relative Power, and High Voltage).
Rear Panel	Line cord. Circuit breakers (two 10 A). Antenna Relay (phono). ALC (phono). RF Input (SO-239). Ground post. RF output (SO-239).



Tubes	Two 3-500Z.
Power Required	120 VAC, 50/60 Hz, at 20 amperes maximum. 240 VAC, 50/60 Hz, at 10 amperes maximum.
Cabinet Size	14-7/8" wide, 8-1/4" high, 14-1/2" deep.
Net Weight	50 lbs.

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

CIRCUIT DESCRIPTION

Refer to the Schematic (fold-out from Page 87) to identify the circuit components while reading this section.

POWER SUPPLY

The power supply uses high voltage transformer, T1, and a filament and bias transformer, T2. Each transformer has dual primary windings which are connected in parallel for 120 VAC operation, or in series for 240 VAC electric service. The transformers are protected by two 10 ampere circuit breakers, wired so they provide appropriate overload protection for either primary voltage.

The fan motor is connected across one of the primary windings on the high voltage transformer and always operates on 120 VAC.

The AC input line is by-passed for RF by capacitors C1 and C2.

HIGH VOLTAGE SUPPLY

The primary windings of the high voltage transformer, T1, are tapped, and the six leads are connected to the Mode and Power switches.

When the Mode switch is in the CW/Tune position, the entire portion of each primary winding is connected to the power line. When this switch is in the SSB position, only the tapped portion of each primary winding is connected to the power line.

When the tapped windings (fewer turns) are connected to the power source, a higher secondary-to-primary turns ratio

is being used and a higher secondary voltage for SSB operation results.

The transformer secondary is connected in a full-wave, voltage-doubling circuit. The AC voltage is rectified by diodes, D1 through D14, and it is filtered by series-connected electrolytic capacitors C10 through C17. Resistors R12 through R19 parallel the filter capacitors and equalize the voltage drop across each capacitor in the series. They also act to discharge the filter capacitors after the power switch is turned off.

The red-yellow transformer lead is connected to the junction of capacitors C13 and C14. During the half-cycle when this lead is positive, capacitors C14 through C17 are charged. During the other half-cycle, the red lead is positive and capacitors C10 through C13 are charged. These two capacitor strings are in series across the load, and the voltages of each group add together.

Resistors R1 and R3 are discussed under "Metering Circuits."

Chokes RFC 1 and RFC 2 and bypass capacitors C6 and C7 are used to keep RF energy out of the power supply circuits.

The interlock grounds the output of the high voltage supply when the top cover of the Amplifier is removed. This feature protects the user against a shock from undischarged filter capacitors. The Amplifier must not be turned on while the top cover is removed as the high voltage supply is short-circuited under these circumstances.

FILAMENT AND BIAS SUPPLY

Transformer T2 has two secondary windings. One winding furnishes 5 VAC at 30 amperes for the amplifier tube filaments. The two #47 pilot lamps for meter illumination are also connected across the filament line.

Filament supply is fed to the two tubes through RFC 3, a coil which is bifilar wound on a ferrite core. This coil forms a choke to raise the tube filaments above RF ground so the driving voltage will not be short-circuited.

The second winding on transformer T2 is used in a half-wave rectifier circuit for the bias supply voltage, to operate relay RL1, and to furnish ALC threshold voltage. The AC voltage from this winding is rectified by D16 and filtered by C4.

This DC voltage is connected to lugs 3 and 11 of relay RL1. In the receive mode, this voltage is applied through lug 9 to the center-tap of the filament winding. This positive voltage increases the voltage difference between the tube grids (which are grounded for DC) and the tube filaments, which now carry the positive DC voltage in addition to the AC filament voltage. The tube grids are consequently biased beyond cutoff and no plate current flows.

In the transmit mode, the center-tap of the filament winding is connected to ground through lugs 9 and 6 of the relay, the 5.1 volt zener diode ZD1, and R3. The plate current through the zener develops 5.1 VDC operating bias for the tubes and limits the idling plate current.

RELAY

The relay has three sets of single-pole, double-throw contacts. When the relay coil circuit is open the contacts are in the receive mode.

Approximately 120 VDC is connected to one side of the relay coil at lug 11. Lug 10 connects the other side of the relay coil to the Antenna Relay jack on the rear panel. This jack is usually connected to normally open relay contacts in the exciter (such as a VOX or PTT relay). When these relay contacts close, they must connect the amplifier relay coil circuit to ground. The amplifier relay will then close and its contacts will be in the transmit mode.

The function of amplifier relay contacts 3, 6, and 9 was discussed in the "Bias Supply" section.

Relay contact 7 is connected to the RF INPUT connector. In the receive mode the incoming signal is transferred directly to the RF Input through relay contacts 8, 2, 1, and 7. In the transmit mode, the RF Input voltage is connected through relay contacts 7 and 4 to lug 1 of Band-switch wafer 1F.

In the transmit mode, the RF Output is connected through relay contacts 5 and 8 to the pi network output circuit of the Amplifier.

RF CIRCUITS

INPUT CIRCUIT

An input impedance-matching pi network circuit for each band is connected by Band-switch wafer 1. After passing through the matching circuit, the RF driving power is coupled to the tube filaments by C32. Capacitor C21 equalizes any RF voltage difference between the filament leads.

TUBES

The amplifier tubes are connected in parallel in a class B grounded grid circuit. RF driving power is applied to the filaments in the normal cathode-driven configuration. As mentioned in "Power Supply" section, RFC 3 holds the filaments above RF ground.

Pins 2, 3, and 4 of each tube are connected together internally. Each of the three grid pins is bypassed to ground. This combination of RF chokes and capacitors provides a predetermined level of negative feedback at the tube grids to further reduce intermodulation distortion.

PC-1 and PC-2 are parasitic chokes in each tube plate lead to suppress any VHF parasitic oscillations.

The positive side of the power supply is connected in parallel to the tubes through RFC 1.

Cooling air is circulated around the tubes by the fan.

OUTPUT CIRCUIT

The tuned output circuit of the Amplifier is a pi network composed of plate tuning capacitor C55, loading capacitors C56 and C57, and coils L6 and L7.

Band-switch wafer 2 progressively shorts out the unused portions of coils L6 and L7. The coil turns in use are tuned to resonance by Tune capacitor C55. Load capacitor C57 is tuned to complete the impedance match between the tubes and the load connected to the RF OUTPUT. On the 80 meter band, fixed capacitor C56 is switched in parallel with C57 to provide the additional capacitance required on this band.

If a DC voltage is unintentionally applied to the plate output circuit, RFC 6 will provide a DC path to ground, thus short-circuiting the high voltage supply and opening the circuit breakers.

ALC CIRCUIT

Approximately 60 VDC ALC threshold voltage is available at the junction of resistors R4 and R5, which form a voltage divider across the bias supply winding of transformer T2. C5 is an RF bypass, and R11 is an isolation resistor.

C47 couples some RF driving voltage to voltage divider R21-R22. C48 and C49 are frequency compensating capacitors for R21 and R22, respectively.

When the RF driving voltage at the junction of R21-R22 exceeds the ALC threshold voltage, D18 will rectify the negative half-cycles. C51 and C53 act as filters and RF bypasses. R23 is an isolation resistor.

The negative voltage appearing at the ALC connector may be coupled back to the exciter to reduce its gain and help reduce "flat-topping" of voice peaks due to overdrive.

METERING CIRCUITS

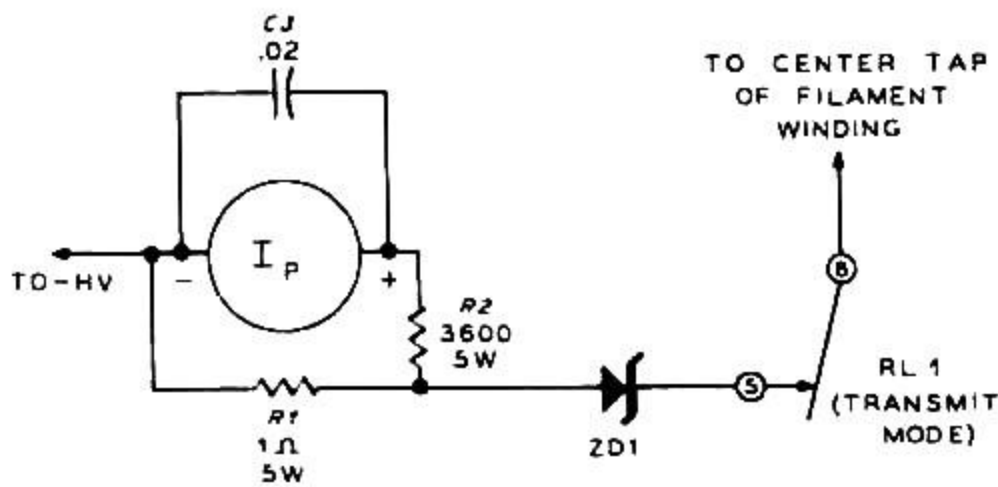


Figure 4-1

PLATE METER (Figure 4-1)

The Plate Meter reads the total plate current drawn by both tubes from 0 to 1 ampere. It is placed in series with a multiplier resistor, R2, and it measures the voltage drop across shunt resistor R1 through which the plate current passes.

MULTI-METER

Grid Current (Figure 4-2)

To read grid current, the Multi-Meter is switched in parallel with shunt resistor R3. The grid circuit return is to the center tap of the filament winding of transformer T2. Note that grid current only passes through R3, as the return for the high voltage circuit is through R1, R2, and the Plate Meter.

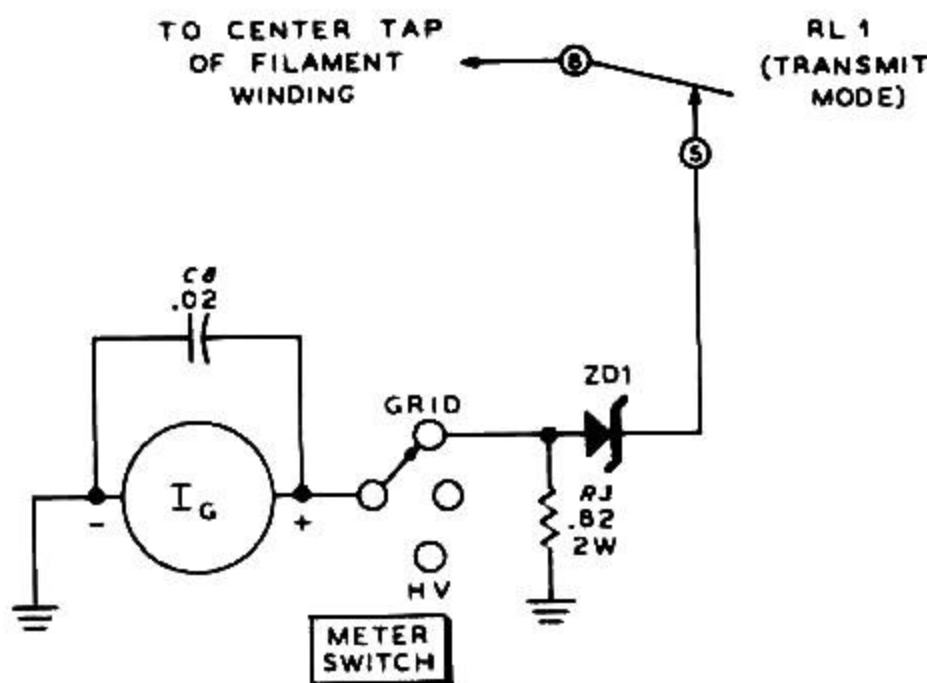


Figure 4-2

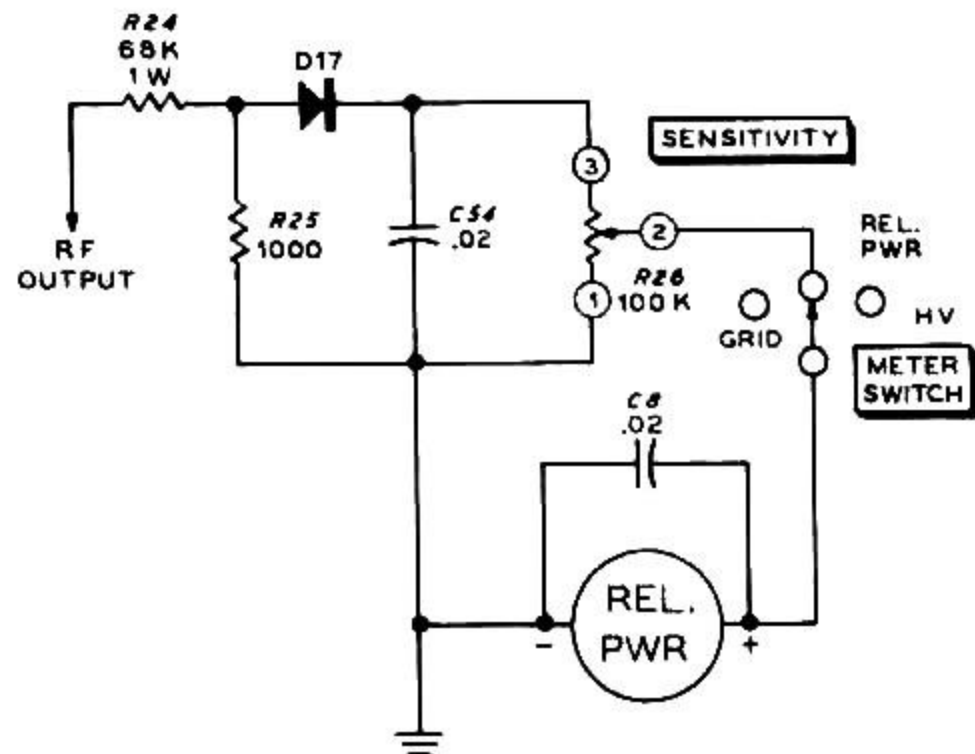


Figure 4-3

Relative Power (Figure 4-3)

Voltage divider R24 and R25 is connected across the RF OUTPUT. The voltage at the junction of these resistors is rectified by diode D17, filtered by C54, and applied through Sensitivity control R26 to the Multi-Meter. The Sensitivity control adjusts the Multi-Meter for the desired reading.

High Voltage (Figure 4-4)

High voltage is measured by switching the Multi-Meter to the junction of the multiplier resistors (R6, R7, and R8) and the shunt resistor R9. The meter scale is calibrated to indicate voltage, based upon the current flowing through the meter and R9 in parallel, the combination being in series with the multiplier resistors R8, R7 and R6.

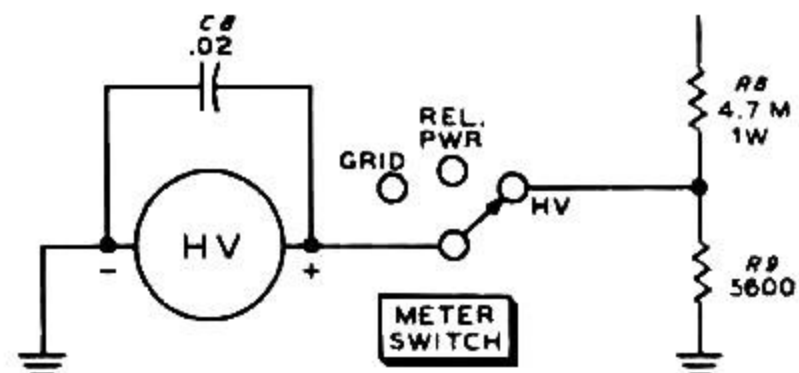
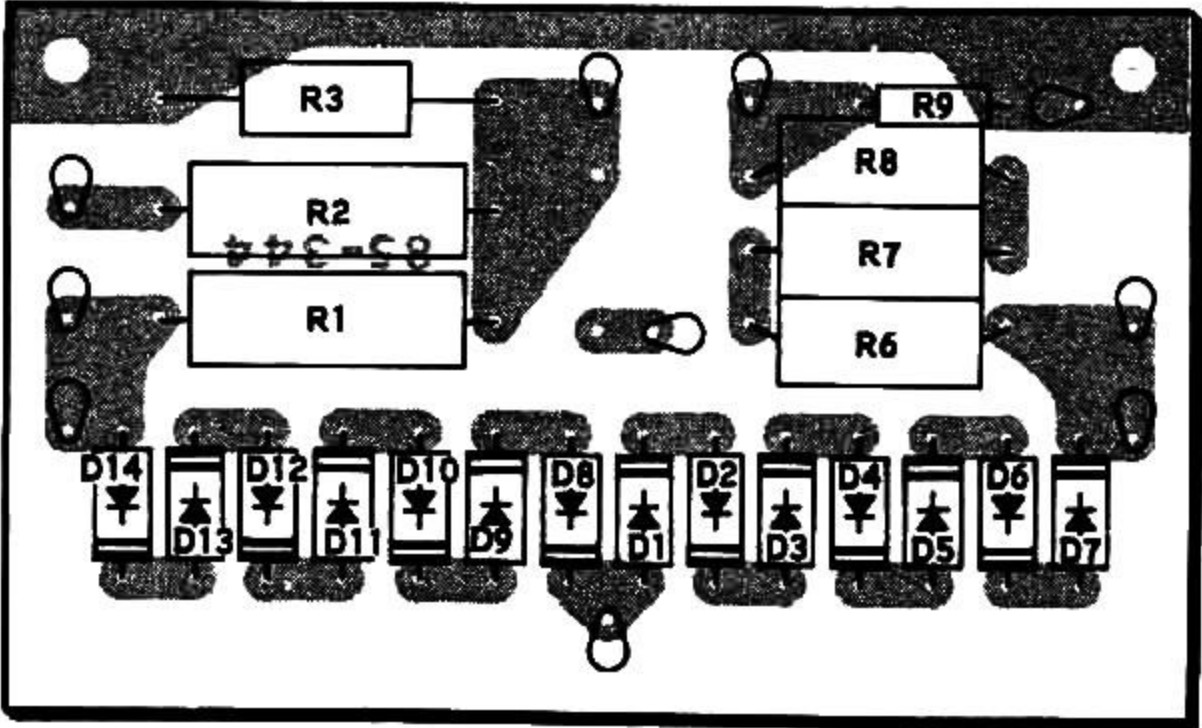


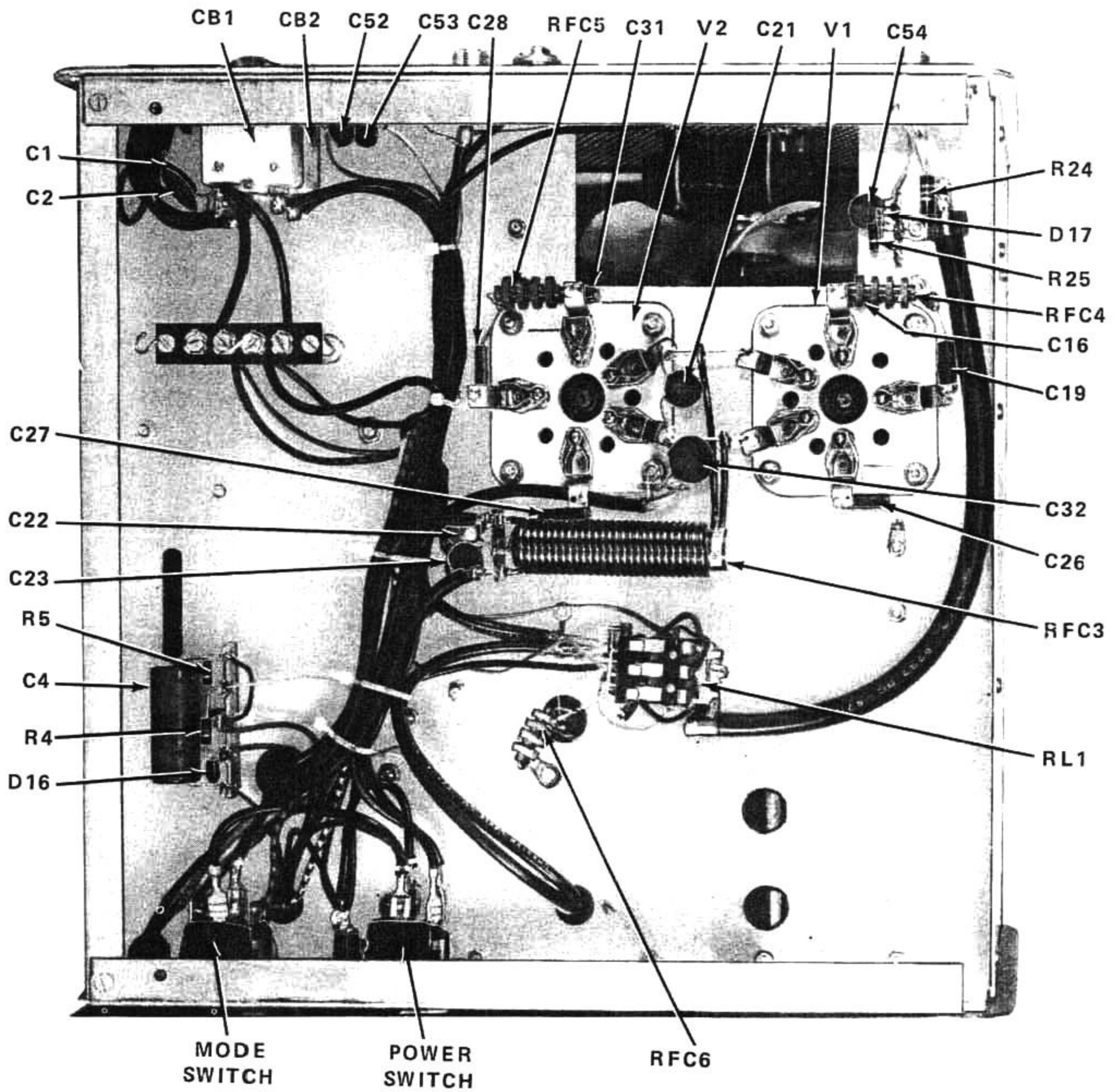
Figure 4-4

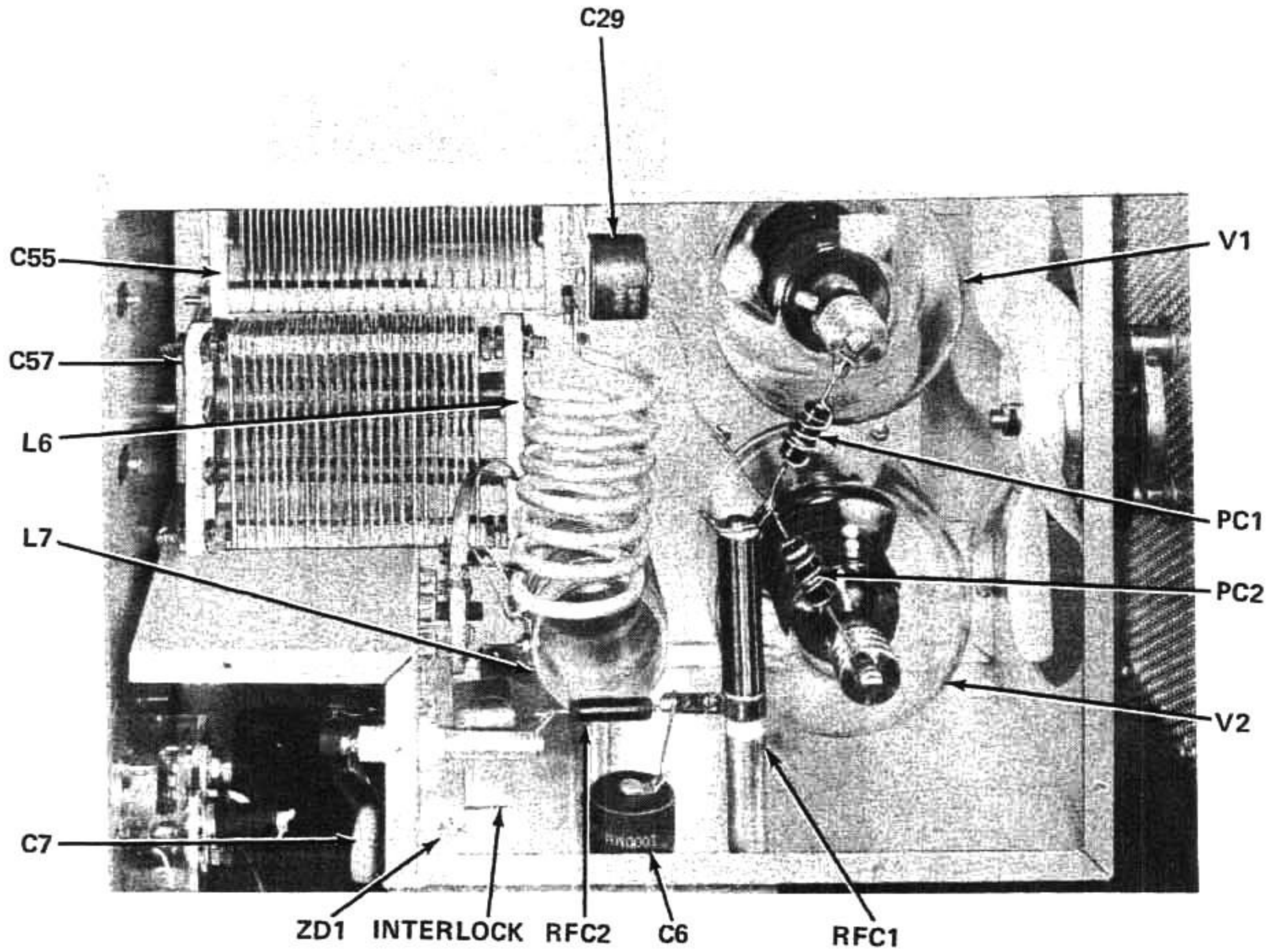
CIRCUIT BOARD X-RAY VIEW

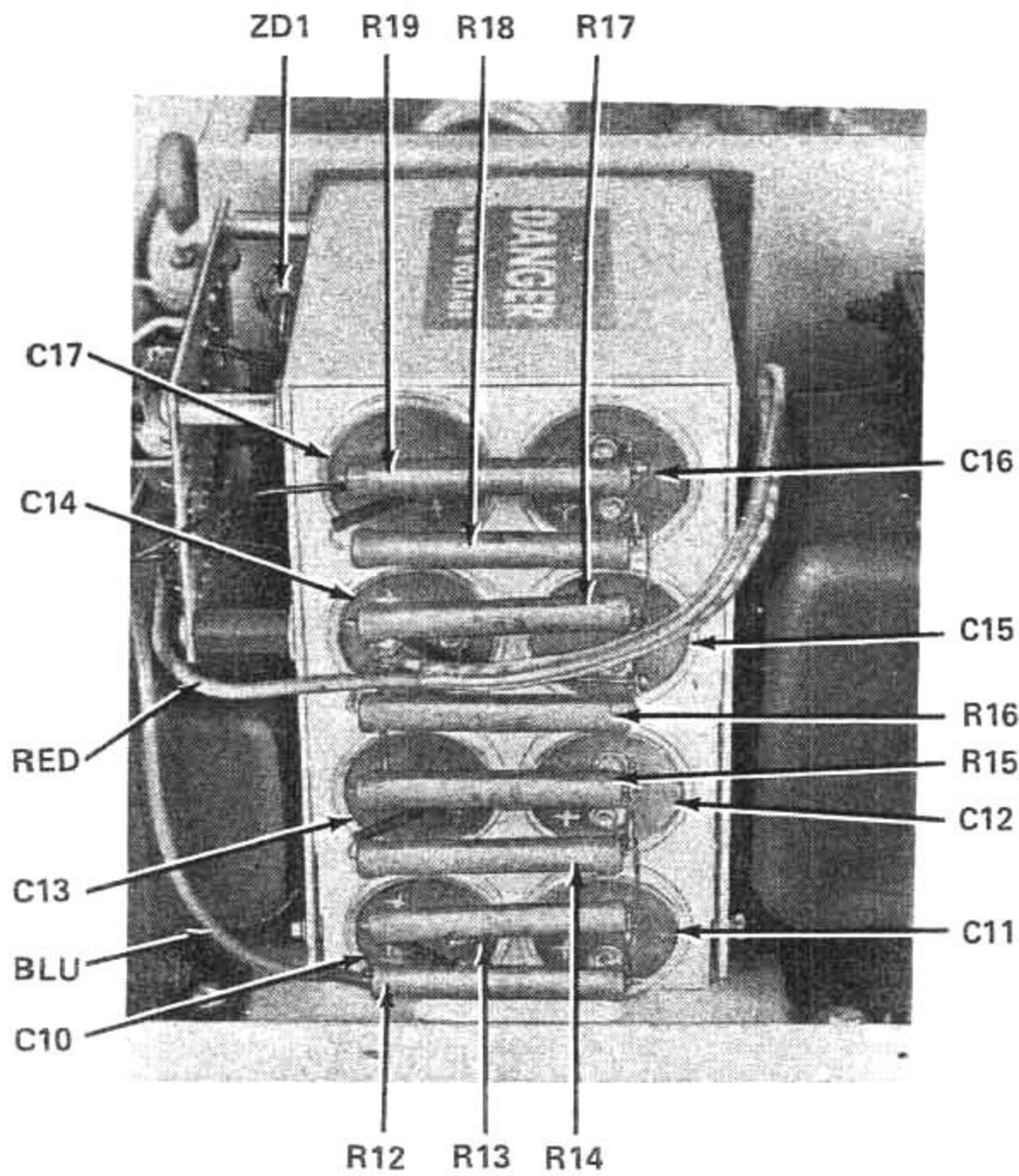
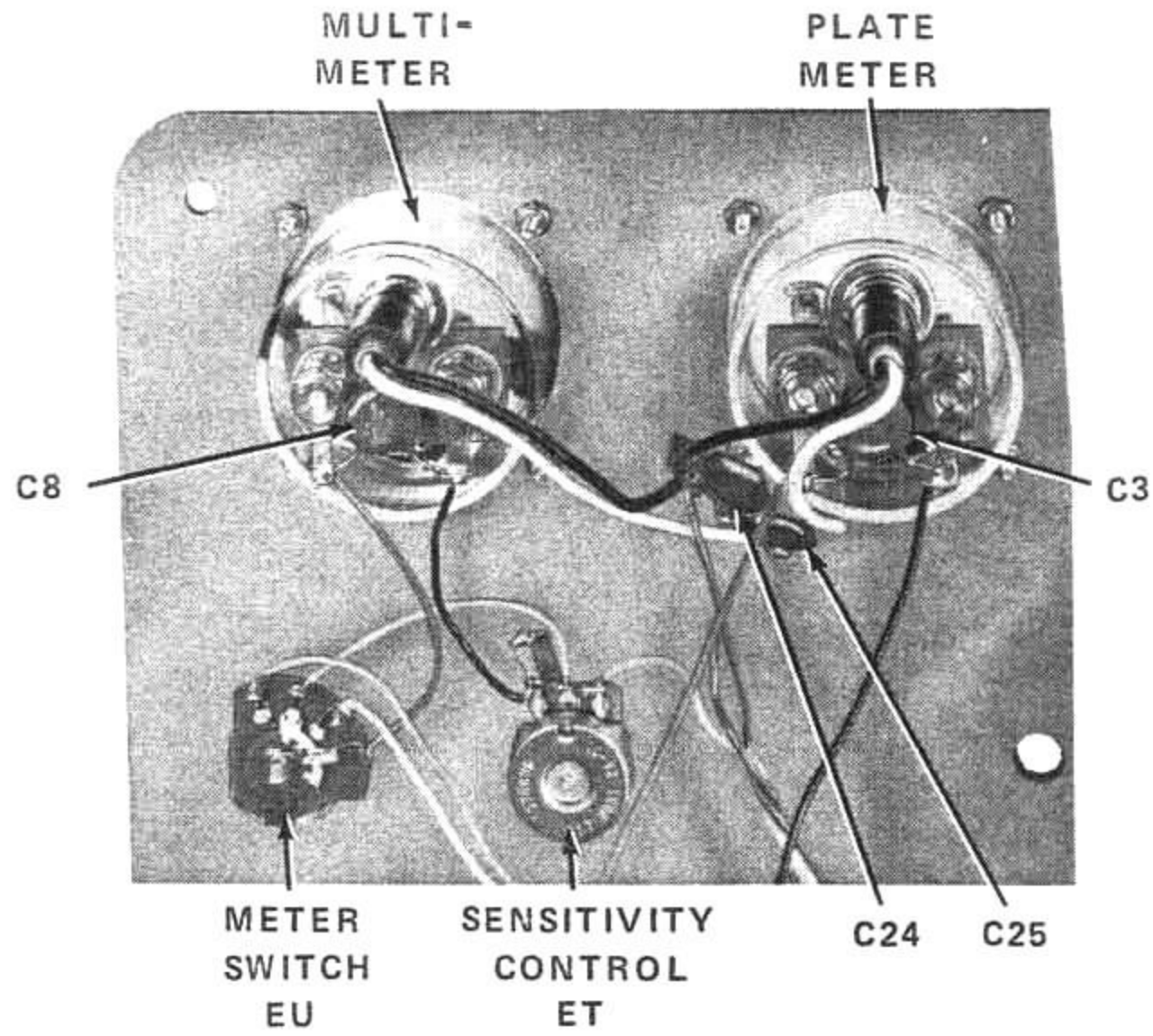


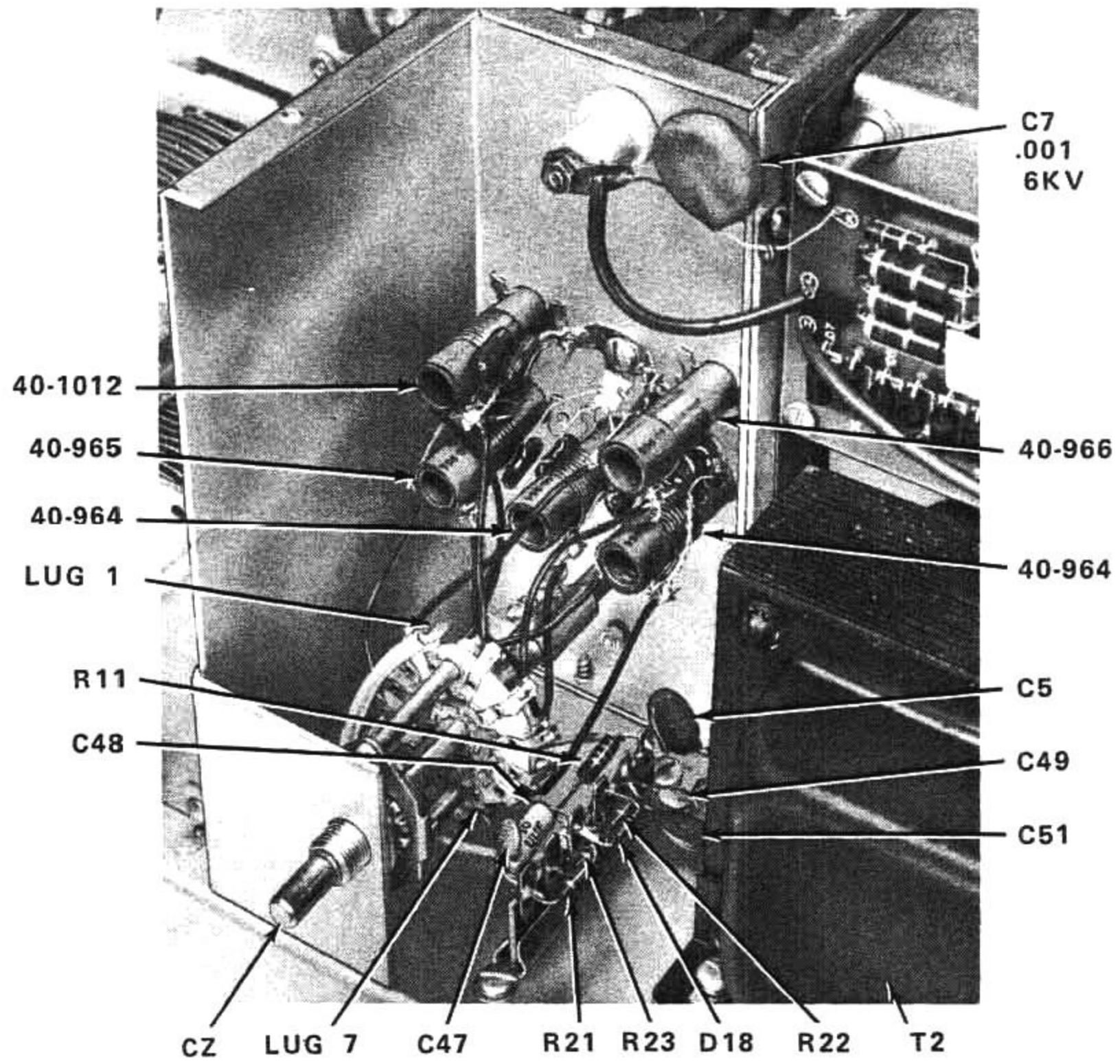
(VIEWED FROM FOIL SIDE)

CHASSIS PHOTOGRAPHS









CUSTOMER SERVICE

REPLACEMENT PARTS

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

ORDERING FROM THE FACTORY

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

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

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

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

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

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

TECHNICAL CONSULTATION

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

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

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

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

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

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

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

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

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

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

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

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

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

Heath Company
Service Department
Benton Harbor, Michigan 49022



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