

Assembly  
and  
Operation  
of the



40-METER  
SSB TRANSCEIVER

Model HW-22A

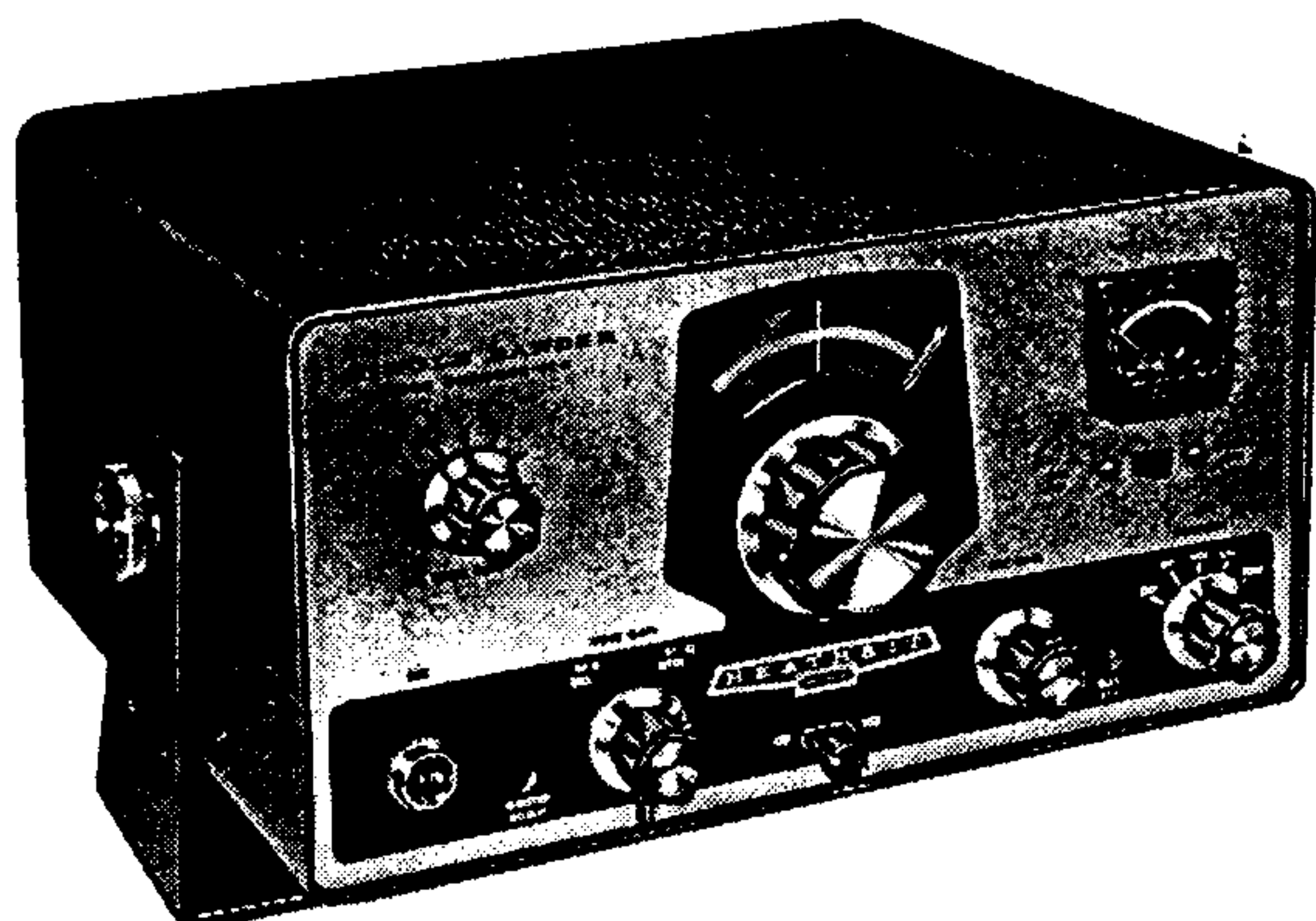


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## INTRODUCTION

The Heathkit Model HW-22A Amateur Transceiver is a 40-meter SSB (single-sideband) transmitter and receiver designed for both mobile and fixed station use. The receiver and transmitter are locked together with a continuously running VFO (variable frequency oscillator) to insure that both sections operate at the same frequency. The low frequency VFO is temperature compensated to provide stable operation.

Provisions have been made for both PTT (push-to-talk) and VOX (voice operated transmitter) operation. Other features include ALC (automatic level control) to prevent the Transmitter from overloading, and AVC (automatic volume control) to maintain constant receiver output over a wide range of input signal strength.

An accessory socket is wired into the circuit so the Heathkit plug-in Crystal Calibrator can be used with the Transceiver to provide

accurate frequency checks at 100 kHz intervals. Connection on the rear of the Transceiver make the Transceiver easily useable with linear amplifiers. Power for the Transceiver can be obtained from the Heathkit Model HP-13 (12 V DC) or Model HP-23 (120 V AC) Power Supplies. Equivalent power supplies may also be used.

NOTE: This Manual uses the new IEEE (Institute of Electrical and Electronic Engineers) international standard term "hertz" as the basic unit of frequency. The terms are used as follows:

Hz (hertz) = cps (cycles per second).

kHz (kilohertz) = kc (kilocycles per second).

MHz (megahertz) = mc (megacycles per second).

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



## PARTS LIST

The numbers in parentheses in the Parts List are keyed to the numbers on the Parts Pictorial (fold-out from Page 5) to aid in parts identification.

PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
<b>RESISTORS</b>			<b>Disc</b>		
<b>1/2 Watt</b>			(5) 21-60	8	18 pf
(1) 1-1	1	47 $\Omega$ (yellow-violet-black)	21-32	7	47 pf
1-3	3	100 $\Omega$ (brown-black-brown)	21-49	1	68 pf
1-66	2	150 $\Omega$ (brown-green-brown)	21-13	8	500 pf
1-45	5	220 $\Omega$ (red-red-brown)	21-35	3	.005 $\mu$ fd 1.6 KV
1-4	2	330 $\Omega$ (orange-orange-brown)	21-57	25	.005 $\mu$ fd
1-9	8	1000 $\Omega$ (brown-black-red)	21-31	34	.02 $\mu$ fd
1-14	3	3300 $\Omega$ (orange-orange-red)	<b>Mylar*</b>		
1-16	7	4700 $\Omega$ (yellow-violet-red)	NOTE: Mylar capacitors may be marked with color bands or stamped with the value.		
1-20	8	10 K $\Omega$ (brown-black-orange)	(6) 27-46	1	.047 $\mu$ fd (yellow-violet-orange)
1-22	5	22 K $\Omega$ (red-red-orange)	27-48	1	.22 $\mu$ fd (wide red-yellow)
1-25	13	47 K $\Omega$ (yellow-violet-orange)	27-61	2	.47 $\mu$ fd (yellow-violet-yellow)
1-26	13	100 K $\Omega$ (brown-black-yellow)	27-47	6	.1 $\mu$ fd (brown-black-yellow)
1-29	8	220 K $\Omega$ (red-red-yellow)	<b>Other Capacitors</b>		
1-35	12	1 megohm (brown-black-green)	(7) 25-54	2	10 $\mu$ fd tubular electrolytic
1-37	4	2.2 megohm (red-red-green)	(8) 25-135	1	20 $\mu$ fd vertical electrolytic
1-70	1	22 megohm (red-red-blue)	(9) 26-35	1	Variable
<b>Other Resistors</b>			26-89	1	Variable
(2) 1-28-1	1	100 K $\Omega$ 1 watt (brown-black-yellow)	<b>COILS</b>		
3-2-2**	1	.33 $\Omega$ 2 watt (orange-orange-silver)	NOTE: Some of the coils or transformers have a plastic insert which can rattle, this is normal.		
(3) 1-21-2	1	20 $\Omega$ 2 watt (red-black-black)	(10) 40-509	1	Crystal filter
1-2-2	1	4700 $\Omega$ 2 watt (yellow-violet-red)	40-514	1	Driver plate
1-22-2	2	12 K $\Omega$ 2 watt (brown-red-orange)	(11) 40-517	1	Driver grid
**NOTE: This resistor is a 2 watt wire-wound resistor, but is the same size as a 1 watt composition resistor.			40-778	1	VFO heterodyne
			(12) 40-511	1	Final plate
			(13) 52-25	1	VFO
<b>CAPACITORS</b>			<b>CHOKES-TRANSFORMERS</b>		
<b>Mica</b>			(14) 45-58	1	13 $\mu$ h bifilar choke
(4) 20-96	2	36 pf	(15) 45-3	2	1 mh choke
20-102	1	100 pf	(16) 45-4	1	1.1 mh choke
20-105	2	180 pf	(17) 45-47	1	2 mh choke
20-134	2	680 pf	(18) 51-55	1	Audio output transformer
20-122	1	1000 pf	52-63	3	2.305 MHz IF transformer
20-127	1	1300 pf			
20-137	1	1800 pf			

\*DuPont Registered Trademark



PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
<b>CONTROLS-SWITCHES</b>			<b>CABLE-WIRE-SLEEVING</b>		
(20)10-130	1	200 $\Omega$ bushing-mount control	134-140	1	Cable assembly
(21)10-17	1	1 megohm bushing-mount control	343-7	1	Coaxial cable
(22)10-57	2	10 K $\Omega$ tab-mount control	344-50	1	Black hookup wire
10-58	1	100 K $\Omega$ tab-mount control	344-52	1	Red hookup wire
10-127	2	1 megohm tab-mount control	346-1	1	Small sleeving
(23)12-73	1	1 megohm/25 K $\Omega$ dual tab-mount control	346-2	2	Large sleeving (clear)
(24)60-13	2	DPDT slide switch			
(25)63-427	1	5-position rotary with/snap switch			
<b>CRYSTALS</b>			<b>KNOBS</b>		
(26)404-196	1	2303.3 kHz	(39)462-7	1	Push-on
404-197	1	2306.7 kHz	(40)462-106	1	11/16" diameter
404-198	1	11.190 MHz	(41)462-191	4	1-1/8" diameter
404-203	Package consisting of the following:		(42)462-210	1	2" diameter
(27)404-191	2	2305.100 kHz	(43)462-218	1	Lever
404-192	2	2303.500 kHz			
<b>DIODES-TUBES-LAMPS</b>			<b>GENERAL</b>		
(28)56-26-1	5	Germanium diode (brown-white-brown)	69-34	1	Relay
(29)57-27	5	Silicon diode	73-1	4	Rubber grommet
411-11	5	6AU6 tube	(44)75-52	1	Slide switch insulator
411-91	1	6BE6 tube	85-69-5	1	Circuit board
411-124	3	6EA8 tube	(45)259-20	48	Terminal
411-161	1	6EB8 tube	(46)260-7	1	IF transformer mounting clip
411-185	2	6GE5 tube	(47)261-4	4	Small rubber foot
411-24	1	12AT7 tube	(48)261-9	2	Medium rubber foot
411-69	1	12BY7A tube	(49)261-21	2	Large rubber foot
412-1	2	#47 pilot lamp	407-99	1	Meter
412-11	1	NE-2 neon lamp	(50)431-14	1	2-lug terminal strip
			431-10	1	3-lug terminal strip
			(51)435-1	1	11-pin mounting ring
			(52)455-11	1	Split bushing
			(53)455-52	1	Lever knob bushing
			464-29-2	1	Plastic dial
			490-1	1	Alignment tool
			490-5	1	Nut starter*
			331-6		Solder
			597-308	1	Kit Builders Guide
			597-260	1	Parts Order Form
			597-367	1	Registration Card
			391-34	1	Blue and white label
			595-830	1	Manual
<b>CONNECTORS-SOCKETS-PLUGS</b>					
(30)432-38	1	Male connector			
(31)432-39	1	Female connector			
(32)434-42	4	Phono socket			
(33)434-44	2	Pilot lamp socket			
(34)434-112	6	7-pin tube socket			
434-105	1	8-pin tube socket			
434-79	6	9-pin tube socket			
434-140	2	12-pin tube socket			
(35)434-118	2	11-pin tube socket			
(36)438-4	4	Phono plug			
(37)438-29	1	11-pin plug			
(38)440-1	2	11-pin plug cap			

\*See Page 3 of the Kit Builders Guide





PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
<b>METAL PARTS</b>			<b>#6 Hardware</b>		
(54) 204-576	1	Gimbal bracket	(72) 250-170	9	#6 x 1/4" sheet metal screw
(55) 90-265	1	Cabinet	(73) 250-56	23	6-32 x 1/4" screw
(56) 206-312	1	Final shield	(74) 250-89	4	6-32 x 3/8" screw
(57) 204-182	1	Final shield mounting bracket	(75) 250-13	6	6-32 x 1" screw
(58) 204-453	1	Pilot lamp mounting bracket	(76) 250-27	2	6-32 x 2" screw
(59) 100-596-2	1	Chassis	(77) 252-3	32	6-32 nut
(60) 100-43	1	Dial mounting plate	(78) 253-2	2	#6 fiber shoulder washer
(61) 204-732	1	Switch lever mounting bracket	(79) 254-1	35	#6 lockwasher
(62) 266-90	1	Switch lever	(80) 255-5	4	#6 x 3/4" spacer
(63) 100-597	1	Front panel	(81) 255-10	2	#6 x 1-1/2" spacer
			(82) 259-1	5	#6 solder lug
			<b>#8 Hardware</b>		
			(83) 250-43	7	8-32 x 1/4" setscrew
			(84) 253-9	6	#8 flat washer
<b>HARDWARE</b>			<b>#10 Hardware</b>		
<b>#3 Hardware</b>			(85) 250-83	8	#10 x 1/2" sheet metal screw
(64) 250-49	4	3-48 x 1/4" screw	(86) 250-54	2	10-32 x 5/8" screw
(65) 252-1	4	3-48 nut	(87) 252-49	2	10-32 x 1-1/4" knurled nut
(66) 254-7	4	#3 lockwasher	(88) 253-19	2	#10 flat washer
			(89) 254-3	2	#10 lockwasher
			(90) 255-44	2	#10 shoulder spacer
			<b>1/4" Control Hardware</b>		
<b>#4 Hardware</b>			(91) 252-39	1	1/4-32 nut
(67) 250-213	14	4-40 x 5/16" screw	(92) 253-39	1	1/4" flat washer
(68) 250-273	20	4-40 x 3/8" screw	(93) 253-36	1	1/4" spring washer
(69) 252-15	8	4-40 nut	(94) 254-14	1	1/4" lockwasher
(70) 252-89	20	4-40 push-on nut			
(71) 254-9	14	#4 lockwasher	<b>3/8" Control Hardware</b>		
			(95) 252-7	2	3/8-32 nut
			(96) 253-10	2	3/8" flat washer
			(97) 254-5	2	3/8" lockwasher

## STEP-BY-STEP ASSEMBLY

### CIRCUIT BOARD ASSEMBLY

Because the circuit board is quite large, it has been divided into small sections to simplify assembly. This will make it easier to identify the points on the circuit board that are referred to throughout the assembly instructions. The sections of the circuit board are similar to those of a road map; the sections are identified by number across the top and bottom, and letters down each side of the circuit board. The dividing lines (see Pictorial 1-1) run vertically and horizontally between the circuit board mounting holes.

For instance, to locate connector 7 in section 1B, you would first find section 1B of the circuit board and then look for connector 7 in this section. Pictorial 1-1 shows the sections of the circuit board.

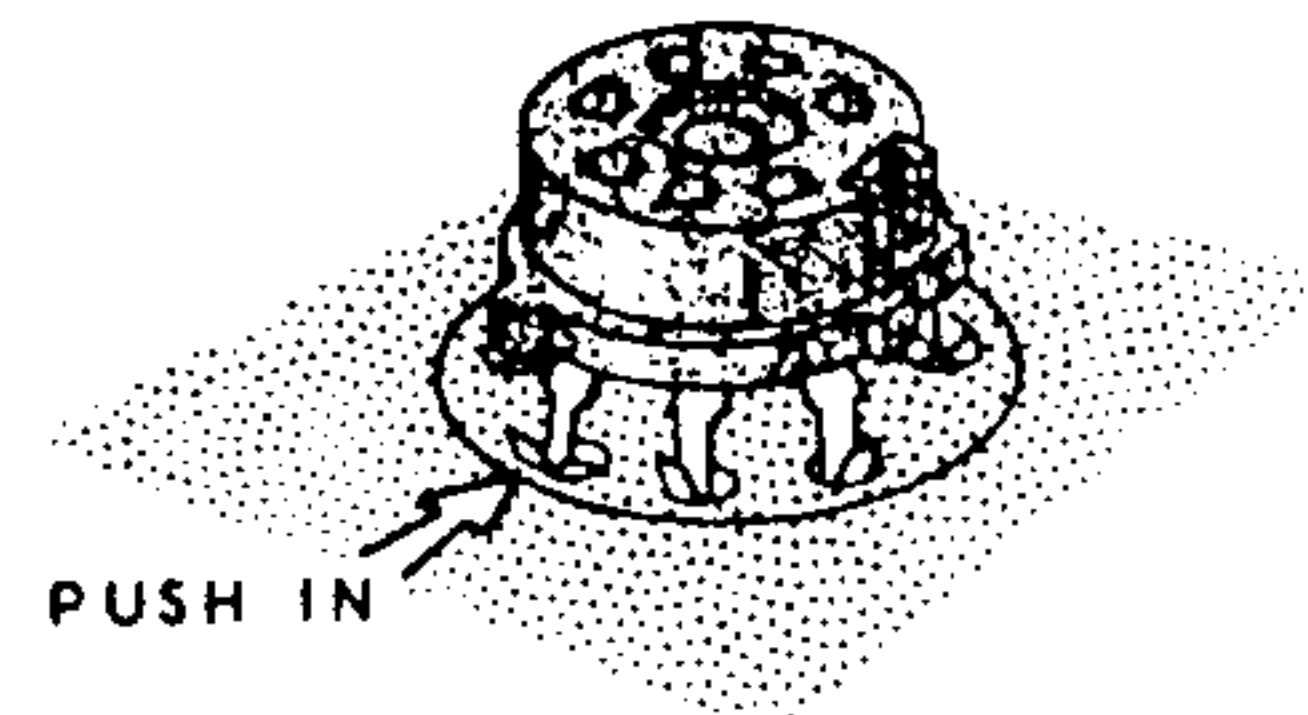
Before starting to assemble this kit, review the circuit board wiring and soldering instructions in the Kit Builders Guide.

Refer to Pictorial 1-1 for the following steps.

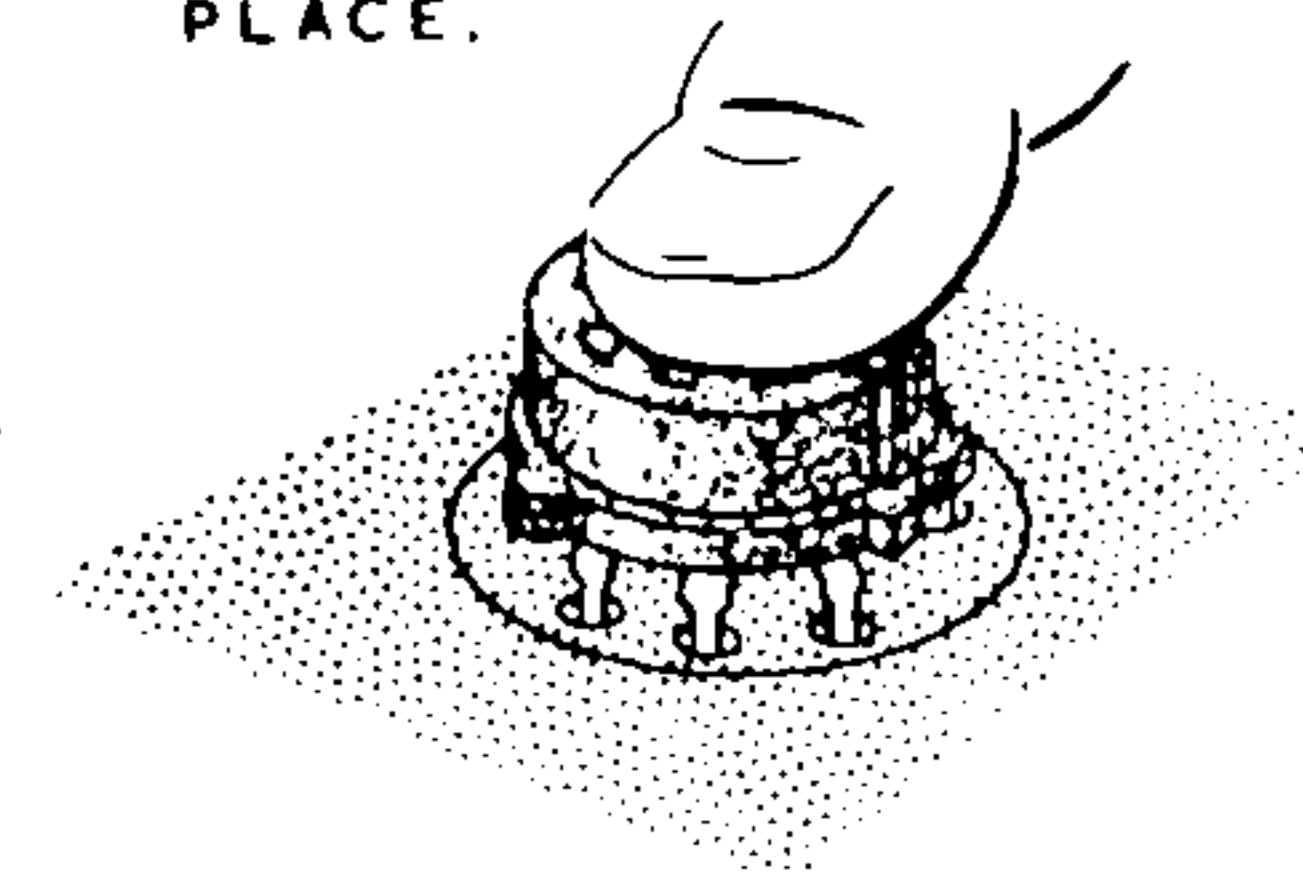
Position the circuit board foil side down as shown.

- ( ) Refer to Detail 1-1A, and install 7-pin tube sockets at locations V3, V4, V9, V10, V13, and V14. Solder all seven pins of each socket.
- ( ) In a like manner, install 9-pin tube sockets at locations V1, V2, V5, V8, V11, and V12. Solder all 9 pins of each socket.
- ( ) Refer to Detail 1-1B, and remove pins 5 and 6 from one of the 12-pin tube sockets. The pin numbers are molded on the top and bottom of the socket.
- ( ) Refer to Detail 1-1C, and install this socket at location V6. Align the keyway of the socket with the arrow printed on the circuit board. Solder all ten pins of the socket.

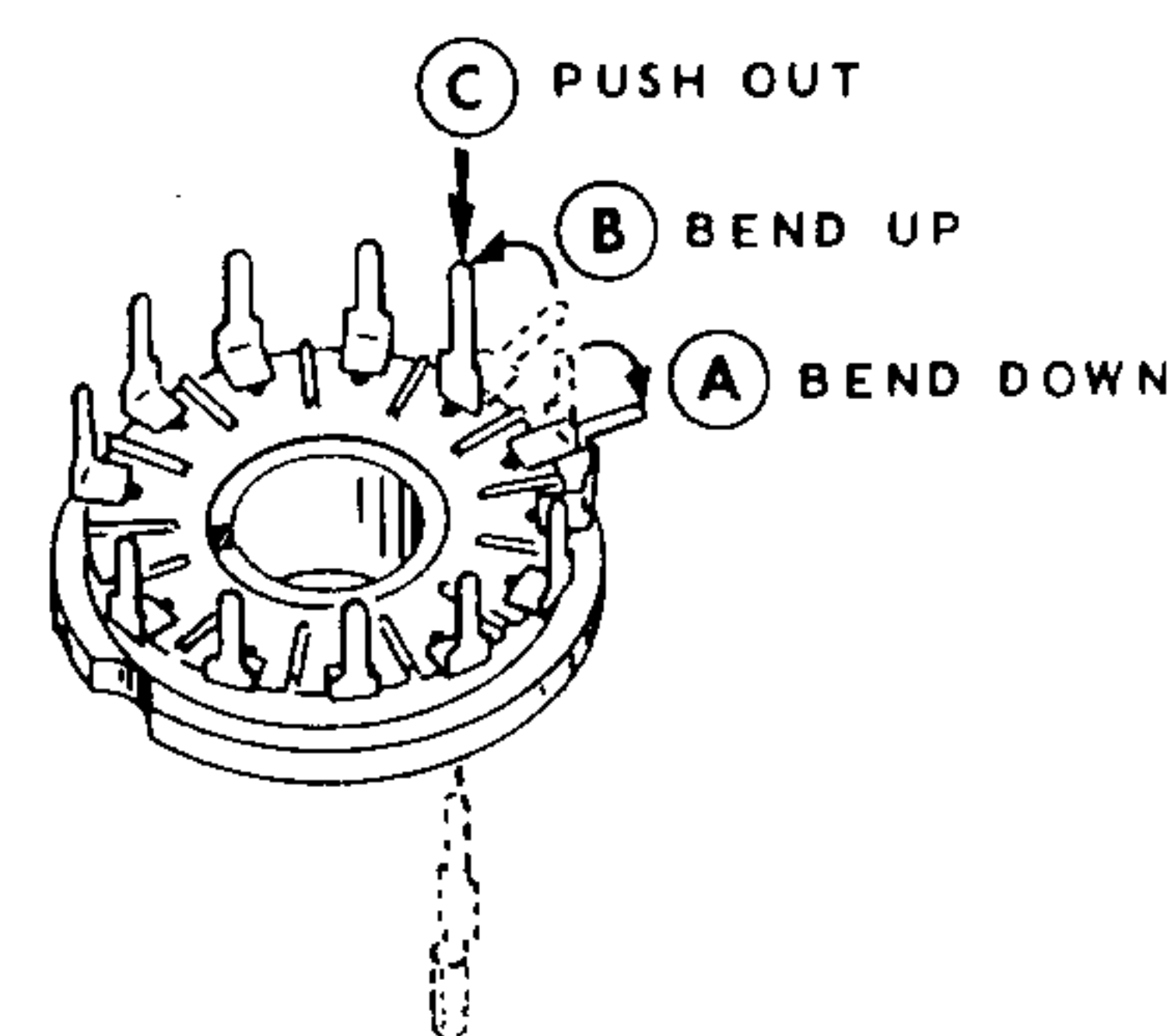
PLACE PINS INTO MOUNTING HOLES. MAKE SURE ALL HOOKS ARE SEATED IN HOLES BEFORE PRESSING.



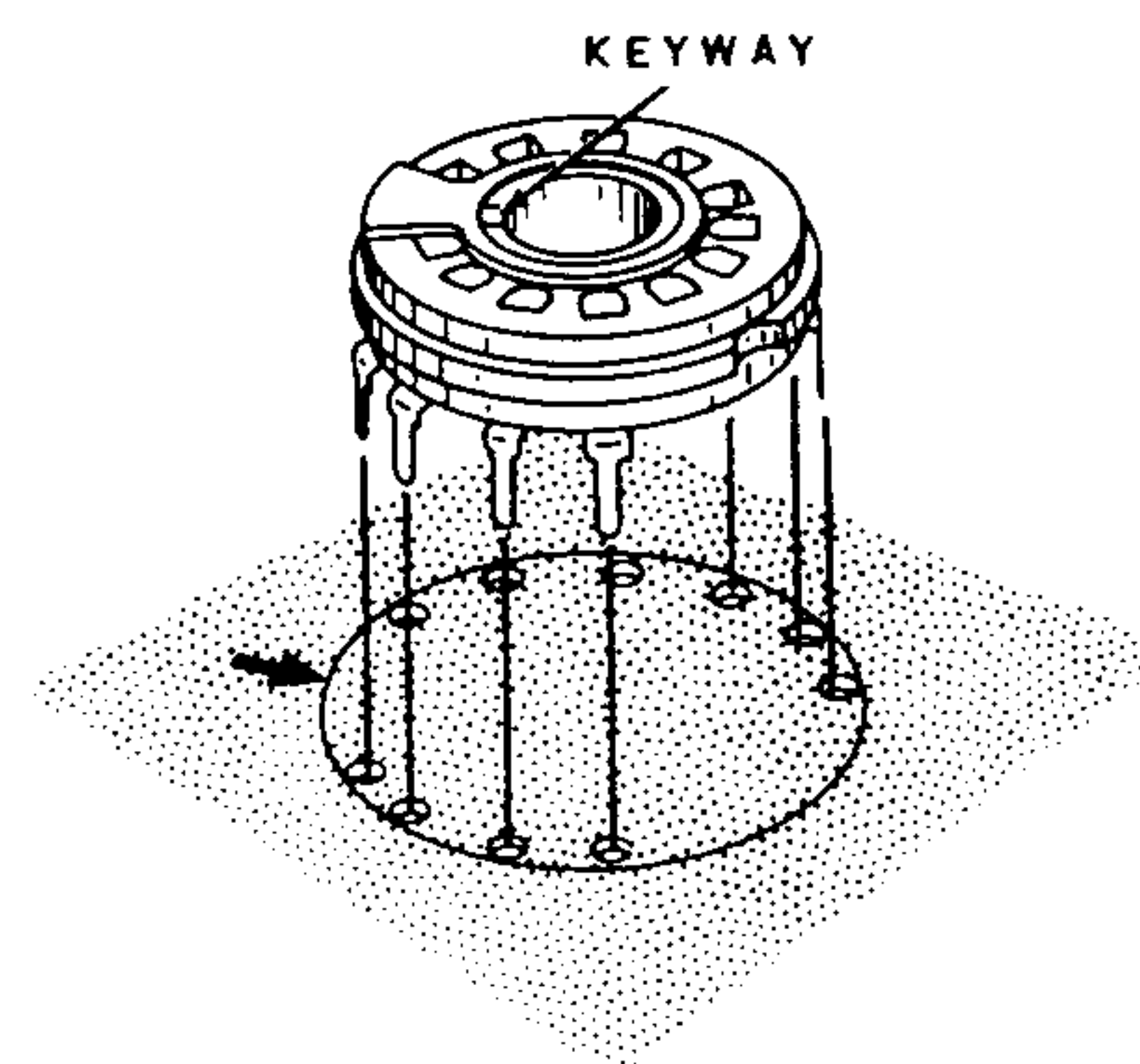
APPLY PRESSURE EVENLY UNTIL ALL PINS SNAP INTO PLACE.



Detail 1-1A



Detail 1-1B



Detail 1-1C

**CIRCUIT BOARD**

Because the circuit board has been divided into sections for assembly, this pictorial points on the circuit board throughout the assembly actions of the circuit board. It is a road map; the sections are marked across the top and side of the circuit board. Pictorial 1-1) runs between the circuit

For instance, to assemble the circuit board, you would first locate the board and then locate the components. Pictorial 1-1) shows the location of the circuit board.

Before starting to assemble the circuit board wiring, refer to the Kit Builders Guide for instructions.

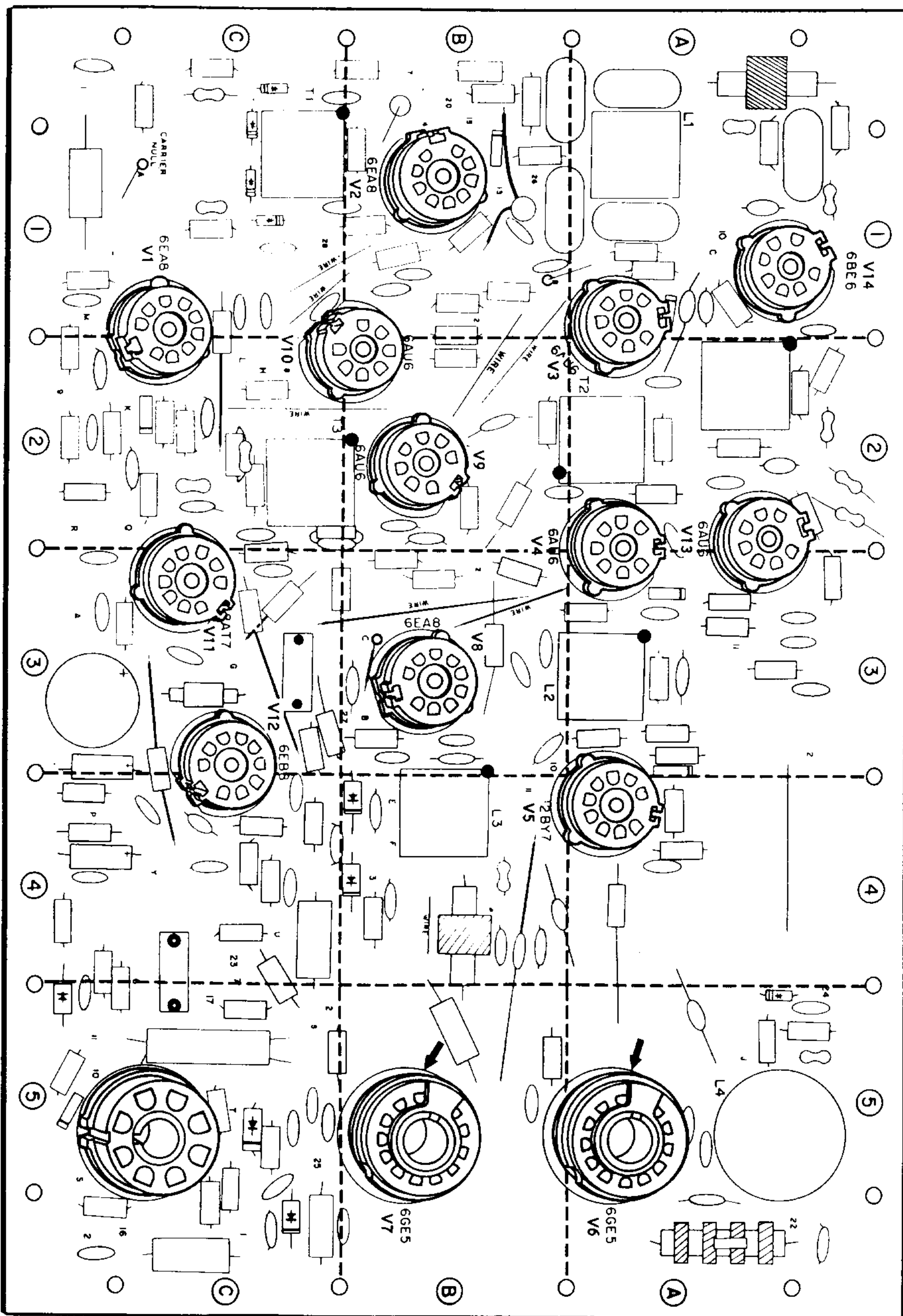
Refer to Pictorial 1-1) for the position of the circuit board. Position the circuit board as shown.

( ) Refer to Detail 1-1) for the location of sockets at locations V1 and V14. Solder all terminals.

( ) In a like manner, solder the components at locations V2 through V12. Solder all 9 pins.

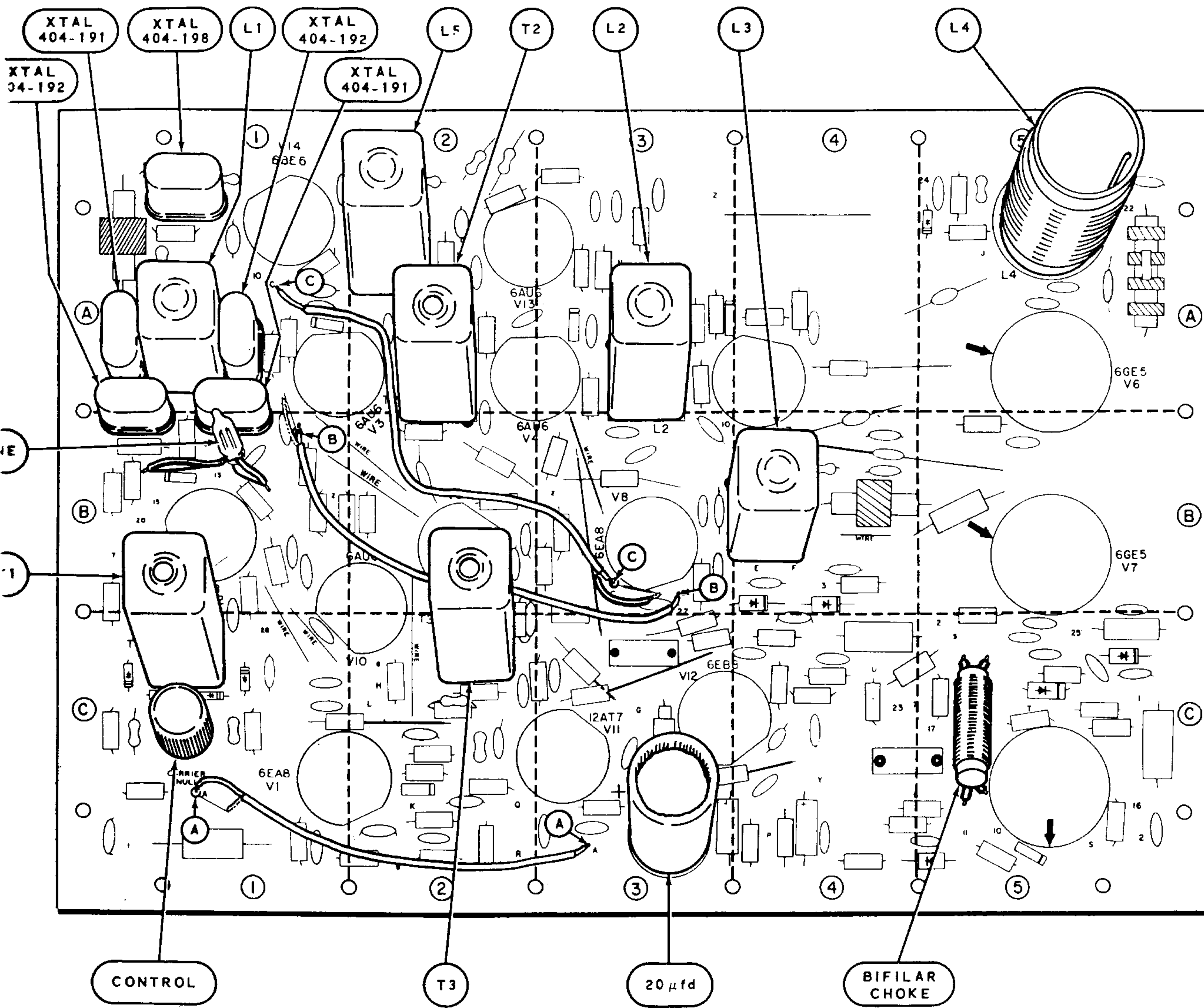
( ) Refer to Detail 1-1) for the location of the components. Solder 6 from one side of the component. Solder the top of the socket.

( ) Refer to Detail 1-1) for the location of the components. Solder the components at location V13 with the arrow. Solder all terminals.



**PICTORIAL 1-1**

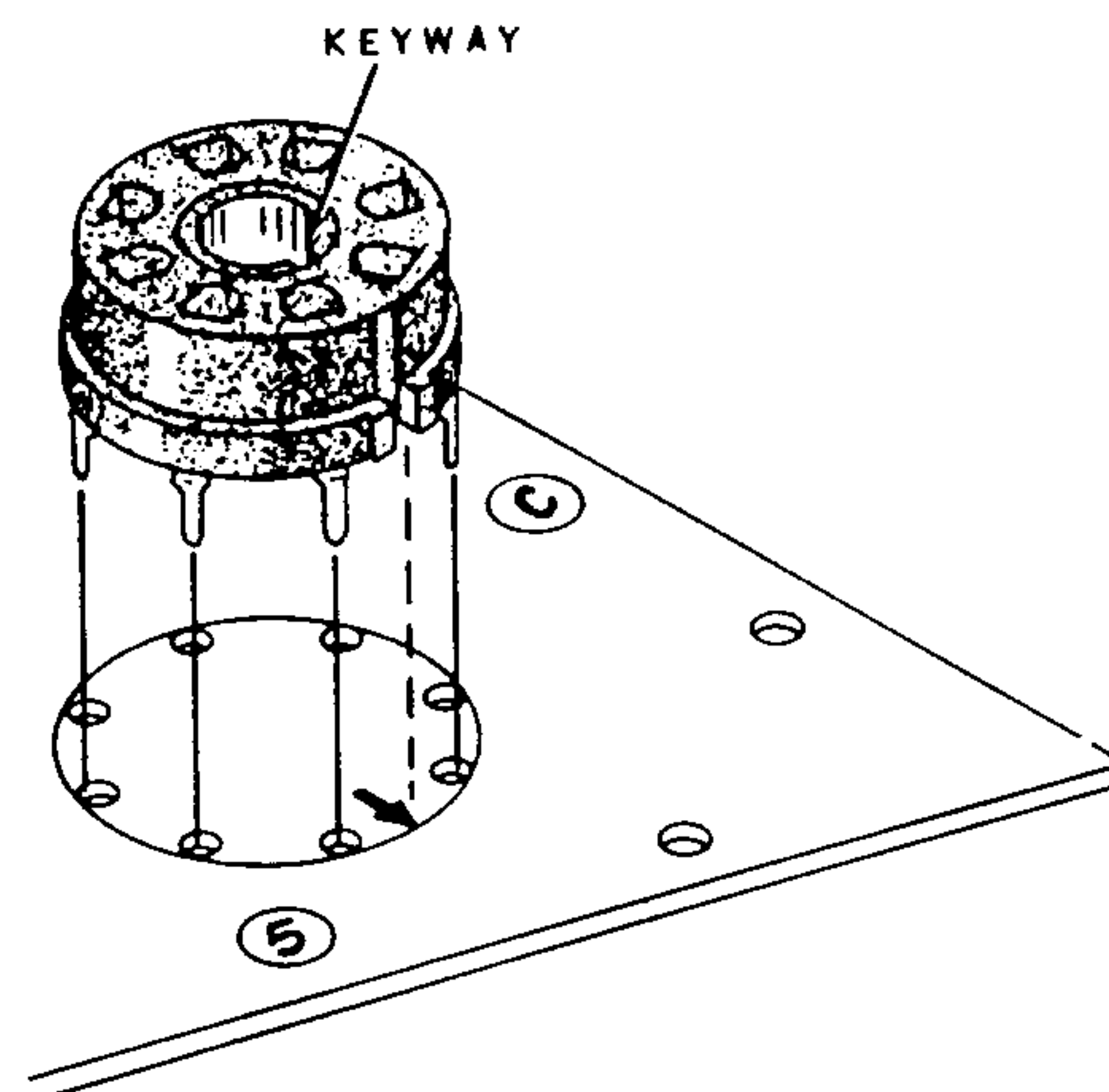




**PICTORIAL 1-10**



- ( ) Remove pins 8 and 9 from the other 12-pin tube socket.
- ( ) Install this socket at location V7. Solder all ten pins of the socket.
- ( ) Refer to Detail 1-1D, and install the 8-pin tube socket at the calibrator location. Align the keyway of the socket with the arrow printed on the circuit board, and solder all eight pins.



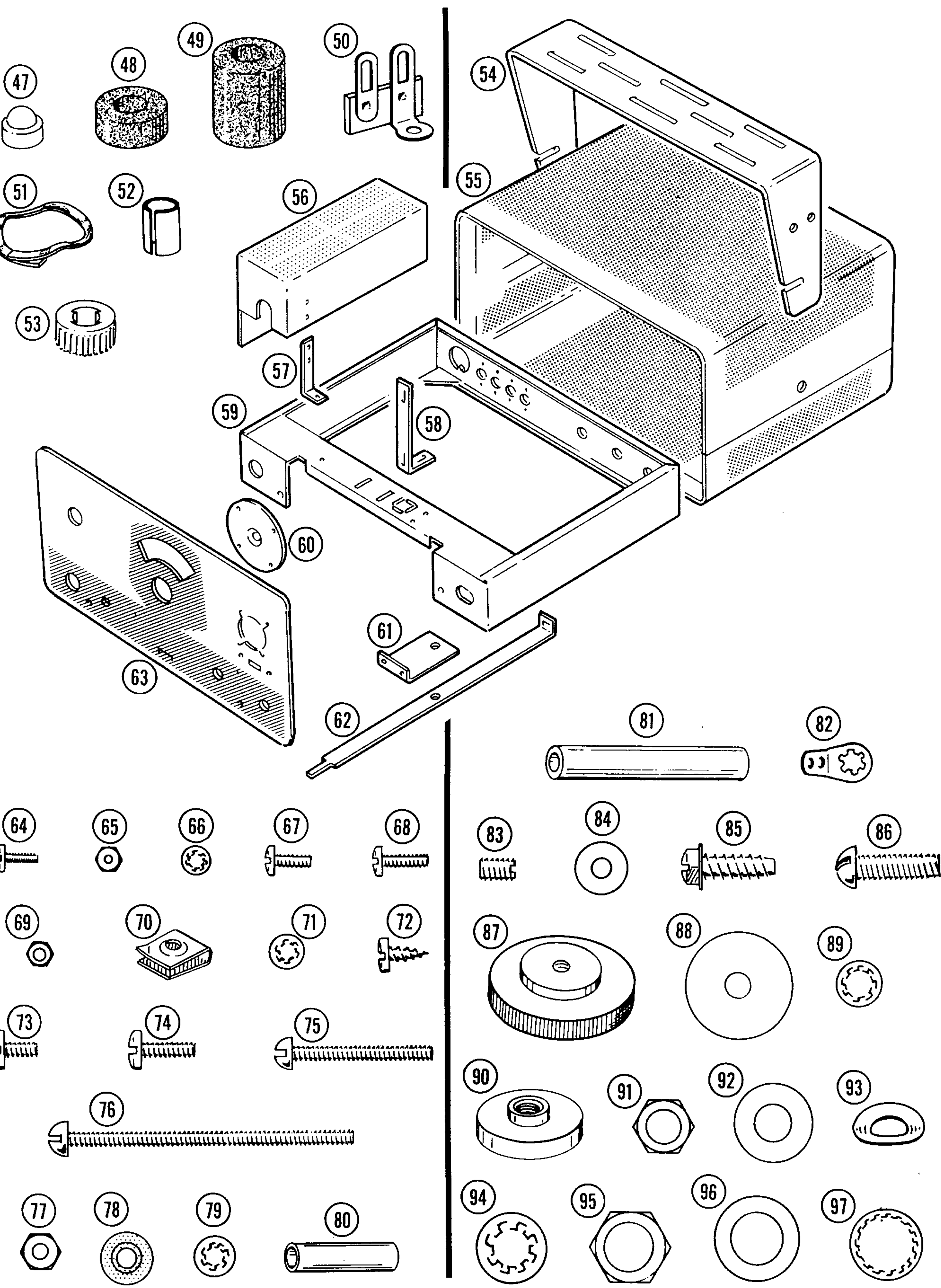
Detail 1-1D

Use 1/2 watt resistors unless directed otherwise in a step. All resistors will be called out by only the resistance value (in  $\Omega$ ,  $K\Omega$ , or megohms) and color code. Capacitors will be called out by only the capacitance value and type.

When a step calls for a "jumper," use the black hookup wire. Prepare the wire by cutting it to the specified length and remove 1/2" of insulation from each end of the wire.

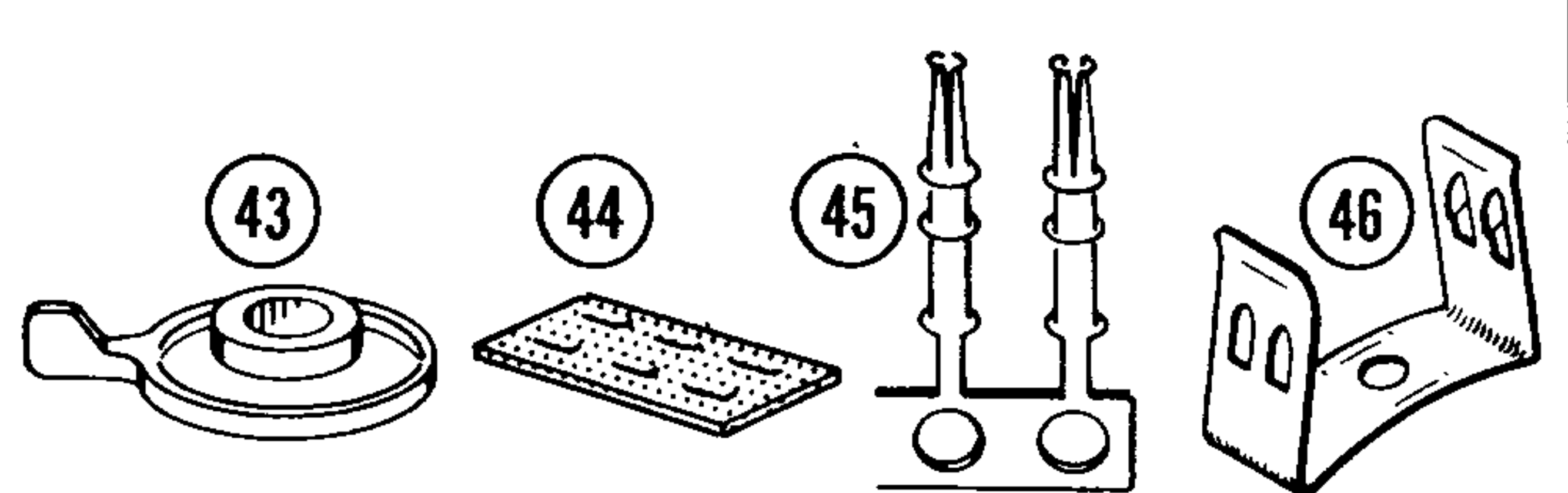
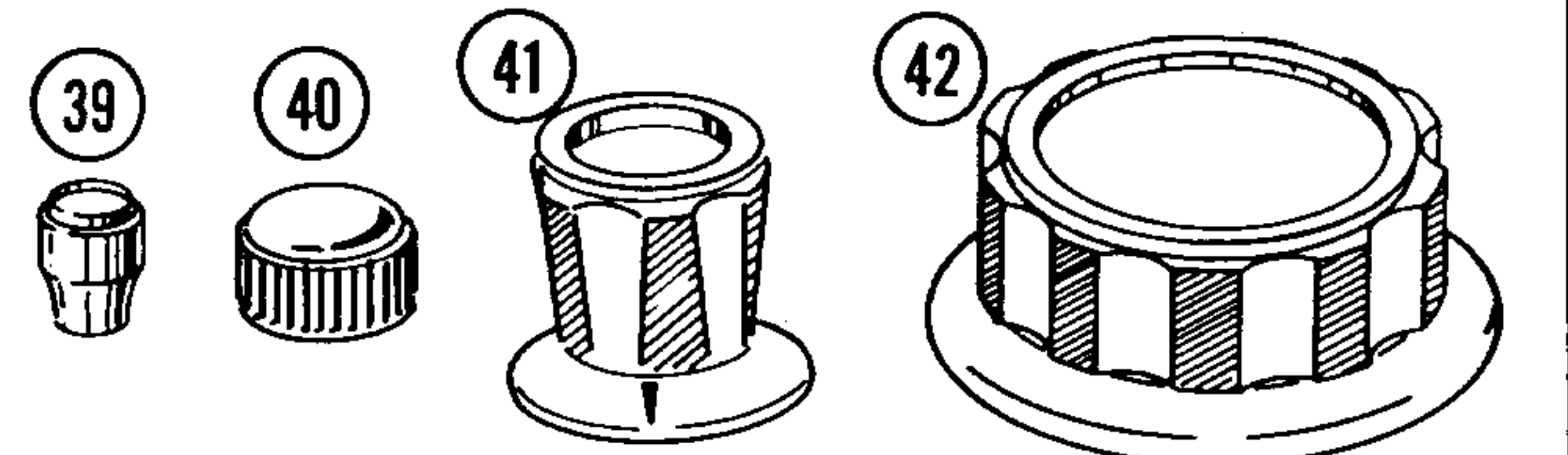
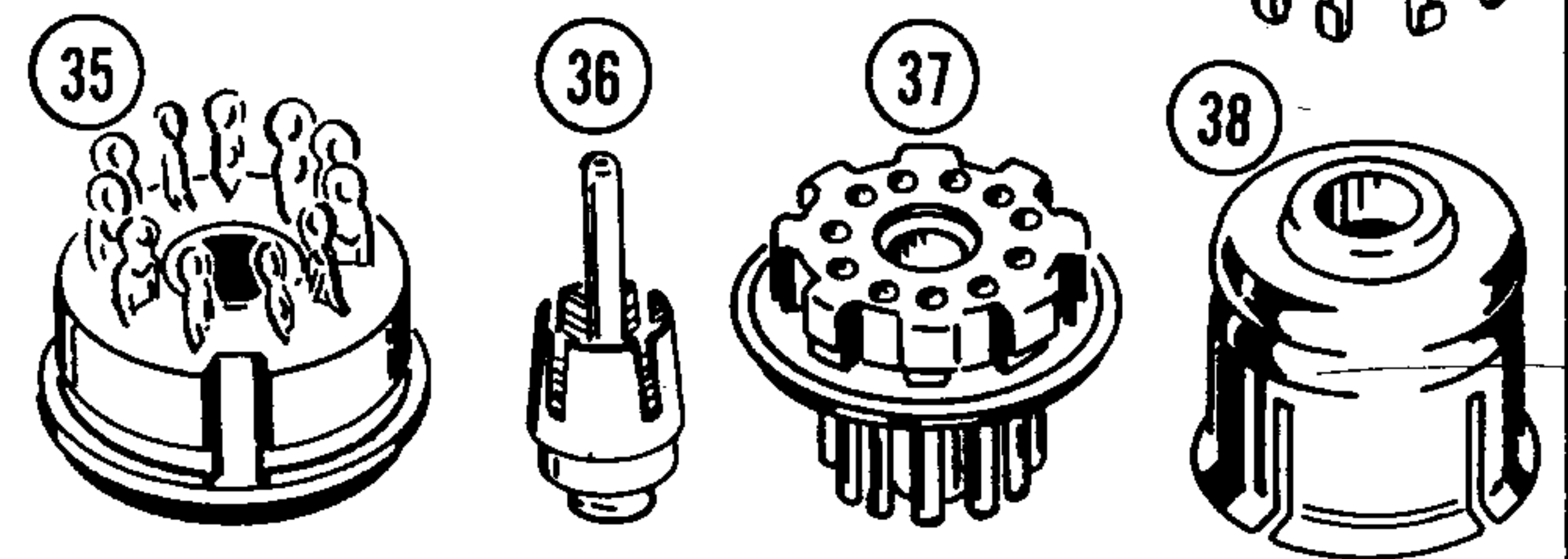
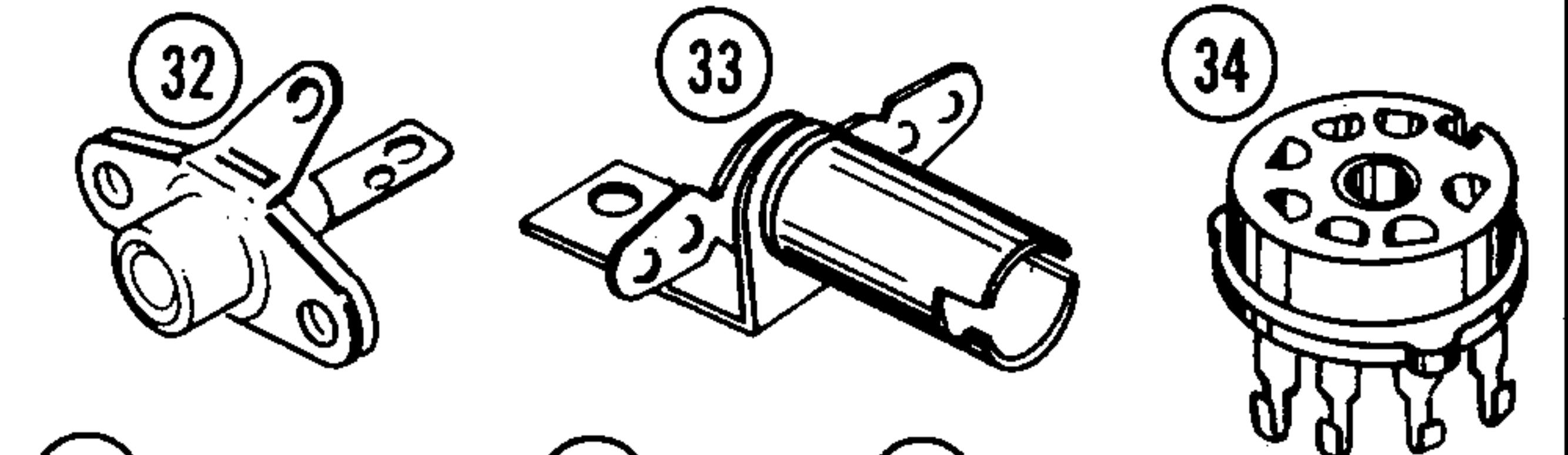
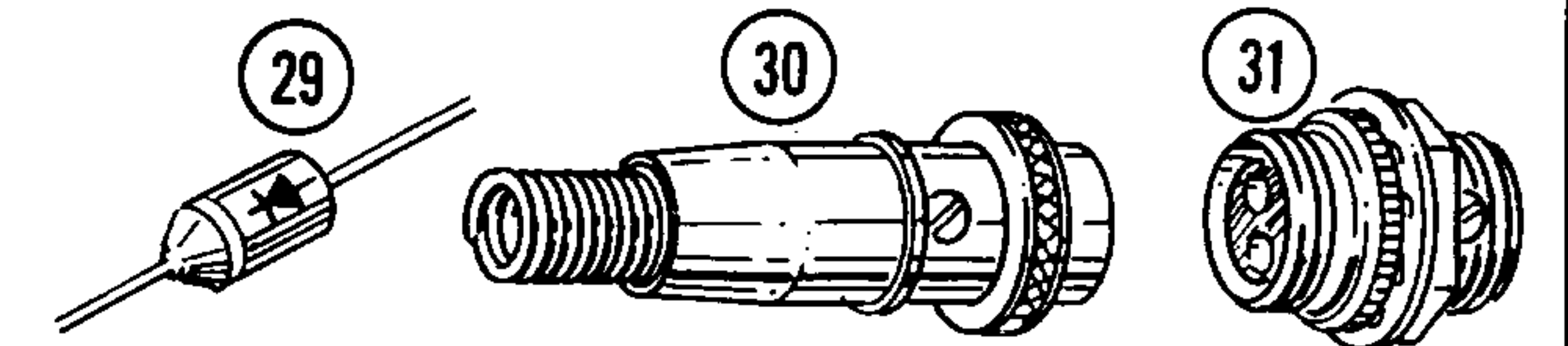
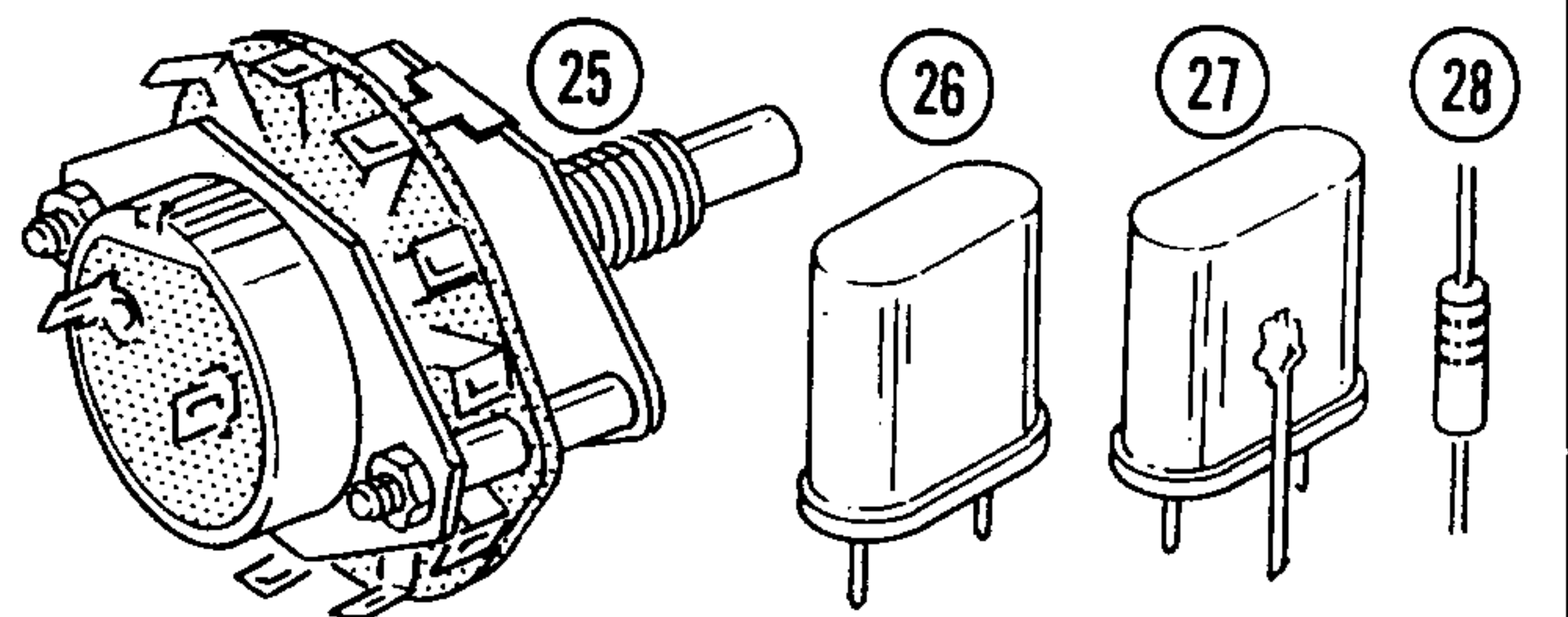
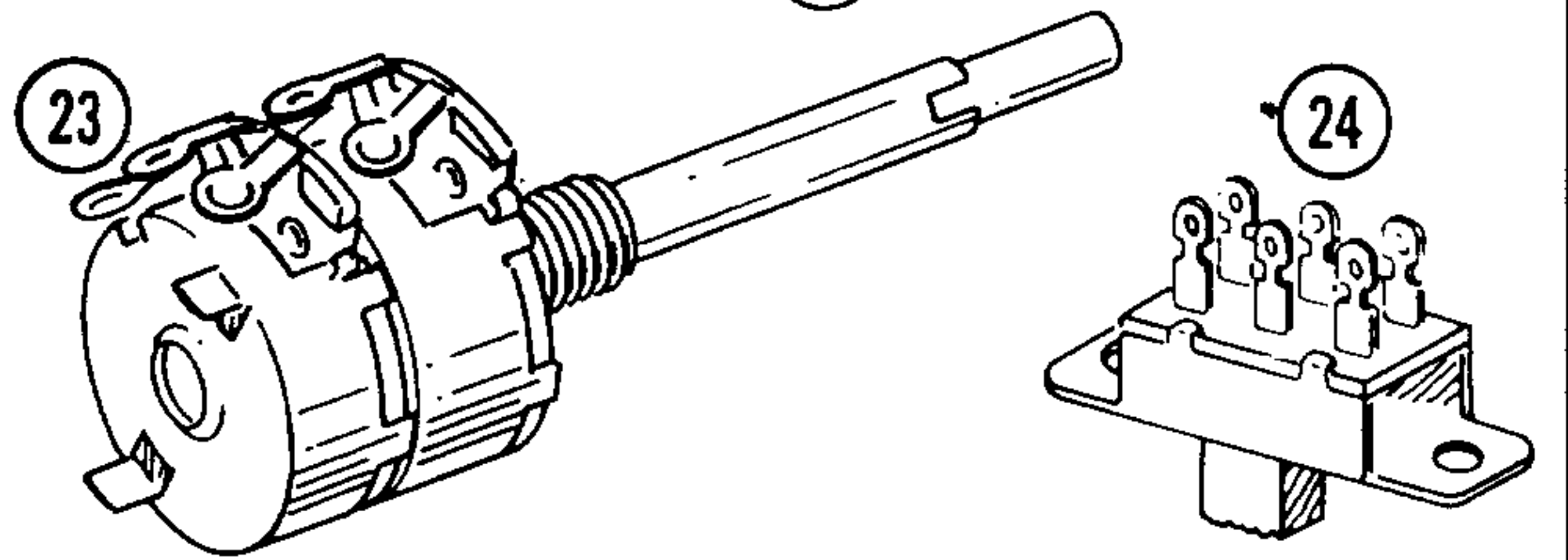
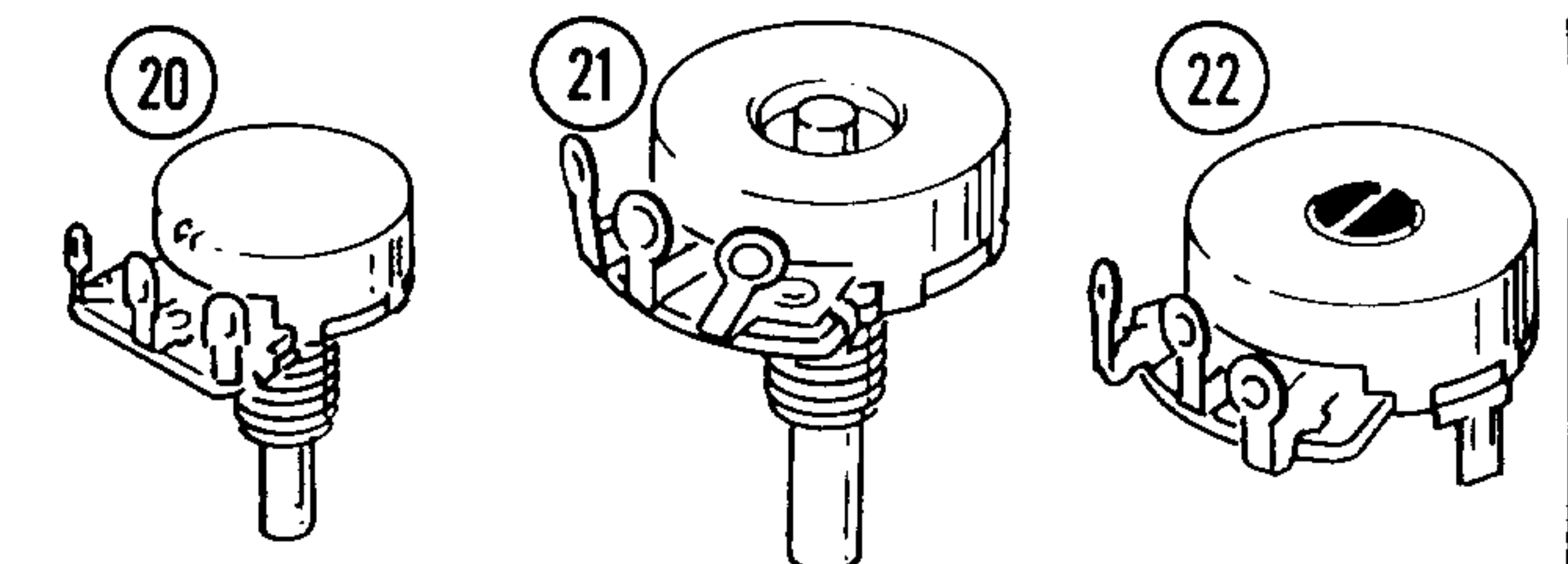
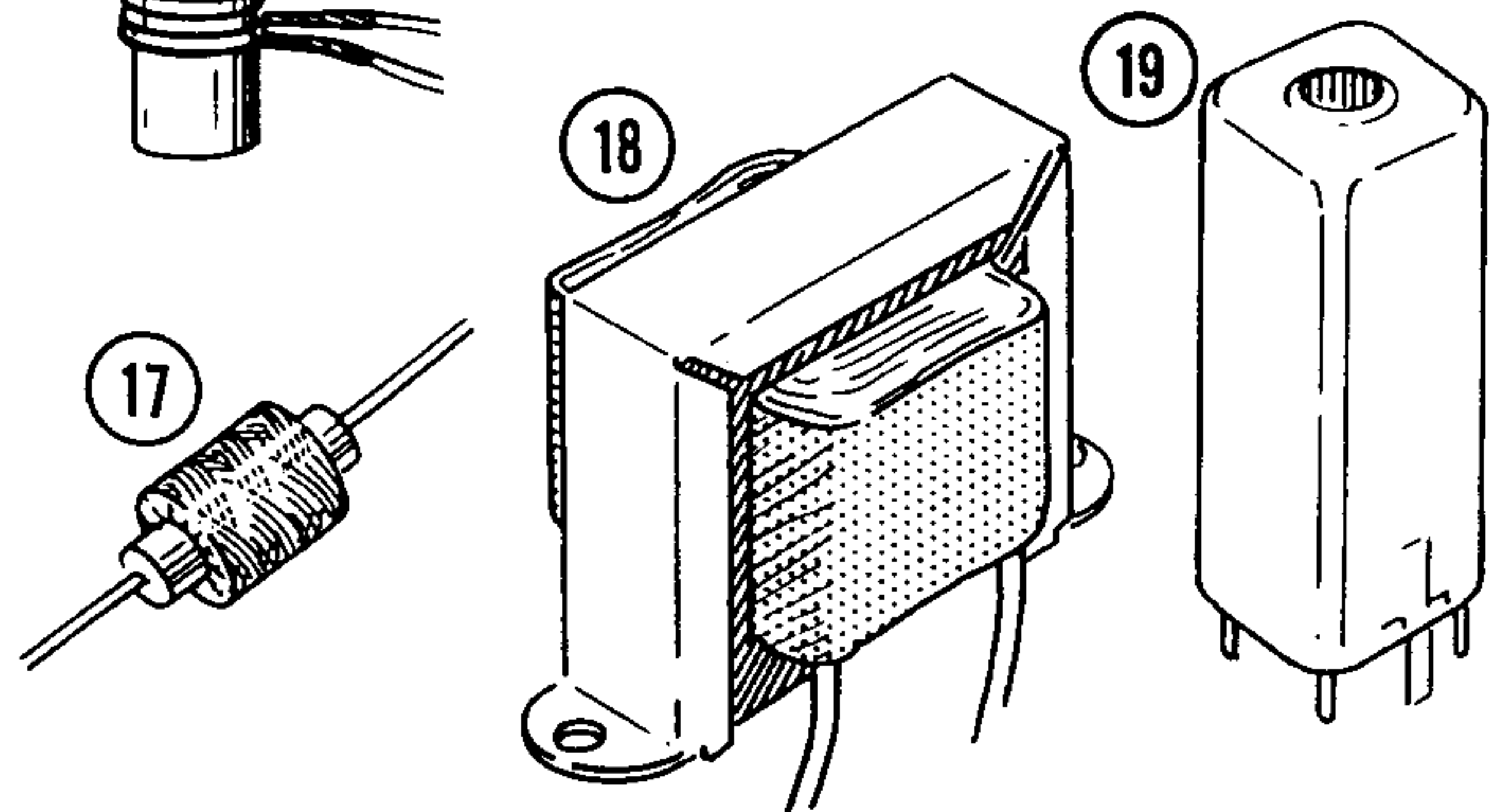
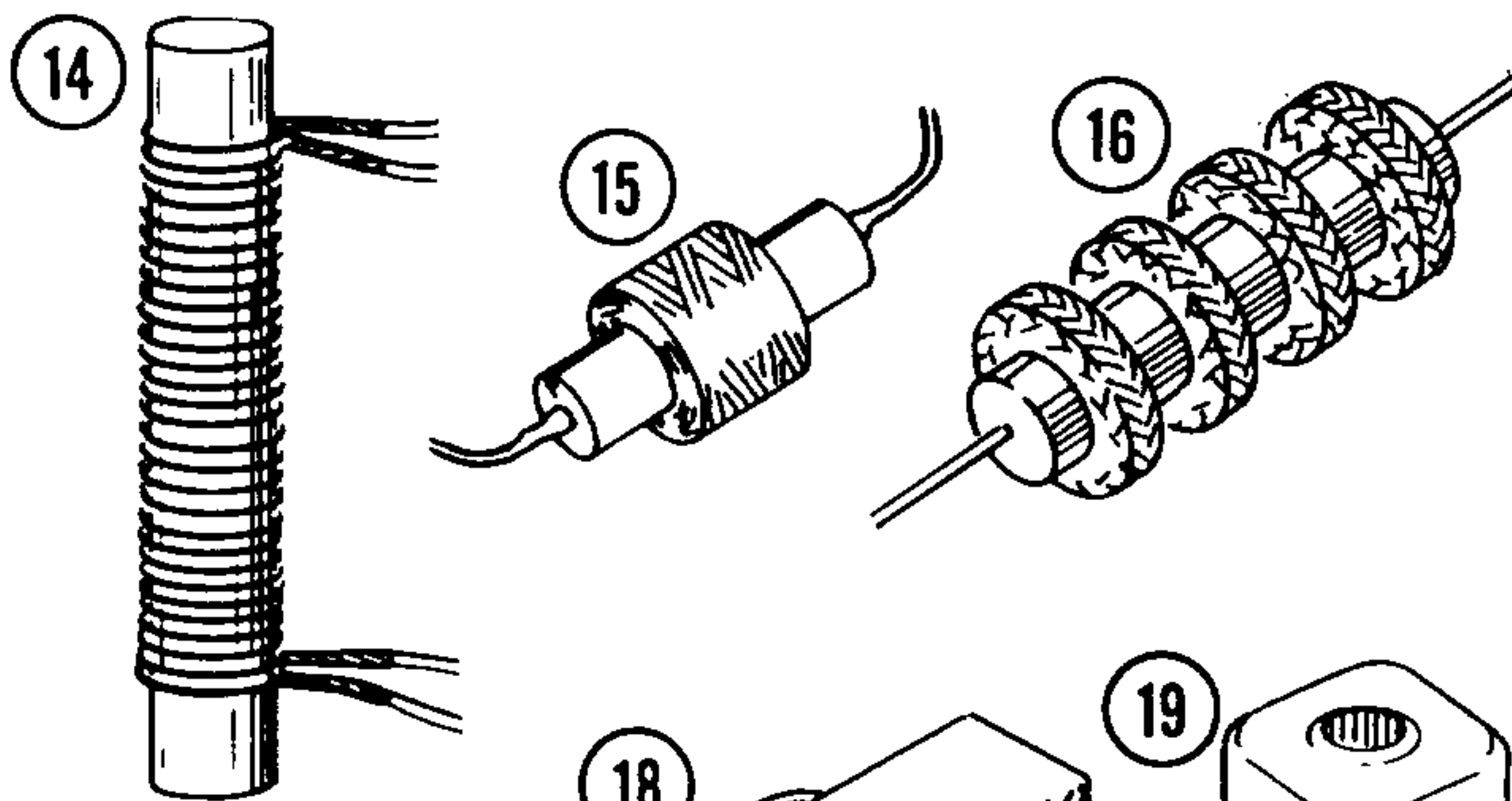
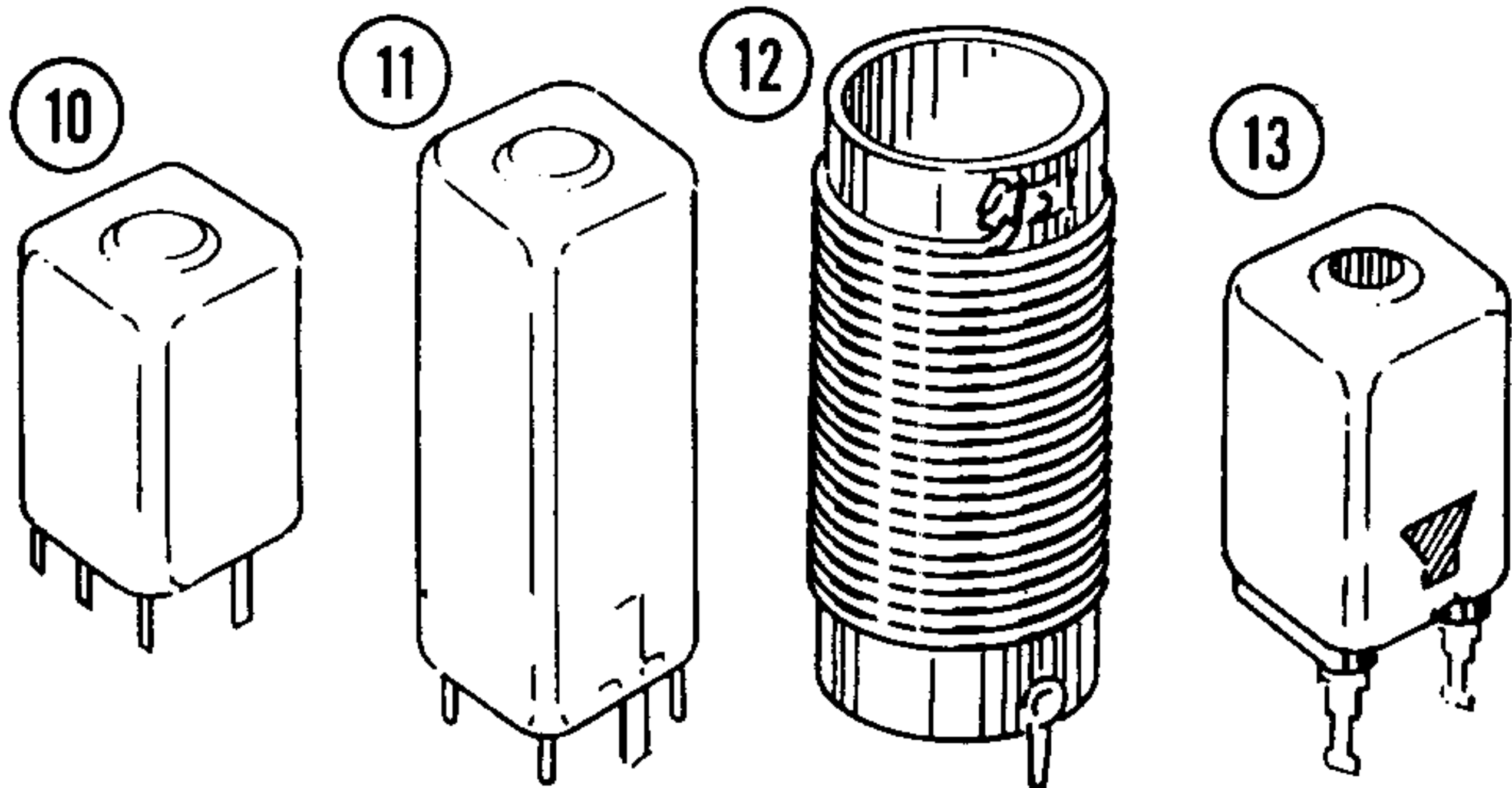
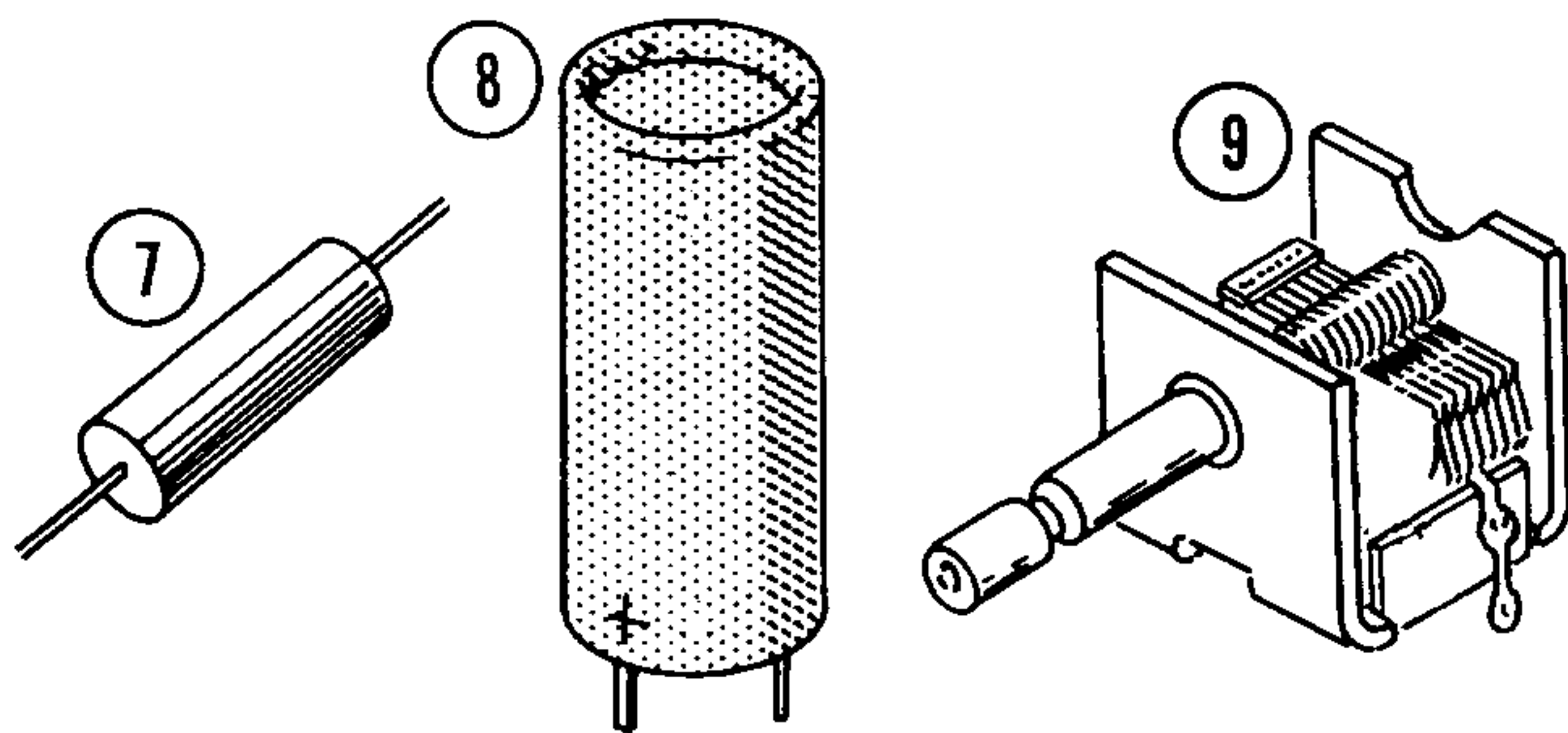
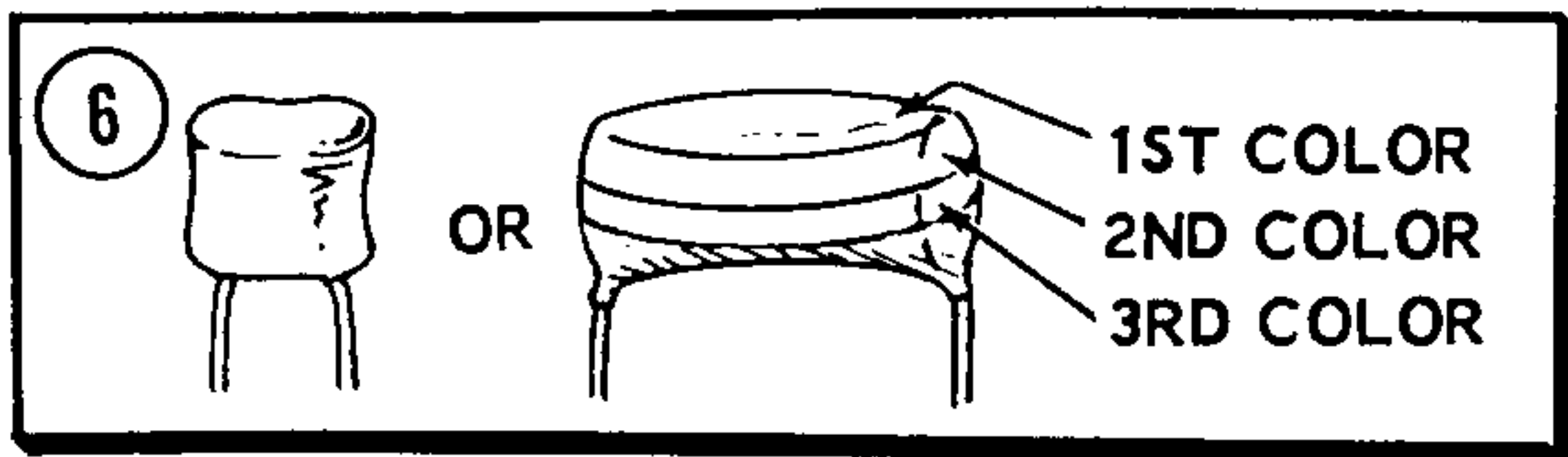
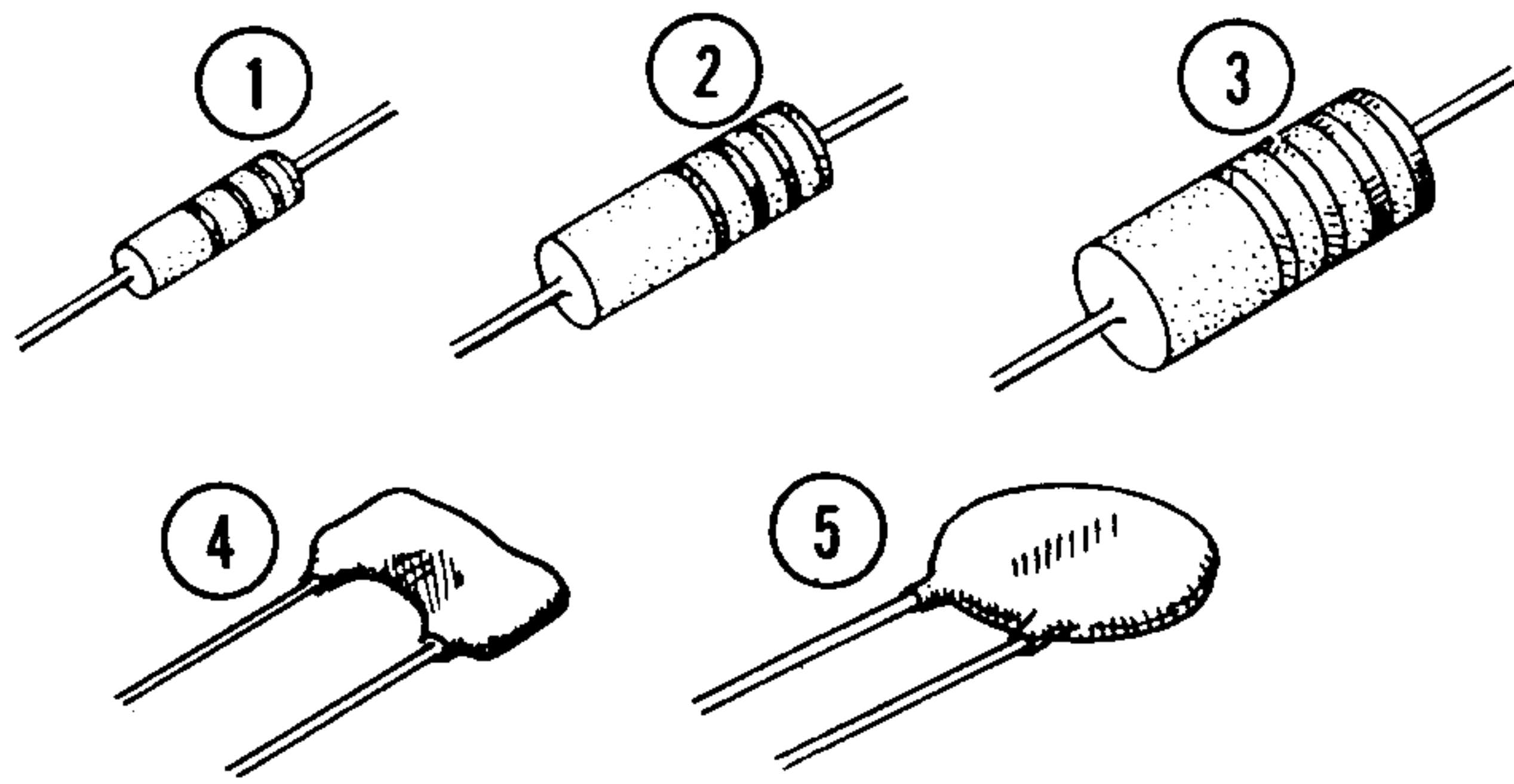
In steps requiring sleeving over a jumper wire or leads of a component, measure the length required directly from the circuit board. Always use the small sleeving unless the large sleeving is specified in a step.

Perform the steps on Pictorials 1-2 through 1-9.



e  
r  
g  
h





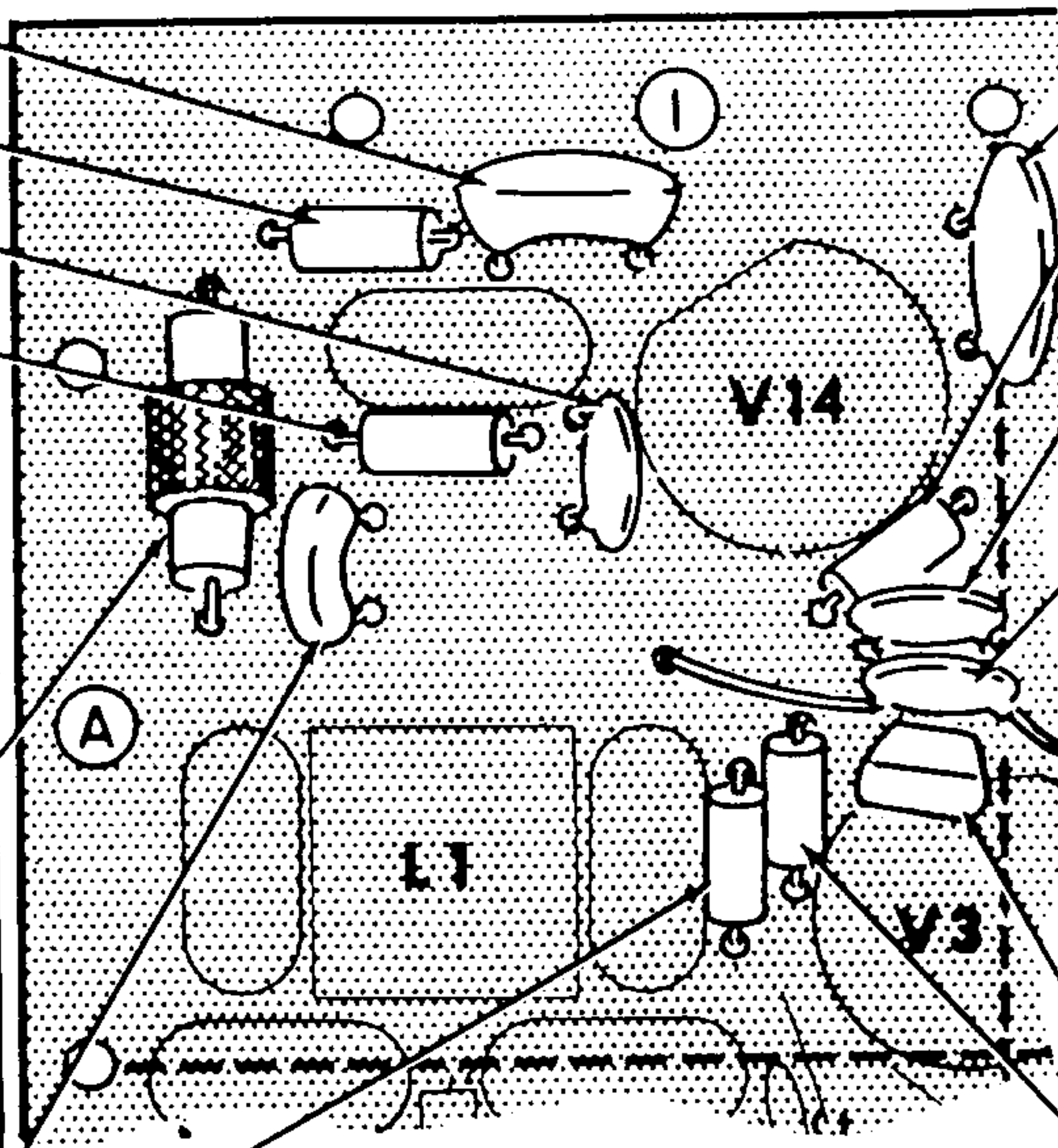
**START**



**CONTINUE**



- ( ) 1800 pf mica.
  - ( ) 150 Ω (brown-green-brown).
  - ( ) 47 pf disc.
  - ( ) 22 KΩ (red-red-orange).
  - ( ) 1 mh (#45-3) choke. Bend each lead toward the slot.
- SLOT
- ( ) 180 pf mica.
  - ( ) 4700 Ω (yellow-violet-red).
  - ( ) Solder all connections and cut off excess leads.



BOARD SECTION 1A

- ( ) .02 μfd disc.
  - ( ) 3300 Ω (orange-orange-red).
  - ( ) .005 μfd disc. NOTE: Do not use the .005 μfd 1.6 KV capacitors until they are called for specifically.
  - ( ) 500 pf disc.
- NOTE: When installing Mylar capacitors having a banded end, position the banded end as marked on the circuit board. If no mark appears on the circuit board, and/or the capacitor, the capacitor can be installed either way.
- ( ) .1 μfd Mylar.
  - ( ) 220 Ω (red-red-brown).
  - ( ) Solder all connections and cut off excess leads.

NOW PERFORM THE STEPS ON PICTORIAL 1-3.

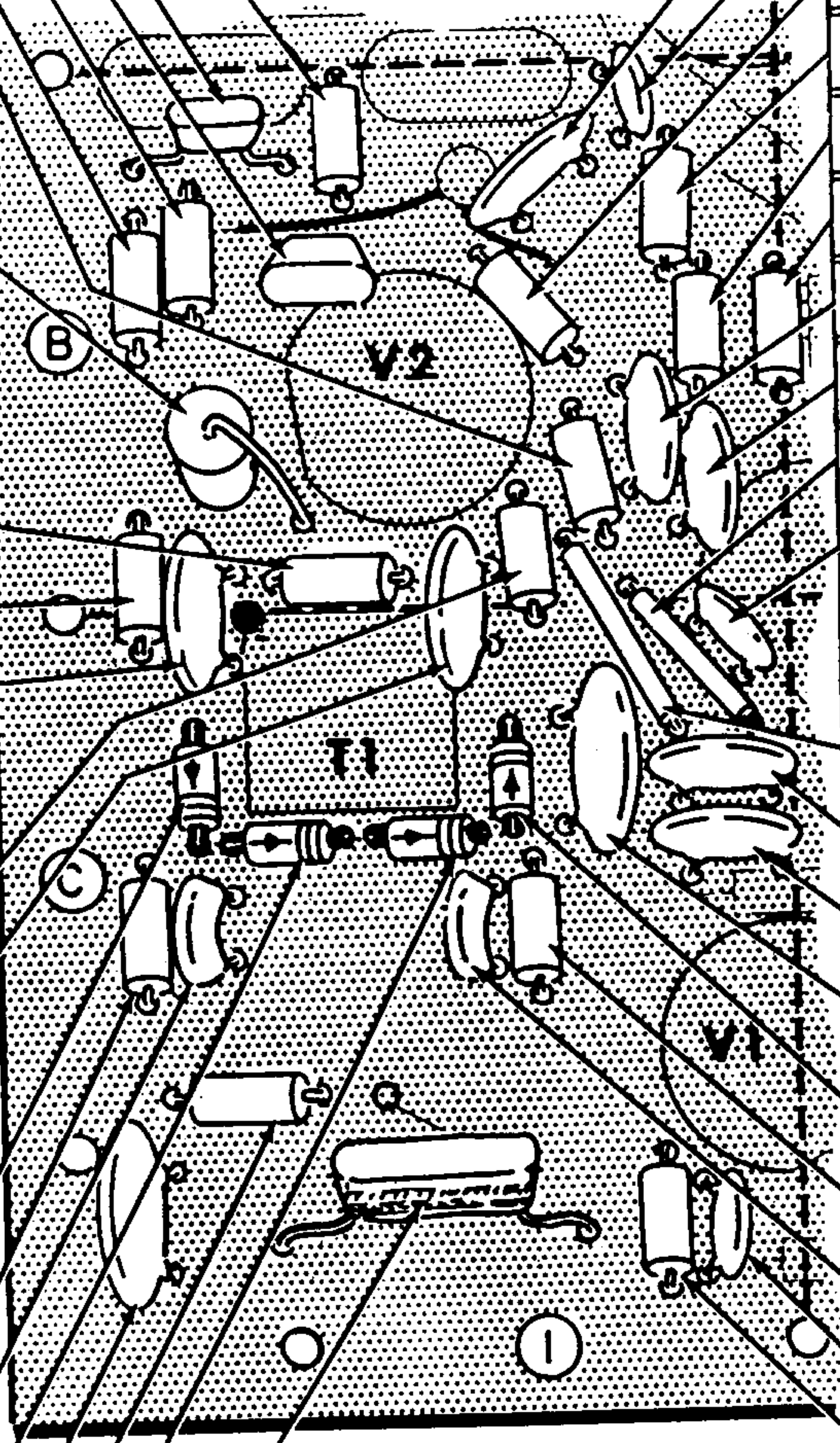
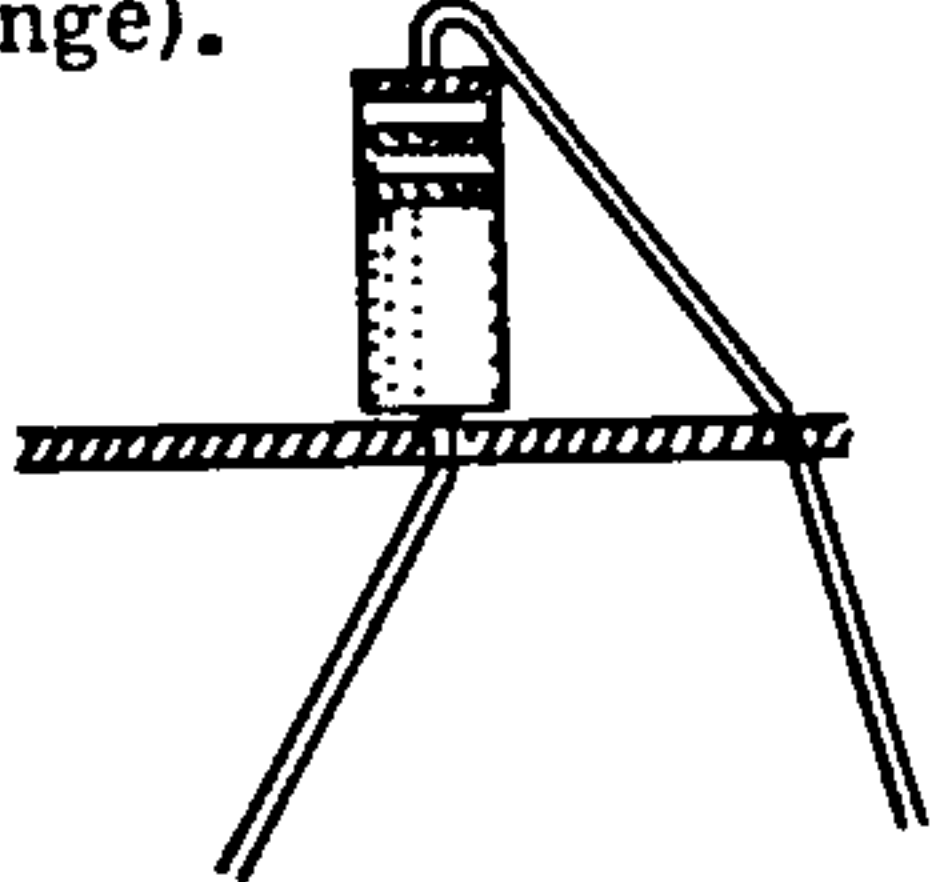
PICTORIAL 1-2



START



- ( ) 220 Ω (red-red-brown).
- ( ) .047 μfd Mylar.
- ( ) .1 μfd Mylar.
- ( ) 1 megohm (brown-black-green).
- ( ) 22 megohm (red-red-blue).
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) 12 KΩ 2 watt (brown-red-orange).
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) .005 μfd disc.
- ( ) Solder all connections and cut off excess leads.
- ( ) 100 KΩ (brown-black-yellow).
- ( ) .005 μfd disc.
- NOTE: Position the banded end of germanium diodes as shown.
- ( ) Germanium diode. Use 1/4" of sleeving on each lead.
- ( ) 220 Ω (red-red-brown).
- ( ) 36 pf mica.
- ( ) Germanium diode. Use 1/4" of sleeving on each lead.
- ( ) .02 μfd disc.
- ( ) 1000 Ω (brown-black-red).
- ( ) Germanium diode. Use 1/4" of sleeving on each lead.
- ( ) .47 μfd Mylar. Be careful when bending the leads so they do not pull out of the capacitor.
- ( ) Solder all connections and cut off excess leads.



BOARD SECTIONS 1B AND 1C

CONTINUE



- ( ) .005 μfd disc.
- ( ) 18 pf disc.
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 220 KΩ (red-red-yellow).
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) 1 megohm (brown-black-green).
- ( ) .02 μfd disc.
- ( ) .02 μfd disc.
- ( ) 1-3/4" jumper.
- ( ) 500 pf disc.
- ( ) Solder all connections and cut off excess leads.
- ( ) 1-7/8" jumper.
- ( ) .005 μfd disc.
- ( ) .005 μfd disc.
- ( ) .02 μfd disc.
- ( ) Germanium diode. Use 1/4" of sleeving on each lead.
- ( ) 220 Ω (red-red-brown).
- ( ) 36 pf mica.
- ( ) 500 pf disc.
- ( ) 1000 Ω (brown-black-red).
- ( ) Solder all connections and cut off excess leads.

NOW PERFORM THE STEPS ON PICTORIAL 1-4.

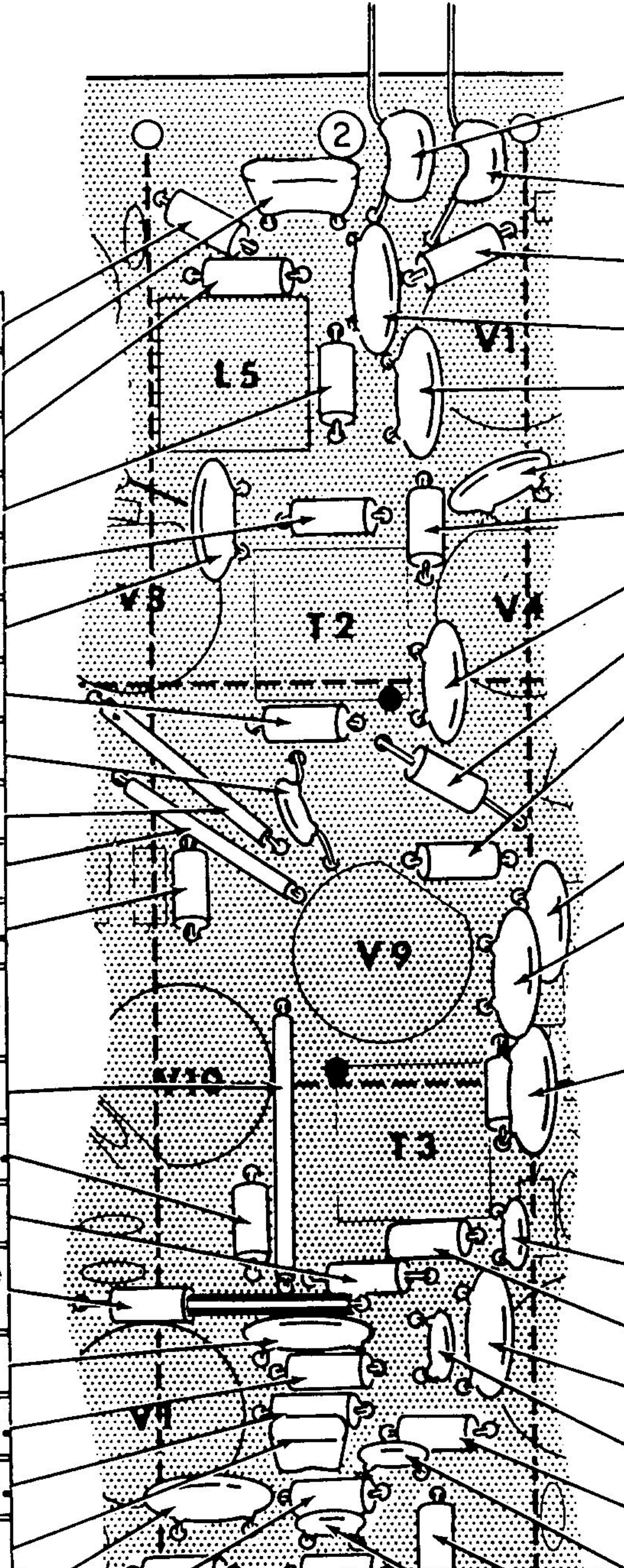
PICTORIAL 1-3



CONTINUE



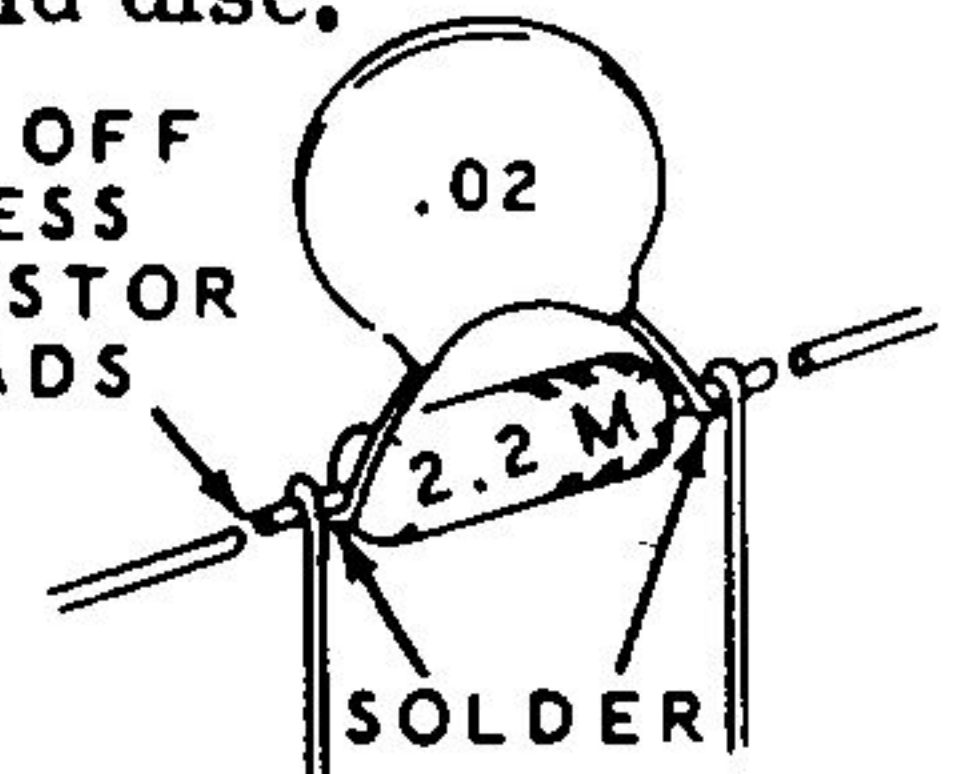
START



- ( ) 100 KΩ (brown-black-yellow).
- ( ) 1000 pf mica.
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) 1000 Ω (brown-black-red).
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) .005 μfd disc.
- ( ) 100 KΩ (brown-black-yellow).
- ( ) 18 pf disc.
- ( ) 2-1/8" jumper.
- ( ) 2" jumper.
- ( ) 1 megohm (brown-black-green).
- ( ) Solder all connections and cut off excess leads.
- ( ) 2-3/8" jumper.
- ( ) 1 megohm (brown-black-green).
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 220 KΩ (red-red-yellow). Use sleeving on one lead.
- ( ) .02 μfd disc.
- ( ) 1 megohm (brown-black-green).
- ( ) 1 megohm (brown-black-green).
- ( ) .1 μfd Mylar.

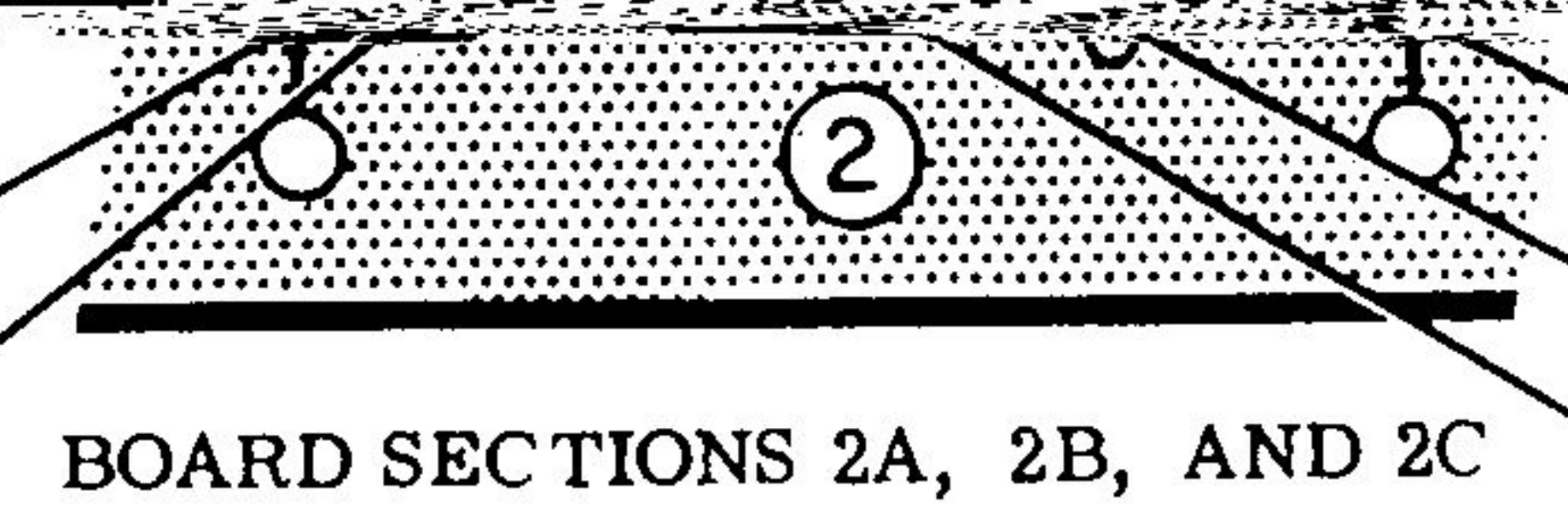
- ( ) 680 pf mica. Connect only one lead (S-1).
- ( ) 100 pf mica. Connect only one lead (S-1).
- ( ) 100 KΩ (brown-black-yellow).
- ( ) .02 μfd disc.
- ( ) .02 μfd disc.
- ( ) .005 μfd disc.
- ( ) 330 Ω (orange-orange-brown).
- ( ) .02 μfd disc.
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 100 KΩ (brown-black-yellow).
- ( ) Solder all connections and cut off excess leads.
- ( ) .005 μfd disc.
- ( ) .02 μfd disc.
- ( ) 2.2 megohm (red-red-green) and .02 μfd disc.
- ( ) 18 pf disc.
- ( ) 220 KΩ (red-red-yellow).
- ( ) .02 μfd disc.
- ( ) 18 pf disc.
- ( ) 3300 Ω (orange-orange-red).
- ( ) .02 μfd disc.

CUT OFF EXCESS RESISTOR LEADS



- ( ) 100 KΩ (brown-black-orange).
- ( ) .02 μfd disc.
- ( ) 100 KΩ (brown-black-yellow).
- ( ) Solder all connections and cut off excess leads.

- ( ) .02 μfd disc.
- ( ) 1000 Ω (brown-black-red).
- ( ) 22 KΩ (red-red-orange).
- ( ) Solder all connections and cut off excess leads.



- ( ) 10 KΩ
- ( ) 500 p
- ( ) 100
- ( ) Solder off ex

PERFORM THE STEPS PICTORIAL 1-5.

NOW ON P

PICTORIAL 1-4



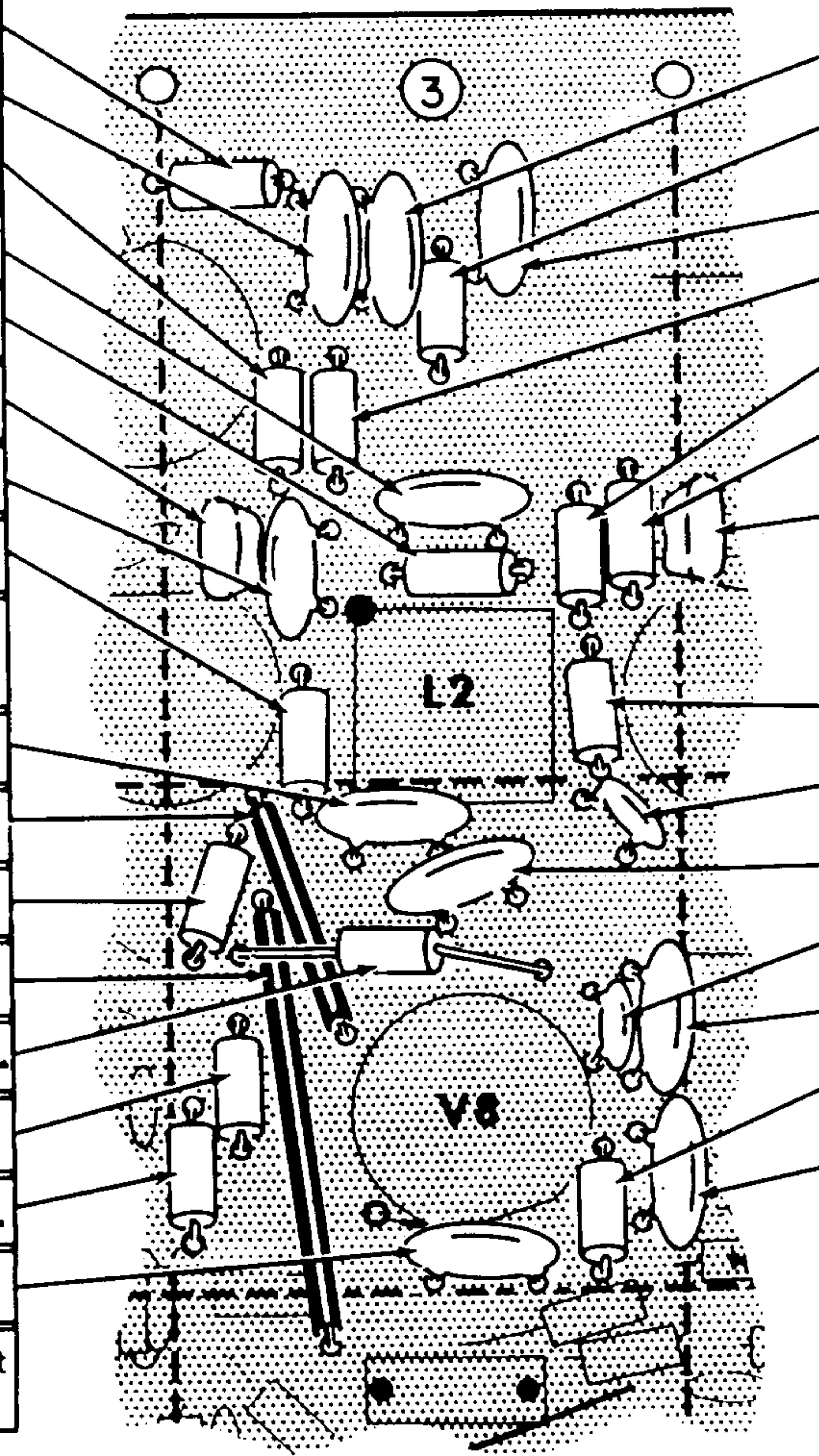
START



CONTINUE



- ( ) 10 KΩ (brown-black-orange).
- ( ) .02 μfd disc.
- ( ) 22 KΩ (red-red-orange).
- ( ) .02 μfd disc.
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) .1 μfd Mylar.
- ( ) .005 μfd disc.
- ( ) 100 KΩ (brown-black-yellow).
- ( ) Solder all connections and cut off excess leads.
- ( ) .02 μfd disc.
- ( ) 2" jumper. Use sleeving.
- ( ) 1000 Ω (brown-black-red).
- ( ) 2-7/8" jumper. Use sleeving.
- ( ) 1 megohm (brown-black-green).
- ( ) 1000 Ω (brown-black-red).
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) .005 μfd disc.
- ( ) Solder all connections and cut off excess leads.



- ( ) .02 μfd disc.
- ( ) 1000 Ω (brown-black-red).
- ( ) .02 μfd disc.
- ( ) 220 KΩ (red-red-yellow).
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 150 Ω (brown-green-brown).
- ( ) .1 μfd Mylar.
- ( ) Solder all connections and cut off excess leads.
- ( ) 47 Ω (yellow-violet-black).
- ( ) 47 pf disc.
- ( ) .02 μfd disc.
- ( ) 47 pf disc.
- ( ) .005 μfd disc.
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) .02 μfd disc.
- ( ) Solder all connections and cut off excess leads.

NOW PERFORM THE STEPS ON PICTORIAL 1-6.

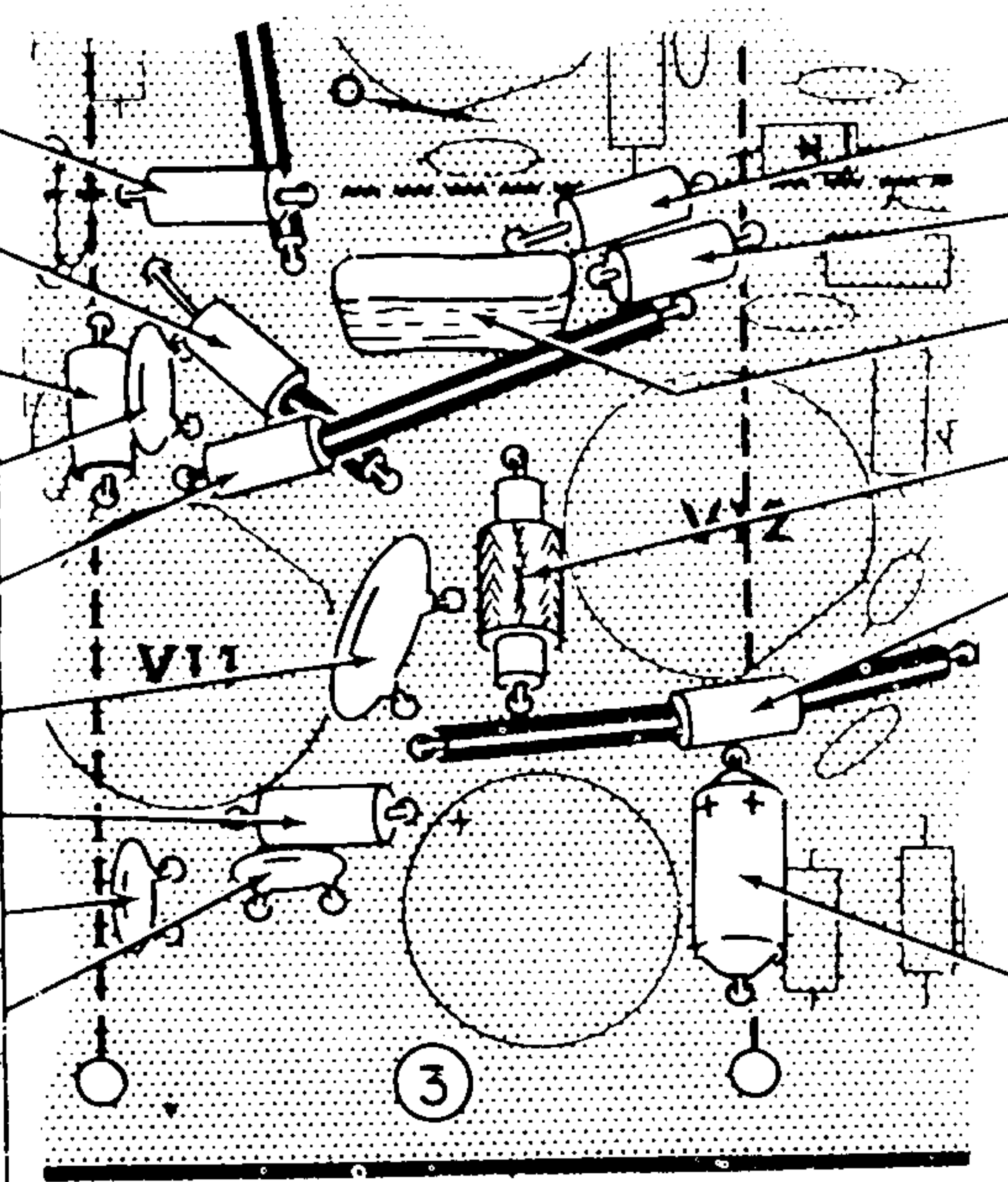
BOARD SECTIONS 3A AND 3B

PICTORIAL 1-5

**START**



- ( ) 2.2 megohm (red-red-green).
- ( ) 1 megohm (brown-black-green).  
Use sleeving on one lead.
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 500 pf disc.
- ( ) 47 KΩ (yellow-violet-orange).  
Use sleeving on one lead.
- ( ) .02 μfd disc.
- ( ) 22 KΩ (red-red-orange).
- ( ) 47 pf disc.
- ( ) 47 pf disc.
- ( ) Solder all connections and cut off excess leads.



BOARD SECTION 3C

**CONTINUE**



- ( ) 1 megohm (brown-black-green).
- ( ) 100 KΩ (brown-black-yellow).
- ( ) .47 μfd Mylar.
- ( ) 2 mh (#45-47) choke. Bend each lead toward the slot.
- ( ) 2.2 megohm (red-red-green).  
Use sleeving on both leads.
- NOTE: When installing electrolytic capacitors, position the positive (+) lead in the (+) marked hole in the circuit board.
- ( ) 10 μfd electrolytic. Note position of (+) end.
- ( ) Solder all connections and cut off excess leads.

NOW PERFORM THE STEPS ON PICTORIAL 1-7.

PICTORIAL 1-6

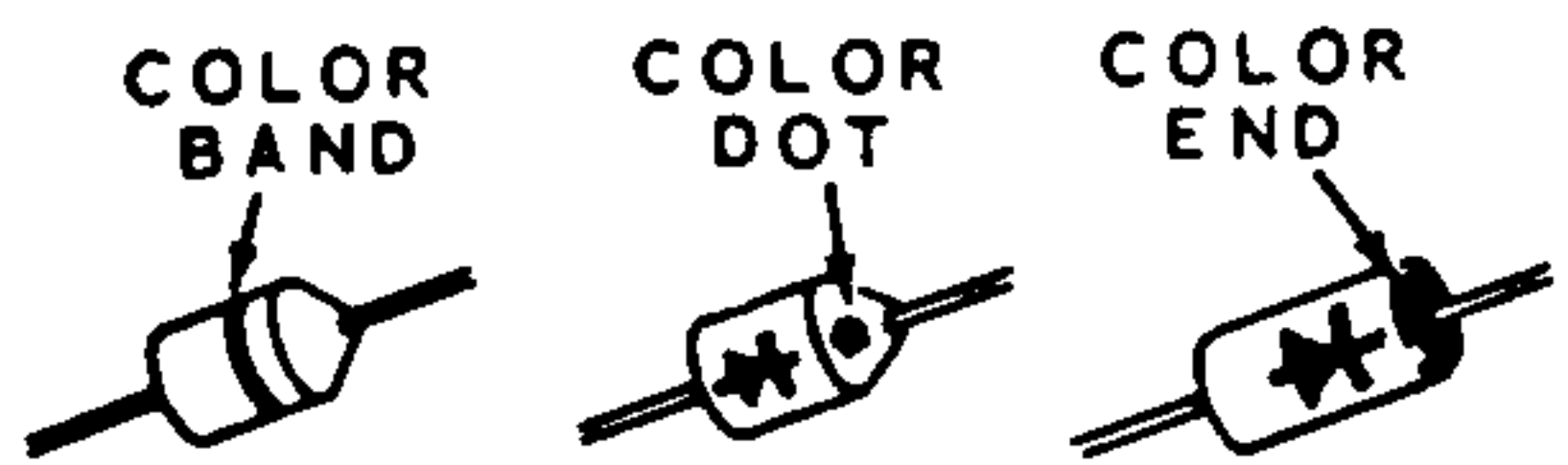


START

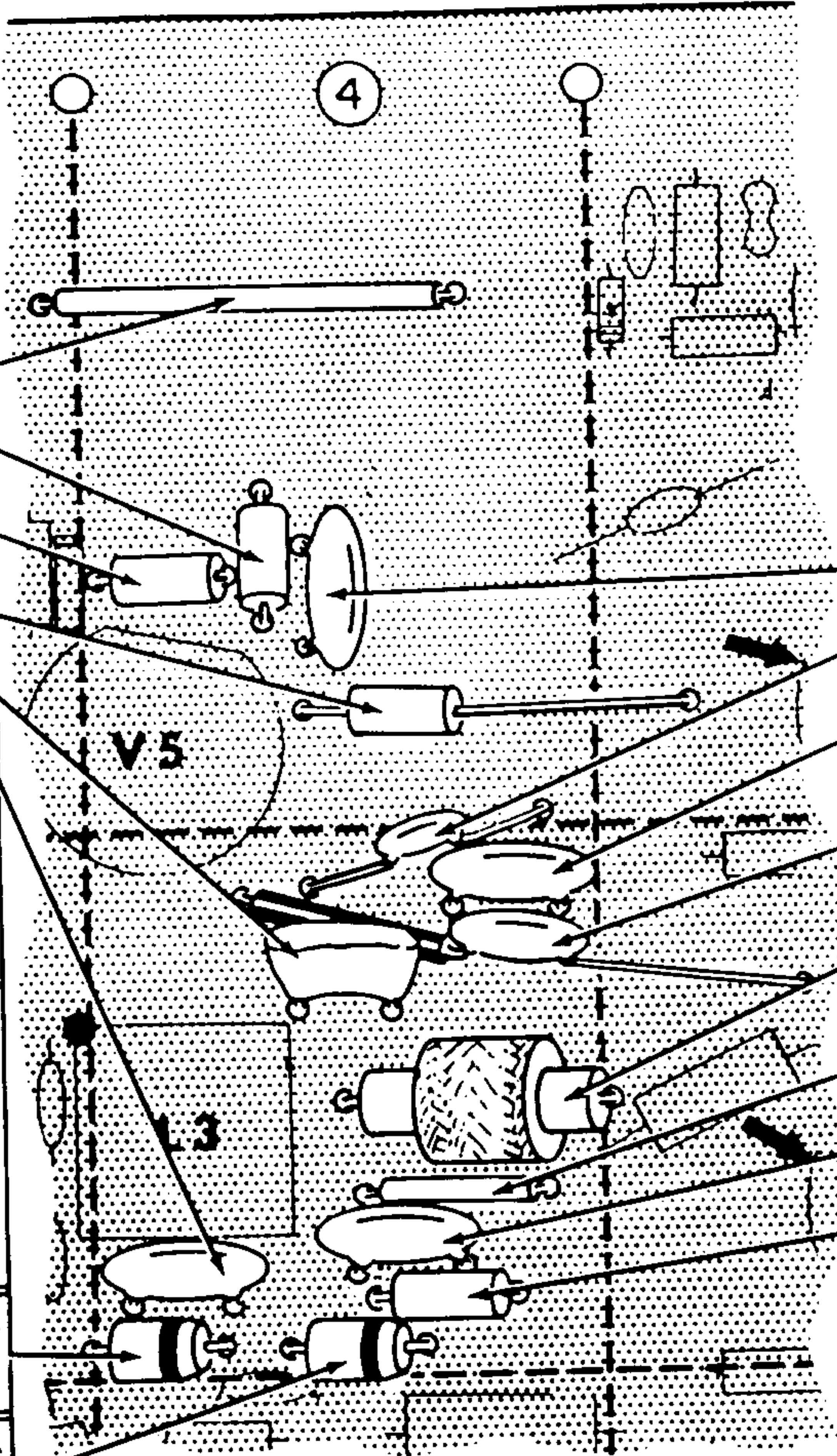


- ( ) 2-1/2" jumper.
- ( ) 100 KΩ (brown-black-yellow).
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) 22 KΩ (red-red-orange).
- ( ) 1300 pf mica.
- ( ) .02 μfd disc.

NOTE: When installing silicon diodes, the banded end should be placed as shown. The banded end is marked with a color end, a color dot, or a color band.



- ( ) Silicon diode. Note position of banded end.
- ( ) Silicon diode. Note position of banded end.
- ( ) Solder all connections and cut off excess leads.



BOARD SECTIONS 4A AND 4B

CONTINUE



- ( ) .005 μfd disc.
- ( ) 18 pf disc.
- ( ) .02 μfd disc.
- ( ) .005 μfd disc. Use sleeving on one lead.
- ( ) 1 mh (#45-3) choke. Bend each lead toward the slot.
- ( ) 1-1/2" jumper.
- ( ) .02 μfd disc.
- ( ) 100 KΩ (brown-black-yellow).
- ( ) Solder all connections and cut off the excess leads.

NOW PERFORM THE STEPS ON PICTORIAL 1-8.

PICTORIAL 1-7

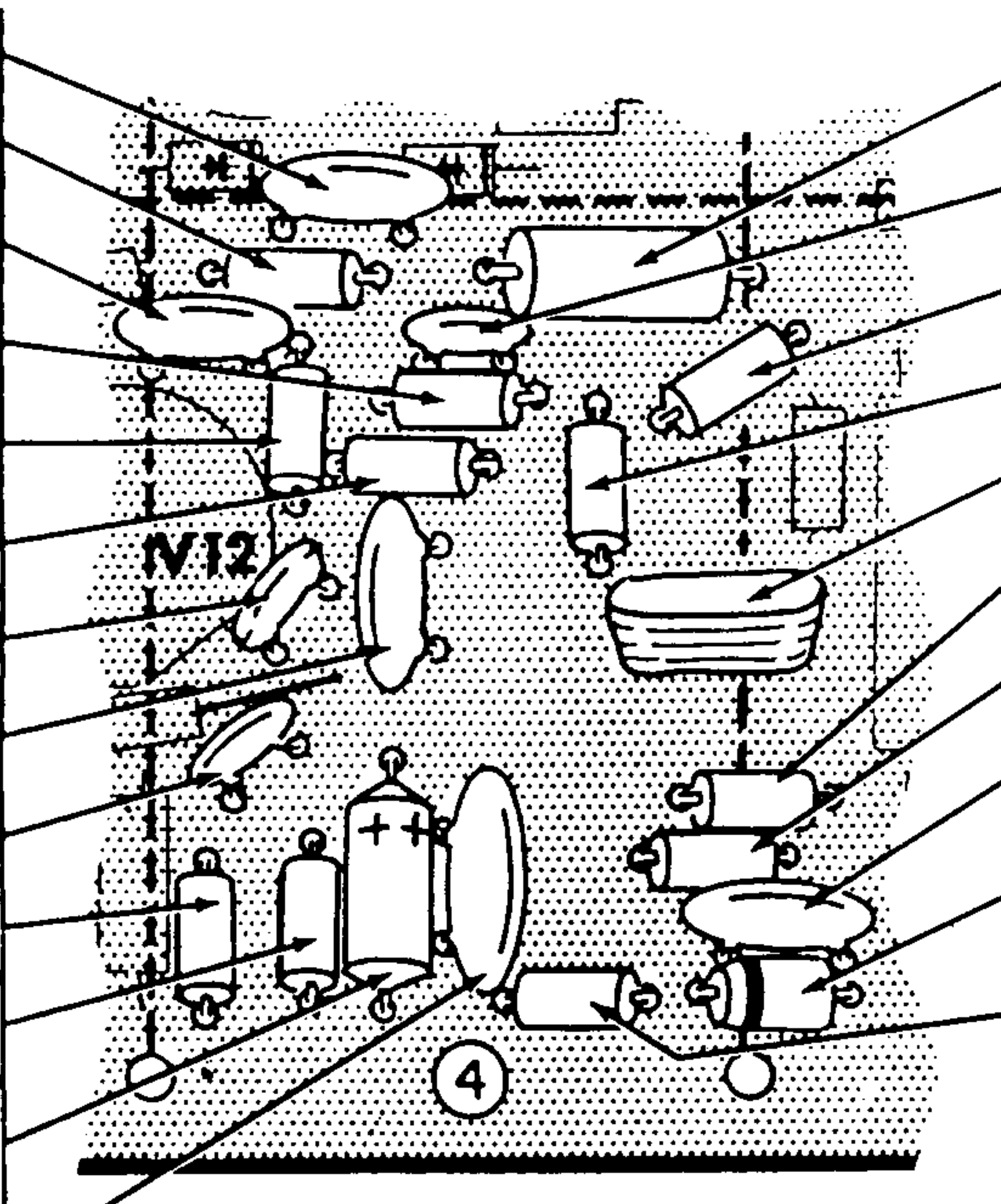
START



CONTINUE



- ( ) .02  $\mu$ f disc.
- ( ) 220 K $\Omega$  (red-red-yellow).
- ( ) .005  $\mu$ f disc.
- ( ) 1 megohm (brown-black-green).
- ( ) 47 K $\Omega$  (yellow-violet-orange).
- ( ) 100 K $\Omega$  (brown-black-yellow).
- ( ) 180 pf mica.
- ( ) .005  $\mu$ f disc.
- ( ) 500 pf disc.
- ( ) 100  $\Omega$  (brown-black-brown).
- ( ) 3300  $\Omega$  (orange-orange-red).
- ( ) 10  $\mu$ f electrolytic. Note position of (+) end.
- ( ) .005  $\mu$ f 1.6 KV disc.
- ( ) Solder all connections and cut off excess leads.



BOARD SECTION 4C

- ( ) 12 K $\Omega$  2 watt (brown-red-orange).
- ( ) 500 pf disc.
- ( ) 2.2 megohm (red-red-green).
- ( ) 10 K $\Omega$  (brown-black-orange).
- ( ) .22  $\mu$ f Mylar.
- ( ) 220 K $\Omega$  (red-red-yellow).
- ( ) 100 K $\Omega$  (brown-black-yellow).
- ( ) .02  $\mu$ f disc.
- ( ) Silicon diode. Note position of banded end.
- ( ) 47 K $\Omega$  (yellow-violet-orange).
- ( ) Solder all connections and cut off excess leads.

NOW PERFORM THE STEPS ON PICTORIAL 1-9.

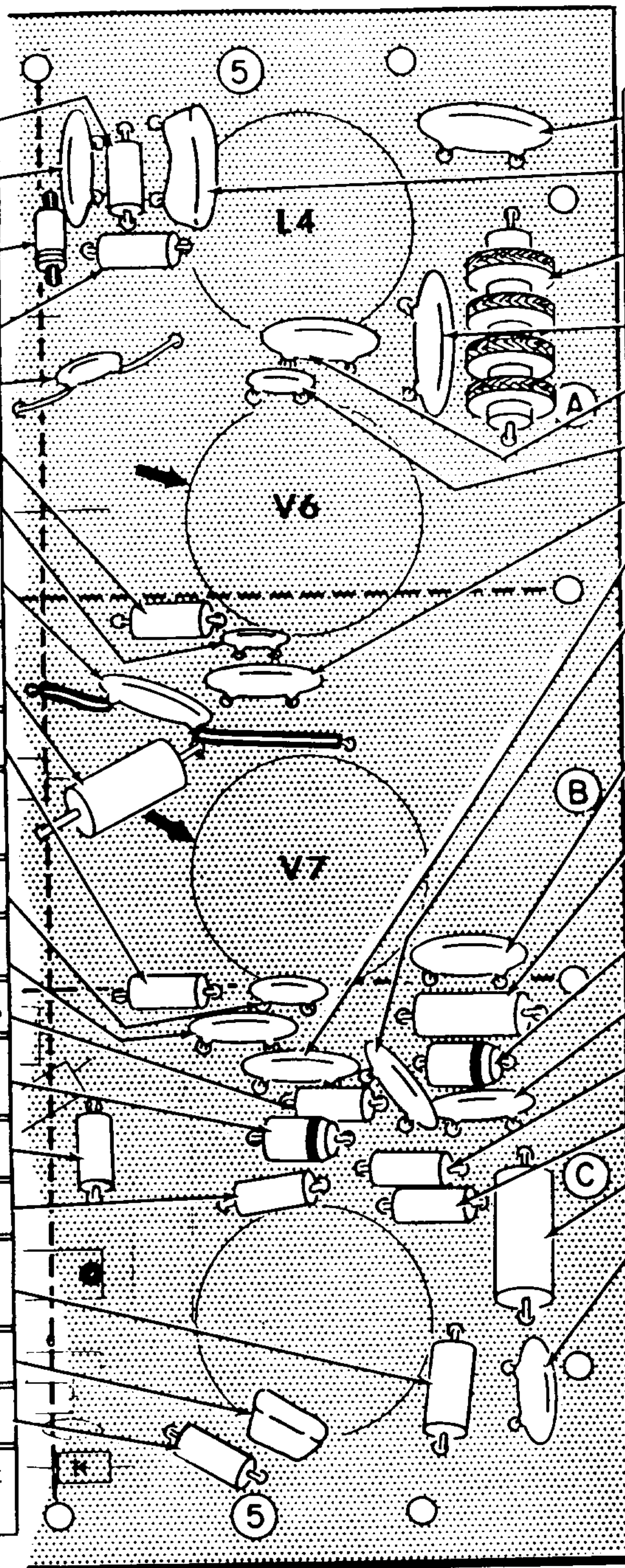
PICTORIAL 1-8



**START**



- ( ) 220 Ω (red-red-brown).
- ( ) .005 μfd disc.
- ( ) Germanium diode. Use 1/4" of sleeving on each lead.
- ( ) 10 KΩ (brown-black-orange).
- ( ) 18 pf disc.
- ( ) 100 Ω (brown-black-brown).
- ( ) .005 μfd disc.
- ( ) .02 μfd disc. Use sleeving on both leads.
- ( ) 4700 Ω 2 watt (yellow-violet-red).
- ( ) 100 Ω (brown-black-brown).
- ( ) Solder all connections and cut off excess leads.
- ( ) 18 pf disc.
- ( ) .005 μfd disc.
- ( ) 1 megohm (brown-black-green).
- ( ) Silicon diode. Note position of banded end.
- ( ) 47 KΩ (yellow-violet-orange).
- ( ) 10 KΩ (brown-black-orange).
- ( ) 100 KΩ 1 watt (brown-black-yellow).
- ( ) .1 μfd Mylar.
- ( ) 1000 Ω (brown-black-red).
- ( ) Solder all connections and cut off excess leads.



**CONTINUE**



- ( ) .005 μfd 1.6 KV disc.
- ( ) 680 pf mica.
- ( ) 1.1 mh (#45-4) choke. Bend each lead toward the slot.
- ( ) .005 μfd 1.6 KV disc.
- ( ) .02 μfd disc.
- ( ) 18 pf disc.
- ( ) .02 μfd disc.
- ( ) .02 μfd disc.
- ( ) .005 μfd disc.
- ( ) Solder all connections and cut off excess leads.
- ( ) .02 μfd disc.
- ( ) .33 Ω 2 watt (orange-orange-silver-gold).
- ( ) Silicon diode. Note position of banded end.
- ( ) .005 μfd disc.
- ( ) 10 KΩ (brown-black-orange).
- ( ) 10 KΩ (brown-black-orange).
- ( ) 20 Ω 2 watt (red-black-black).
- ( ) .005 μfd disc.
- ( ) Solder all connections and cut off excess leads.

PROCEED TO PAGE 16.

BOARD SECTIONS 5A, 5B, AND 5C

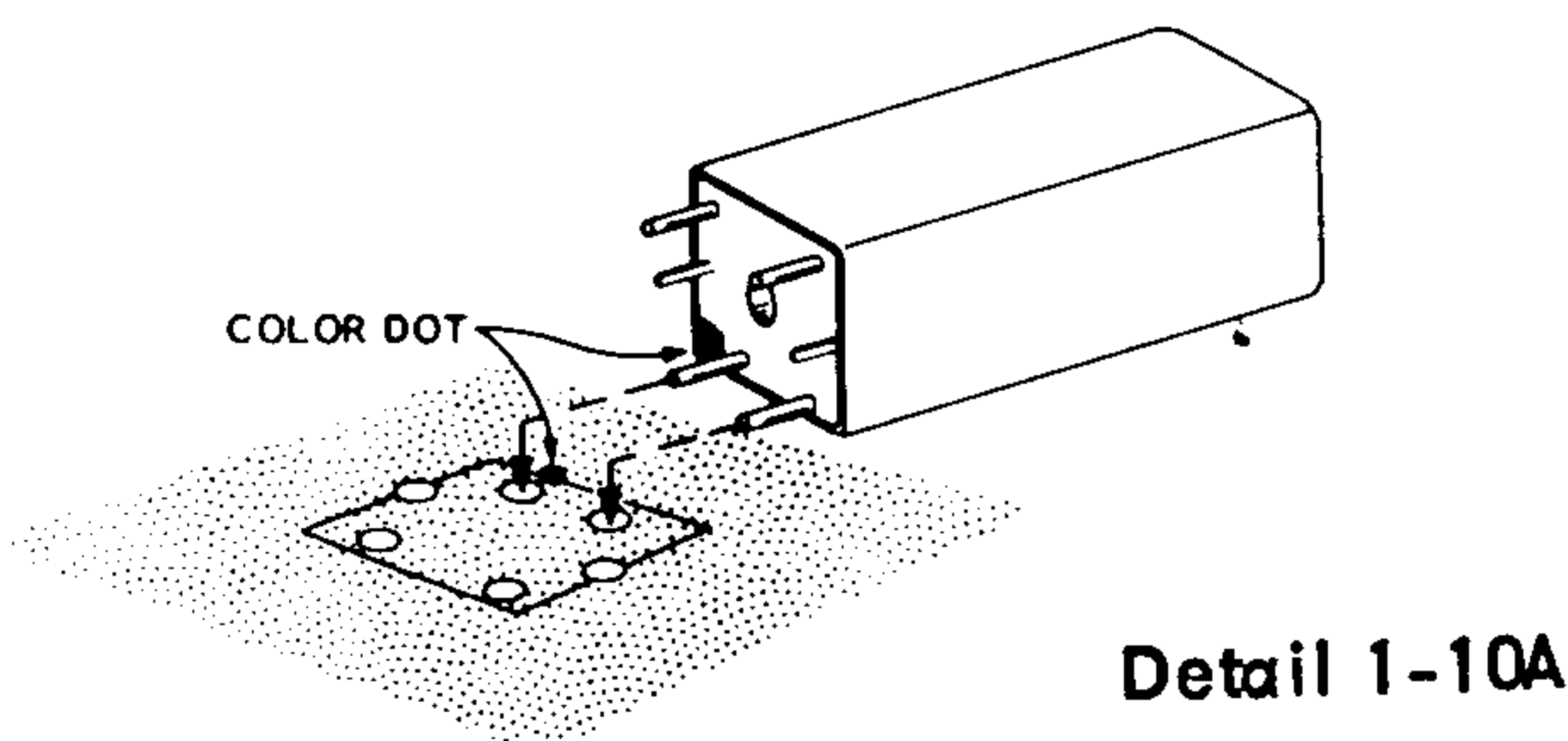
PICTORIAL 1-9

Refer to Pictorial 1-10 (fold-out from Page 6) for the following steps.

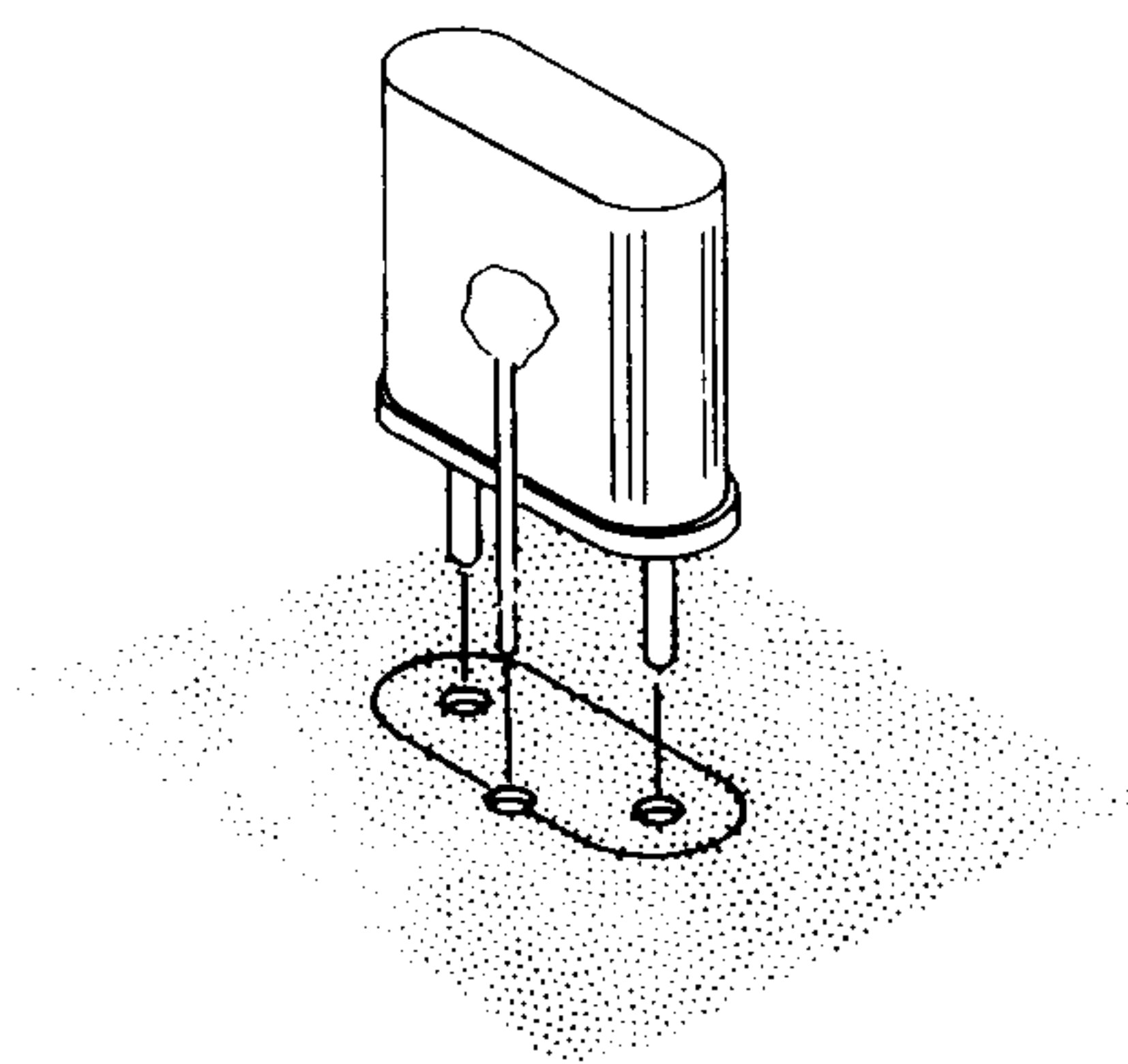
NOTE: Each of the following parts will be easier to mount if it is soldered right after it is installed on the circuit board. When mounting each of the following coils and transformers, be sure to align its color dot with the dot printed on the circuit board.

CAUTION: Do not turn any of the adjusting slugs of the coils or transformers, as they are pre-adjusted at the factory.

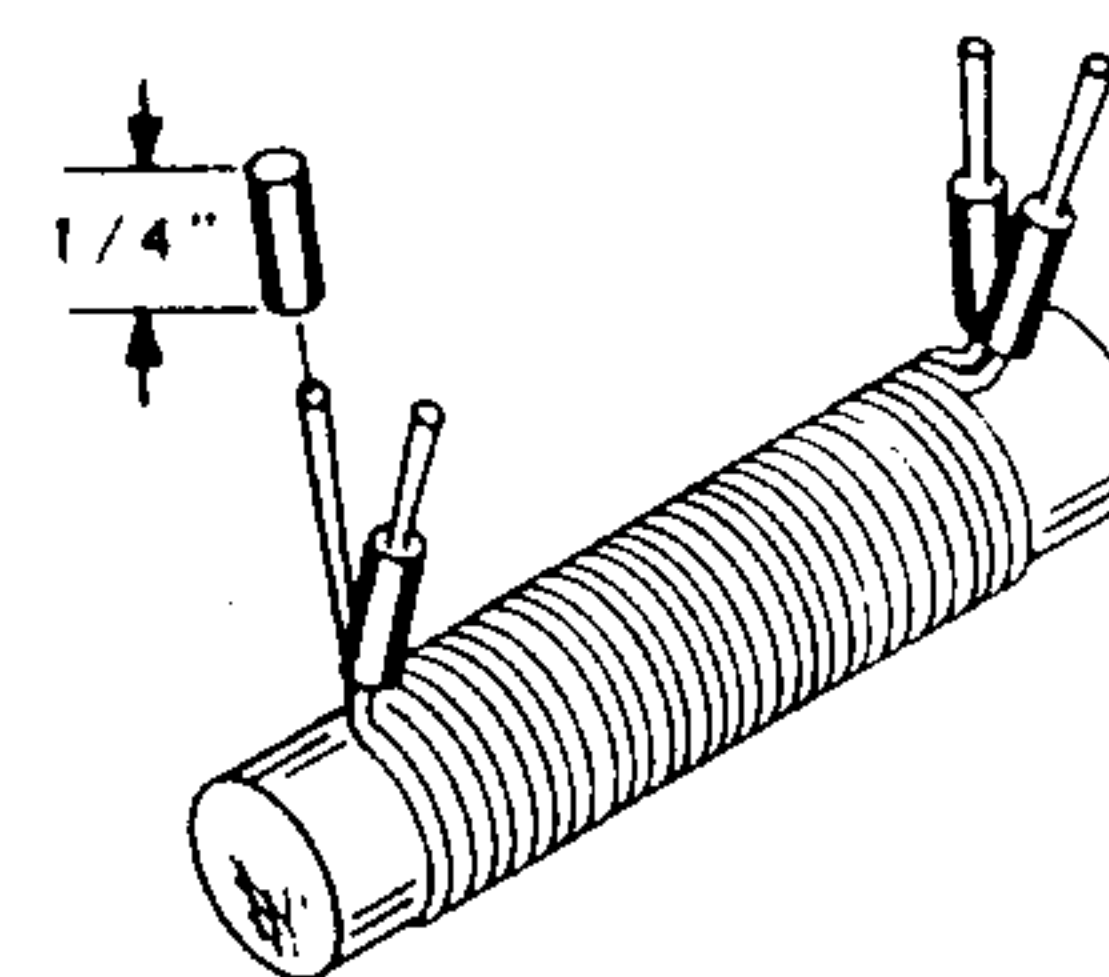
- ( ) Refer to Detail 1-10A and install the three #52-63 transformers at locations T1, T2, and T3.



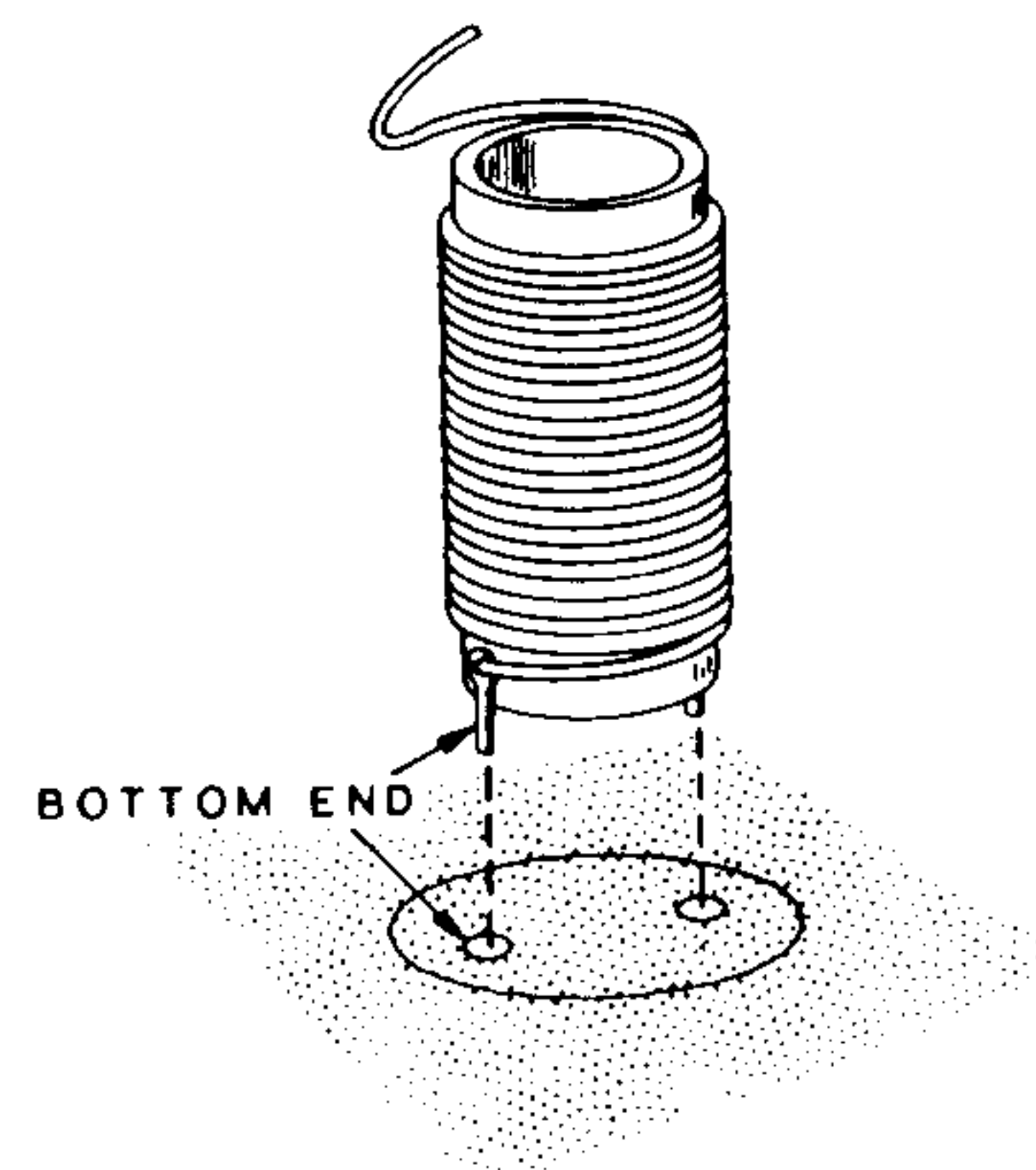
- ( ) Install coil #40-509 at L1.
- ( ) Install coil #40-517 at location L2.
- ( ) Install coil #40-514 at location L3.
- ( ) Install coil #40-778 at location L5.
- ( ) Refer to Detail 1-10B, and install the two #404-191 crystals at their proper locations in section 1A.



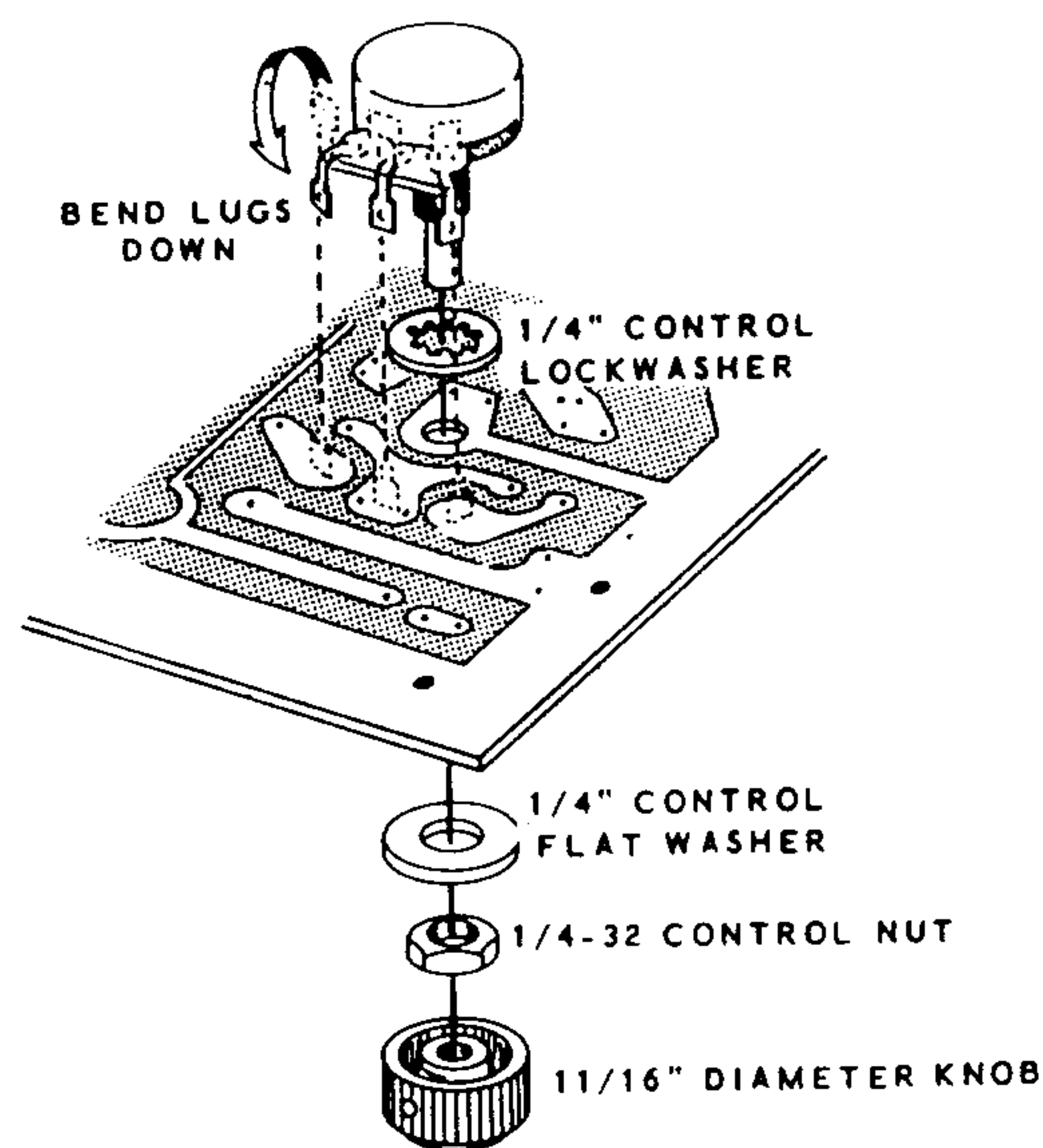
- ( ) In a like manner install the two #404-192 crystals in their proper locations in section 1A.
- ( ) Install crystal #404-198 at its location in section 1A.
- ( ) Refer to Detail 1-10C, and place 1/4" lengths of sleeving on each of the four leads of bifilar choke #45-58.



- ( ) Install this choke at its proper location in section 5C. The leads can be placed in either circuit board hole at the ends of the choke. Press the choke down below the top of the calibrator socket.
- ( ) Refer to Detail 1-10D, and mount final plate coil #40-511 at location L4. Be sure to position the bottom end of the coil winding as shown. The coil lead will be connected later.

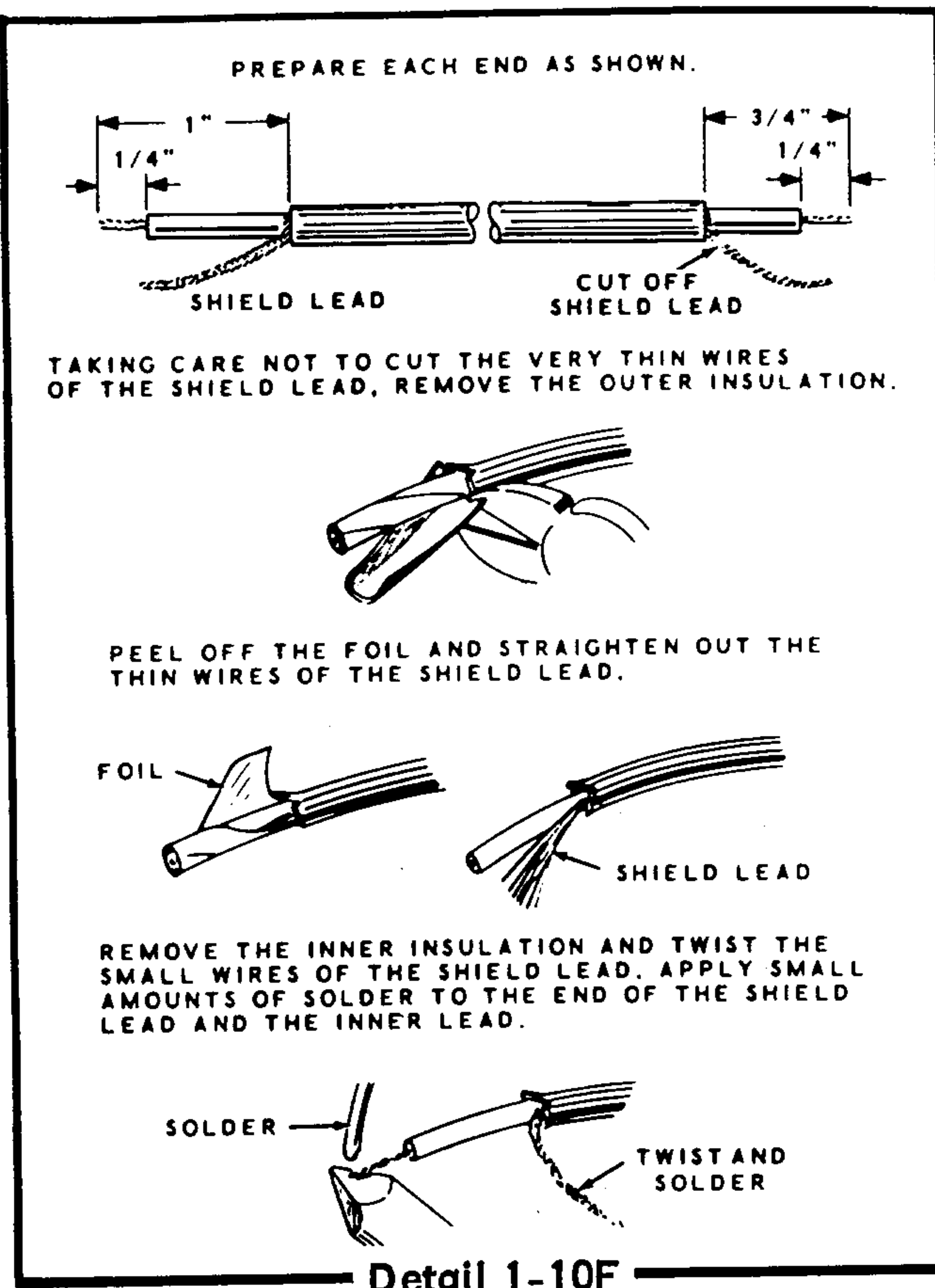






Detail 1-10E

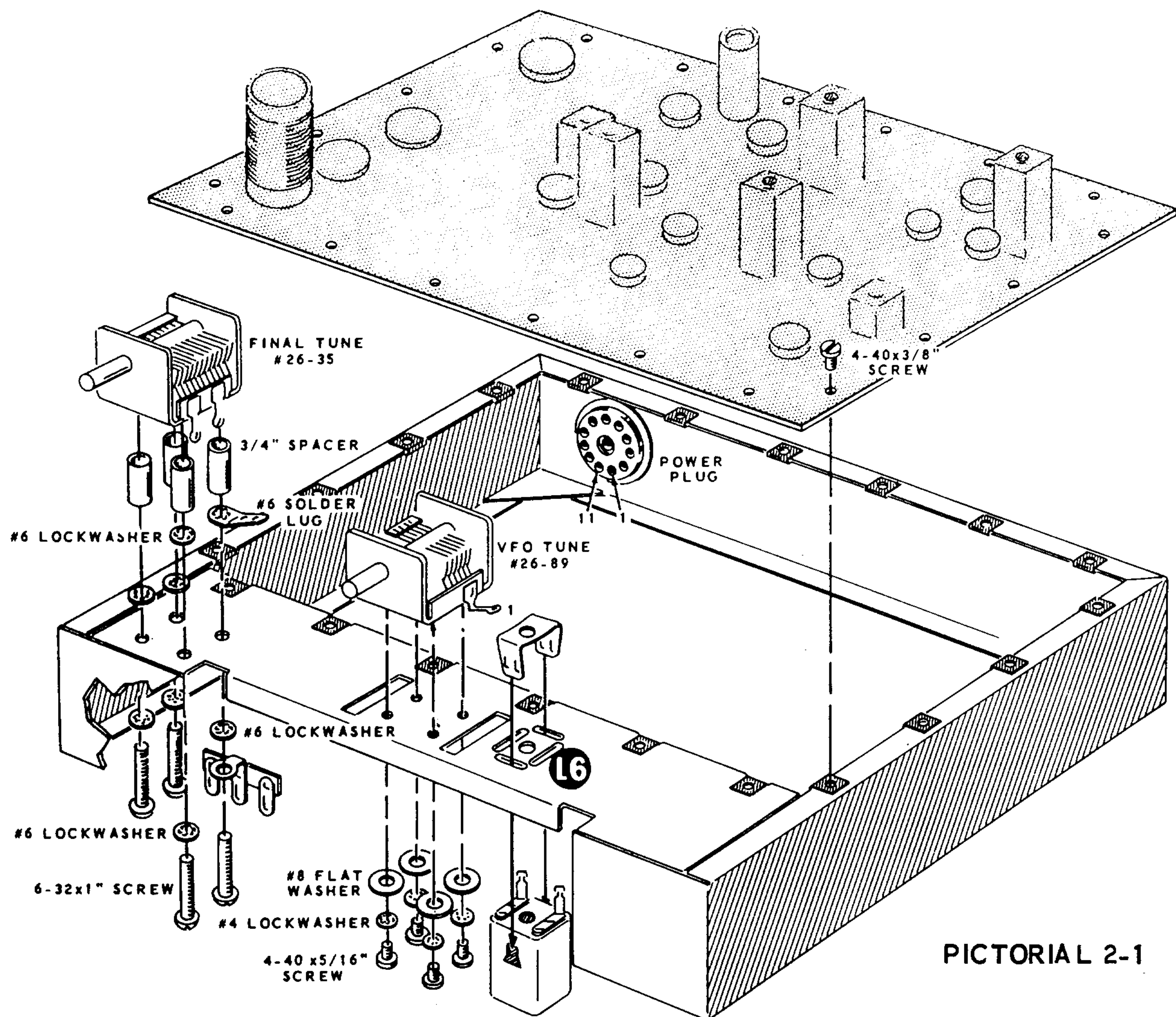
- ( ) Refer to Detail 1-10E, and bend the lugs of the 200  $\Omega$  bushing mount control (#10-130) as shown.
- ( ) Install this control at the Carrier Null location in section 1C. Use a 1/4" control lockwasher, 1/4" control flat washer, and a 1/4-32 control nut. Before soldering, be sure the control lugs are aligned with the proper foils.
- ( ) Install the 11/16" diameter knob on this control. If necessary, push the two diodes apart so the knob will turn freely.
- ( ) Place 3/4" length of sleeving on the leads of the NE-2 neon lamp. Install the lamp at NE in section 1B.
- ( ) Install the 20  $\mu$ fd vertical electrolytic capacitor in section 3C. Note the position of the positive (+) marking.
- ( ) Refer to Detail 1-10F, and prepare the ends of a 5" length of coaxial cable.
- ( ) At the end of this cable with no shield, connect the inner lead in hole A in section 3C.
- ( ) Connect the other end of this cable at A in section 1C. The inner lead goes in the hole with the circle around it.
- ( ) Prepare the ends of a 6-1/2" coaxial cable as before.



- ( ) At the end of this cable with no shield, connect the inner lead in hole C in section 1A.
- ( ) Connect the other end of this cable at C in section 3B. The inner lead goes to the hole with the circle around it. Use a 3/4" length of sleeving on the shield lead. Position the cable as shown in the Pictorial.
- ( ) Prepare the ends of a 6" length of coaxial cable.
- ( ) At the end of this cable with no shield, connect the inner lead in hole B in section 3B.
- ( ) Connect the other end of the cable at B in section 1B. The inner lead goes to the hole with the circle around it.

This completes the mounting of all components on the lettered side of the circuit board. Check to see that all connections are soldered and that there are no solder bridges between foils.

Set the circuit board aside until called for later.

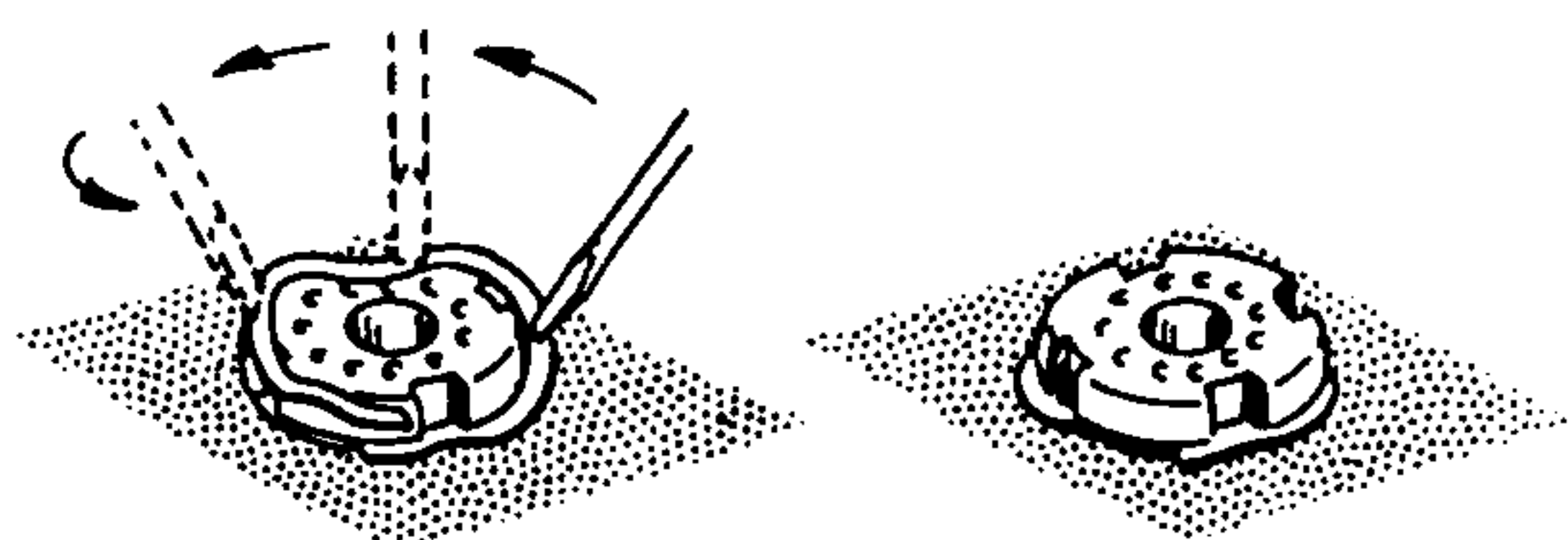


PICTORIAL 2-1

**PARTS MOUNTING-CHASSIS**

Refer to Pictorial 2-1 for the following steps.

- ( ) Refer to Detail 2-1A, and mount the 11-pin plug at the Power Plug location using the 11-pin plug mounting ring. Position pins 1 and 11 as shown.

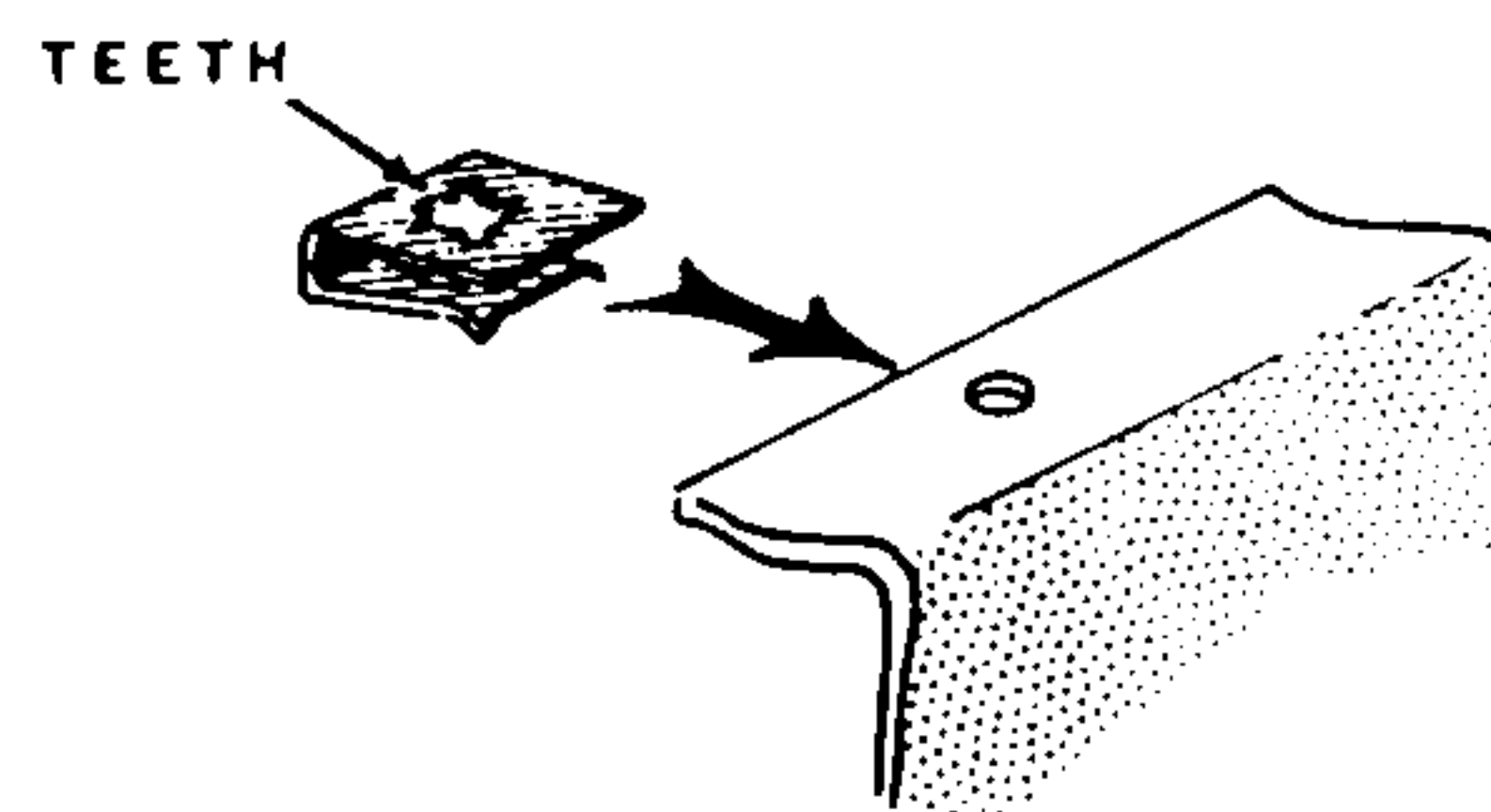


HOLD THE PLUG IN THE CHASSIS HOLE AND PLACE ONE END OF THE RING INTO THE GROOVE OF THE PLUG. USING A SCREWDRIVER, PRESS THE RING INTO THE GROOVE AROUND THE PLUG.

Detail 2-1A

- ( ) Install coil #52-25 at location L6, using the transformer mounting clip. Position the coil as shown.

- ( ) Refer to Detail 2-1B, and install 4-40 push-on nuts at the twenty circuit board mounting holes on the chassis. Be sure to position the teeth of the nuts upward as shown.



Detail 2-1B





- ( ) Install the circuit board on the chassis using 4-40 x 3/8" screws. Position the circuit board as shown. Be sure not to over-tighten the screws as the threads can be stripped from the nuts. CAUTION: Be sure the push-on nut indicated by the arrow in Pictorial 2-2 is not shorting to the foil that is outlined.

NOTE: Keep the plates of variable capacitors fully meshed (closed) at all times during the assembly of the kit, to prevent them from being damaged.

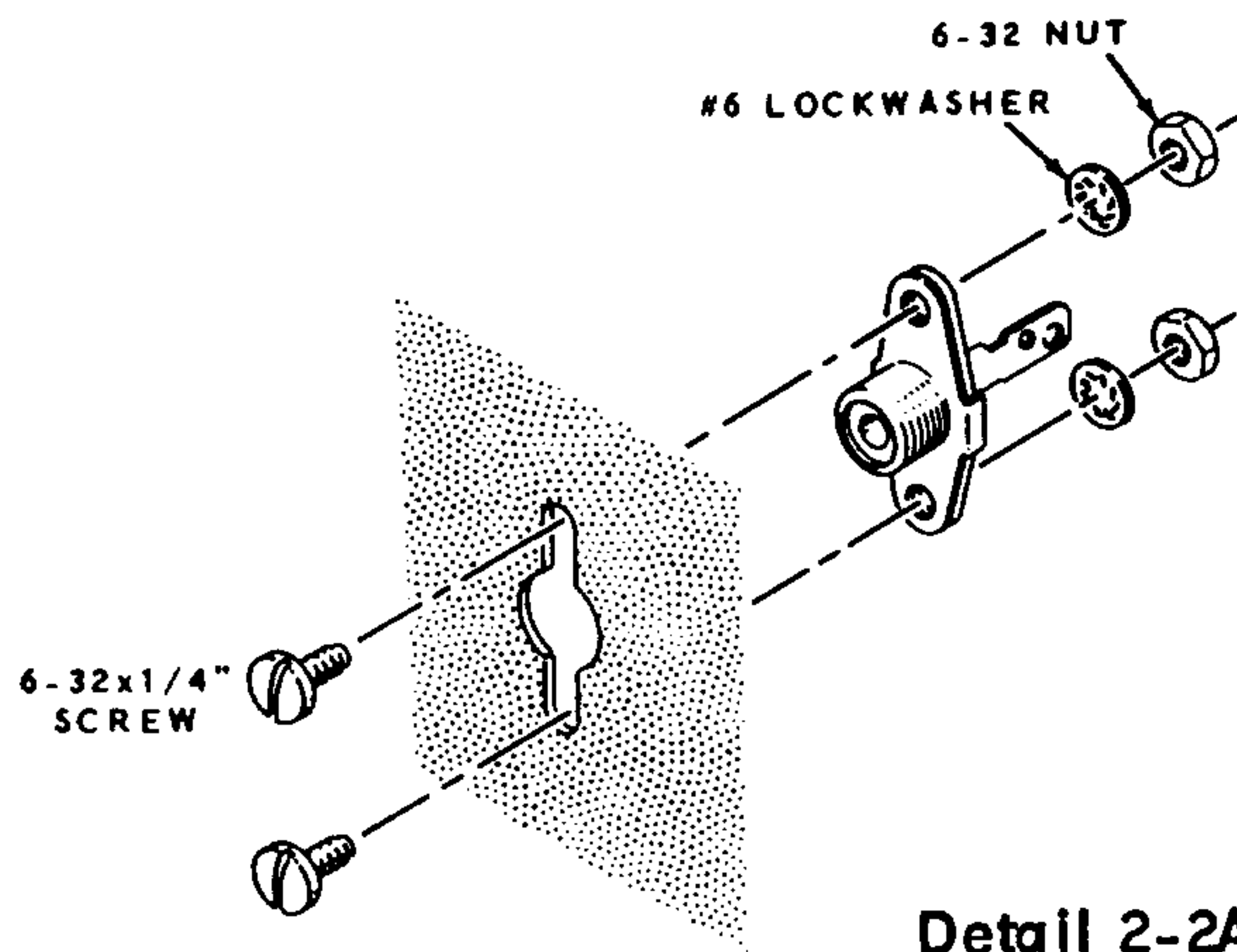
- ( ) Locate variable capacitor #26-89 and bend lug 1 up as shown.
- ( ) Mount this capacitor at the VFO Tune location using 4-40 x 5/16" screws, #4 lock-washers, and #8 flat washers. Position the capacitor back against the circuit board.

- ( ) Mount variable capacitor #26-35 at the Final Tune location, with a #6 solder lug and a 3-lug terminal strip. Use 6-32 x 1" screws, #6 x 3/4" spacers, and #6 lockwashers.

Refer to Pictorial 2-2 (fold-out from Page 19) for the following steps.

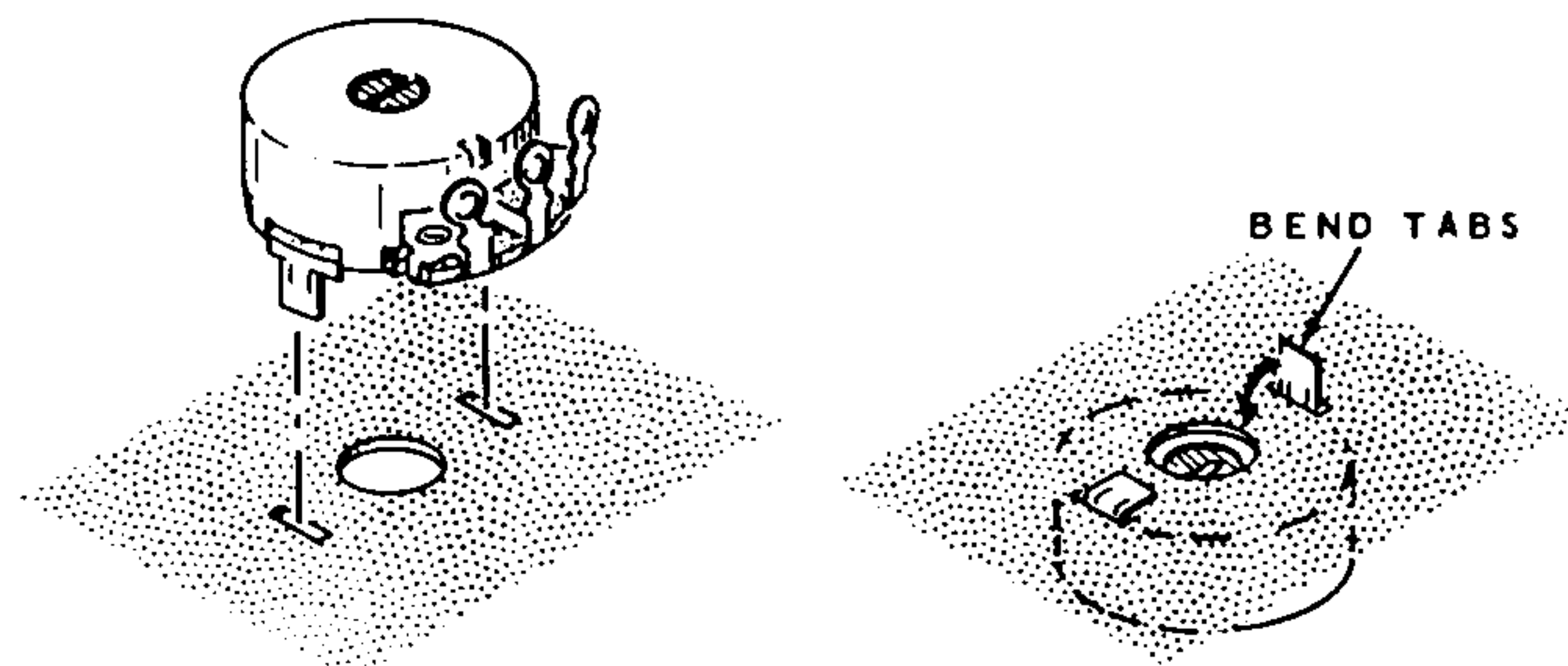
NOTE: When hardware is called for in a step, only the screw size will be given. For instance, if "6-32 x 1/4" hardware" is called for, it means that a 6-32 x 1/4" screw, one or more #6 lock-washers, and a 6-32 nut should be used. The Detail referred to in the step will show the proper number of lockwashers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

- ( ) Refer to Detail 2-2A, and install a phono socket at the Receiver (RCVR) location. Use 6-32 x 1/4" hardware. Position the socket shown.



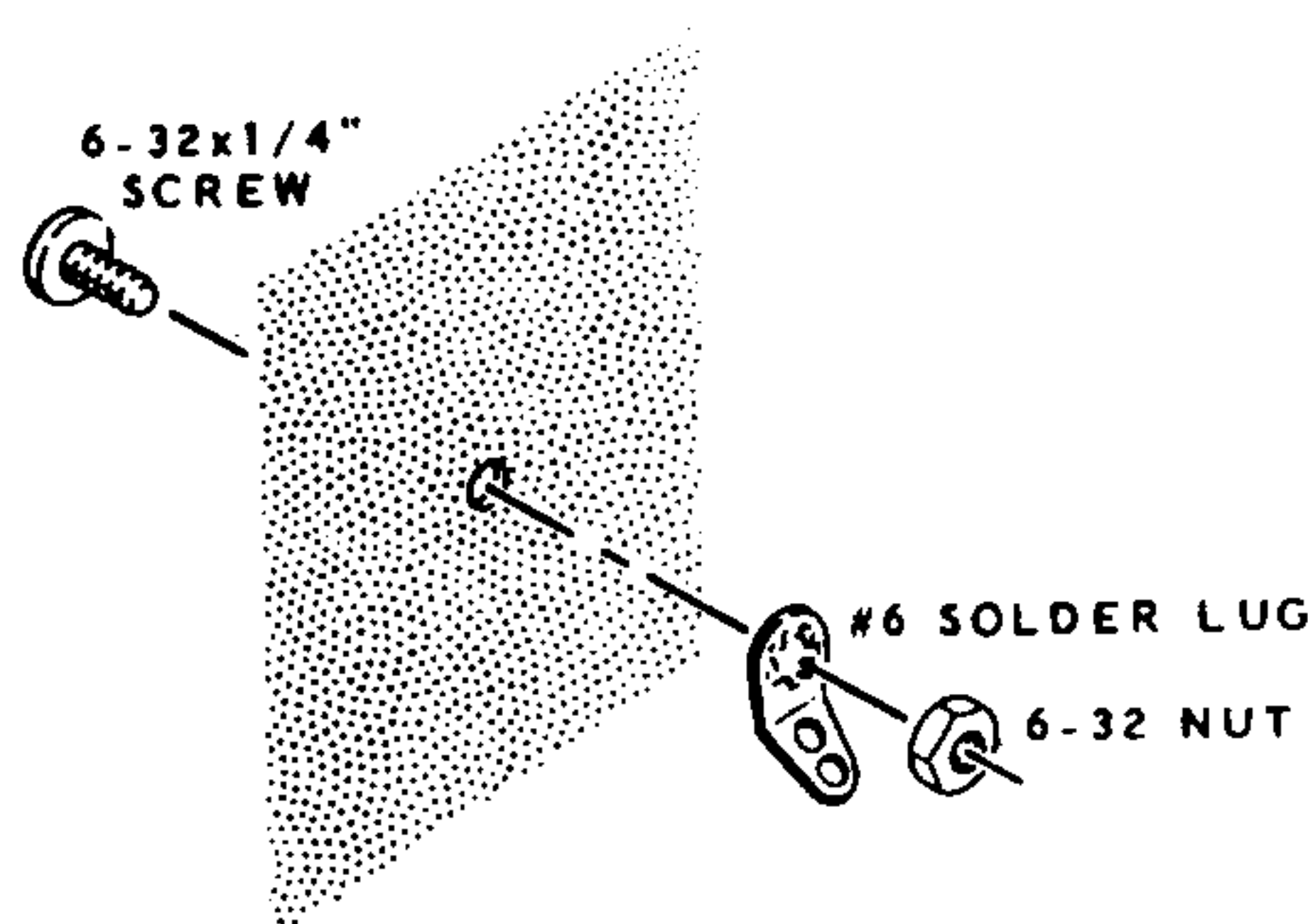
Detail 2-2A

- ( ) In a like manner, install phono sockets at the Antenna (ANT), ALC, and Speaker (SPKR) locations. Use 6-32 x 1/4" hardware. Position each socket as shown.
- ( ) Refer to Detail 2-2B, and install 100 K $\Omega$  tab-mount control #10-58 at the Tune Level location. Bend the tabs inward towards the center of the control.



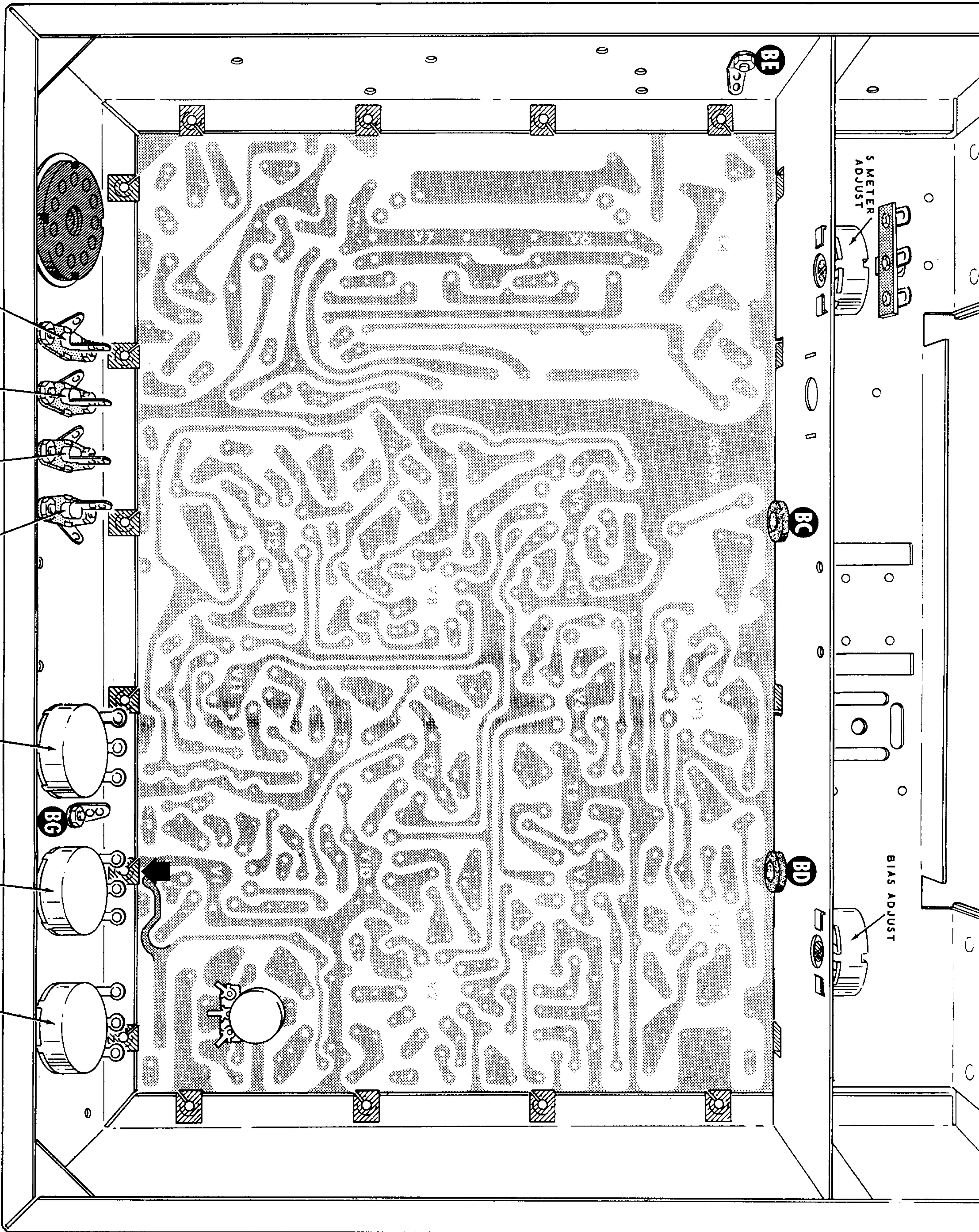
Detail 2-2B

- ( ) In a like manner, install 1 megohm tab-mount controls #10-127 at the VOX Sensitivity (VOX SENS) and VOX Delay locations. Bend the tabs as before.
- ( ) Install 10 K $\Omega$  tab-mount controls (#10-57) at the S Meter Adjust and Bias Adjust locations.
- ( ) Refer to Detail 2-2C, and install #6 solder lugs at locations BE and BG. Use 6-32 x 1/4" screws and 6-32 nuts.
- ( ) Install rubber grommets in the square holes at locations BC and BD.



Detail 2-2C





PICTORIAL 2-2

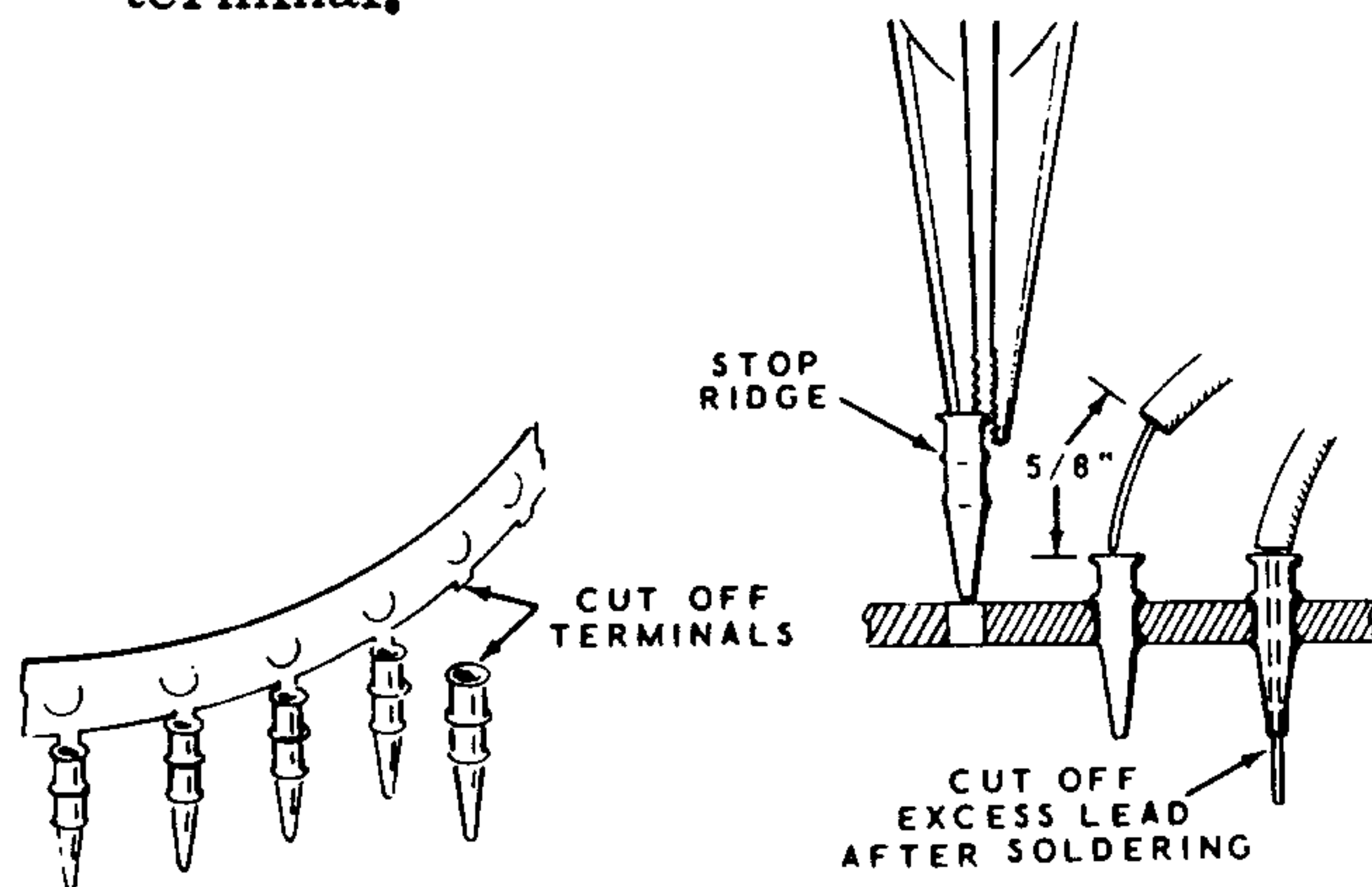


## CABLE ASSEMBLY WIRING

Refer to Pictorial 2-3 for the following steps.

**NOTE:** To obtain the best possible performance from your kit, it should be wired neatly. Position all wires and components as shown in the Manual. All wires, whenever possible, should be positioned down against the chassis. Because the drawings are distorted to show the parts better, you should refer to the Chassis Photographs on Pages 64 and 65 from time to time during the assembly of the kit.

- ( ) Refer to Detail 2-3A, and install terminals in the circuit board from the foil side, at the forty-eight numbered and lettered locations, except for the holes lettered A, B, C, D, and V. A small pair of long-nose pliers will be helpful in installing the terminals. Do not solder the terminals to the circuit board at this time. When you are directed to solder these terminals later, be sure to flow solder into and around the terminal.



**Detail 2-3A**

**NOTE:** The cable assembly (#134-140) has a number of locations where several wires "break out" from the assembly. These locations are indicated in the following steps as BO#1 through BO#9.

- ( ) Refer to Detail 2-3B, and position the cable assembly into the chassis. BO#6 should be positioned just behind the chassis partition. Note that BO#3 and BO#6 each have a red-red-white wire extending from them, and BO#5 has the long black-white and brown-white wires.

- ( ) Refer to the inset drawing on Detail 2-3B, and cut two rubber grommets. Position these grommets around the cable assembly at the two locations where the cable assembly fits over the chassis partition.
- ( ) Form the cable assembly down and along the front of the chassis partition.

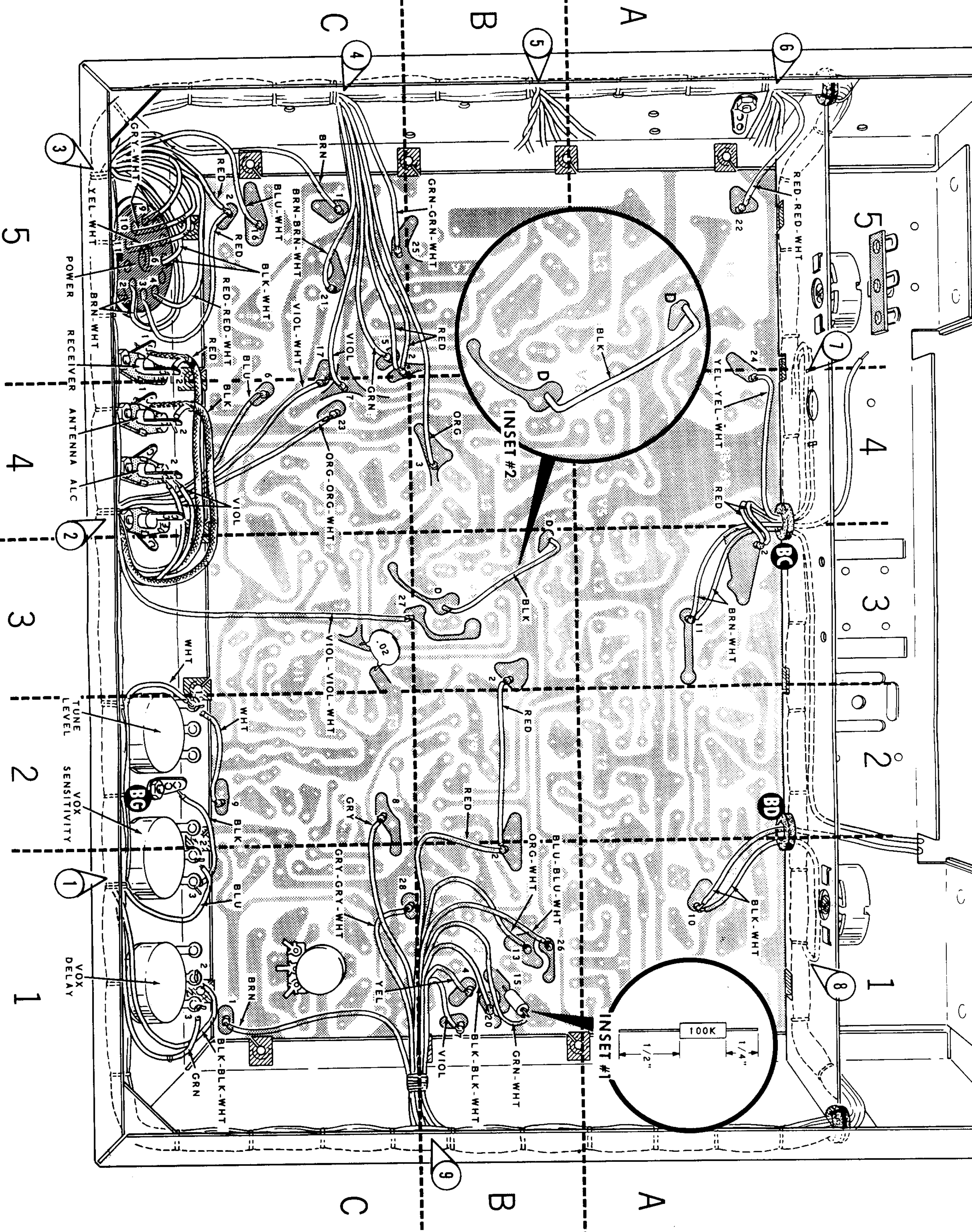
**NOTE:** In the following three steps, four of the cable assembly wires will have lengths of wire cut from them. These cut-off wires should be saved for use in later wiring steps. Measure each wire from the breakout of the cable assembly and cut it to the lengths given. After cutting, remove 1/2" of insulation from the ends of the cut-off cable assembly wires.

- ( ) At BO#1, cut all but 4" from the white wire.
- ( ) At BO#5, cut all but 6" from the black-white and brown-white wires.
- ( ) At BO#8, cut all but 5" from the red-white wire.
- ( ) At BO#7, pass either red, the brown-white, and the yellow-yellow-white wires through grommet BC for connection later.
- ( ) At BO#8, pass the black-white wire through grommet BD for connection later.
- ( ) Also at BO#8, position the green-green-white wire around the front edge of the chassis as shown, to be connected later. Be sure you do not use either of the green-white wires.

**NOTE:** When a wire of a specified length and color are called for in a step, use the hookup wire supplied or those wires cut from the cable assembly. Remove 1/2" of insulation from the end of any wire that connects to the circuit board terminals or the Power plug, and remove 1/4" of insulation from the end that connects to points other than a circuit board terminal or Power plug.

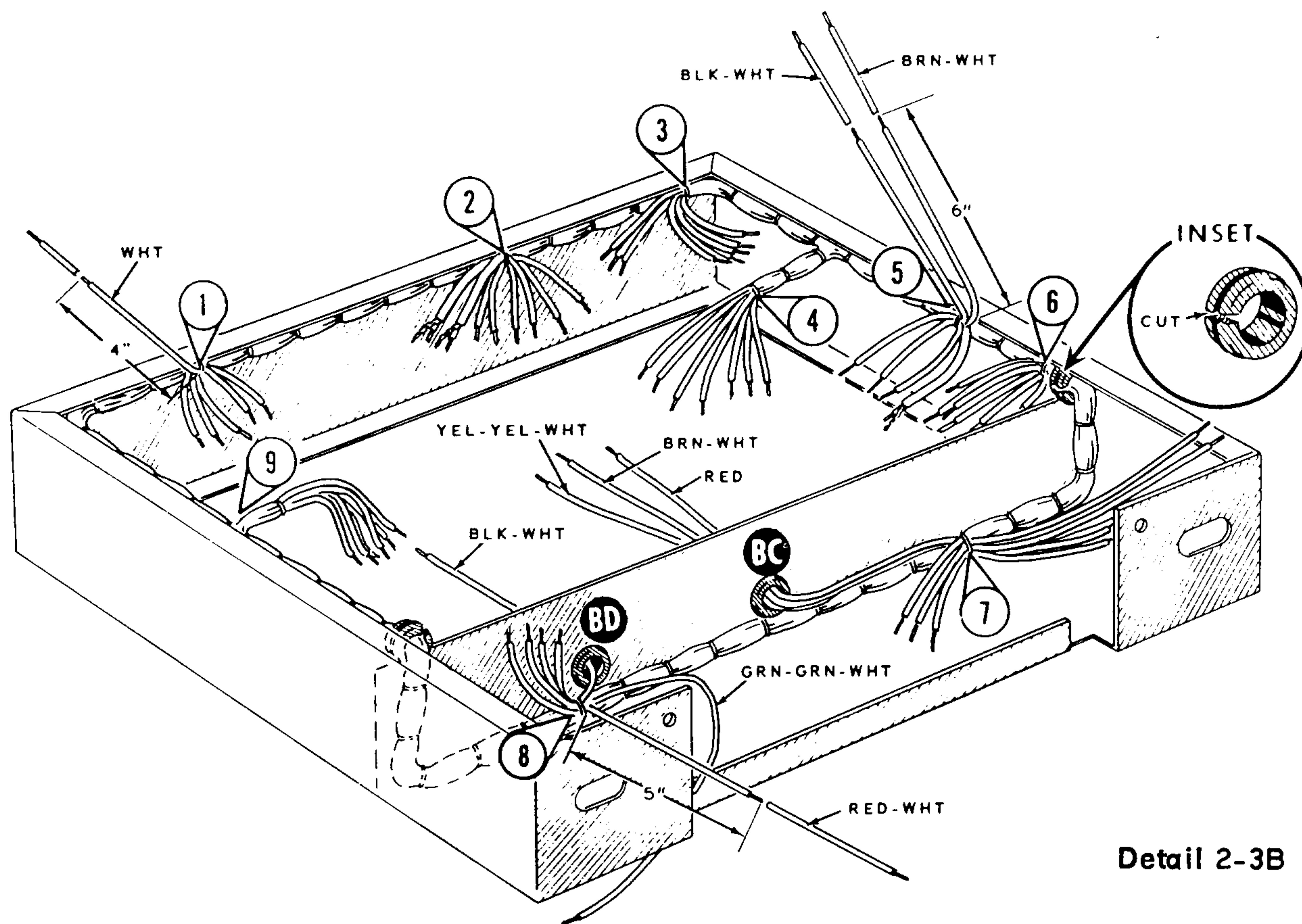
- ( ) Connect a 1-1/2" black wire from lug 3 of the VOX Sensitivity control (NS) to solder lug BG (NS).
- ( ) Connect a 2-1/4" white wire from terminal 9 in section 2C (S-1) to lug 1 of the Tune Level control (NS).





PICTORIAL 2-3





Detail 2-3B

- ( ) Cut both leads of a .02  $\mu$ fd disc capacitor to 3/8". Connect this capacitor between the indicated foils in section 3C. Solder the leads directly to the foils.

NOTE: The terminals in the circuit board are numbered to correspond to the wire colors of the cable assembly. The color-number relationship is based on the resistor color code; brown = 1, red = 2, orange = 3, etc. For instance, a red wire will go to a #2 terminal, and an orange wire to a #3 terminal, etc. Wires with a single color stripe and a white background are in the 10 series numbers; a black-white wire will go to a #10 terminal, and orange-white wire to a #13 terminal, etc. Wires with two like color stripes and a white background are in the 20 series numbers; a green-green-white wire would go to a #25 terminal, a blue-blue-white wire to a #26 terminal, etc.

The stripped ends of the cable assembly wires are correct for connecting to the circuit board terminals, but are too long for control and switch lugs. Cut the stripped end of each of these wires to 1/4" when connecting it to a control or switch lug.

Connect the wires from BO#1 of the cable assembly as follows:

NOTE: Even though some of the cable assembly wires may be too long, it is not recommended that you shorten the wires. Any excess wire should be positioned back along the main trunk of the cable assembly.

- ( ) Green to lug 3 of the VOX Delay control (S-1).
- ( ) Black-black-white to lug 2 of the VOX Delay control (S-1).
- ( ) Blue to lug 2 of the VOX Sensitivity control (S-1).
- ( ) White to lug 1 of the Tune Level control (S-2).

The coaxial cables will be connected later.

Connect the wires from BO#2 to the circuit board as follows:

- ( ) Violet-violet-white to terminal 27 section 3C (S-1). Be sure you do not use the violet-white wire.
- ( ) Blue to terminal 6 section 4C (S-1).
- ( ) Violet-white to terminal 17 section 4C (S-1).
- ( ) Orange-orange-white to terminal 23 section 4C (S-1).

NOTE: There are only three coaxial cable types in the cable assembly. One has no color marking (paint, tape, or color stripe); this one will be referred to as the "black coaxial cable." Another cable, which has a red marking, will be referred to as the "red coaxial cable." The remaining cable has two inner leads, instead of one, and will be referred to as the "2-wire coaxial cable."

- ( ) Apply very small amounts of solder to the ends of the inner leads of the black and red coaxial cables; this will hold the small wire strands together.

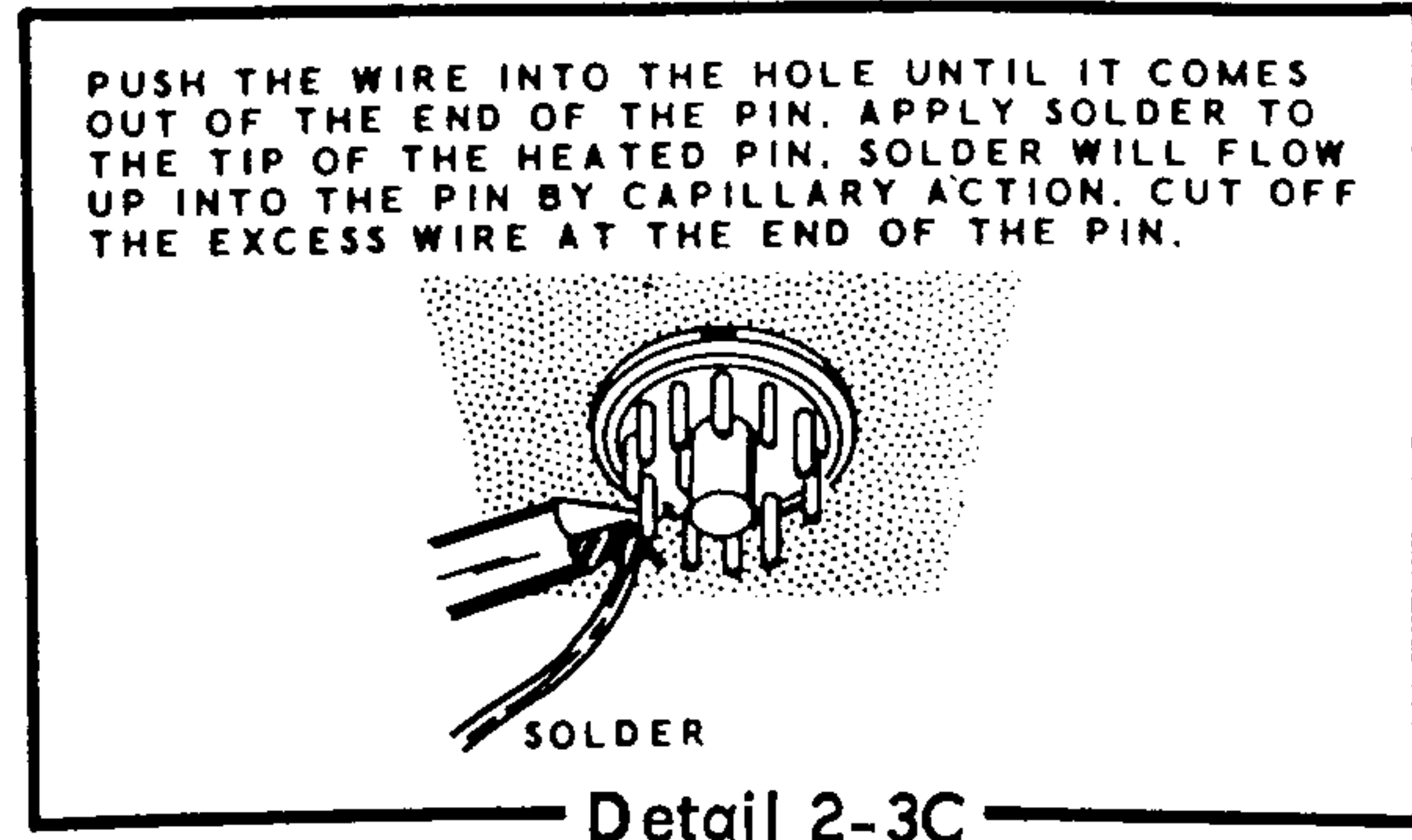
Connect the remaining wires from BO#2 as follows:

- ( ) Red coaxial cable: inner lead to lug 2 (NS) and the shield to lug 1 (NS) of the Receiver socket.
- ( ) Black coaxial cable: inner lead to lug 2 (S-1) and the shield to lug 1 (S-1) of the Antenna socket.
- ( ) Both violet to lug 2 of the ALC socket (S-2).

The 2-wire coaxial cable will be connected later.

NOTE: Refer to Detail 2-3C for soldering the pins of the Power Plug. Connect the wires from BO#3 to the Power plug as follows:

- ( ) Yellow-white to pin 11 (NS).
- ( ) Either gray-white to pin 10 (S-1).
- ( ) Other gray-white to pin 9 (S-1).



- ( ) Both black-white to pin 6 (NS).
- ( ) Red-red-white to pin 4 (S-1).
- ( ) Both brown-white to pin 2 (NS).

Connect the remaining wires from BO#3 to the circuit board as follows:

- ( ) Brown to terminal 1 section 5C (S-1).
- ( ) Blue-white to terminal 16 section 5C (S-1).
- ( ) One end of a 3-1/2" red wire and the red wire from BO#3 to terminal 2 section 5C (S-2). Connect the free end of this wire to pin 3 of the Power plug (NS).

Connect the wires from BO#4 to the circuit board as follows:

NOTE: In the following six steps, do not position the wires against the chassis. The audio output transformer will be mounted under these wires later.

- ( ) Green-green-white to terminal 25 section 5C (S-1).
- ( ) Brown-brown-white to terminal 21 section 5C (S-1).
- ( ) Green to terminal 5 section 5C (S-1).
- ( ) Both red to terminal 2 section 5C (S-2).
- ( ) Violet to terminal 7 section 4C (S-1).
- ( ) Orange to terminal 3 section 4B (S-1).

The wires from BO#5 will be connected later.





- ( ) Connect the red-red-white wire from BO#6 to terminal 22 section 5A of the circuit board (S-1).

The remaining wires from BO#6 will be connected later.

Connect the wires from BO#7 that pass through grommet BC as follows:

- ( ) Connect one end of a 4-1/2" red wire and the red wire extending from grommet BC to terminal 2 section 3A of the circuit board (S-2). Pass the free end of the wire through grommet BC for connection later.
- ( ) Connect one end of an 11-1/2" brown-white wire and the brown-white wire extending from grommet BC to terminal 11 section 3A of the circuit board (S-2). Pass the free end of the wire through grommet BC and along the chassis partition to the top of the chassis as shown. This end of the wire will be connected later.
- ( ) Connect the yellow-yellow-white wire extending from grommet BC to terminal 24 section 5A of the circuit board (S-1).

The remaining wires from BO#7 will be connected later.

- ( ) Connect one end of a 7-1/2" black-white wire and the black-white wire (from BO#8) extending from grommet BD to terminal 10 section 1A (S-2). Pass the free end of the wire through grommet BD and to the top of the chassis for connection later.

The remaining wires from BO#8 will be connected later.

- ( ) Cut the leads of a 100 K $\Omega$  (brown-black-yellow) resistor as shown in the inset drawing #1 on Pictorial 2-3. Connect the long lead of the resistor to terminal 15 section 1B (S-1).

- ( ) Connect the green-white wire from BO#9 to the free end of the resistor just installed (S-1).

Connect the wires from BO#9 to the circuit board as follows:

- ( ) Yellow to terminal 4 section 1B (S-1).
- ( ) Violet to terminal 7 section 1B (S-1).
- ( ) Black-black-white to terminal 20 section 1B (S-1).
- ( ) Orange-white to terminal 13 section 1B (S-1).
- ( ) Blue-blue-white to terminal 26 section 1B (S-1).
- ( ) Gray to terminal 8 section 2C (S-1).
- ( ) Gray-gray-white to terminal 28 section 1C (S-1).
- ( ) Brown to terminal 1 section 1C (S-1).
- ( ) Connect a 3-1/4" red wire between terminal 2 section 3B (S-1) and terminal 2 section 1B (NS).
- ( ) Connect the red wire from BO#9 to terminal 2 section 1B (S-2).

NOTE: There are no holes in the circuit board for the wire to be installed in the next step. Solder the ends of the wire directly to the foil.

- ( ) Remove 1/4" of insulation from both ends of a 2-1/4" black wire. Connect this wire between the two foils lettered D in section 3B as shown in inset drawing #2. Solder each end of the wire to the foil and position the wire approximately 1/4" above the circuit board.

Refer to Pictorial 2-4 (fold-out from Page 27) for the following steps.

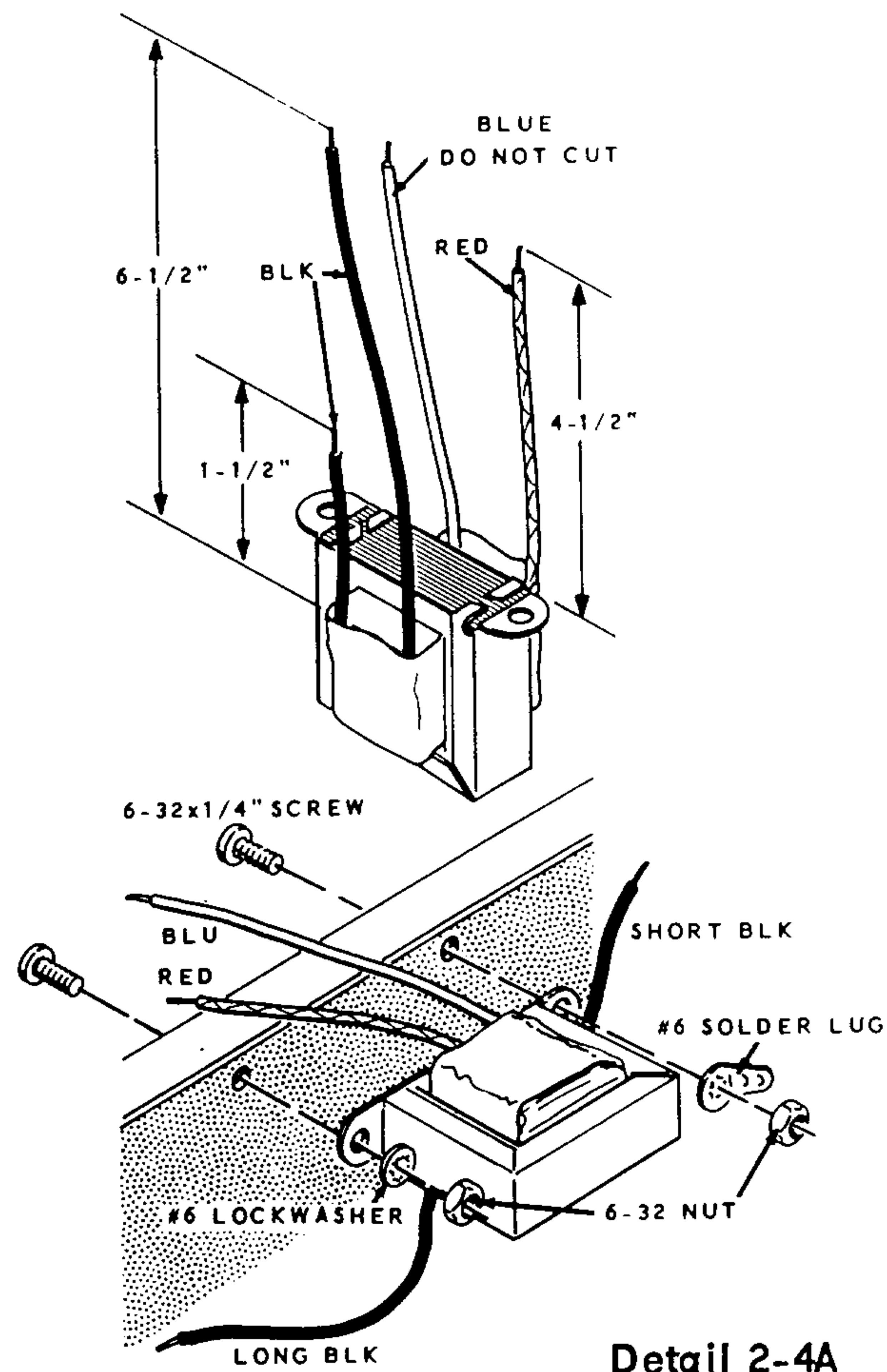
- ( ) Connect a 220 KΩ (red-red-yellow) resistor from lug 1 of the VOX Delay control (S-1) to lug 3 of the VOX Sensitivity control (S-2).

Connect the leads of the 2-wire coaxial cable from BO#1 as follows:

- ( ) Pass the shield lead through solder lug BG (S-3) and through lug 3 (NS) to lug 2 (S-1) of the Tune Level control.
- ( ) Connect the red lead to terminal L section 2C (S-1) and the black lead to terminal M section 1C (S-1) of the circuit board.
- ( ) Connect a 2-1/2" black wire from lug 1 of the VOX Sensitivity control (S-1) to terminal H section 2C (S-1).
- ( ) Also at BO#1, connect the black coaxial cable inner lead to terminal K section 2C of the circuit board (S-1) and the shield to lug 3 of the Tune Level control (S-3).

Connect the 2-wire coaxial cable at BO#2 as follows:

- ( ) Red lead to terminal Y section 4 C (S-1) and the black lead to terminal G section 3C (S-1) of the circuit board.
- ( ) Shield lead to lug 2 (ground) of the Speaker socket (S-1).
- ( ) Connect a 3-1/4" brown-white wire from terminal 11 section 5C of the circuit board (S-1) to pin 2 of the Power plug (S-3).
- ( ) Connect a 2-1/4" black-white wire from terminal 10 section 5C of the circuit board (S-1) to pin 6 of the Power plug (S-3).
- ( ) Connect a 2-3/4" black wire between pins 5 (NS) and 7 (S-1) of the Power plug.
- ( ) Connect a 2" black wire from pin 5 of the Power plug (S-2) to lug 1 (ground) of the Receiver socket (NS).
- ( ) Connect a 6-1/2" black wire from pin 1 of the Power plug (S-1) to terminal U section 4C of the circuit board (S-1).



Detail 2-4A

- ( ) Refer to Detail 2-4A, and cut the leads of output transformer #51-55 to the lengths shown. Measure the leads from where they come out of the transformer. Do not cut the blue lead. Remove 1/4" of insulation from the end of each black lead, and 1/2" insulation from the end of the red lead.
- ( ) Mount the output transformer at T4 with a #6 solder lug. Use 6-32 x 1/4" hardware. Do not pinch any cable assembly or transformer wires between the chassis and transformer.

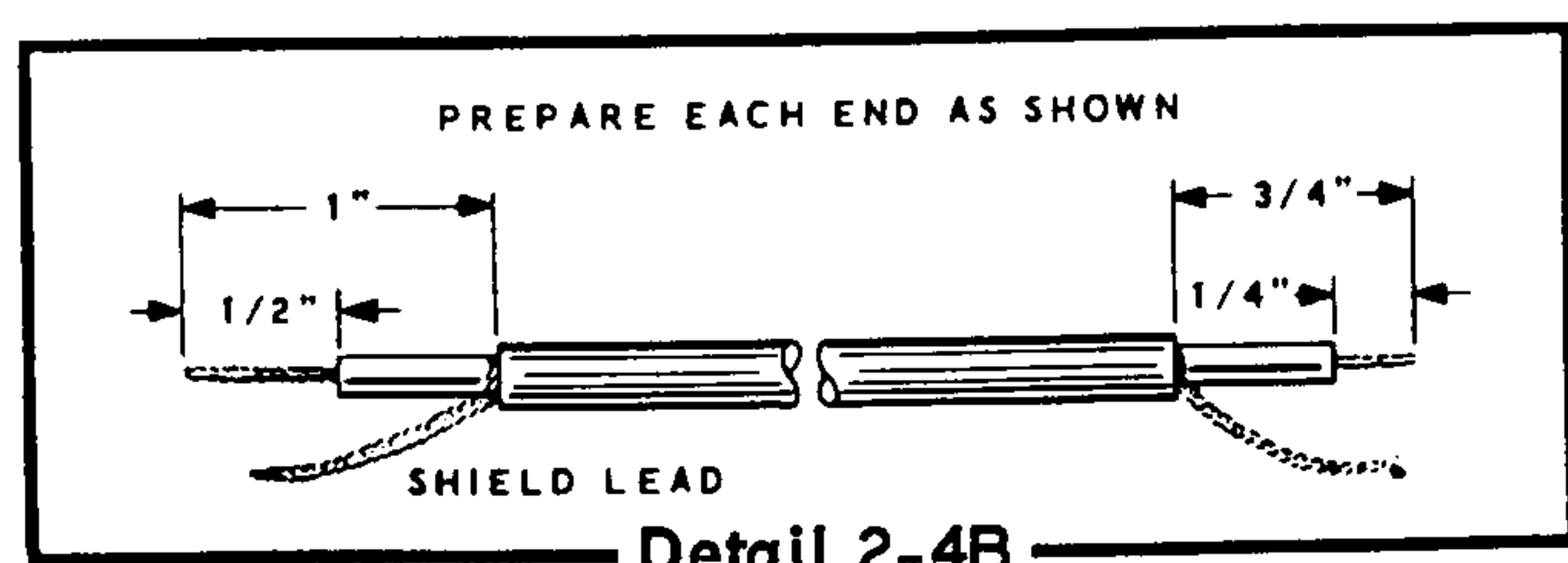
Connect the wires of transformer T4 as follows:

- ( ) Short black to solder lug BF (NS).
- ( ) Long black to lug 1 of Speaker socket (S-1).
- ( ) Red to pin 3 of the Power plug (S-2).
- ( ) Blue to terminal P section 4C of the circuit board (S-1).





- ( ) Connect a .005  $\mu$ fd disc capacitor from pin 11 of the Power plug (S-2) to lug 1 of the Receiver socket (NS).
- ( ) Now, check to see that all the wires connected to the Power plug are soldered. This can be done by pulling on each wire with a pair of long-nose pliers from the inside of the chassis. Pin 8 of the Power plug is not used.
- ( ) Refer to Detail 2-4B, and prepare the ends of a 4-3/4" length of coaxial cable.



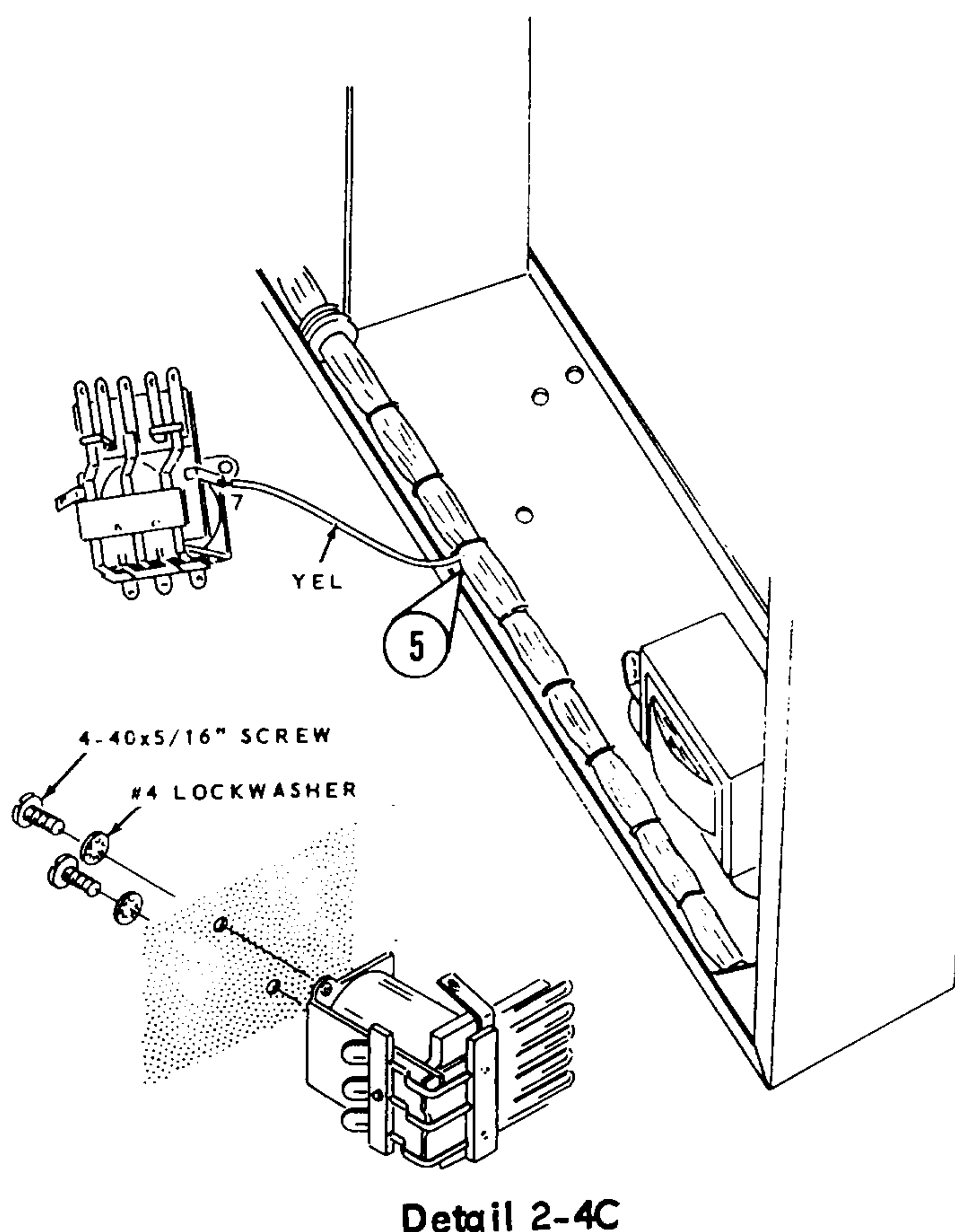
- ( ) At the end of this coaxial cable with the most insulation removed, connect the inner lead to terminal E (S-1) and the shield to terminal F (S-1) section 4B of the circuit board.
- ( ) At the other end of this cable, connect the inner lead to lug 2 (NS) and the shield to lug 1 (S-4) on the Receiver socket.
- ( ) Connect a 2-1/2" black wire from lug 2 of the Receiver socket (S-3) to terminal S section 5C of the circuit board (S-1).

Refer to Detail 2-4C for the following steps.

- ( ) Connect the yellow wire from BO#5 to lug 7 (S-1) of relay #69-34.
- ( ) Mount the relay to the chassis using 4-40 x 5/16" screws and #4 lockwashers. Do not pinch any wires between the chassis and relay. Handle the relay carefully so you do not bend any of the contacts.

Refer to Pictorial 2-4 (fold-out from Page 27) for the following steps.

- ( ) Pass one lead of a 330  $\Omega$  (orange-orange-brown) resistor through solder lug BF (NS) to lug 9 of the relay (S-1). Connect the other lead of this resistor to lug 8 of the relay (S-1).



Connect the wires from BO#5 of the cable assembly to the relay as follows:

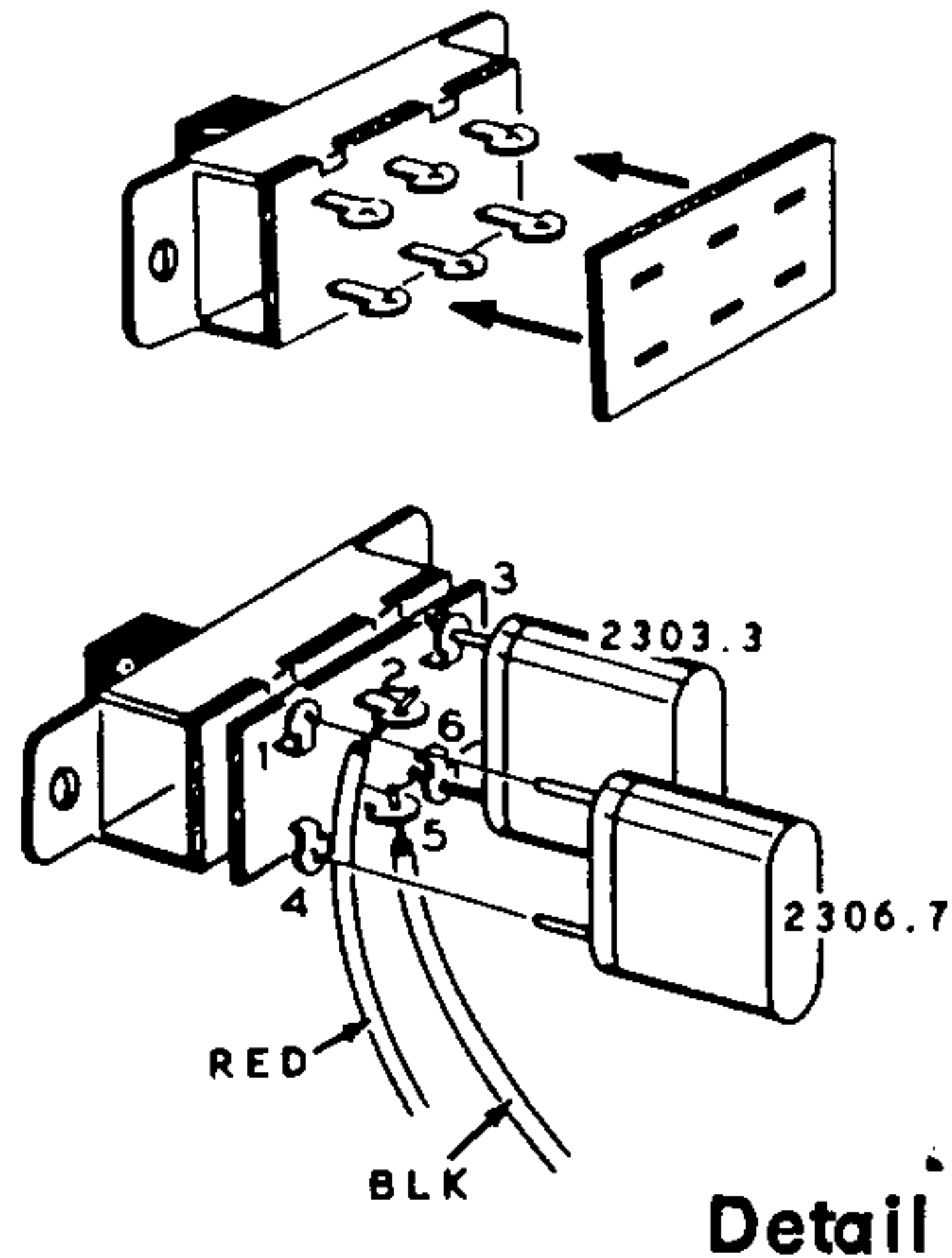
- ( ) Black coaxial cable: inner lead to lug 10 (S-1) and the shield to solder lug BF (S-4).
- ( ) Both red to lug 6 (S-2).
- ( ) Twist together the black-white and brown-white wires from BO#5 to form a twisted pair. Connect the brown-white wire to terminal 11 section 4B (S-1) and the black-white to terminal 10 section 3B (S-1) of the circuit board.

Connect the wires from BO#6 to the relay as follows:

- ( ) Red coaxial cable: inner lead to lug 4 (S-1) and the shield to solder lug BE (S-1).
- ( ) Yellow-white to lug 3 (S-1).
- ( ) Orange to lug 2 (S-1).

- ( ) Both brown to lug 1 (S-2).
- ( ) Connect a 2-1/4" black wire from lug 5 of the relay (S-1) to terminal J of the circuit board (S-1).

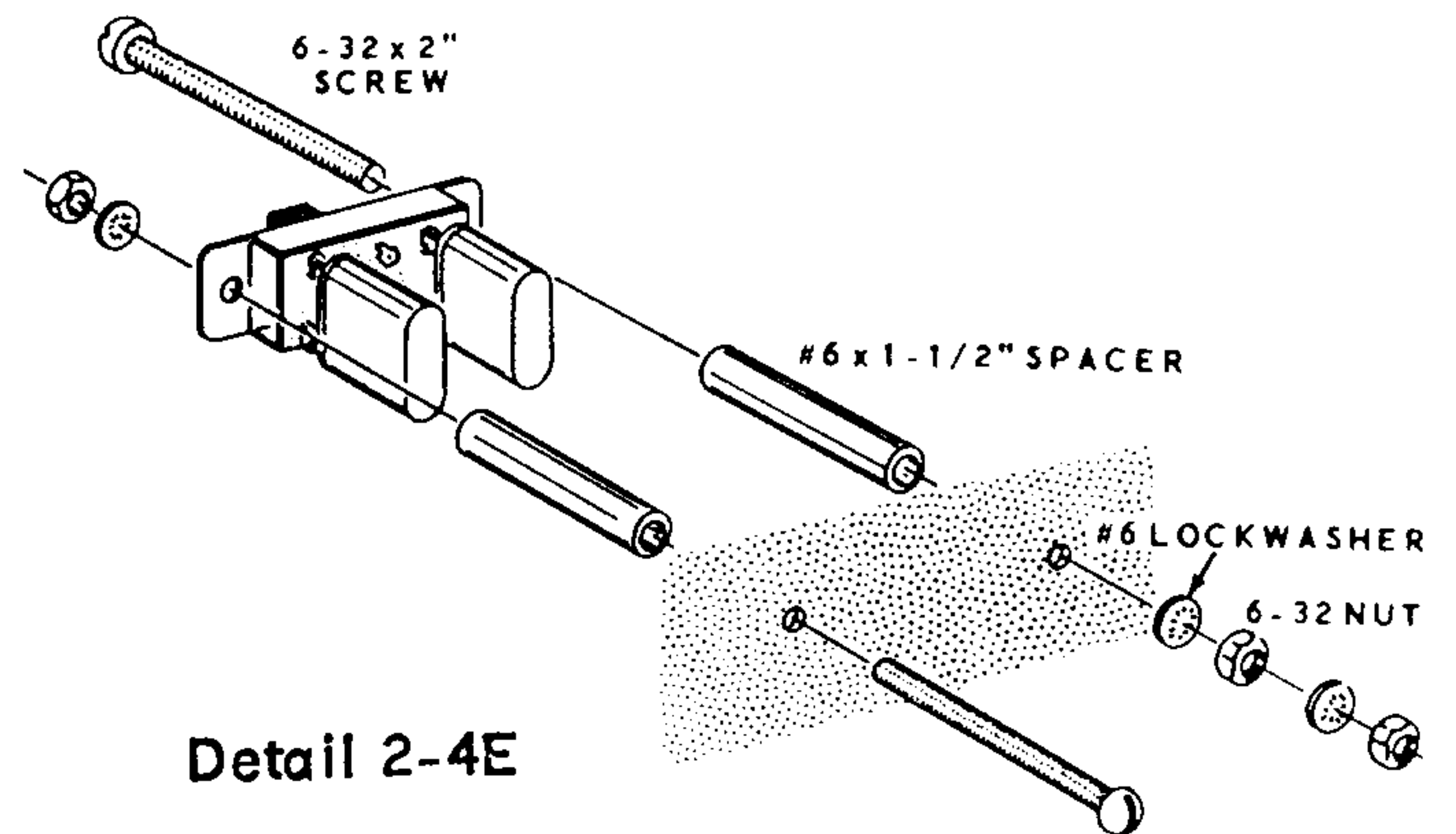
Refer to Detail 2-4D for the following steps.



- ( ) Position the slide switch insulator over the lugs of a DPDT slide switch.
- ( ) Bend lugs 1, 3, 4, and 6 of the switch as shown.
- ( ) Connect one end of a 3-1/2" red wire to lug 2 of the switch (S-1). The other end of this wire will be connected later.
- ( ) Connect one end of a 3" black wire to lug 5 of the switch (S-1). The other end of this wire will be connected later.
- ( ) Connect the 2303.3 kHz crystal (#404-196) between lugs 3 (S-1) and 6 (S-1) of this switch. Position the pins of the crystal into the holes in the lugs of the switch.
- ( ) In a like manner, connect the 2306.7 kHz crystal (#404-197) between lugs 1 (S-1) and 4 (S-1) of this switch.

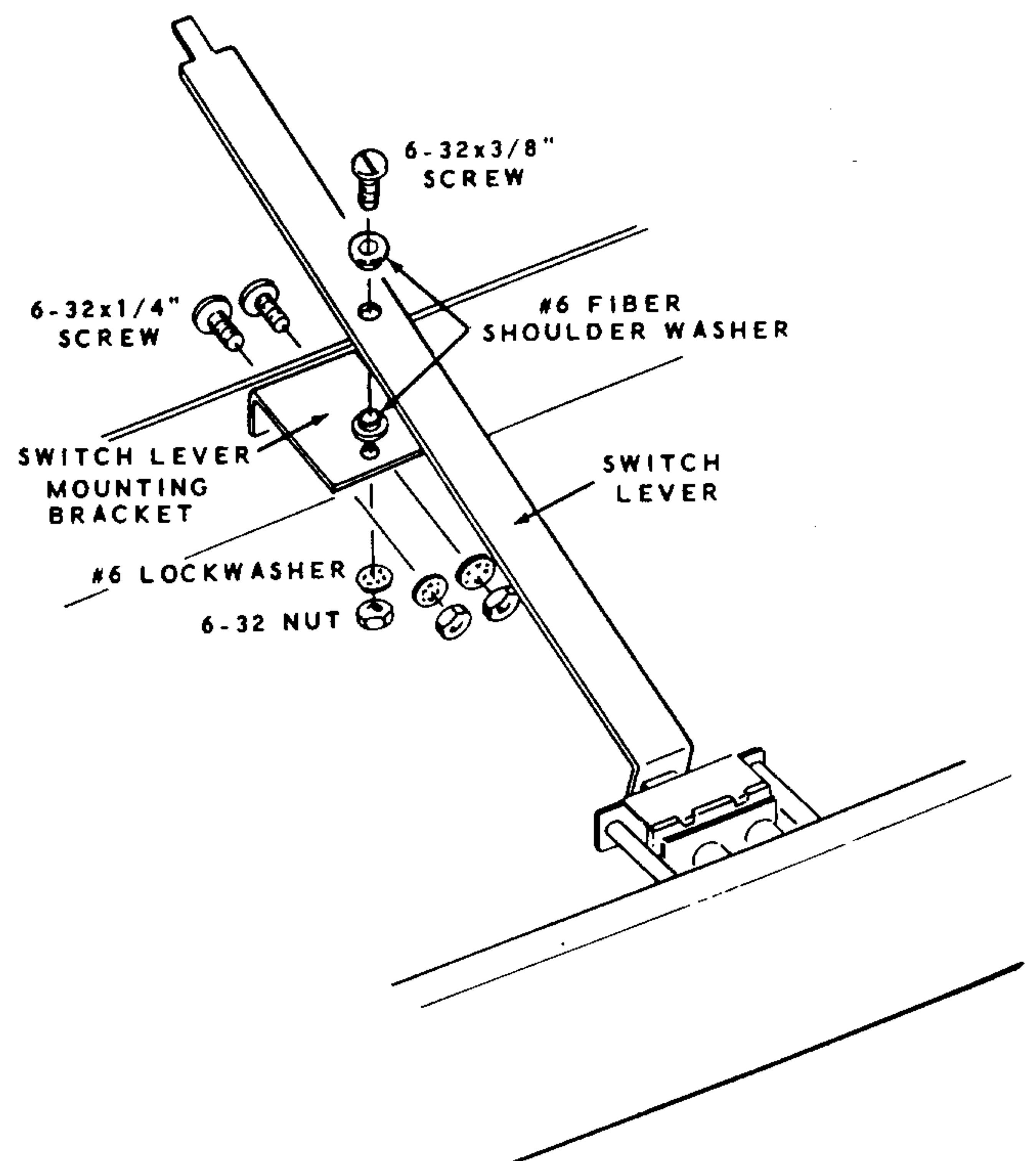
**NOTE:** Be careful not to pinch any of the harness wires between the crystals and chassis in the next step.

- ( ) Refer to Detail 2-4E, and mount the Sideband switch assembly on the chassis. Use 6-32 x 2" hardware and #6 x 1-1/2" spacers. Be sure to position the switch as shown in Pictorial 2-4.



Refer to Detail 2-4F for the following steps.

- ( ) Mount the switch lever mounting bracket on the chassis partition. Use 6-32 x 1/4" hardware.
- ( ) Fit the slotted end of the switch lever over the knob on the Sideband switch.
- ( ) Secure the switch lever to the switch lever mounting bracket with 6-32 x 3/8" hardware and two #6 fiber shoulder washers. Check the operation of the lever and switch to see that they operate freely.





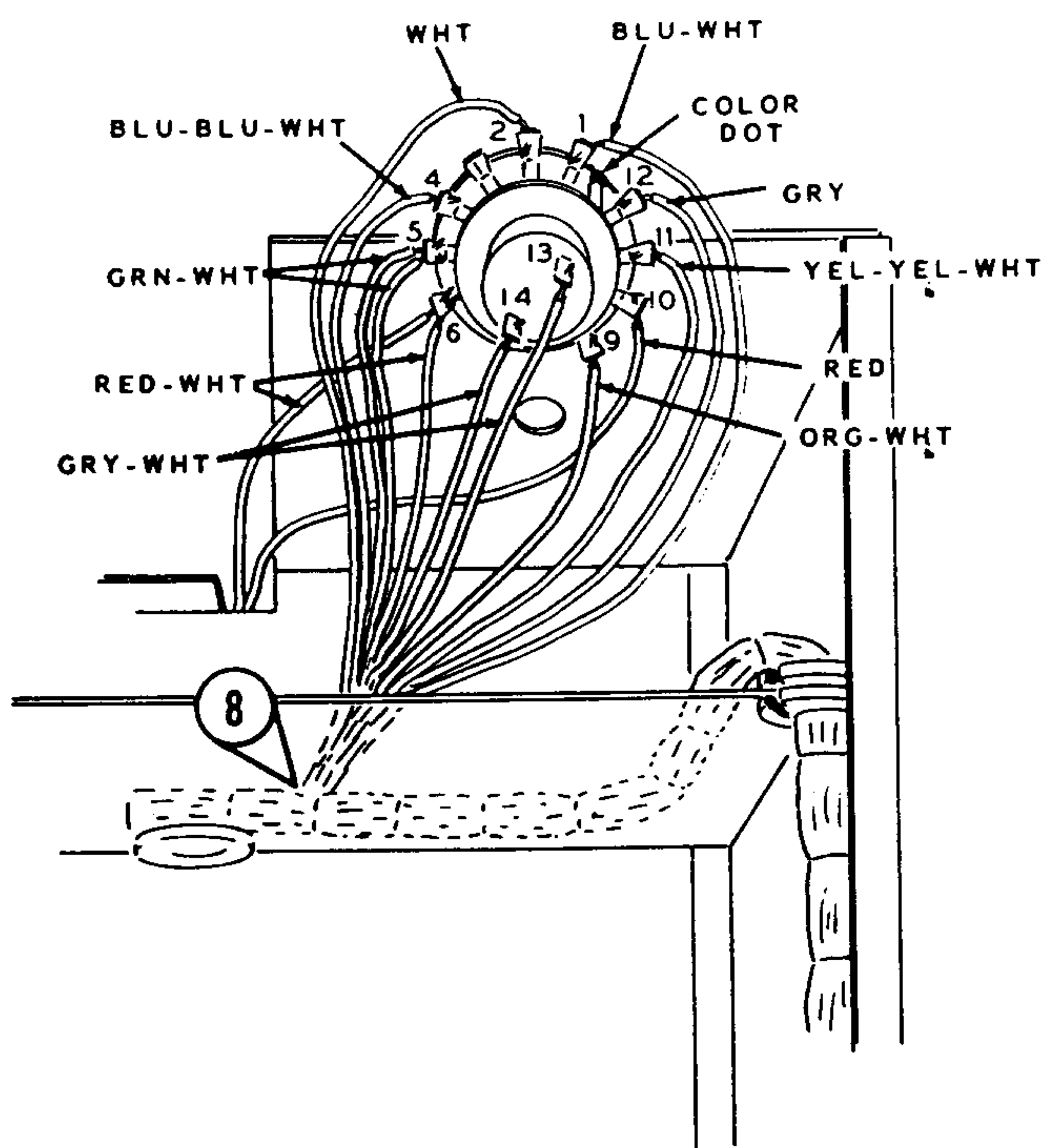


Refer to Pictorial 2-4 for the following steps.

- ( ) Connect the free end of the red wire coming from lug 2 of the Sideband switch, to terminal R section 2C on the circuit board (S-1).
- ( ) Connect the free end of the black wire coming from lug 5 of the Sideband switch, to terminal Q section 2C on the circuit board (S-1).

### FUNCTION SWITCH WIRING

Refer to Pictorial 2-5 for the following steps.



PICTORIAL 2-5

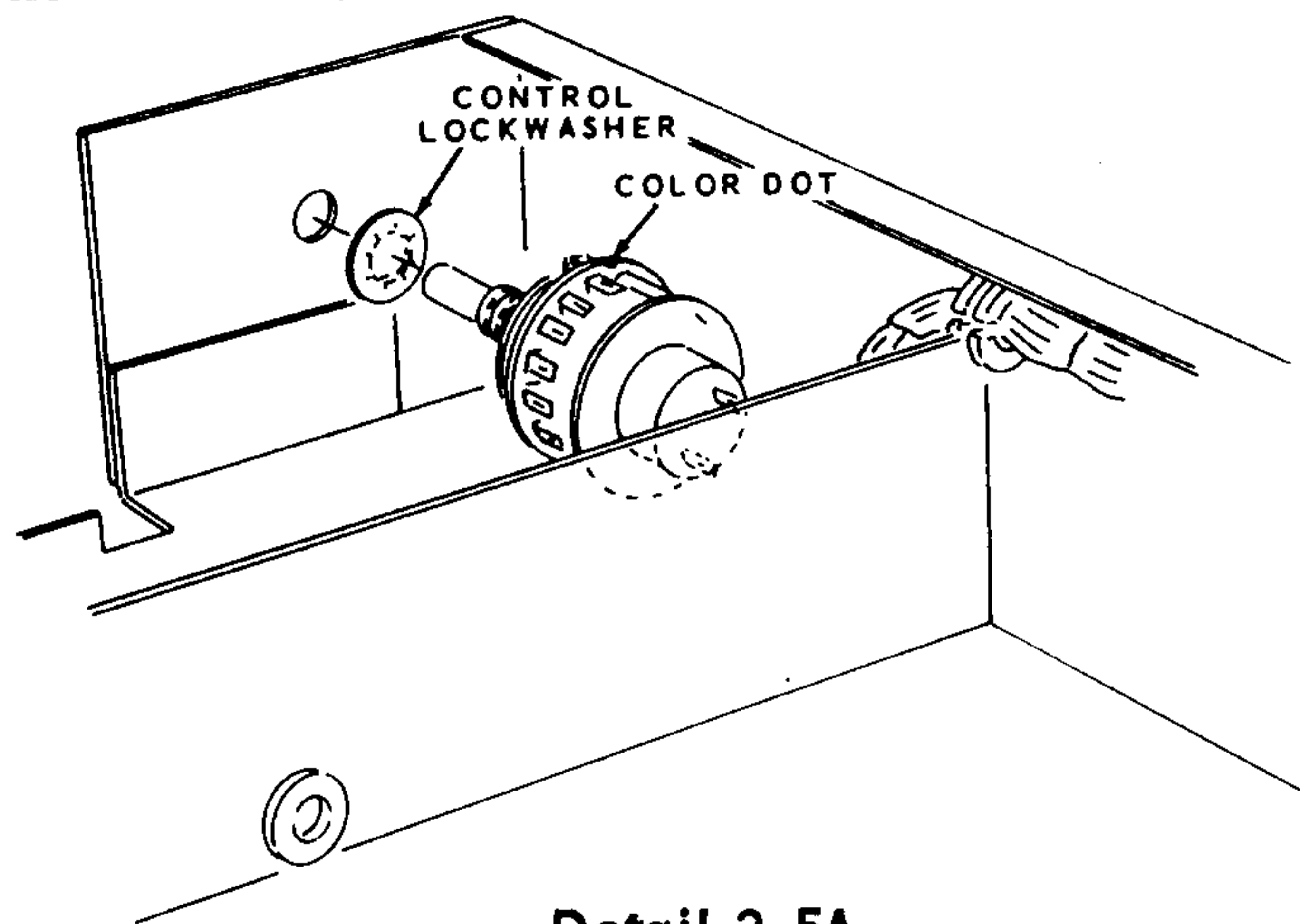
- ( ) Locate the 5-position rotary with snap switch (#63-427). Position the switch as shown. Note that the color dot is between lugs 1 and 12 of the wafer on this (Function) switch.
- ( ) Connect one end of a 5-1/2" red wire to lug 10 of the Function switch (S-1). Position the other end of the wire over the front edge of the chassis for connection later.

- ( ) Connect one end of a 4-1/2" red-white wire to lug 6 of the Function switch (NS). Position the other end of the wire over the front edge of the chassis for connection later.

Connect the wires from BO#8 to the Function switch as follows:

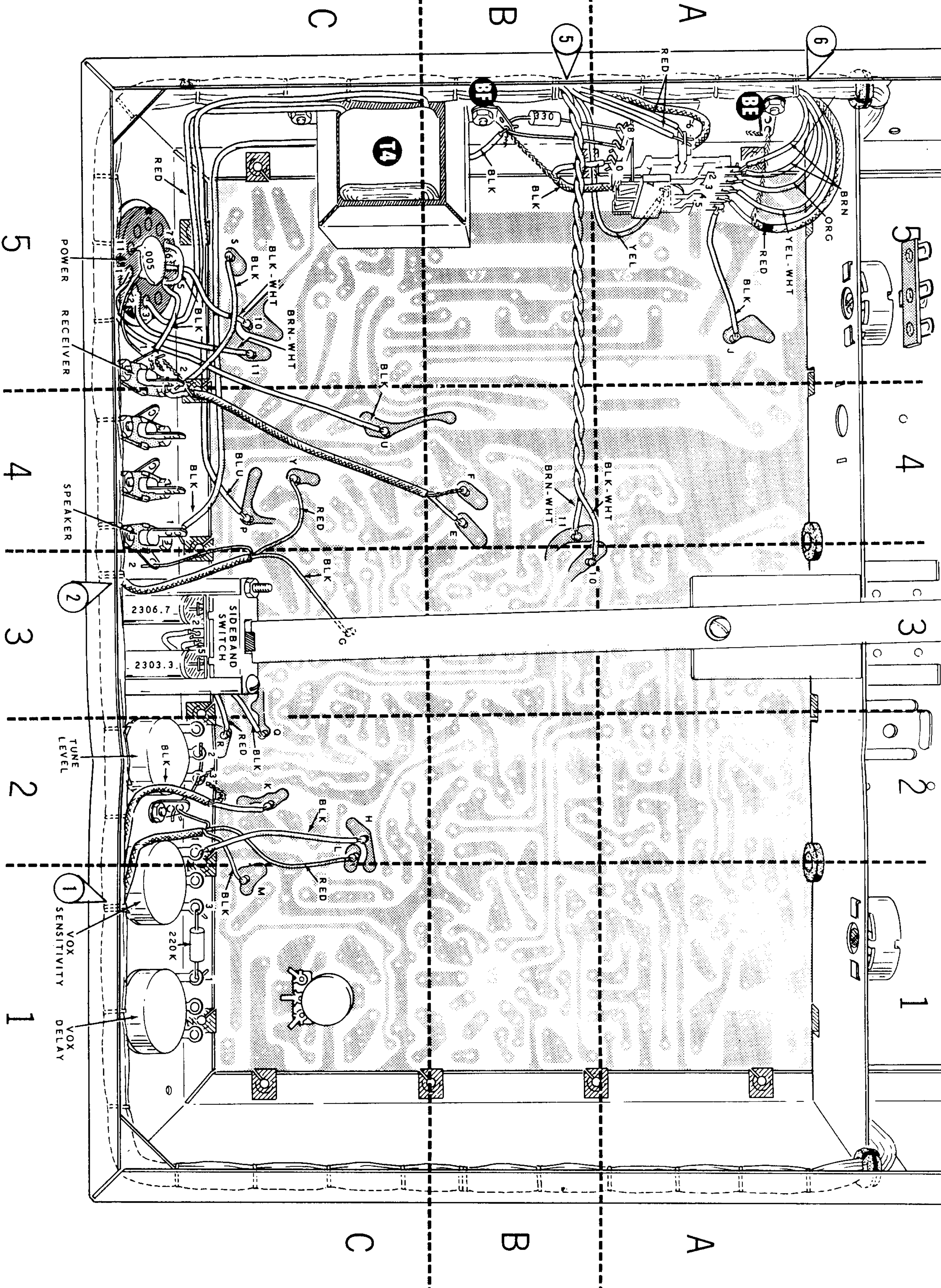
- ( ) Red-white to lug 6 (S-2).
- ( ) Both green-white to lug 5 (S-2). Do not use the green-green-white wire.
- ( ) Blue-blue-white to lug 4 (S-1). Do not use the blue-white wire.
- ( ) White to lug 2 (S-1).
- ( ) Orange-white to lug 9 (S-1). Do not use the orange-orange-white wire.
- ( ) Yellow-yellow-white to lug 11 (S-1).
- ( ) Gray to lug 12 (S-1).
- ( ) Blue-white to lug 1 (S-1).
- ( ) Either gray-white to lug 14 (S-1).
- ( ) Other gray-white to lug 13 (S-1).
- ( ) Refer to Detail 2-5A, and position the Function switch into its mounting hole in the chassis. Use a 3/8" control lockwasher. Form the excess harness wires down into the chassis.

The remaining wires from BO#8 will be connected later.



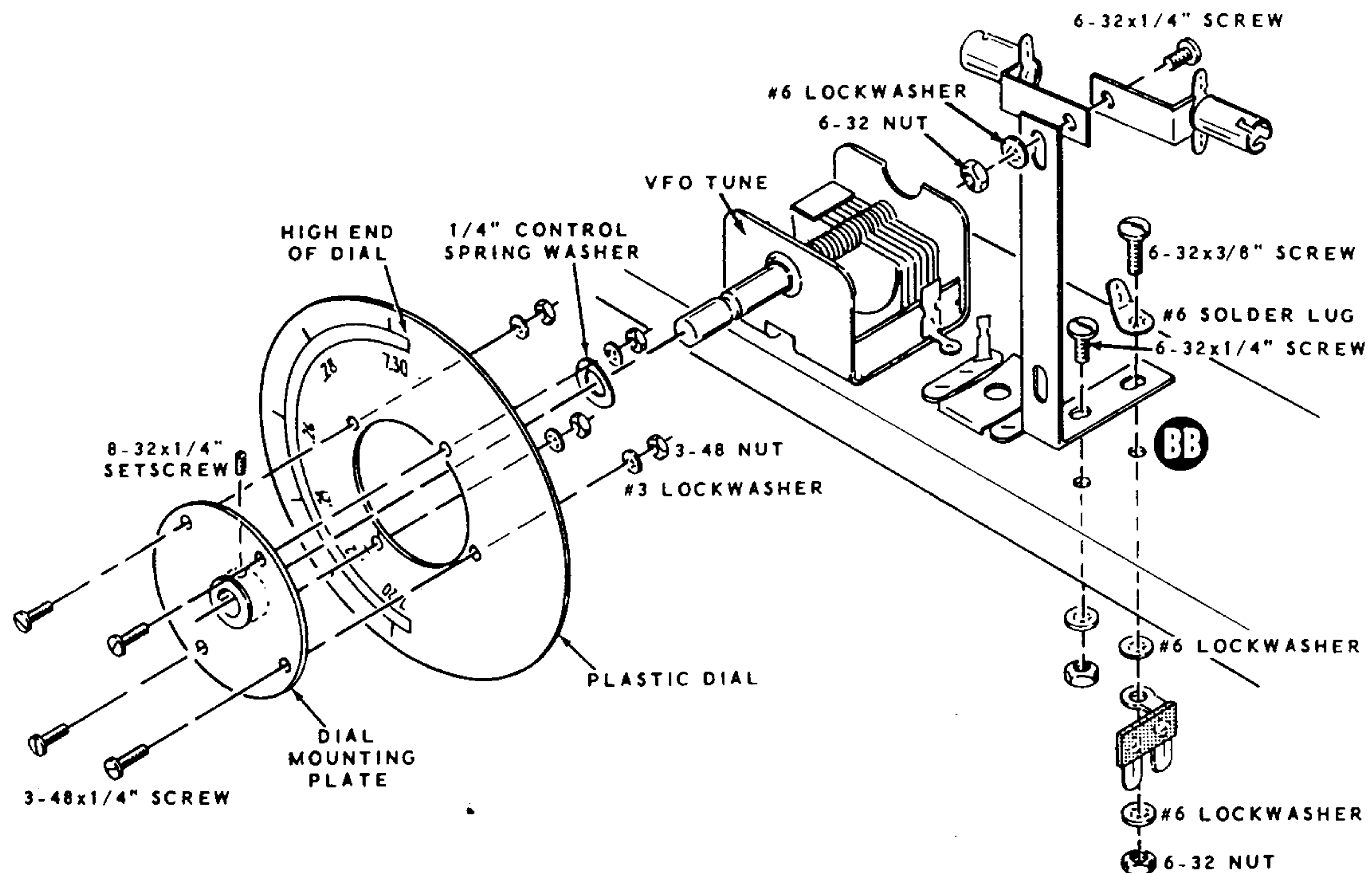
Detail 2-5A





PICTORIAL 2-4





PICTORIAL 2-6

## TOP CHASSIS AND FRONT PANEL ASSEMBLY

Refer to Pictorial 2-6 for the following steps.

- ( ) Install the pilot lamp mounting bracket, a #6 solder lug, and a 2-lug terminal strip at location BB. Use 6-32 x 1/4" hardware and 6-32 x 3/8" hardware.
- ( ) Install two pilot lamp sockets on the pilot lamp mounting bracket. Use 6-32 x 1/4" hardware. Position each socket as shown.
- ( ) Install the plastic dial on the dial mounting plate with 3-48 x 1/4" hardware. Position the setscrew hole in the dial mounting plate bushing as shown.
- ( ) Start an 8-32 x 1/4" setscrew in the tapped hole of the dial mounting plate bushing.
- ( ) Place a 1/4 control spring washer on the shaft of the VFO tune capacitor. Be sure to position this washer with the cupped side toward the dial.
- ( ) Install the plastic dial on the shaft of the VFO Tune capacitor. With the plates of the capacitor fully meshed, push on the plastic

dial until the spring washer is about half compressed; then tighten the setscrew. The high frequency end of the plastic dial (nearest the 7.3 marking) should be straight up.

Set the chassis aside temporarily.

Refer to Detail 2-7A for the following steps.

Place a soft cloth on your work area to prevent scratching the front panel.

- ( ) Install a DPDT slide switch at the Meter switch location using 6-32 x 1/4" hardware.
- ( ) Install meter #407-99 on the front panel using the lockwashers and nuts supplied with the meter. Do not overtighten the hardware, as the meter case can be broken.
- ( ) Remove and discard the shorting wire from between the meter lugs.
- ( ) Install a 1 megohm bushing-mount control (#10-17) at the Mic Gain control position. Use a 3/8" control lockwasher, a 3/8" control flat washer, and a 3/8-32 control nut.

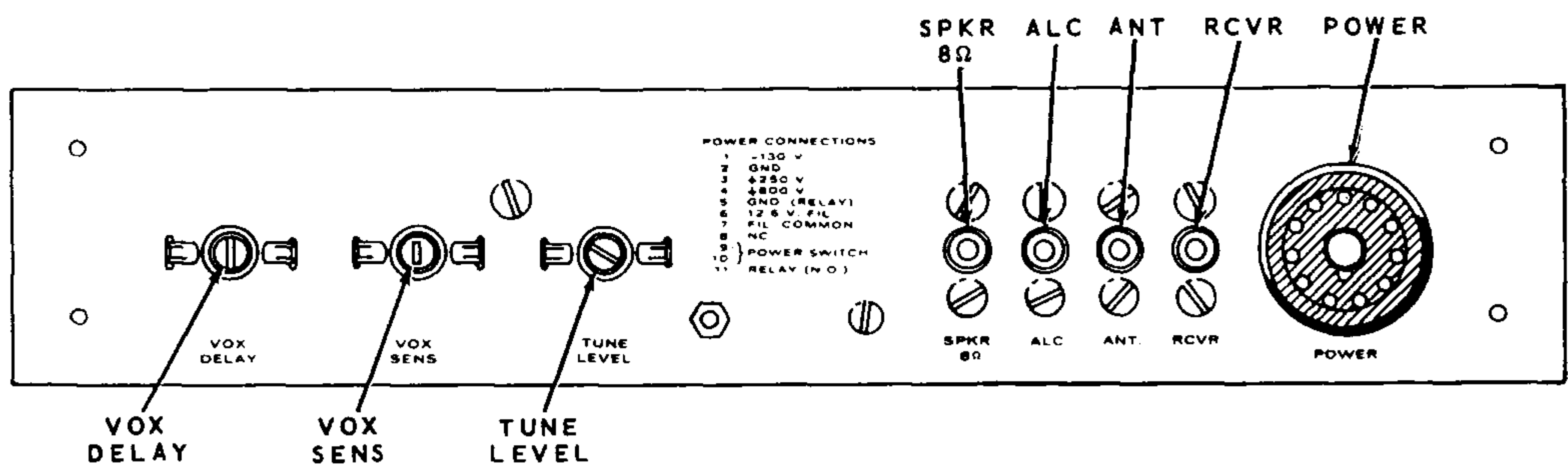
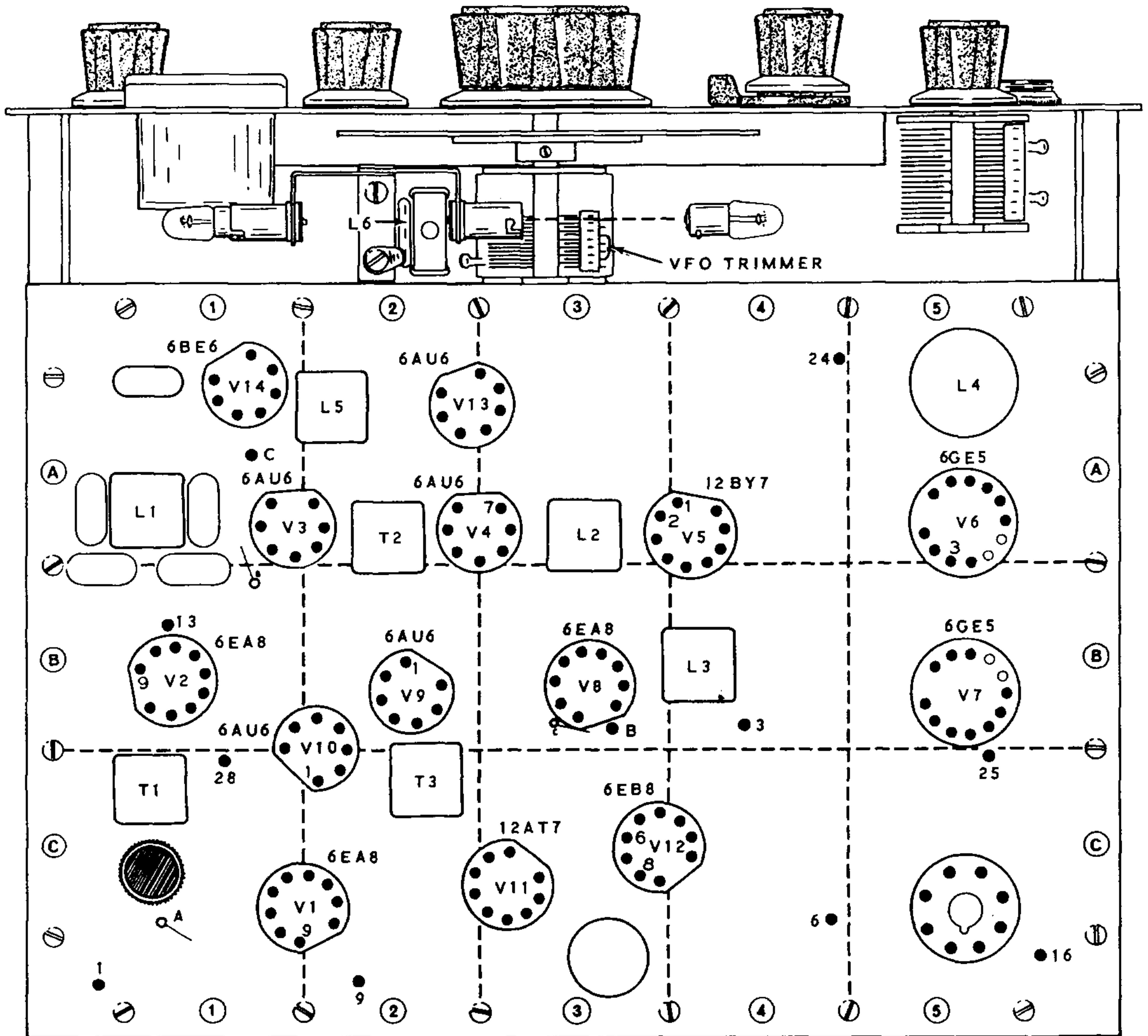
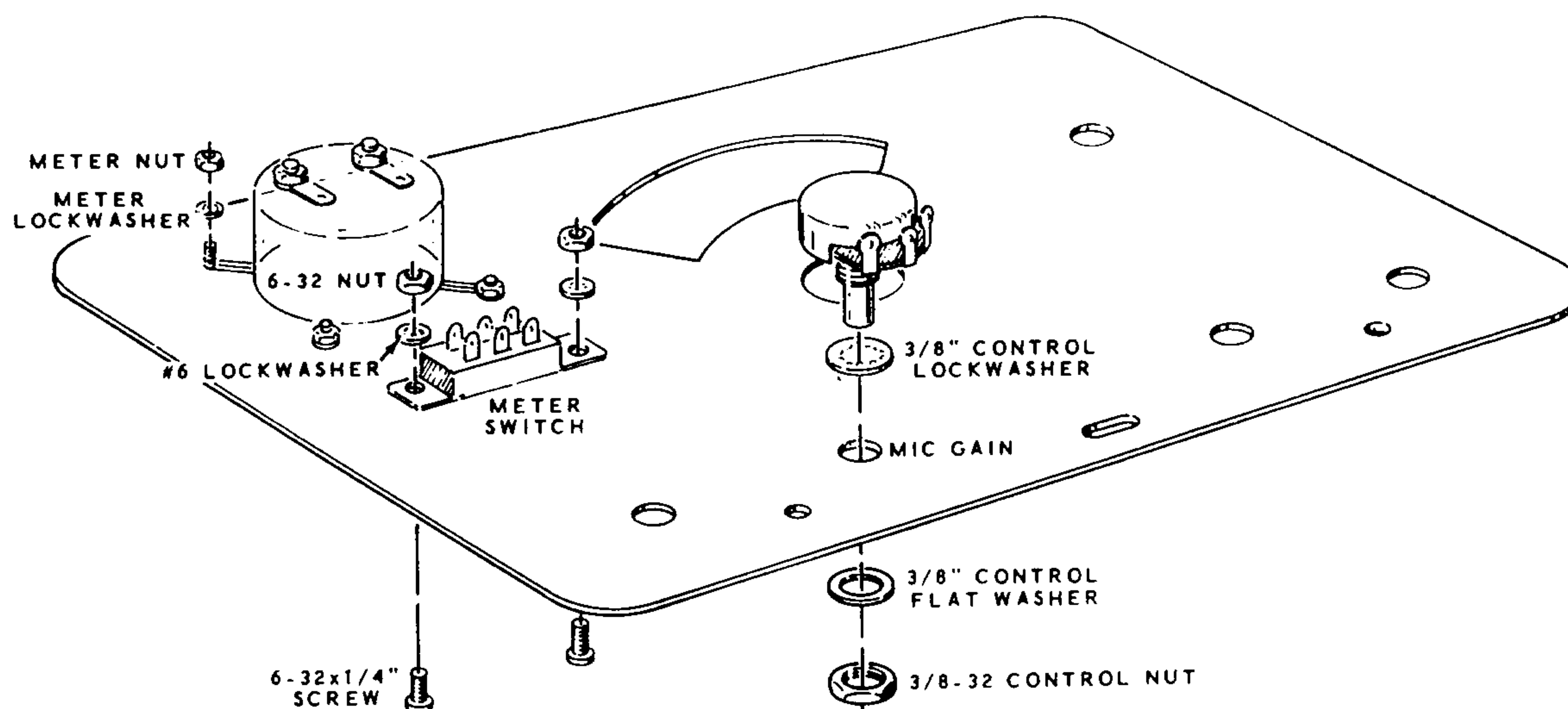


FIGURE 1-1

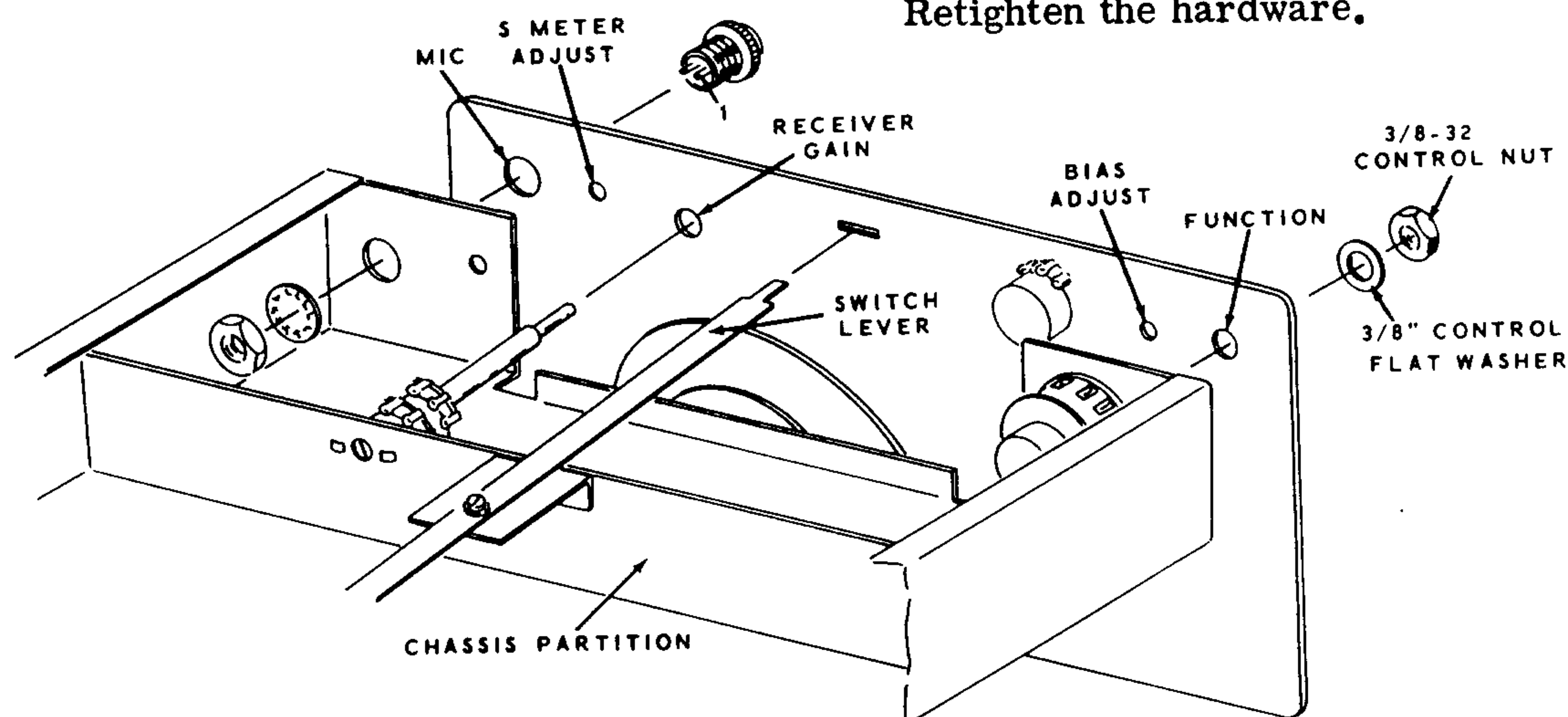




Detail 2-7A

Refer to Pictorial 2-7 for the following steps.

- ( ) Install the 1 megohm/25 K $\Omega$  dual tab-mount control (#12-73) at the Receiver Gain (RCVR GAIN) location on the chassis partition. Bend the mounting tabs as shown.
- ( ) Position the front panel on the chassis. Fit the switch lever through the small slot in the front panel.
- ( ) Install a 3/8" control flat washer and a 3/8-32 control nut on the Function switch. Do not tighten the nut at this time.
- ( ) Install the female connector at the Mic location using the lockwasher and nut supplied with the connector. Position lug 1 of the connector as shown. Do not tighten the nut yet.
- ( ) Carefully line-up the holes of the front panel and chassis at the S Meter Adjust and Bias Adjust locations. Now, tighten the nuts on the Function switch and Mic connector. Be sure the red dot on the Function switch is directly in line with the VOX marking on the front panel.
- ( ) Operate the switch lever to see that it does not hit either end of the slot in the front panel. If it does, loosen the switch lever mounting bracket and adjust it as required. Retighten the hardware.



PICTORIAL 2-7

## FINAL WIRING-CHASSIS BOTTOM

Refer to Pictorial 2-8 for the following steps.

- ( ) Connect the free end of the red wire extending from grommet BC to lug 3 of terminal strip BA (NS).

Connect the wires from BO#7 as follows:

- ( ) Green-white to lug 2 of the Mic connector (NS).
- ( ) Gray-gray-white to lug 1 of the S Meter Adjust control (S-1).
- ( ) Red-white to lug 2 of the S Meter Adjust control (S-1).
- ( ) Red to lug 3 of terminal strip BA (NS).
- ( ) Black coaxial cable: inner lead to lug 1 (NS) and the shield to lug 2 of terminal strip BA (NS).

- ( ) Place a 3/4" length of sleeving on the shield lead of the 2-wire coaxial cable. Then, connect the shield lead to lug 4 (NS), the black lead to lug 5 (NS), and the red lead to lug 6 (S-1) of the Receiver Gain control. Be sure lugs 4, 5, and 6 do not touch the chassis partition.

- ( ) Violet-violet-white to lug 2 of the Receiver Gain control (S-1).

- ( ) Connect a 3" black wire from lug 3 of the S Meter Adjust control (NS) to lug 3 on the Receiver Gain control (S-1).

- ( ) Pass one lead of a .005  $\mu$ fd disc capacitor through lug 2 of terminal strip BA (S-3) to lug 3 of the S Meter Adjust control (S-2). Place a 3/4" length of sleeving on the other lead and connect it to lug 2 of the Mic connector (S-2).

- ( ) Connect a 10 K $\Omega$  (brown-black-orange) resistor from lug 1 of the Mic connector (S-1) to lug 1 of terminal strip BA (S-2).

- ( ) Place a 7/8" length of sleeving on one lead of a 220 K $\Omega$  (red-red-yellow) resistor. Connect this lead to lug 1 of the Receiver Gain control (S-1). Connect the other lead to lug 3 of terminal strip BA (S-3).

- ( ) Connect a 500 pf disc capacitor between lugs 4 (S-2) and 5 (S-2) of the Receiver Gain control. Be sure the leads of the capacitor and the lugs of the control do not touch the chassis partition.

Connect the wires from BO#8 as follows:

- ( ) Both brown to lug 1 of terminal strip BB (NS).

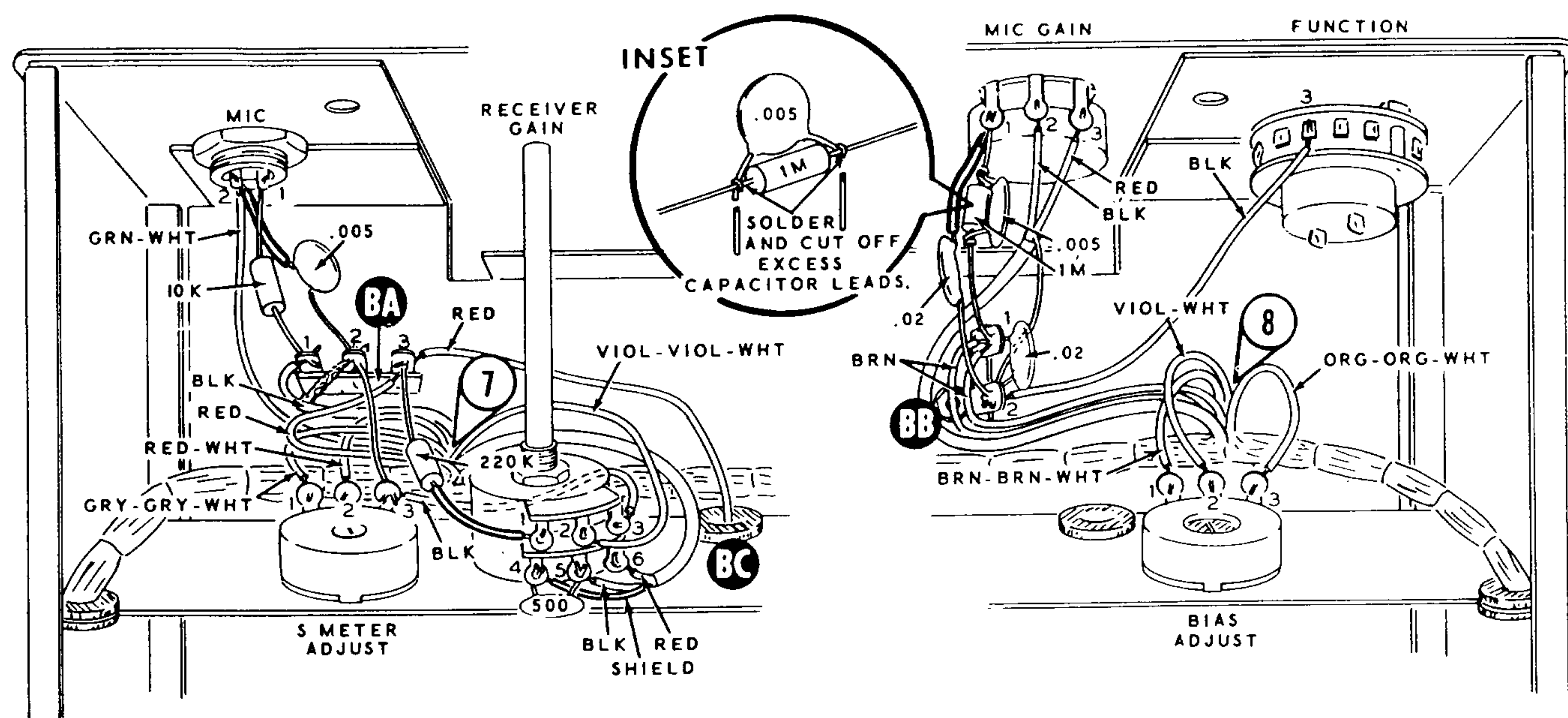
- ( ) Two wire coaxial cable: shield lead to lug 2 of terminal strip BB (NS), black lead to lug 2 (S-1), and the red lead to lug 3 (S-1) of the Mic Gain control.

- ( ) Brown-brown-white to lug 1 of the Bias Adjust control (S-1).

- ( ) Violet-white to lug 2 of the Bias Adjust control (S-1).

- ( ) Orange-orange-white to lug 3 of the Bias Adjust control (S-1).

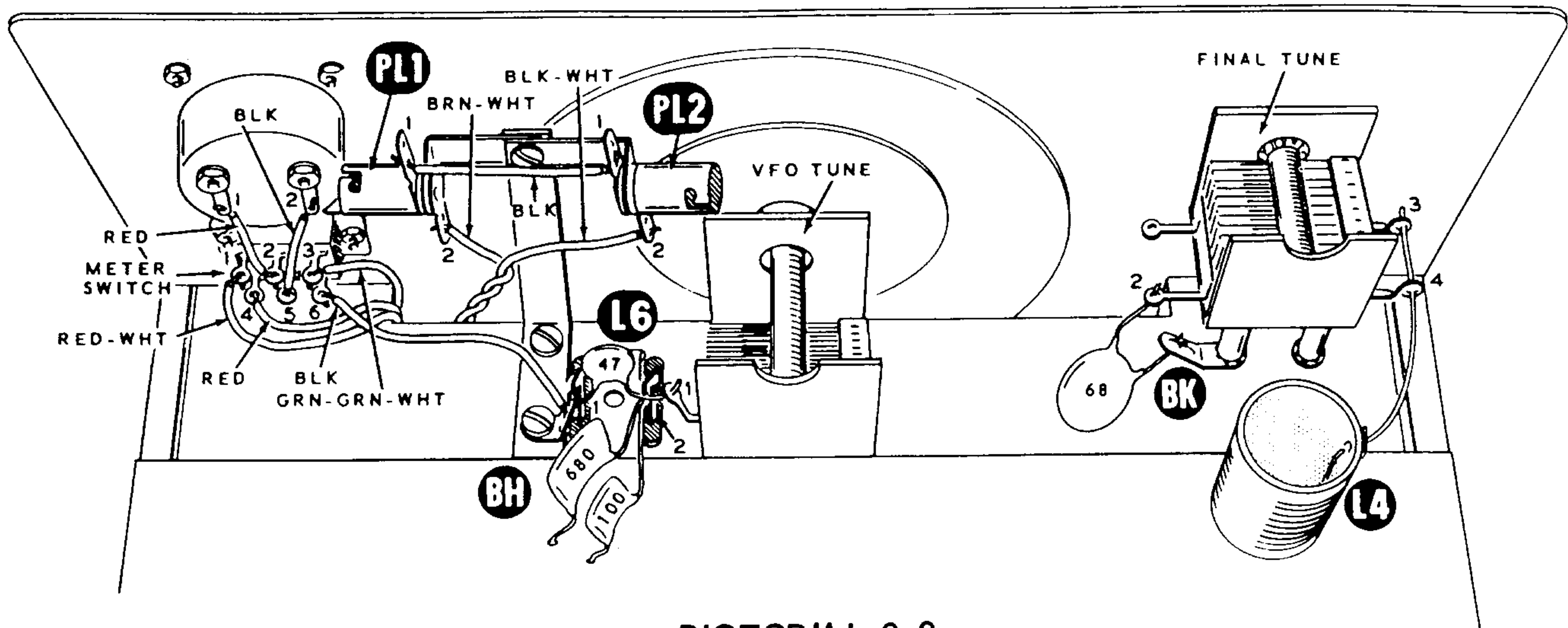




PICTORIAL 2-8

- ( ) Connect a 4" black wire from lug 2 of terminal strip BB (NS) to lug 3 of the Function switch (S-1).
- ( ) Prepare a resistor capacitor combination using a 1 megohm (brown-black-green) resistor and a .005  $\mu$ fd disc capacitor as shown in the inset drawing on the Pictorial.
- ( ) Connect this combination between lug 1 of the Mic Gain control (NS) and lug 1 of terminal strip BB (NS).
- ( ) Place a 1" length of sleeving on one lead of a .02  $\mu$ fd disc capacitor. Connect this lead to lug 1 of the Mic Gain control (S-2). Connect the other lead of this capacitor to lug 2 of terminal strip BB (NS).
- ( ) Connect a .02  $\mu$ fd disc capacitor between lugs 1 (S-4) and 2 (S-4) of terminal strip BB.

This completes the wiring on the bottom of the chassis. Check to see that all connections are soldered, and shake out any wire clippings or solder splashes. Be sure that all wires are clear of the four small holes in the rear apron of the chassis. This will prevent possible damage to these wires when the cabinet is installed later.



PICTORIAL 2-9

### FINAL WIRING - CHASSIS TOP

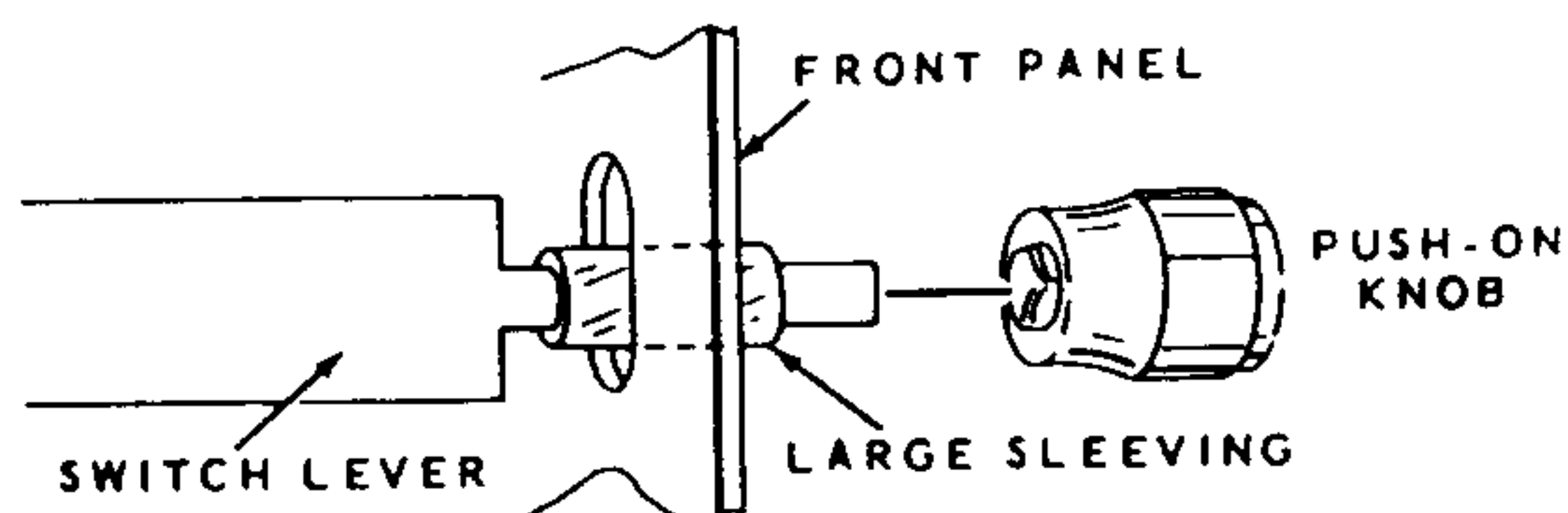
Refer to Pictorial 2-9 for the following steps.

Connect the wires extending from the bottom of the chassis as follows:

- ( ) Red-white to lug 1 of the Meter switch (S-1).
- ( ) Green-green-white to lug 3 of the Meter switch (S-1).
- ( ) Red to lug 4 of the Meter switch (S-1).
- ( ) Twist together the black-white and brown-white wires to form a twisted pair. Connect the brown-white wire to lug 2 of pilot lamp socket PL1 (S-1), and the black-white wire to lug 2 of pilot lamp socket PL2 (S-1).
- ( ) Connect a 1-3/4" black wire from lug 1 of pilot lamp socket PL1 (S-1) to lug 1 of pilot lamp socket PL2 (S-1).
- ( ) Connect a 3" black wire from lug 6 of the Meter switch (S-1) to solder lug BH (NS).
- ( ) Connect a 1-3/4" red wire from lug 2 of the Meter switch (S-1) to lug 1 of the meter (S-1).
- ( ) Connect a 2-1/4" black wire from lug 5 of the Meter switch (S-1) to lug 2 of the meter (S-1).
- ( ) Wrap one lead of a 47 pf disc capacitor around lug 2 of coil L6 (NS) and to lug 1 of the VFO tuning capacitor (S-1). Connect the other lead of the capacitor to lug 1 of coil L6 (S-3). Be sure solder lug BH is soldered to lug 1 of coil L6.
- ( ) Connect the free leads of the 680 pf mica and 100 pf mica capacitors coming from the circuit board, to lug 2 of coil L6 (S-4).
- ( ) Bend all four lugs of the Final Tune capacitor as shown.
- ( ) Connect a 68 pf disc capacitor from lug 2 of the Final Tune capacitor (S-1) to solder lug BK (S-1).
- ( ) Connect the free lead from coil L4 (on the circuit board) through lug 4 (S-2) to lug 3 (S-1) of the Final Tune capacitor. Twist the capacitor lugs as shown.

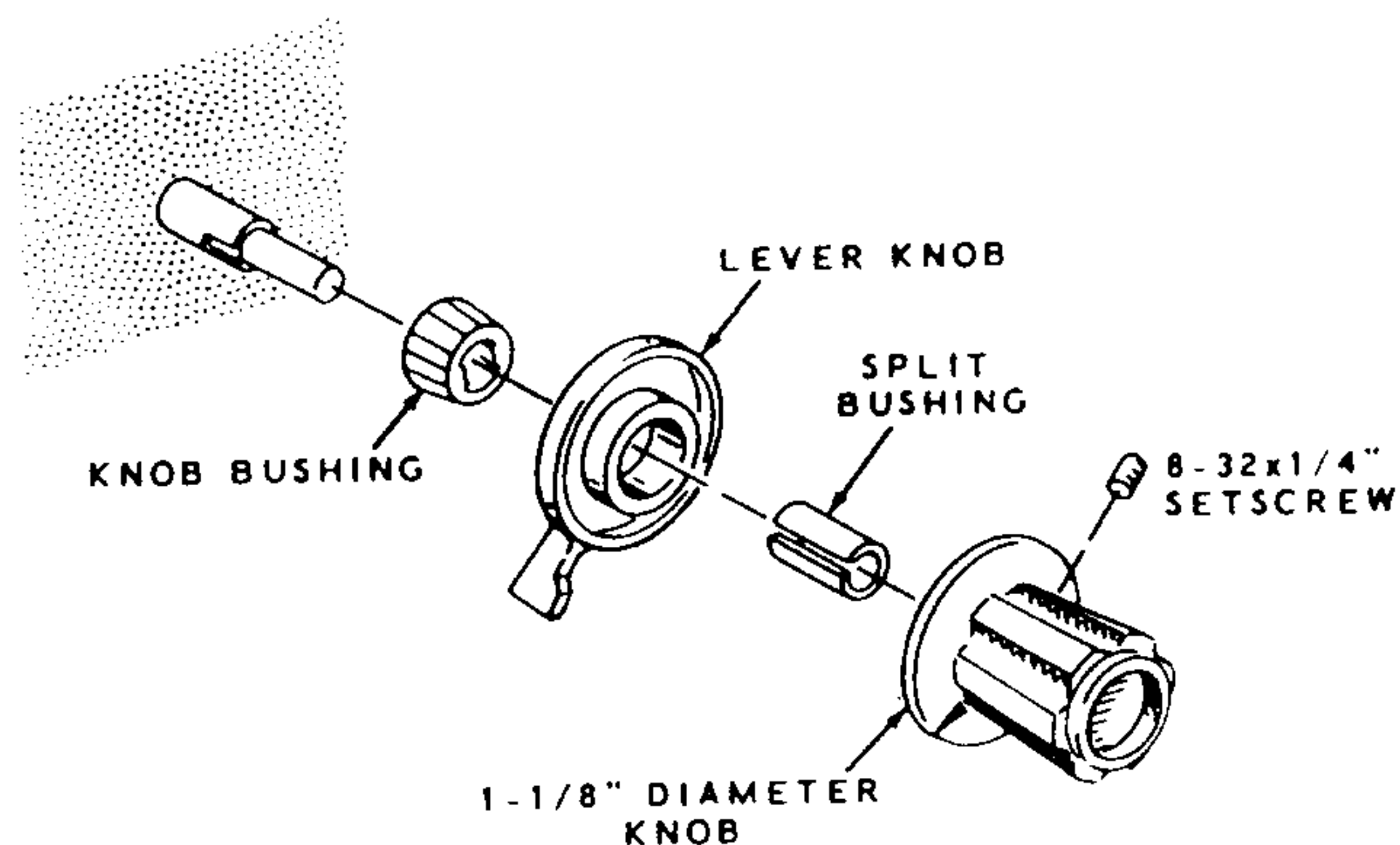
This completes the wiring on the top of the chassis. Check to see that all connections are soldered and shake out any wire clippings or solder splashes.





Detail 2-9A

- ( ) Refer to Detail 2-9A, and install a 1/4" length of large sleeving and the push-on knob on the switch lever at the LSB/USB location of the front panel. Work the sleeving into the slot of the front panel.
- ( ) Turn all the control, switch, and capacitor shafts fully counterclockwise.
- ( ) Refer to Detail 2-9B, and install the knob bushing on the large shaft at the Receiver Gain position. Position the knob as shown, and push the lever knob on the bushing. Support the rear of this control with your finger when pushing the knob on the knob bushing.
- ( ) Start 8-32 x 1/4" setscrews in the tapped holes of the 1-1/8" and 2" diameter knobs.



Detail 2-9B

- ( ) Insert a split bushing in one of the 1-1/8" diameter knobs, and install this knob at the Receiver Gain location. Position the pointer as shown.
- ( ) Install the 2" diameter knob at the Tuning location.
- ( ) Install 1-1/8" diameter knobs on the remaining shafts. Position the knob pointer at the Mic Gain location at the 7 o'clock position. The other pointers should be at the fully counterclockwise markings on the panel.

## INITIAL TEST

Before installing the tubes and pilot lamps, the following resistance checks should be performed. If the actual resistance readings vary more than  $\pm 20\%$  from those listed, refer to the In Case Of Difficulty section of the Manual on Page 53.

Connect the common test lead of an ohmmeter to the chassis and the positive lead to the Test Points listed in the following chart.

**NOTE:** The internal wiring of most ohmmeters is such that the positive terminal of the ohmmeter battery is connected to the positive (red) test lead, and the negative terminal is connected to the negative (black) test lead. In some ohmmeters, this wiring is reversed and

erroneous readings will be obtained when making these measurements. Try reversing the ohmmeter test leads if the measurements do not check out correctly the first time. Also, try different ohmmeter ranges. Diodes conduct in a non-linear manner giving different resistance readings on different ohmmeter ranges.

Refer to Figure 1-1 (fold-out from Page 28) for the locations of the test points.

Set the controls as follows:

Sideband switch: LSB.

FUNCTION: PTT.

Meter switch: BIAS SET.

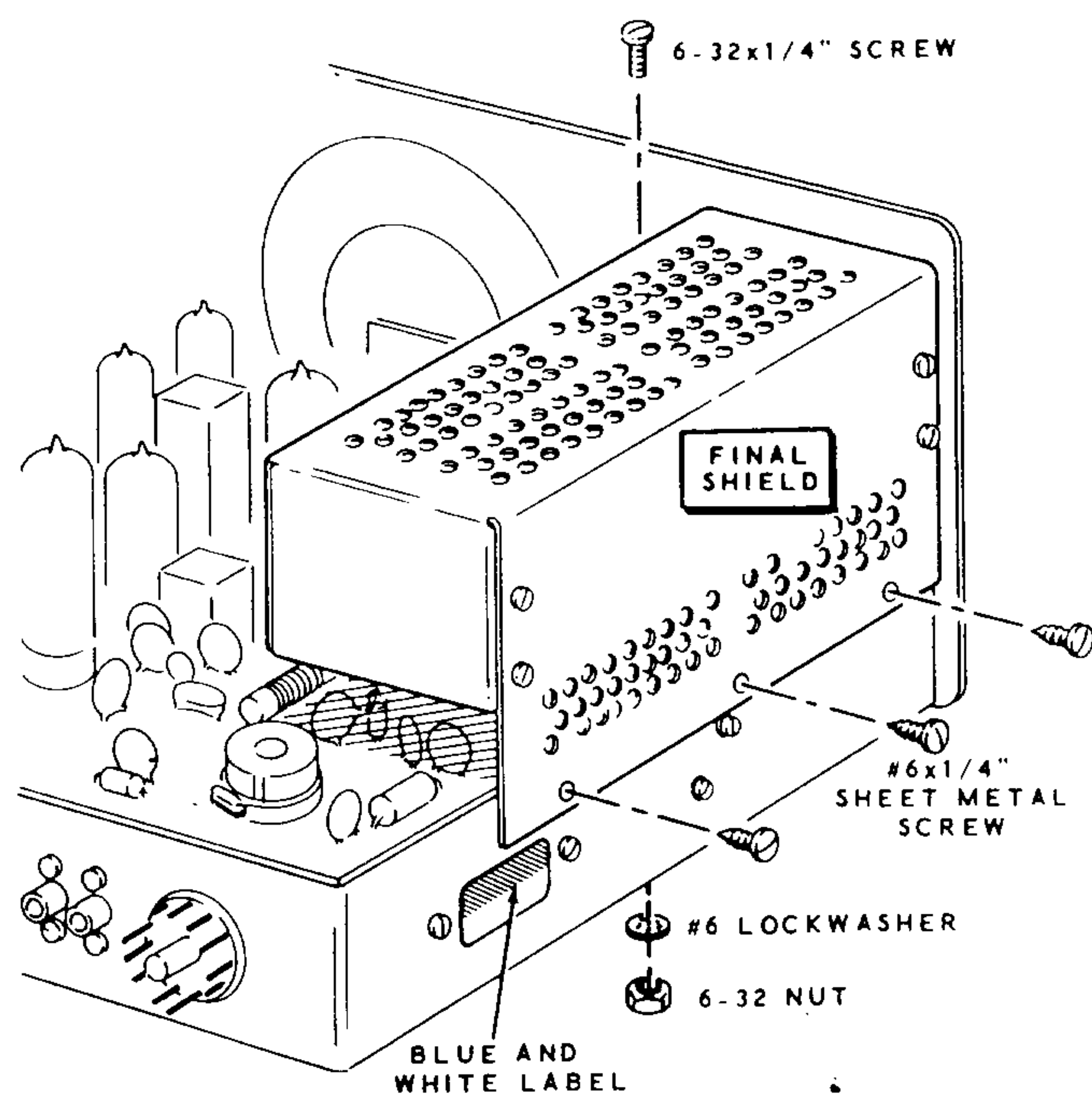
All other controls: Fully counterclockwise.

<u>TEST POINT</u>	<u>RESISTANCE</u>	<u>TEST POINT</u>	<u>RESISTANCE</u>
( ) POWER plug pin 1	37 K $\Omega$	( ) Tube socket V12 pin 8	35 K $\Omega$
( ) POWER plug pin 2	1000 $\Omega$	( ) Tube socket V12 pin 6	120 $\Omega$
( ) POWER plug pin 3	31 K $\Omega$	( ) Tube socket V1 pin 9	1 to 2 megohm (varies with setting of MIC GAIN control)
( ) POWER plug pin 4	Infinity	( ) Tube socket V10 pin 1	0 $\Omega$
( ) POWER plug pin 5	0 $\Omega$	( ) Tube socket V2 pin 9	23 megohm
( ) POWER plug pin 6	Infinity	( ) 6 in section 4C	0 to 500 K $\Omega$ (varies with setting of VOX SENS control)
( ) POWER plug pin 7	0 $\Omega$	( ) 9 in section 2C	0 $\Omega$
( ) POWER plug pin 8	Infinity	( ) MIC #1	Infinity
( ) POWER plug pin 9	Infinity	( ) MIC #2	23 megohm
( ) POWER plug pin 10	Infinity	( ) 16 in section 5C	0 $\Omega$
( ) POWER plug pin 11	Infinity	( ) Set FUNCTION switch to VOX.	
( ) 28 in section 1C	9 K $\Omega$	( ) Tube socket V10 pin 1	2 megohm
( ) A in section 1C	200 $\Omega$ to 500 $\Omega$	( ) Tube socket V2 pin 9	23 megohm
( ) B in section 3B	250 K $\Omega$	( ) 9 in section 2C	0 $\Omega$
( ) C in section 1A	3300 $\Omega$	( ) MIC #2	23 megohm
( ) 13 in section 1B	220 $\Omega$	( ) Set FUNCTION switch to CAL.	
( ) Tube socket V4 pin 7	330 $\Omega$	( ) 16 in section 5C	131 K $\Omega$
( ) Tube socket V5 pin 1	150 $\Omega$	( ) MIC #2	23 megohm
( ) Tube socket V5 pin 2	200 K $\Omega$ to 1.1 megohm		
( ) Tube socket V6 pin 3	75 K $\Omega$		
( ) Tube socket V9 pin 1	1.25 megohm		





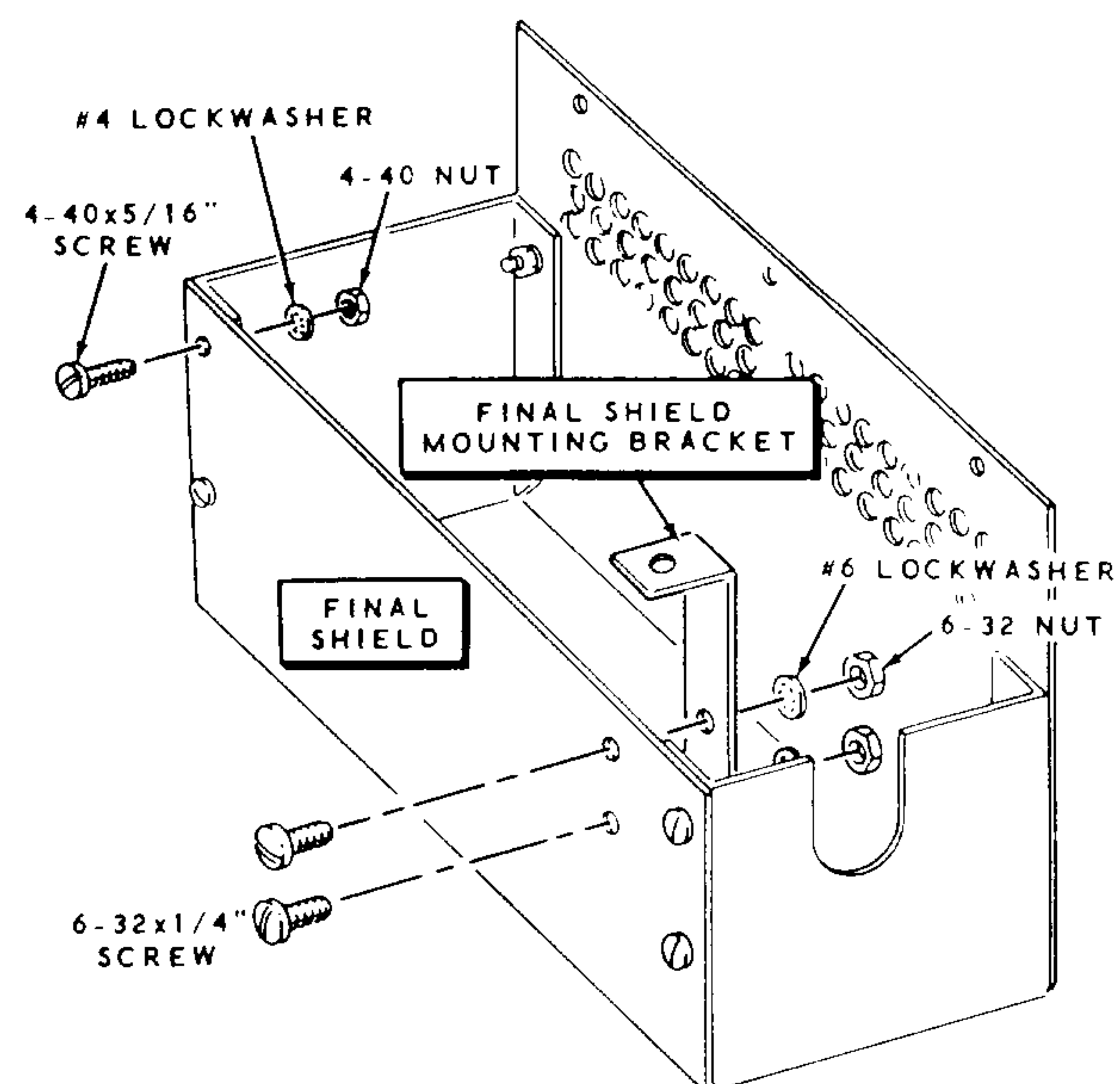
<u>TEST POINT</u>	<u>RESISTANCE</u>	<u>TEST POINT</u>	<u>RESISTANCE</u>
( ) Set FUNCTION switch to TUNE.		( ) ANT socket	0.4 $\Omega$ , then press relay for 10 K $\Omega$
( ) Tube socket V10 pin 1	2 megohm	( ) RCVR socket	0.1 $\Omega$
( ) Tube socket V2 pin 9	100 K $\Omega$		
( ) 9 in section 2C	0 to 20 K $\Omega$ (varies with setting of TUNE LEVEL control)	NOTE: Use the proper ohmmeter range for each of the following tests.	
( ) MIC #2	0 $\Omega$	( ) 1 in section 1C	15 K $\Omega$ , then press relay for 330 $\Omega$
( ) Set FUNCTION switch to PTT and the METER switch to OPERATE TUNE.		( ) 3 in section 4B	330 $\Omega$ , then press relay for 120 K $\Omega$
NOTE: Use the OHMS X100 range. Just touch the test point and note that the S Meter deflects; do not attempt to measure the resistance.		( ) 27 in section 3C	0 to 22 K $\Omega$ (varies with setting of RF ATTN control)
( ) 13 in section 1B	S Meter deflects a small amount (direction depends on ohmmeter polarity)	( ) G in section 3C	0-1 megohm (varies with setting of AF VOL control)
( ) Set FUNCTION switch to TUNE and use OHMS X100 range.		( ) Tube socket V6 pin 3	80 K $\Omega$ , press relay for 70 K $\Omega$
( ) 24 in section 4A.	S Meter deflects	( ) ALC socket	1 megohm (may be 30 K $\Omega$ with ohmmeter leads reversed)
( ) Set FUNCTION switch to PTT and the Meter switch to BIAS SET. Use OHMS X1 range.			
( ) 25 in section 5C	Meter deflects (opposite direction)		
( ) SPKR socket	0.4 $\Omega$		
( ) POWER Plug pin 11	Infinity, then press relay for 0 $\Omega$		
		This completes the Initial Tests.	
		( ) Install the tubes in their respective sockets. The tube numbers are lettered on the circuit board. Support the circuit board from underneath with your finger while installing tubes to prevent damage to the circuit board.	
		( ) Install the pilot lamps in their sockets. Be sure the one lamp does not touch the case of the meter.	



PICTORIAL 2-10

Refer to Pictorial 2-10 and Detail 2-10A for the following steps.

- ( ) Install 4-40 hardware in the eight endholes of the final shield.
- ( ) Mount the final shield mounting bracket on the final shield with 6-32 x 1/4" hardware.



Detail 2-10A

- ( ) Mount the final shield on the chassis with three #6 x 1/4" sheet metal screws in the side of the chassis, and 6-32 x 1/4" hardware in the top of the chassis. Fit the front of the shield between the front panel and the Final Tune capacitor.
- ( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the side of the chassis. Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

## POWER SUPPLY CONNECTIONS

This Transceiver was designed to operate with the Heathkit Models HP-13 (12 V DC power source) and HP-23 (120 V AC power source) Power Supplies. The following information will help you wire the 11-pin socket (supplied with the Transceiver) for the power cable of the Power Supply you intend to use.

### HP-13 POWER SUPPLY CONNECTIONS

**CAUTION:** Be sure the alternate connection in the low voltage DC circuit of the HP-13

Power Supply is connected for +250 volts output as outlined in the HP-13 Manual. Be sure the charging rate of the automobile voltage regulator is set to not exceed 14.5 volts.

Refer to Figure 2-1 for the following steps.

- ( ) Install the 11-pin socket cap over the free end of the 8-wire cable from the HP-13 Power Supply, as shown.



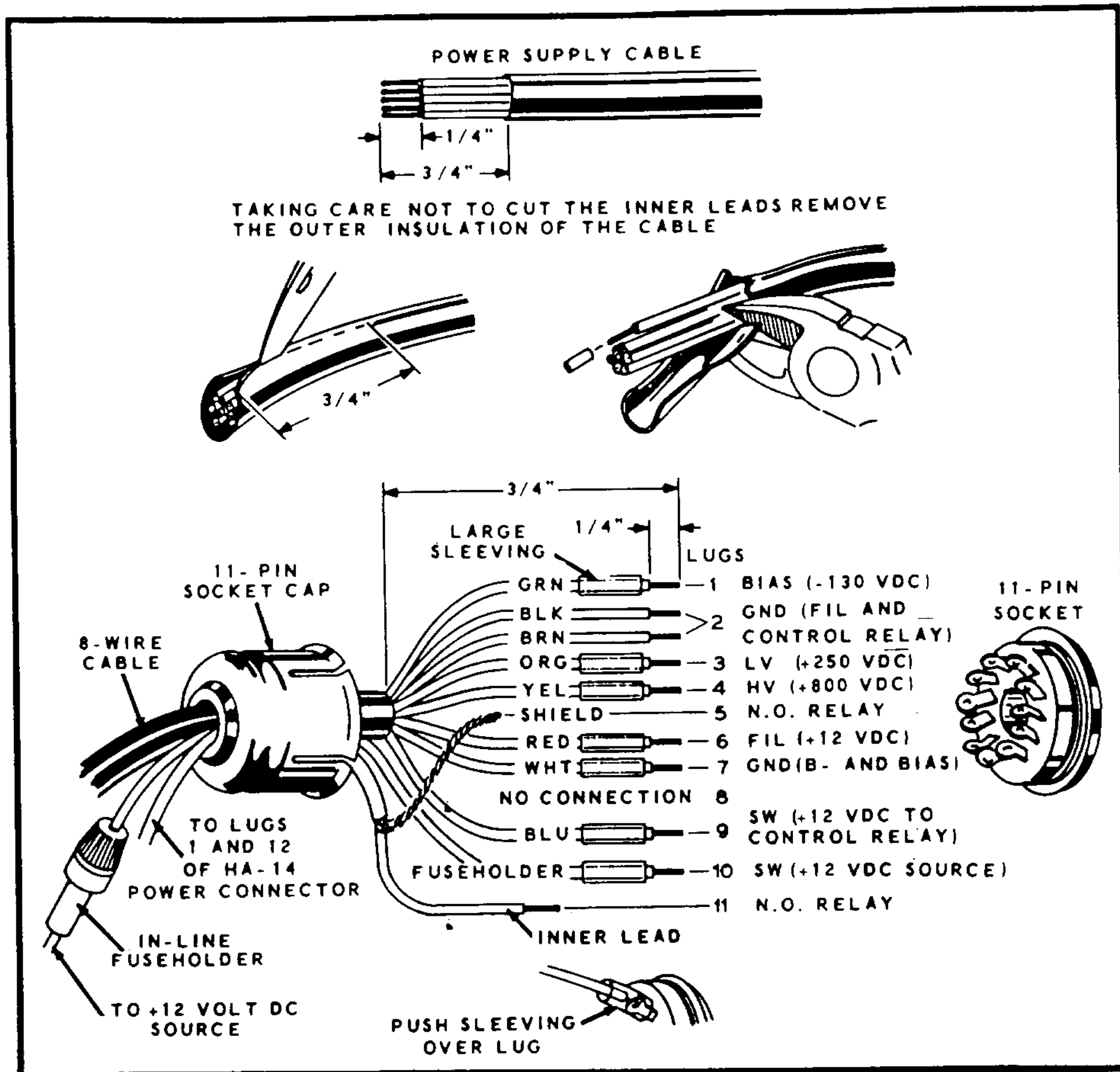


Figure 2-1

- ( ) Remove 3/4" of the outer insulation from the end of the 8-wire cable. Then remove 1/4" of insulation from the end of each wire.
- ( ) Melt a small amount of solder on each of the exposed wire ends to hold the small strands of wire together.
- ( ) Insert the lead from the cap end of the fuseholder (an in-line fuseholder with lead is supplied with the HP-13 Power Supply) through the socket cap as shown.
- ( ) Cut seven 5/8" lengths of large sleeving and slip them over the indicated wires.
- ( ) Connect the wires of the 8-wire cable, the fuseholder lead, and the coaxial cable (if the HA-14 Linear Amplifier is used) to the 11-pin socket lugs as shown. Solder each connection.
- ( ) Push the lengths of sleeving over the lugs of the socket.
- ( ) Snap the socket cap onto the 11-pin socket. **IMPORTANT:** When using the HP-13 Power Supply with the Transceiver, be sure the Bias control of the Power Supply is in its fully clockwise position. This setting will supply full bias voltage to pin 9 of the power socket.

If the Heathkit Model HA-14 Linear Amplifier is used, a coaxial cable, that has its inner lead connected to lug 12 and its shield connected to lug 1 of the HA-14 power connector, should be inserted through the socket cap as shown.

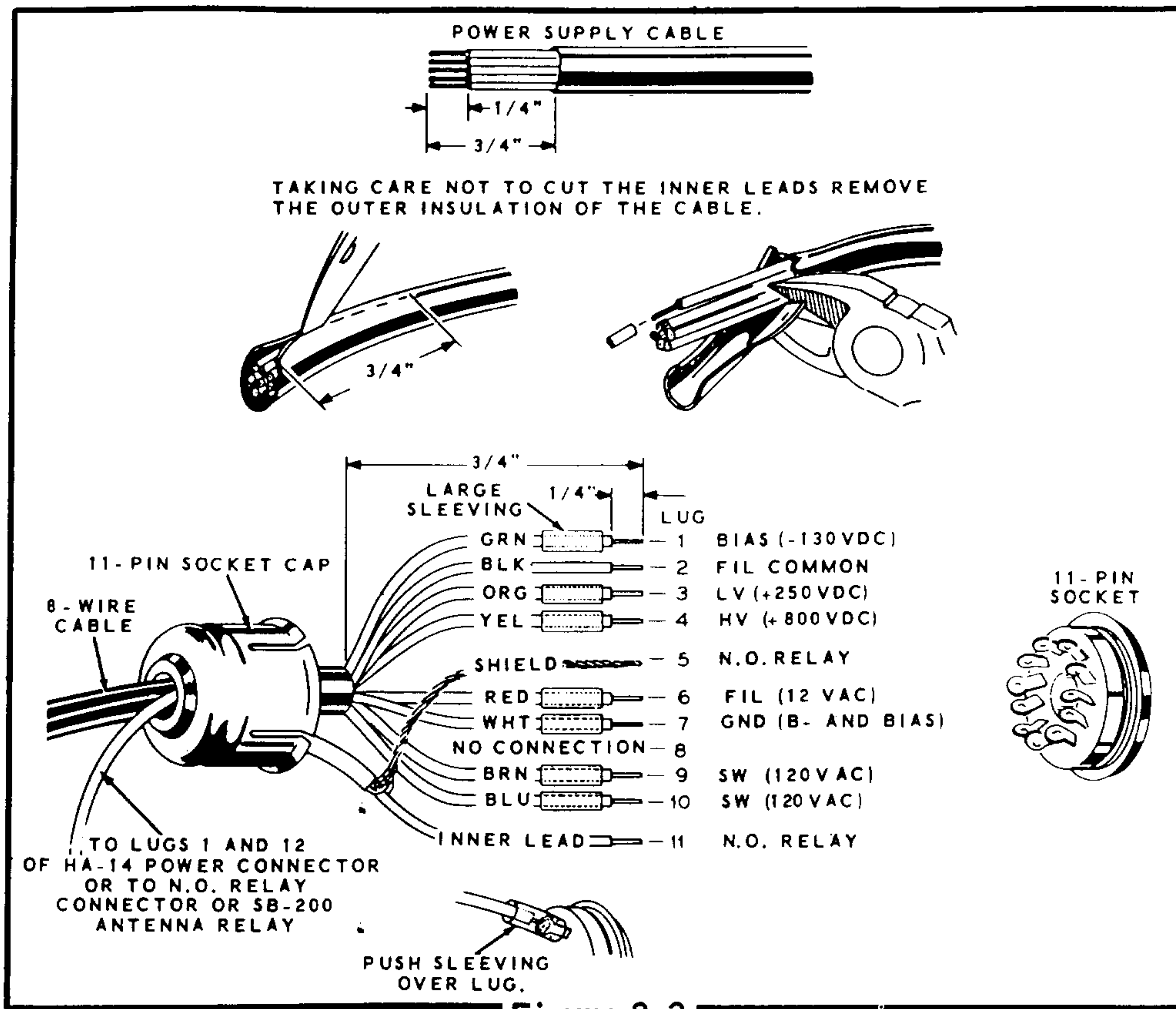


Figure 2-2

## HP-23 POWER SUPPLY CONNECTIONS

**CAUTION:** Be sure the alternate connection in the low voltage DC circuit of the HP-23 Power Supply is connected for +250 volts DC output as outlined in the HP-23 Manual.

Refer to Figure 2-2 for the following steps.

- ( ) Install the 11-pin socket cap over the free end of the 8-wire cable from the Power Supply.
- ( ) Remove 3/4" of the outer insulation from the end of the 8-wire cable. Then remove 1/4" of insulation from the end of each wire.
- ( ) Melt a small amount of solder on each of the exposed wire ends to hold the small strands of wire together.

If the Heathkit Model HA-14 Linear Amplifier is to be used, a coaxial cable from the HA-14 power connector should be inserted through the

socket cap as shown. Use the coaxial cable with the inner lead connected to lug 12 and the shield to lug 1 of the HA-14 power connector. For the SB-200 and other Linear Amplifiers, use a piece of coaxial cable through the cap to bring out the relay connections.

- ( ) Cut seven 5/8" lengths of large sleeving and slip them over the indicated wires.
- ( ) Connect the wires of the 8-wire cable and the coaxial cable (if a Linear Amplifier is used) to the 11-pin socket lugs as shown. Solder each connection.
- ( ) Push the lengths of sleeving over the lugs of the socket.
- ( ) Snap the socket cap onto the 11-pin socket.

**NOTE:** With the above connections, the Bias control in the HP-23 Power Supply is inoperative. Proper bias settings are accomplished with the Bias control in the Transceiver.





## ALIGNMENT AND ADJUSTMENT

Refer to Figure 1-1 (fold-out from Page 28) for the following steps.

Set the controls as follows:

RF ATTN: fully clockwise.  
 VOX SENS, VOX DELAY, AF VOL, and TUNE LEVEL: half rotation.  
 BIAS ADJ and MIC GAIN: fully counterclockwise.  
 Meter switch - BIAS SET.  
 FUNCTION switch: OFF.  
 Sideband switch: LSB.  
 S METER ADJ: fully counterclockwise.  
 CARRIER NULL: any position.

Using an ohmmeter, make the following resistance checks at the Power plug:

TEST POINT	RESISTANCE
Pin 1:	37 K $\Omega$
Pin 3:	33 K $\Omega$
Pin 4:	Infinity

If any of these resistance readings vary more than  $\pm 20\%$ , refer to the In Case Of Difficulty section on Page 53 of the Manual before proceeding.

### RECEIVER ALIGNMENT

NOTE: Phono plugs are provided for making connections to the sockets on the rear of the Transceiver. Refer to Figure 2-3 for wiring a phono plug to coaxial cable.

Connect an 8  $\Omega$  speaker (a 3.2  $\Omega$  to 16  $\Omega$  speaker may be used with reduced efficiency) to the SPKR socket, and a 50  $\Omega$  dummy load to the ANT socket. With the power supply wired according to the instructions in the Power Supply section of the Manual, connect it to the Transceiver Power plug. Make sure the VOX DELAY control is at the center of its rotation. The relay will click during the first few seconds of warmup. This is normal.

( ) Turn the FUNCTION switch to PTT. The pilot lamps and the tube filaments should light. Watch to see that the meter remains

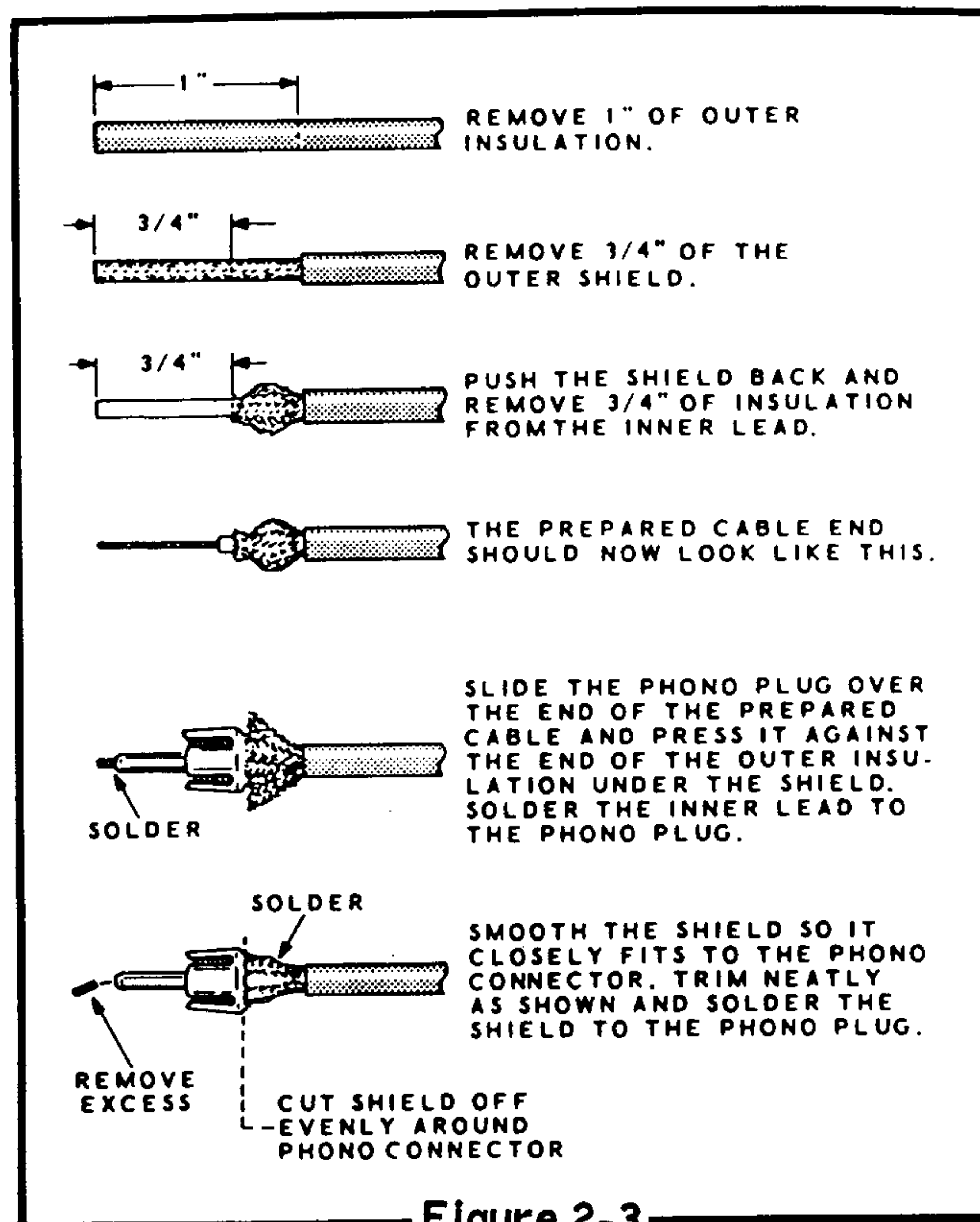


Figure 2-3

at zero; if it should start to deflect, the Transceiver should be turned off immediately, as the bias circuit of tube stages V6 and V7 is probably shorted and must be corrected before proceeding.

- ( ) Place the Meter switch in the OPERATE TUNE position and adjust the S METER ADJ control for a zero indication on the meter.
- ( ) Remove the dummy load from the ANT socket and plug an antenna into the ANT socket.
- ( ) Turn up the AF VOL control until noise is heard in the speaker. Tune up and down the band with the VFO. Stations should be heard if there is any local activity.
- ( ) Tune in a station that gives approximately a midscale (S9) meter reading.

- ( ) Adjust the top and bottom slugs of receiver IF transformer T3 for the highest meter reading. Use the short end of the alignment tool for the top slug, and the long end of the alignment tool for the bottom slug. When passing the long end of the alignment tool through the top slug to reach the bottom slug, be careful not to disturb the adjustment of the top slug.
- ( ) Repeat the adjustment of T3 for the highest meter reading.
- ( ) Turn the FUNCTION switch to OFF.
- ( ) Turn the VFO dial fully counterclockwise until the plates of the VFO capacitor are fully closed.
- ( ) Loosen the setscrew of the dial. Rotate the dial so that the end of the white strip near the 7.3 marking is aligned with the hairline and tighten the setscrew. Check to see that full rotation of the dial does not cause any drag or rubbing. If it does, move the dial or knob slightly on the shaft, then recalibrate and retighten the setscrew with the spring washer compressed about half way.
- ( ) Bend the pilot lamp bracket and adjust the lamp position for best illumination of the dial and meter.

### VFO CALIBRATION

Disconnect the antenna from the Transceiver and plug the dummy load into the ANT socket.

The following steps present two ways to check the dial calibration with two different types of receivers. Use the method that applies to the type of receiver available.

#### Calibration With A Standard AM Broadcast Receiver

- ( ) Connect one end of a short wire to the antenna terminal of the broadcast receiver. Place the other end of this wire near tube V14 in the Transceiver.
- ( ) Tune the receiver dial to a station of known frequency near 1600 kHz. Now, subtract this frequency from 8,885 kHz and set the VFO dial to the difference between these two frequencies.

Example:

	8885 kHz
Receiver frequency:	<u>1600 kHz</u>
Set VFO dial to:	7285 kHz

- ( ) With the Sideband switch in LSB, set the FUNCTION switch to PTT and allow the Transceiver to warm up.
- ( ) Adjust the slug of coil L6 until the VFO is heard in the speaker of the receiver. Coil L6 will normally have to be turned counterclockwise, as viewed from the top of the chassis. The VFO trimmer need not be adjusted at this time.
- ( ) Turn the FUNCTION switch to OFF.

This alignment should calibrate the VFO fairly closely. However, do not operate the Transceiver near the ends of the VFO dial until the VFO calibration is checked with a crystal calibrator or a very accurate amateur receiver.

#### Calibration With Amateur Band Receiver

NOTE: The following procedure gives the correct dial readings for zero beat (carrier frequency) in LSB only. In USB, the dial reading is 3.4 kHz higher than the carrier frequency.

- ( ) Connect one end of a short wire to the antenna terminal of the receiver. Place the other end of this wire near tube V4 in the Transceiver.
- ( ) Temporarily remove V5, the 12BY7 tube.
- ( ) With the Sideband switch in the LSB position, turn the FUNCTION switch to TUNE and allow the Transceiver to warm up.
- ( ) Move the Meter switch to BIAS SET. The meter should indicate "0." If it is not at "0," check to see that the BIAS ADJUST control is in its fully counterclockwise position. If the meter still will not reach "0," turn the Transceiver OFF and check the bias circuitry before proceeding.
- ( ) Set the dials of the receiver and Transceiver to 7.25 megahertz. The receiver should be operated in the CW mode.





NOTE: The VFO trimmer can be adjusted in the following step by inserting an insulated screwdriver through the large hole in the side of the final shield.

- ( ) Adjust coil L6 clockwise (from the top of the chassis) until the Transceiver signal is heard in the amateur receiver speaker. Check the VFO dial calibration by setting the dial of both the receiver and Transceiver first to 7.2 megahertz and then to 7.3 megahertz. The calibration should check near these points, and any dial variations should be corrected by adjusting coil L6 at 7.3 megahertz the trimmer on the VFO variable capacitor at 7.2 megahertz.
- ( ) Turn the FUNCTION switch to OFF.
- ( ) Replace tube V5.

#### Crystal Calibrator Check Of VFO Dial Settings

The preceding adjustments of the VFO will only be as accurate as the receiver used. The calibration can be accurately checked by using the Heathkit plug-in Crystal Calibrator as an accessory with the Transceiver. The Crystal Calibrator accuracy should be checked against WWV by using a receiver other than the one in the Transceiver to set the Calibrator at 5, 10, or 15 megahertz.

NOTE: The following procedure gives the correct dial readings for zero beat (carrier frequency) in LSB only. In USB, the dial reading is displaced and reads 3.4 kHz higher than the carrier frequency. Other 100 kHz calibrators can be used by connecting their output to the antenna socket.

- ( ) Plug the Crystal Calibrator into the calibrator socket of the Transceiver.
- ( ) With the antenna plugged into the ANT socket, place the FUNCTION switch in the CAL position, the Sideband switch in the LSB position, and the Meter switch in the OPERATE TUNE position. Allow sufficient time for the Calibrator to warm up.
- ( ) Check the calibration accuracy of the VFO at the 7.2 and 7.3 megahertz settings of the VFO dial of the Transceiver. Any dial variations should be corrected by adjusting coil L6 at 7.3 megahertz and the VFO trimmer at 7.2 megahertz. Repeat until the dial checks with the calibrator signals.

- ( ) Turn the FUNCTION switch to OFF.

#### TRANSMITTER ALIGNMENT

##### Bias Setting

- ( ) Connect the dummy load to the ANT socket.
- ( ) Remove V5, the 12BY7 tube.
- ( ) Set the FUNCTION switch to TUNE and the Meter switch to BIAS SET.
- ( ) Then adjust the BIAS ADJ control for a reading of S3 on the meter. There is a small triangle above the "3" on the meter to indicate the proper bias setting.
- ( ) Turn the FUNCTION switch to OFF, and replace tube V5.

#### IF AMPLIFIER ADJUSTMENT

- ( ) With the VFO dial set to 7.25, place the FUNCTION switch to the TUNE position and the Meter switch to TUNE OPERATE. The meter should indicate some output.
- ( ) Adjust the FINAL TUNE control for maximum output, which should give a reading of over S3 on the Transceiver meter. If the meter goes above S9, adjust the CARRIER NULL control to drop the level to S9.
- ( ) Adjust both slugs of transformer T2 for a maximum meter indication.
- ( ) Adjust the top slug of heterodyne mixer coil L5 for maximum power output.

#### Balanced Modulator Adjustment

- ( ) Connect a voltmeter across the dummy load, if your dummy load provides a DC voltmeter connection, or to a connector 24 (section 4A on the circuit board) or use a VTVM with an RF probe positioned near the dummy load. Do not connect the RF probe to the dummy load as there is sufficient voltage output to burn out the diodes of some RF probes.

NOTE: If a voltmeter is not available, the panel meter may be used, with reduced accuracy. Set the FUNCTION switch to TUNE and the TUNE LEVEL control to its fully counterclockwise position. Another receiver can also be used as a null indicator.

- ( ) Place the FUNCTION switch in the PTT position. Allow the Transceiver to warm up for at least one-half hour before adjusting the balanced modulator.
  - ( ) With the Sideband switch in the LSB position, press the PTT switch or ground lug 2 of the MIC socket with a short wire, and adjust the CARRIER NULL control for a minimum signal indication on the test meter.
  - ( ) Using the long end of the alignment tool, turn the bottom slug of transformer T1 two full turns toward the bottom of its travel (clockwise from the top of the chassis).
  - ( ) Adjust the top slug of T1 for a maximum signal indication. This should take only a very slight turn of the slug. If the slug is turned down too far, a larger, but false peak will appear.
  - ( ) Again, adjust the CARRIER NULL control for a minimum signal indication.
- NOTE: The signal level should now become quite low, and if a VTVM and RF probe are being used, the probe should be connected to the center pin (pin 2) of the ANT socket.
- ( ) Now adjust the bottom slug of T1 back up into the transformer. As the slug is adjusted, there will be a dip to a minimum indication. Adjust the slug for this minimum (dip) indication.
- ( ) Readjust the CARRIER NULL control and the bottom slug of transformer T1 for the lowest possible minimum signal indication. The adjustments are now quite critical; turn them slowly. Repeat this adjustment until the best null is obtained.
  - ( ) Change the Sideband switch to USB and check the null. Repeat the adjustment in the previous step for both the LSB and USB positions; until the best null setting is obtained. Measured RF voltage should be 0.5 volts or less at null.
  - ( ) Disconnect the voltmeter (or VTVM) from the Transceiver and if used, the wire connected between lug 2 of the MIC socket and the chassis.
  - ( ) Turn the FUNCTION switch to TUNE and the Meter switch to OPERATE TUNE.
  - ( ) Adjust the TUNE LEVEL control to obtain a meter reading between S3 to S6 indication. This reading will normally vary as you tune across the band, and between LSB and USB.

### Driver Tuning

Driver tuning coils L2 and L3 are preset at the factory and need no further adjustment.

## FINAL ASSEMBLY

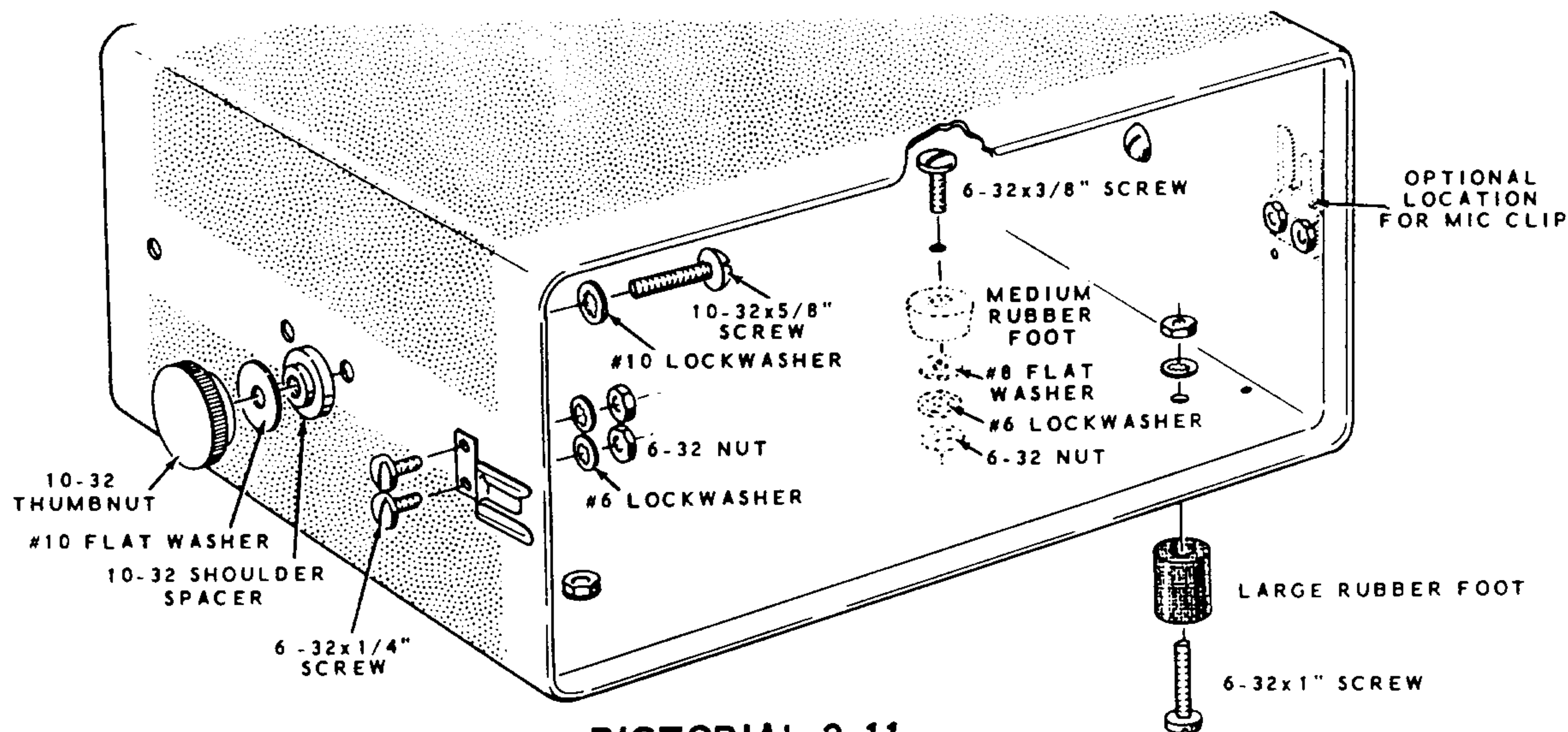
### FIXED STATION-MOBILE CONSIDERATIONS

Before installing the Transceiver in the cabinet, determine whether it will be used for fixed station or mobile operation, or both. For fixed station use only, perform the steps under "For Fixed Stations;" for mobile use only, perform the steps under "For Mobile Stations." If you plan to use the Transceiver alternately in fixed station and mobile installations, perform the steps in both sections.

Refer to Pictorial 2-11 for the following steps.

NOTE: If a microphone clip is to be used (supplied with your microphone), it may be installed on either end of the cabinet, so the microphone can be lifted up and out, or so the microphone can be pulled toward the front and out. Use 6-32 x 1/4" hardware to mount the microphone clip.





PICTORIAL 2-11

**For Fixed Stations**

- ( ) Install the medium rubber feet at the rear holes in the bottom of the cabinet, using 6-32 x 3/8" hardware and #8 flat washers.
- ( ) Install large rubber feet at the front holes (nearest the perforated holes) in the bottom of the cabinet, using 6-32 x 1" hardware.

**For Mobile Stations**

Determine whether the Transceiver is to be mounted under the dash or on the floor of the automobile. See Figure 3-1. If under-the-dash

mounting is preferred, there are two holes near the center on each side of the cabinet which can be used for mounting. For floor mounting, the holes at the rear on each side of the cabinet can be used. Choose the holes that will provide best balance for you installation.

- ( ) Mount the gimbal bracket hardware in the cabinet holes decided upon. Use 10-32 x 5/8" screws, #10 lockwashers, 10-32 shoulder spacers, #10 flat washer, and 10-32 thumb-nuts. See Pictorial 2-11.
- ( ) Refer to Detail 2-11A, and install four small rubber feet into the gimbal bracket. This is easily done by looping a length of bare wire around the groove of the rubber foot and passing the wire through the hole in the gimbal bracket. Pull on the wire until the rubber foot is properly seated in the hole.

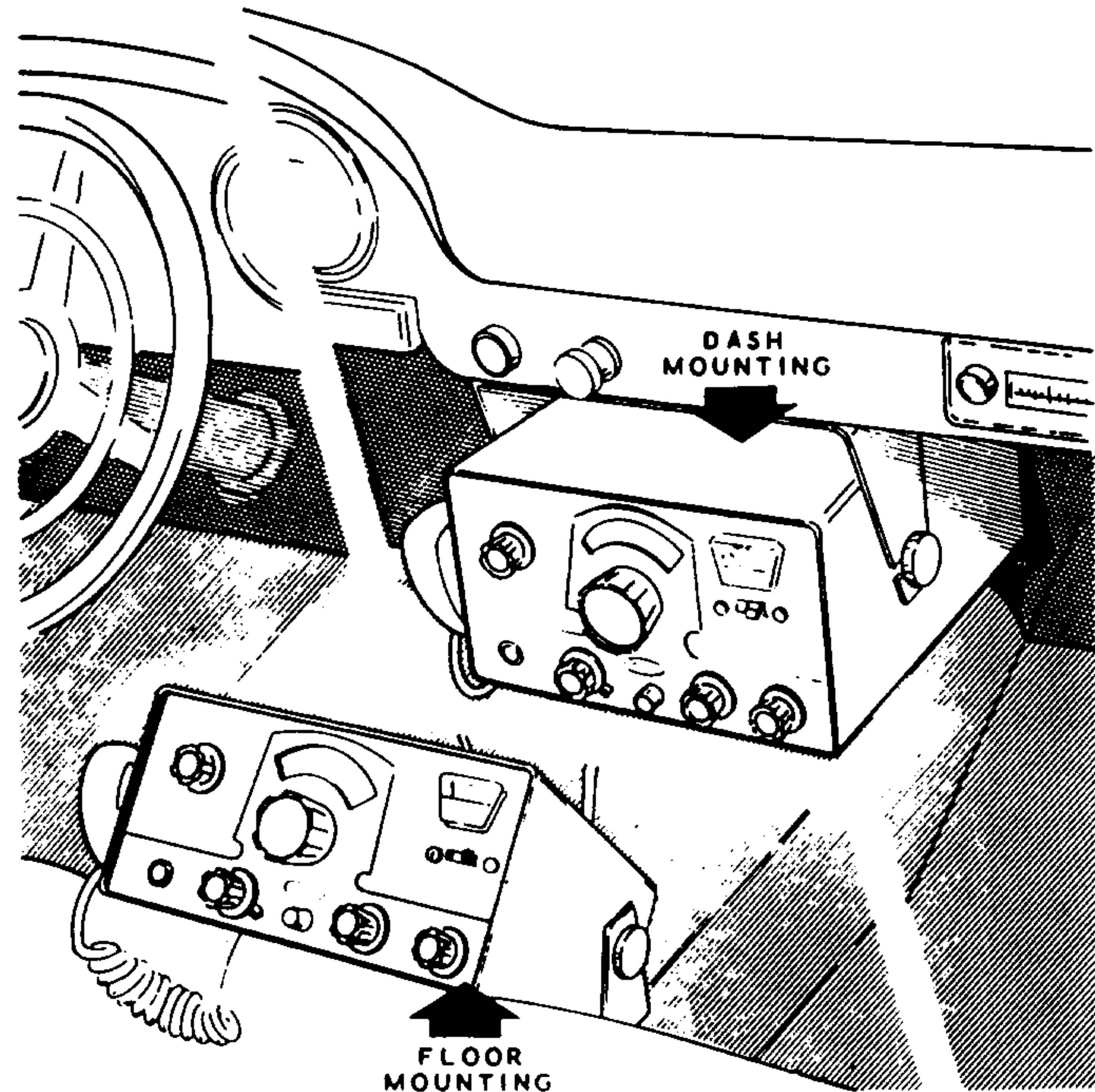
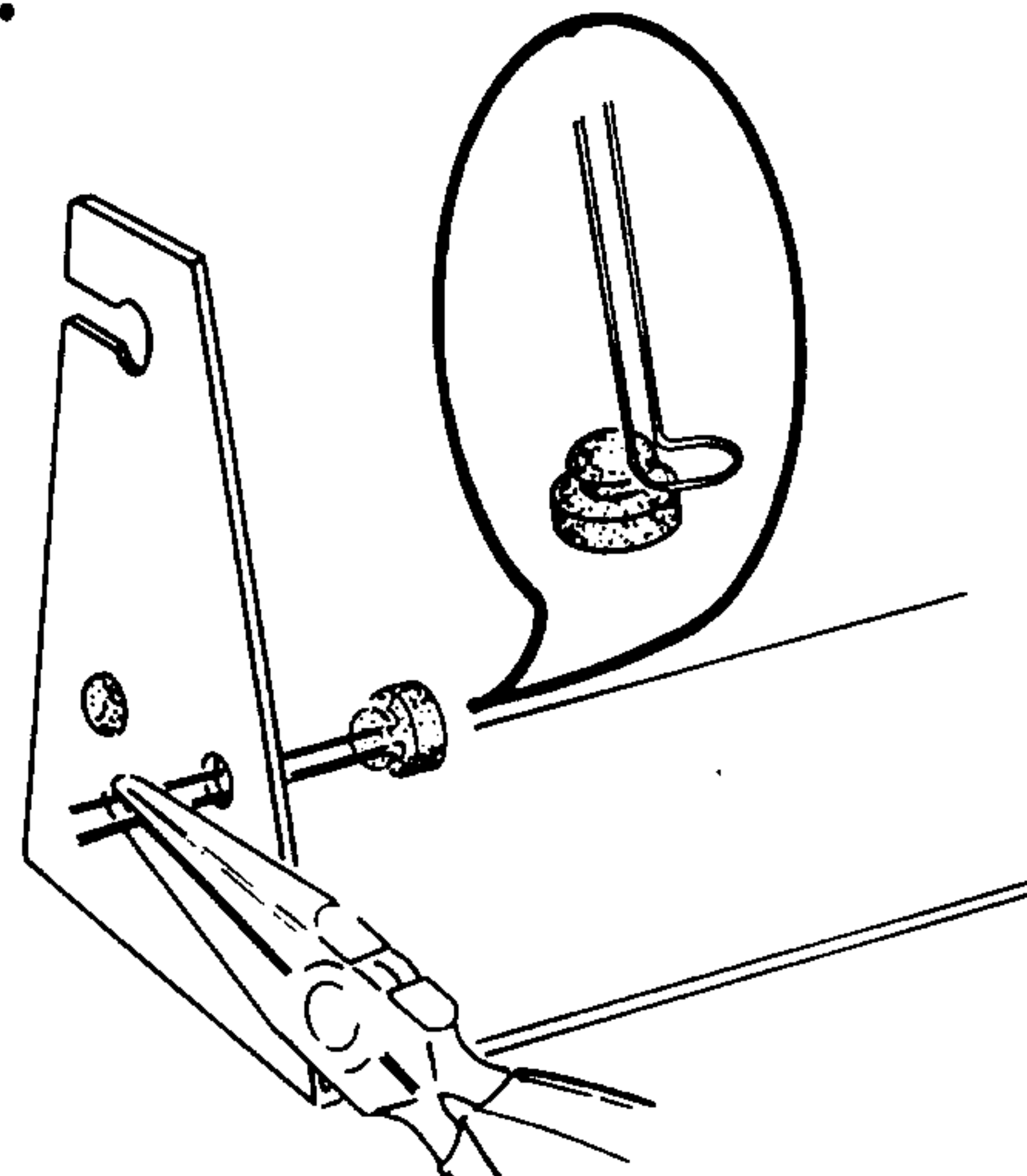
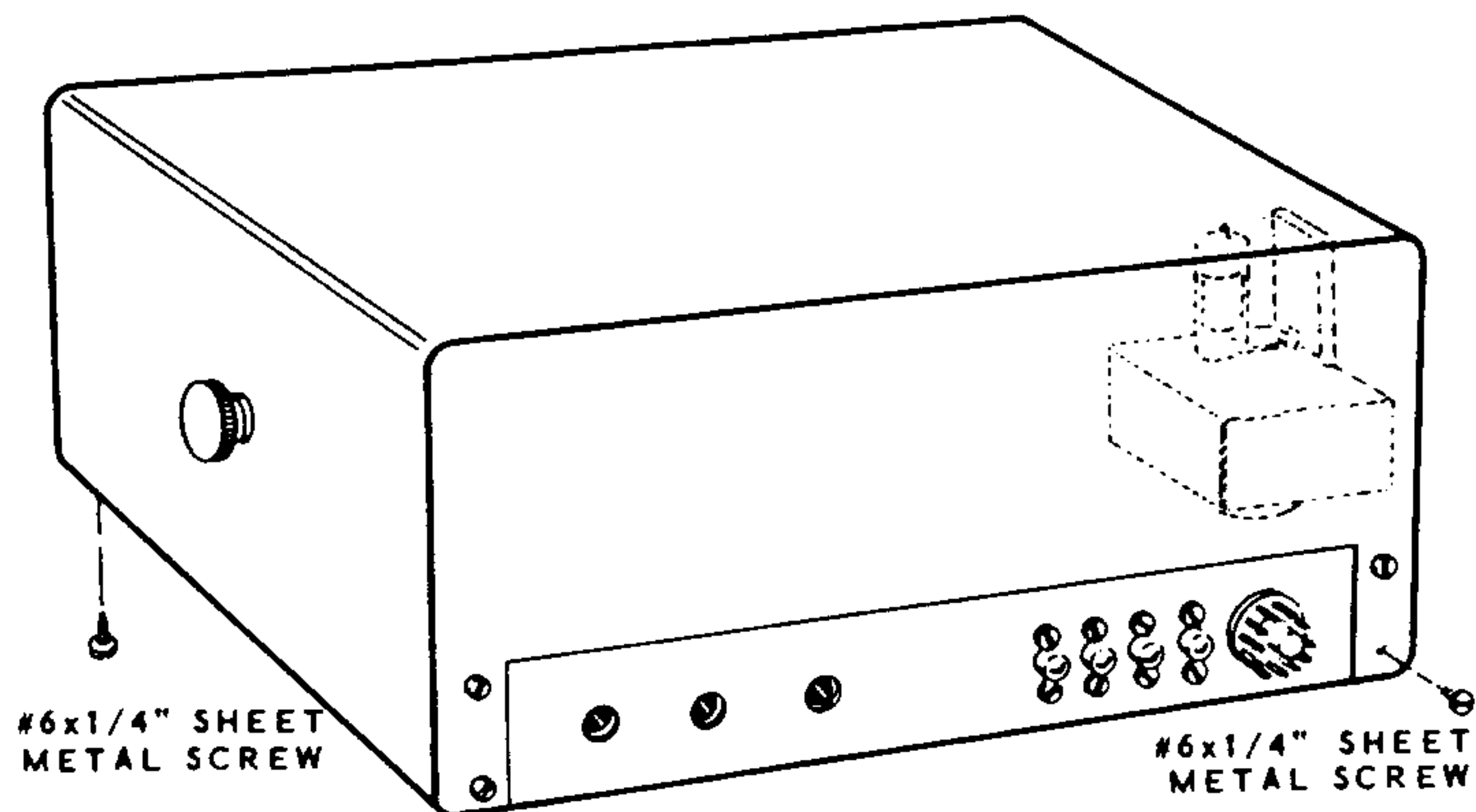


Figure 3-1



Detail 2-11A



PICTORIAL 2-12

### CRYSTAL CALIBRATOR MOUNTING

Refer to Pictorial 2-12 for the following steps.

If the Heathkit plug-in Crystal Calibrator is to be used with the Transceiver, plug it into the Calibrator socket of the Transceiver.

### CABINET MOUNTING

Refer to Pictorial 2-12 for the following steps.

( ) Slide the transceiver chassis into the cabinet. If the Crystal Calibrator is used, be careful not to damage it when sliding the Transceiver into the cabinet.

( ) Secure the chassis in the cabinet with six #6 x 1/4" sheet metal screws, four in the back and two in the bottom. Be sure the screws do not hit any of the wires under the chassis.

### MICROPHONE

Any high impedance crystal, dynamic, or ceramic microphone with an output rating between -45 db and -60 db can be used with the Transceiver.

Figure 3-2 shows how most communication microphones can be wired for VOX, PTT, or both types of operation. The only difference in wiring to change the microphone from just PTT operation to both types of operation, is the addition of the jumper wire in the microphone. This additional wire keeps the audio lead from being opened when the microphone button is released, thus permitting VOX operation with the Transceiver. When wired in this manner the switch of

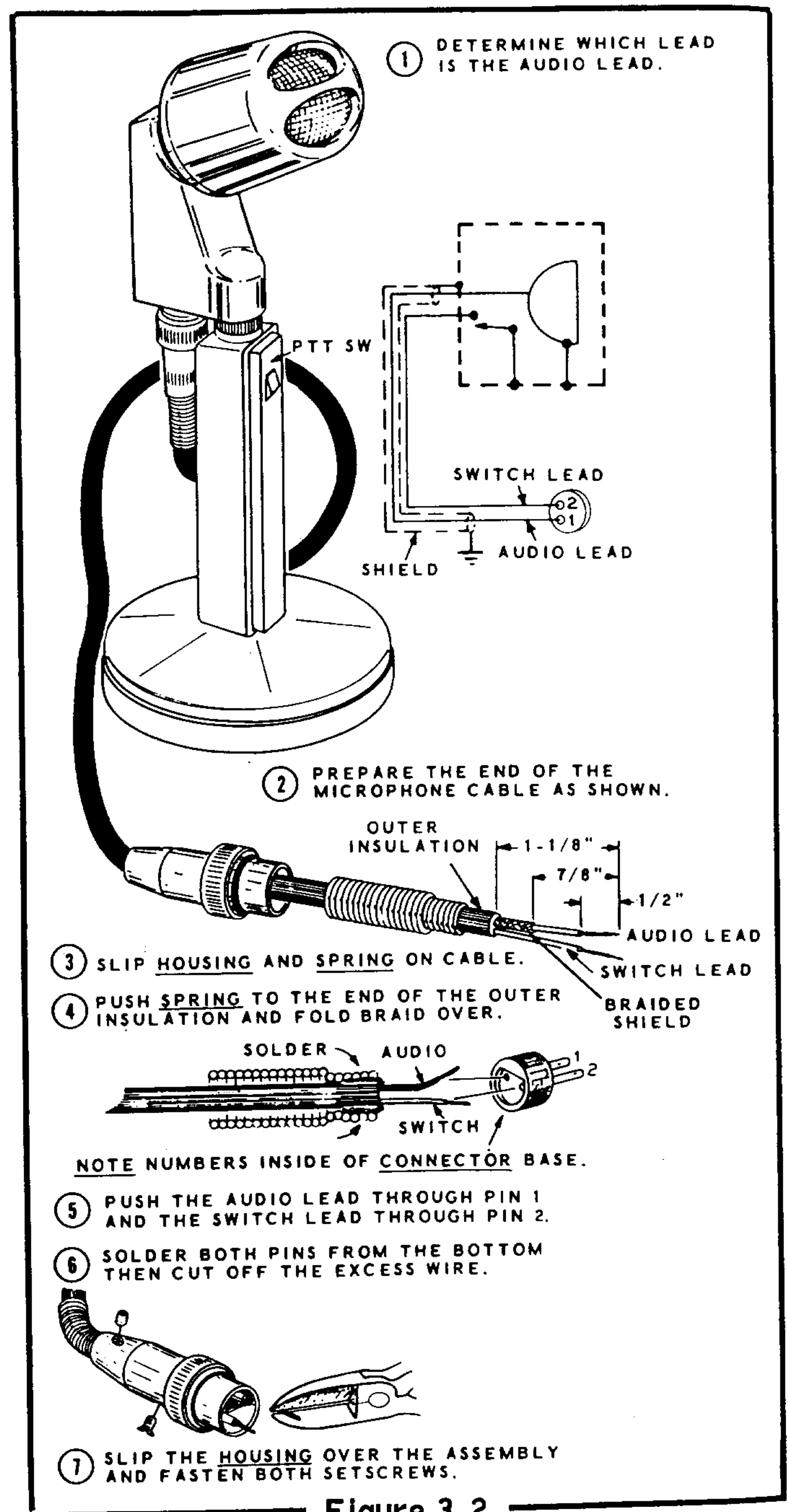


Figure 3-2

the microphone will actuate the relay of the Transceiver for PTT operation.

A microphone without a switch can be used for VOX operation if you install the male microphone connector supplied with this Transceiver. The audio lead should be connected to pin #1 and the shield should be connected to the spring of the connector.





## INSTALLATION

### FIXED STATION

The Transceiver must be placed in a location with adequate ventilation because of the amount of heat given off by the tubes. Inadequate ventilation could cause considerable damage to the circuit components.

The power supply can be mounted in the SB-600 Speaker cabinet (if used) or in some other out-of-the-way place, since it is controlled by the FUNCTION switch of the Transceiver.

Because the Transceiver requires about 300 watts of power when transmitting, it should not be operated from an already heavily loaded AC outlet.

The Transceiver should be grounded to a ground rod or cold water pipe. Make the ground connection to the Transceiver at one of the side-band switch mounting screws.

A doublet antenna fed by RG-58 or RG-59 cable, or an inverted "Vee" type antenna fed with

coaxial cable will work very well with the Transceiver. Other types of antennas using high impedance end-feeding, off-center feeding, open wire lines, or 300  $\Omega$  twin lead, can be used if an antenna coupler is used between the antenna and Transceiver. The antenna used must provide a low SWR (standing wave ratio) to the Transceiver for successful operation. Lightning arrestors on the antenna are a must. The antenna should be disconnected and grounded, and the Transceiver should be taken off the air when a lightning storm is near. The FINAL TUNE knob should peak near the center third of rotation with a properly matched antenna. Connect an SWR bridge to the antenna and make sure the SWR is below 1.5 to 1. Power for operating the bridge may be obtained by carrier output in the TUNE position of the FUNCTION switch.

Use an 8  $\Omega$  speaker capable of handling one watt of audio power.

Two typical installations are shown in Figures 4-1 and 4-2. Figure 4-1 shows a basic hookup suitable for either fixed station or mobile operation.

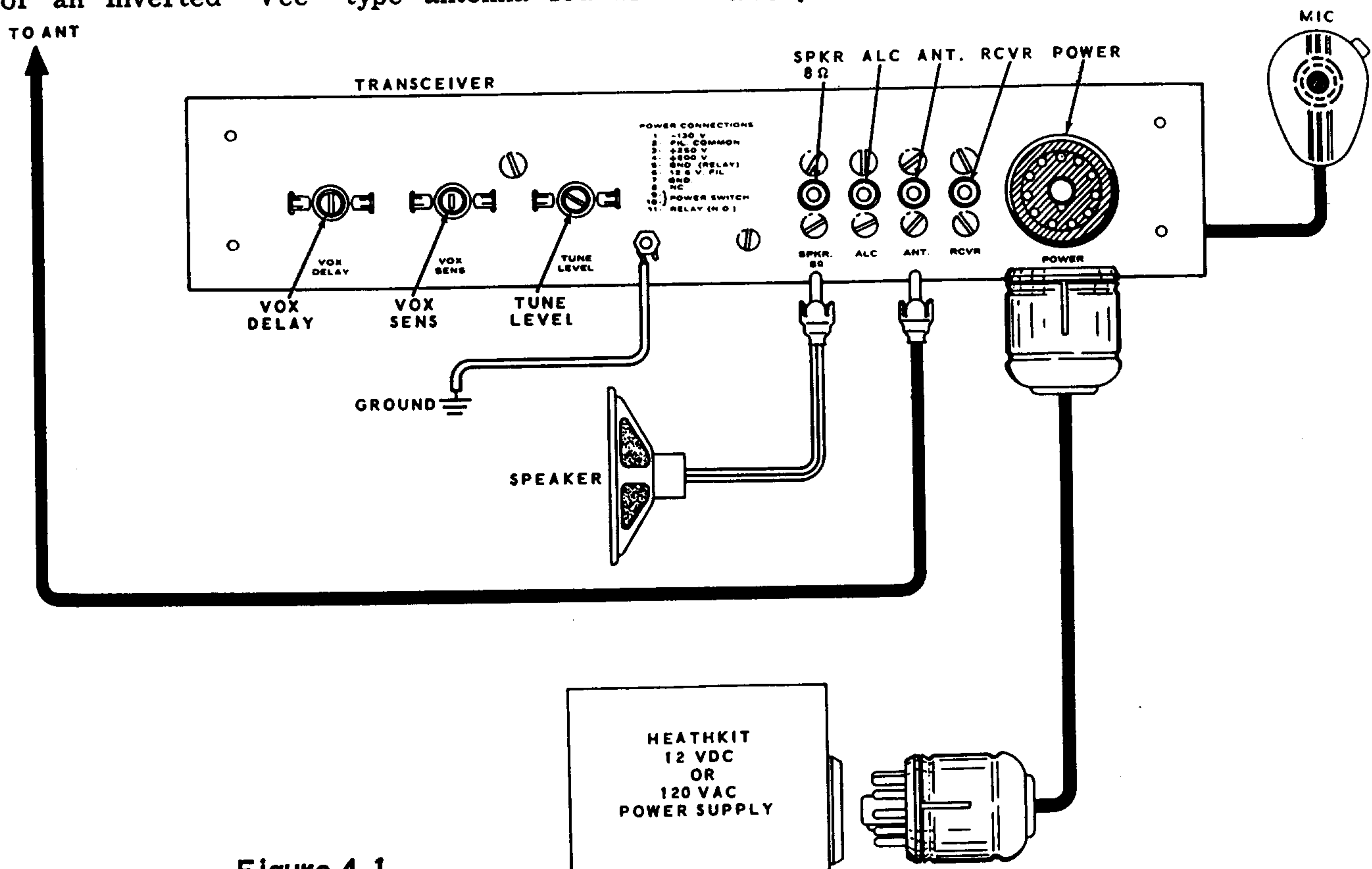


Figure 4-1

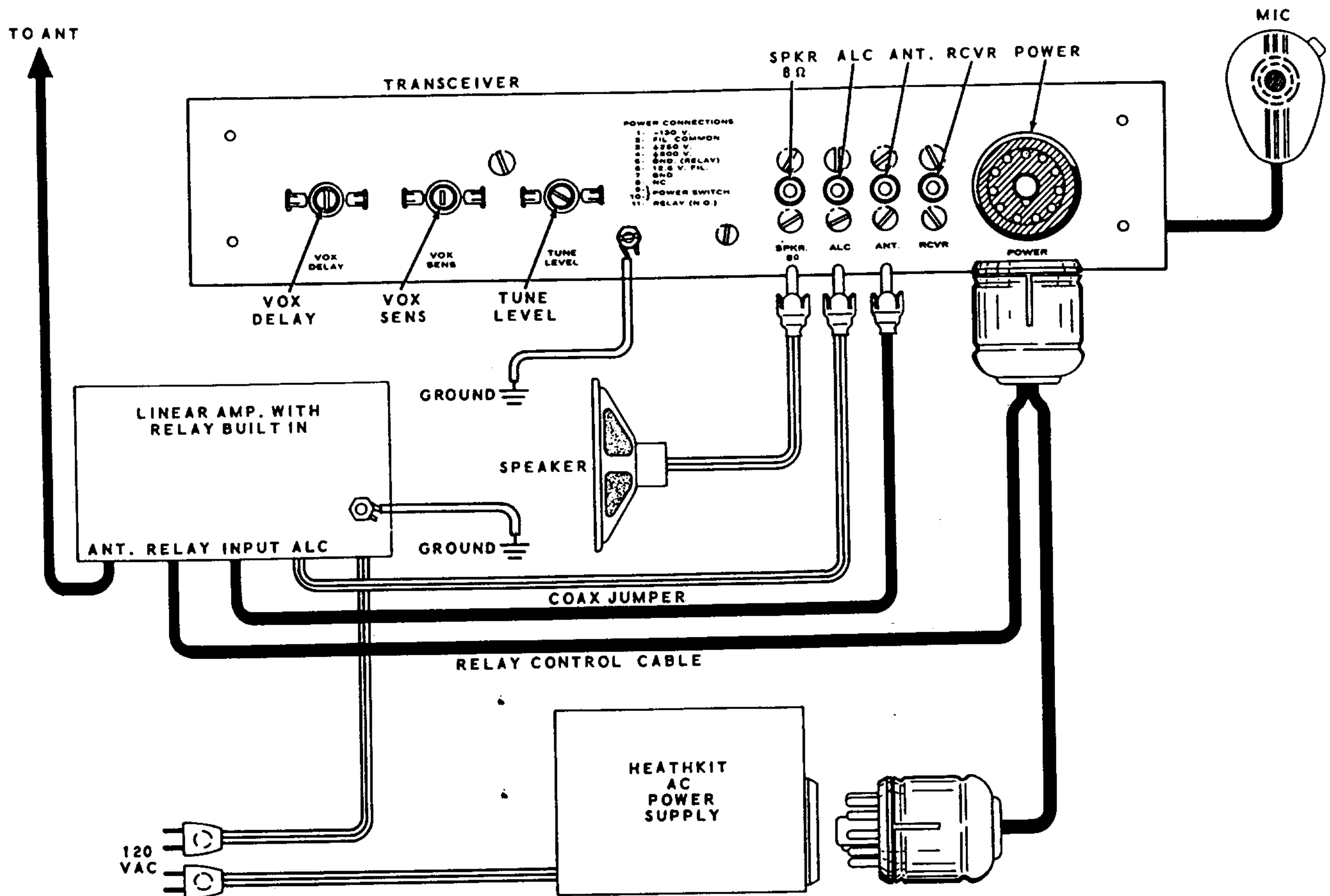


Figure 4-2

Figure 4-2 shows a fixed station installation using a linear amplifier with a built-in antenna relay switched by the Transceiver.

**CAUTION:** Remember that one side of the External Relay connection in the Transceiver is connected to the chassis. Therefore, it should not be connected to 120 volt AC lines for relay switching. The AC voltage could cause the Transceiver chassis to be "hot," creating a shock hazard. The switching circuit of an AC external relay must be isolated from the Transceiver by using an isolation transformer.

If low voltage DC is used on the relay switching line, be very careful to get the polarity of the voltage connected properly. The grounded DC lead must be connected to the outside of the plug (chassis). Maximum contact ratings of the relay are: 1 ampere at 28 V DC or 120 V DC, noninductive.

## MOBILE Transceiver

The preferred location for the Transceiver for mobile operation is under the dash, although you may desire to mount the unit on the floor. See Figure 3-1 (on Page 43). The gimbal bracket should be mounted in the desired location in the automobile, using the #10 x 1/2" sheet metal screws. The starting holes for these screws should be made with a 9/64" drill, being careful not to drill into existing wiring or instruments. Keep all Transceiver cables clear of the automobile pedals and control cables.

Any cables that have to go through the fire wall will usually fit through existing grommets. If it is necessary to make holes through a sheet metal partition, a long tapered punch usually works better than a drill. Drilled holes leave sharp edges which can cut the wires. When a punch is driven through the metal, the sharp edge is rolled back and a smooth hole will





result. Be sure to leave enough extra cable so the Transceiver can be removed from the gimbal bracket and operated, to permit adjusting the rear apron controls.

Be sure the voltage regulator of the automobile is set to not exceed 14.5 volts.

### Antenna

Mount the antenna according to the manufacturer's instructions. Be sure to make a good ground connection between the shield of the coaxial cable and the car body at the antenna base.

A whip antenna that is properly tuned on 40 meters will have a high peak of receiver activity for about 50 kHz around the antenna's resonant frequency. Turn on the receiver and tune through the band to discover where this high peak of receiver activity is for the present setting of your antenna. Then adjust the length of the whip in 1/4 inch increments and retune the receiver until the peak of receiver activity is centered around the frequency at which you normally operate. The antenna can then be tuned as described in the following steps.

- ( ) 1. Connect an SWR meter in series with the lead to your antenna.
- ( ) 2. Set the SWR meter to the "forward" position.
- ( ) 3. Turn the Meter switch on your Transceiver to BIAS SET. If the meter needle does not point to the small triangle near "3" on the meter, perform the Bias Setting steps on Page 41.
- ( ) 4. Turn the FUNCTION switch to TUNE, and place the Meter switch in the OPERATE-TUNE position.

**NOTE:** Proceed as follows if you cannot obtain a full-scale indication on the SWR meter in the next step: Connect a microphone to the MIC INPUT (for step 5) and whistle or hum into it while adjusting the MIC GAIN control for a full-scale indication on the SWR meter. Then be sure to whistle or hum at the same level while you perform step 6.

- ( ) 5. Adjust the TUNE LEVEL control (on the rear of the Transceiver) for a full-scale meter indication on the SWR bridge.

- ( ) 6. Switch the SWR meter to the "reverse" position and note the SWR reading.
- ( ) 7. Switch the SWR meter to the "forward" position. Then set the transmitter to higher and lower frequencies, and repeat steps 5 and 6 at each frequency, until you find the minimum SWR.
- ( ) 8. Set the transmitter to the desired operating frequency. Then adjust the length of the antenna as follows:

A. If the point of lowest SWR is lower than the desired operating frequency, shorten the antenna as described below.

B. If the point of lowest SWR is higher than the desired operating frequency, lengthen the antenna as described below.

C. Change the antenna length in 1/4" increments and repeat steps 2, 5, and 6, at each new length until the minimum SWR is obtained. The SWR should be about 1.2 or less at the desired frequency.

**NOTE:** With a properly matched antenna, the FINAL TUNE knob will peak in the center third of its rotation. Since this peak is very broad, due to the fixed output capacitors of the pi network and the limited range of the FINAL TUNE capacitor, there will be only a small rise in the meter indication as the peak is tuned. Meter peaks may also occur slightly beyond the range of the FINAL TUNE capacitor, due to off-resonance operation or the varying of the antenna load impedance at different operating frequencies. However, since the output pi network has a very low Q, the output efficiency will not be much less under these conditions.

Connect the cables and mount the Transceiver in the gimbal bracket. Then position the Transceiver as desired and tighten the thumbnuts.

### Accessories

The Heath Mobile Speaker can be installed in an automobile, or a car radio speaker (3.2 to 16  $\Omega$ ) may be used with reduced efficiency.

## Noise Suppression

To obtain good noise suppression, you must suppress electrical interference at its source, so it does not reach the input of the receiver. Once it has been radiated, noise cannot be suppressed by bypassing, etc.

It is difficult to determine the source of various types of noise, particularly when several items are contributing to the noise. Follow the procedure outlined below to isolate and identify the various items that may be producing the major noise interference.

In most cases, one source of interference will mask others. Consequently, it will be necessary to suppress the strongest item first, and then continue with the other steps. Figure 4-3 (fold-out from Page 51) shows a typical ignition system and the suggested placement of noise suppression components.

1. Position the vehicle in an area that is free from other man-made electrical interference, such as power lines, manufacturing processes, and other automobiles.
2. With the Transceiver turned on, drive the automobile at medium speed. Then let up on the gas, and turn the ignition switch off and to the accessory position. Allow the vehicle to coast in gear. If the noise stops, the major source of interference is from the ignition system.
3. If the noise interference continues from step 2, but at a reduced level, both the ignition and generator systems are at fault.

4. If the noise has a "whine" characteristic, changes in pitch with varying engine speed, and is still present with the ignition off, then the generator is the major source of interference.
5. A distinct but irregular clicking noise, or "hash," that disappears with the engine idling, indicates the voltage regulator is at fault.
6. A steady popping noise that continues with ignition off indicates wheel or tire static interference. This is more pronounced on smooth roads.
7. The same type of interference as in step 6, but more irregular when on bumpy roads, particularly at slow speeds, indicates body static.

Refer to the Troubleshooting Chart on Page 49 and Figure 4-3 (fold-out from Page 51) to help determine how to suppress most noise interference. Naturally, not all vehicles will require suppression to the extent shown in Figure 4-3, but some stubborn cases may require all the suppression components shown, plus shielding of the ignition system.

Bonding of various parts of the automobile may also be necessary, starting from the hood and continuing to the trunk, even including bonding of the transmission line every few feet from the antenna.





## Noise Suppression Troubleshooting Chart

TYPE OF NOISE	POSSIBLE CAUSE	RECOMMENDED REMEDY
Loud popping increasing to buzz with increased engine speed.	Ignition system.	<ol style="list-style-type: none"> <li>1. Replace plugs with resistor type.</li> <li>2. Loose crimped connections should be cleaned and soldered.</li> <li>3. Place resistors in distributor system.</li> </ol>
Whine; varies with engine speed.	Generator.	<ol style="list-style-type: none"> <li>1. 0.1 <math>\mu</math>fd coaxial-type capacitor in series with the armature ("A" lead).</li> <li>2. Clean commutator.</li> <li>3. Replace brushes.</li> <li>4. Ground generator shaft.</li> <li>5. Parallel trap (#10 wire-coil and suitable capacitor) in series with armature lead, tuned to operating frequency.</li> </ol>
Distinct but irregular clicking noise.	Voltage regulator.	<ol style="list-style-type: none"> <li>1. 0.1 <math>\mu</math>fd coaxial type capacitor in series with the battery (B) and armature (A) leads.</li> <li>2. A series combination of a .002 <math>\mu</math>fd mica capacitor and a 4 <math>\Omega</math> carbon resistor to ground from the field (F) terminal. All components should be mounted as shown in the diagram, close to the voltage regulator.</li> </ol>
Same as above.	Energy transfer to primary system.	<ol style="list-style-type: none"> <li>1. Install bypass capacitors as follows: 0.1 <math>\mu</math>fd coaxial in the lead from the ignition switch to the coil; 0.5 <math>\mu</math>fd at the battery lead to the ammeter; 0.5 <math>\mu</math>fd at the gas gauge; 0.5 <math>\mu</math>fd at the oil signal switch; 0.5 <math>\mu</math>fd at the headlight and tail light leads; 0.5 <math>\mu</math>fd at the accessory wiring from the engine compartment.</li> </ol>
Loud popping noise that changes from one type road to another. Most pronounced on concrete.	Wheel static.	<ol style="list-style-type: none"> <li>1. Install front wheel static collectors (available from most automotive distributors). These should be checked every 5000 miles for excessive wear.</li> </ol>
Same as above.	Tire static.	<ol style="list-style-type: none"> <li>1. Injection of anti-static powder into tire through valve stem.</li> </ol>
Irregular popping noise when on bumpy roads, particularly at slow speeds.	Body static.	<ol style="list-style-type: none"> <li>1. Tighten all loose screws.</li> <li>2. Use heavy flexible braid and bond the engine to the frame and fire wall. Bond the control rods, speedometer cable, exhaust pipes, etc., to the frame.</li> </ol>

If an extensive amount of suppression is required, the engine should be retimed and tuned up at a reputable garage.

## OPERATION

**NOTE: IT IS NECESSARY TO HAVE AN AMATEUR RADIO OPERATOR AND STATION LICENSE (GENERAL CLASS PRIVILEGES) TO PLACE THIS TRANSCEIVER ON THE AIR.** Information regarding licensing and amateur frequency allocations may be obtained from publications of the Federal Communications Commission or the American Radio Relay League.

### FUNCTION OF OPERATING CONTROLS

Figure 4-4 contains a brief description of the function of each control. Read the control descriptions carefully, then proceed with the following information.

#### VFO

Tune the VFO for the most natural sounding voice when receiving. Since they are already locked together in frequency, it is not necessary to zero beat the receiver frequency with the transmitter. Therefore, be careful not to disturb the VFO dial during a contact, or your transmitted signal frequency will change.

#### SIDEBAND SELECTION

The lower sideband (LSB) is generally used on the 40-meter band, although the upper sideband (USB) may be used in some locations. Shifting from the lower to the upper sideband (USB) causes a shift in the operating frequency of 3.4 kHz. This makes it necessary to retune the VFO to get back on the same operating frequency. The dial will read 3.4 kHz high in the USB position.

#### RECEIVING

The Transceiver is quite simple to operate since there is little tuning to do after it is aligned. Turn the Transceiver on by placing the FUNCTION switch in the PTT position. After a short warmup period, stations should be heard by tuning the VFO dial. The volume is adjusted by the RF ATTN and AF VOL controls.

With the Meter switch in the OPERATE TUNE position and the RF ATTN control at the maximum clockwise position, the meter will indicate received signal strength in "S" units, and db over S9. Normally, the RF ATTN control is oper-

ated at this maximum clockwise position. If signals are extremely strong, the RF ATTN control can be reduced to give the desired volume level, but the S METER reading will be reduced, since this control can attenuate the input signal by as much as 30 db.

#### TRANSMITTING

After an operating frequency has been selected by tuning the VFO dial, turn on the transmitter by placing the FUNCTION switch in the TUNE position. Then change the Meter switch to OPERATE TUNE and adjust the FINAL TUNE control for a maximum indication on the meter. This indicates proper tuning and maximum output power. Now put the transmitter "on the air" by placing the FUNCTION switch in the PTT or VOX position.

The meter will indicate ALC voltage while you are transmitting, when the Meter is set to OPERATE TUNE. As the operator talks, the meter should deflect a couple of S units, indicating maximum output peaks. The meter may rest above or below the zero mark while transmitting without harm. (The Heath Monitorscope can also be used with the Transceiver in fixed-station operation to provide a visual display of transmitter output.)

If the Meter switch is placed in the BIAS SET position while you transmit, the meter will indicate plate current variations of the final RF amplifiers. Normal talking should produce peaks at about S6 on the meter, with loud steady tones resulting in full-scale peaks. If the peaks of average talking levels are above S9, the MIC GAIN is set too high, and should be reduced to where the S6 level peaks are produced.

To keep the transmitter in peak operating condition, it should be adjusted periodically as directed in the Alignment and Adjustments section of the Manual. The BIAS ADJ control setting should also be checked and adjusted whenever power supplies are changed. After alignment has been completed and the carrier properly nulled, the bias level can be checked and adjusted anytime by observing the meter in the BIAS SET position when the PTT button is pressed, with no modulation.





**FINAL TUNE**  
After the VFO dial has been set to the desired operating frequency and the FUNCTION switch set to the TUNE position, this control is adjusted for a maximum meter indication, tuning the transmitter for maximum output.

**CARRIER NULL (ON CIRCUIT BOARD)**  
This control serves to balance the balanced modulator to eliminate the carrier from the output signal of the transmitter.

**VFO**  
Turning the VFO dial selects the desired operating frequency; the transmitter and receiver are set at the exact same frequency.

**METER**  
In the BIAS SET position, the meter indicates final cathode current; 300 ma full scale. In the OPERATE-TUNE position, it indicates signal strength, ALC action, and relative output power.

**METER SWITCH**  
Placing this switch in the OPERATE TUNE or BIAS SET position gives the operator a quick check on the various functions in the transceiver.

**FUNCTION**  
The FUNCTION switch permits turning the Transceiver On or Off, and selects the PTT, VOX, CAL, or TUNE mode of operation.

**BIAS ADJ**  
With the microphone button depressed for PTT operation and with the Meter switch in the BIAS SET position, the BIAS ADJ control should be adjusted for an S3 meter reading. A triangle is marked at S3 on the meter scale to indicate the proper bias setting. Do not allow the meter reading to exceed S3 without modulation.

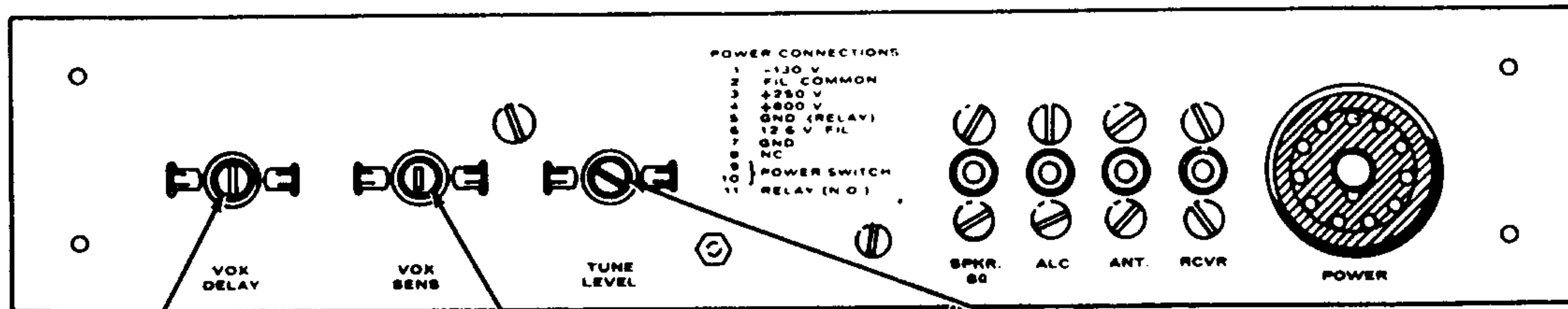
**MIC GAIN**  
When the operator talks into the microphone, the MIC GAIN control should be adjusted so the meter indication is about three to six "S" units on average talking, with the meter switch in the OPERATE-TUNE position. There will always be some output, even when control is turned fully counterclockwise.

**LSB USB**  
Used to select the desired sideband.

**S METER ADJ**  
With the FUNCTION switch set at PTT and the METER switch in the OPERATE-TUNE position, adjust the S METER ADJ control for a zero indication with the RF GAIN control fully counterclockwise and with no signal being received.

**AF VOL**  
The setting of the AF VOL control determines the audio output level to the speaker.

**RF ATTN**  
Normally this control is operated in the fully clockwise position. For extremely strong stations, the control should be turned counterclockwise until the desired level is obtained.



**VOX DELAY**  
Turning this control counterclockwise increases the time the transmitter stays on after the operator stops talking into the microphone when using VOX.

**VOX SENS**  
The VOX SENS control is adjusted for the desired sensitivity to turn the transmitter on when the operator talks into the microphone. Clockwise rotation increases the sensitivity.

**TUNE LEVEL**  
After an operating frequency has been selected by the VFO dial, the FINAL TUNE control is adjusted for a maximum meter indication, with the FUNCTION switch in TUNE and the meter switch at OPERATE TUNE. The TUNE LEVEL control should then be adjusted for approximately an S6 meter reading.

Figure 4-4

# CAUTION

THE VOLTAGE REGULATOR SHOWN IS ONLY REPRESENTATIVE. BATTERY, ARMATURE AND FIELD CONNECTIONS MAY NOT BE IN ORDER INDICATED. DO NOT BYPASS FIELD WINDING WITHOUT A RESISTOR IN SERIES. CHECK TERMINAL LOCATION CAREFULLY.

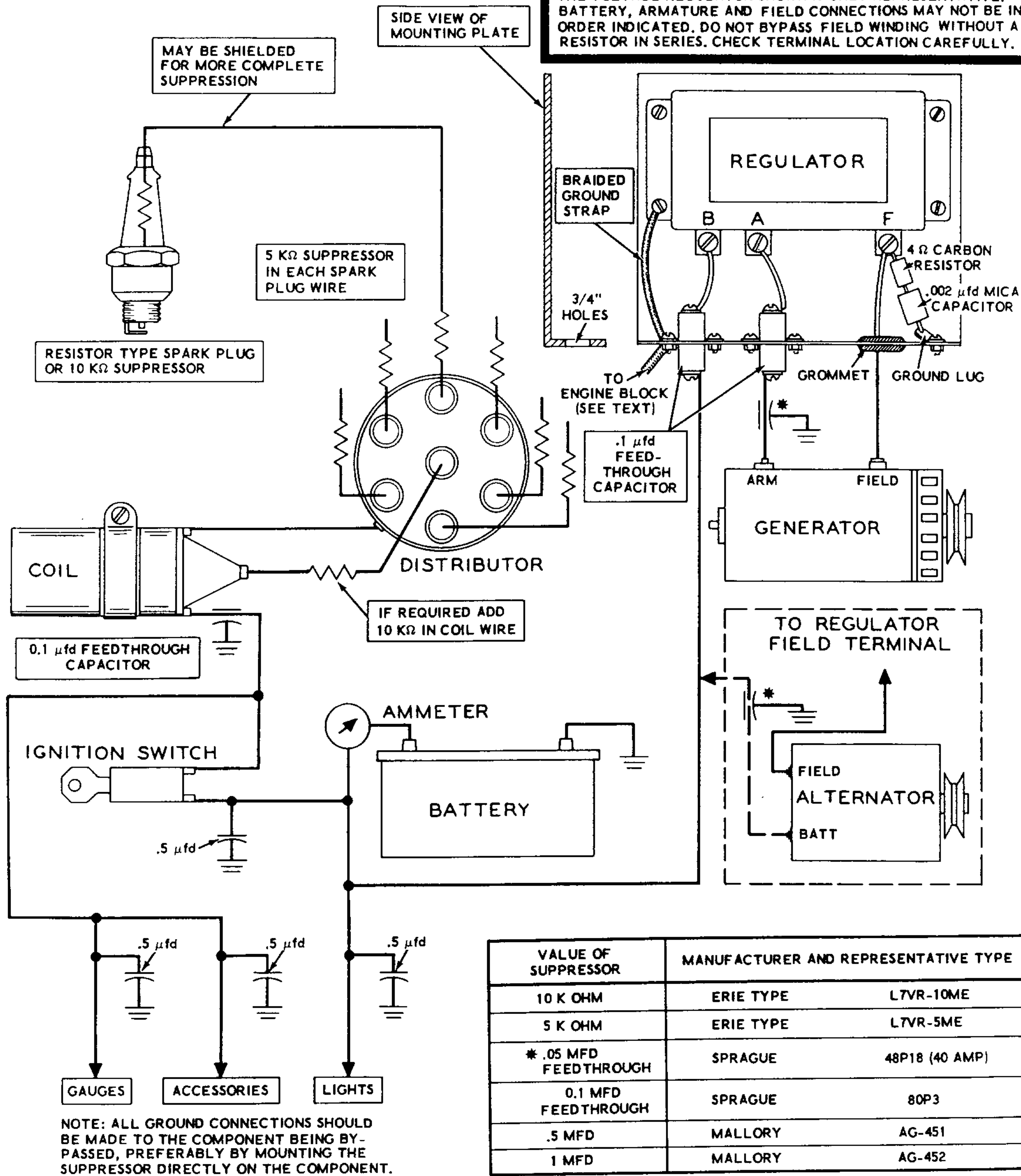


FIGURE 4-3





## VOX

To use the voice controlled relay, place the FUNCTION switch in the VOX position. Adjust the VOX SENS control for the microphone sensitivity desired to turn on the transmitter. The VOX DELAY control should be adjusted for the hold-in time desired after the operator stops talking. Maximum counterclockwise setting of the control will keep the transmitter ON all the time.

## ANTENNA

The antenna must have a low SWR (standing wave ratio), since the output of the Transceiver has fixed loading and a limited tuning range. The antenna tuning should be checked with a reflected power meter or SWR bridge to make sure it has an SWR of 1.5 to 1, or less. Operation with a high SWR will result in overloading the output tubes. When using an SWR bridge, a carrier may be obtained for tuning the antenna by switching the FUNCTION switch to the TUNE position. Do not overload the SWR bridge when transmitting SSB, since the peak output power is much higher than the output power in the TUNE position.

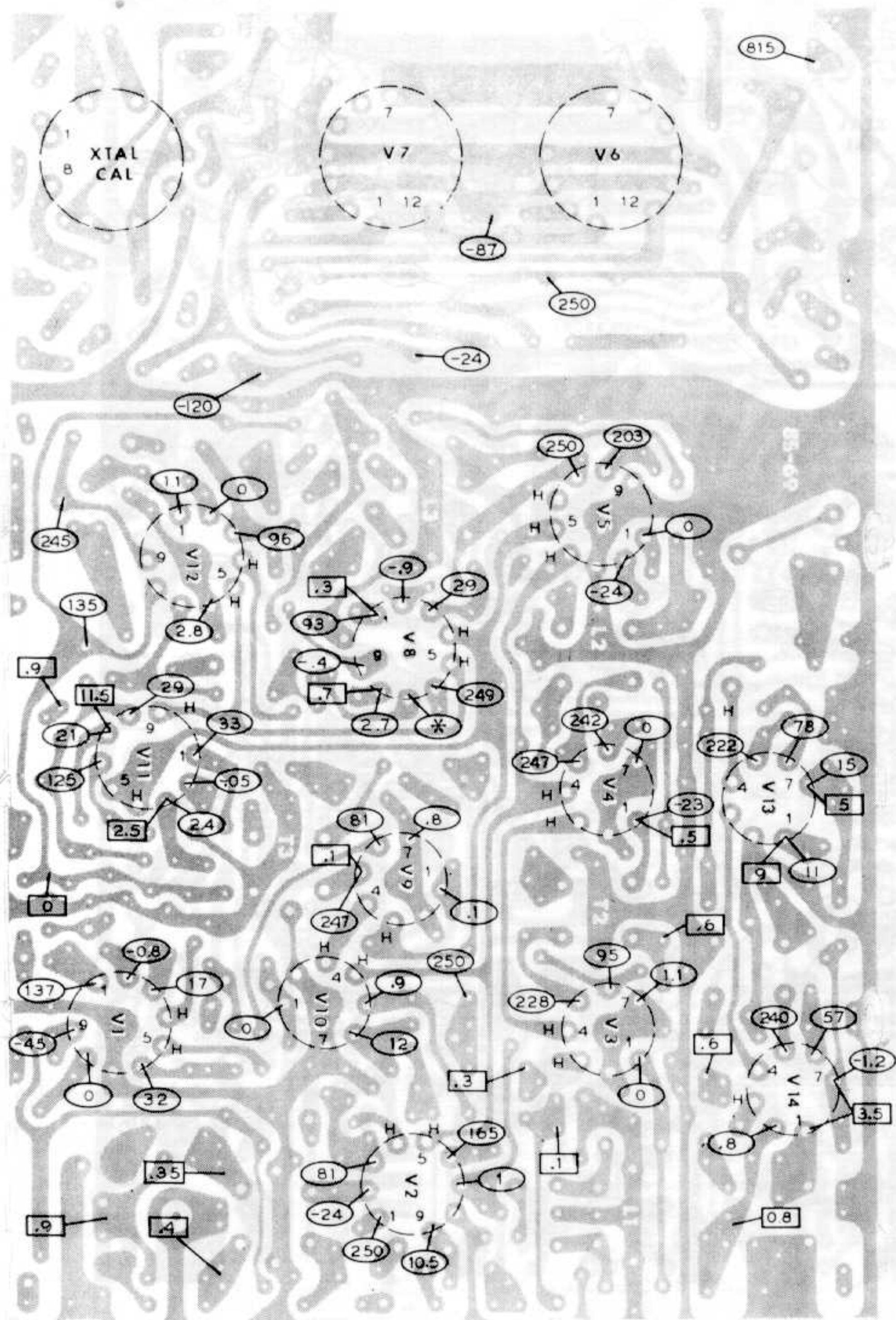
The antenna must be matched to, and fed with, 50  $\Omega$  coaxial cable for best results; the transmitter is not designed to load into random lengths of wire or open-wire transmission lines.

Special care must be taken with mobile installations, since short loaded and center loaded antennas are very critical to tune. An operating frequency change of 40 or 50 kHz will often change the antenna tuning considerably. Better antennas, with loading coils, have higher "Q" and sharper tuning. Follow the antenna manufacturer's instructions carefully to obtain proper adjustment.

## CRYSTAL CALIBRATION

The Heathkit plug-in Crystal Calibrator will provide convenient, accurate signals at 100 kHz intervals for receiver dial checking. The Crystal Calibrator can be plugged into the calibrator socket of the Transceiver. It is turned on by placing the FUNCTION switch in the CAL position. Do not transmit when in the CAL position because of possible interference.





\* 0 to 25 Varies With RF ATTN

- NOTES:
1. No Signal Input
  2. RF ATTN - Clockwise
  3. AF GAIN - 9 o'clock
- Voltages, DC, VTVM (11 - MS Input)
- RF Voltages, RF Probe and VTVM
4. Meter - OPERATE TUNE 5-Meter Zeroed
  5. All Other Controls - Counterclockwise
  6. FUNCTION Switch - PTT
  7. With HP-23 Power Supply

**RECEIVER VOLTAGE CHART**  
**FIGURE 6-2**









## IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial at 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 builder.
2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of the Kit Builders Guide.
3. Check to be sure that all tubes and cable connections are in their proper locations. Make sure that all tubes light up properly.
4. Check the tubes with a tube tester or by substitution of tubes of the same types that are known to be good.
5. 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.
6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.
7. If, after careful checks, the trouble is still not located and an ohmmeter and voltmeter are available, check the resistance and voltage readings against those shown in Figures 6-1 (fold-out from Page 51), 6-2, 6-3 (fold-out from Page 52), and 6-4 (fold-out from Page 55). NOTE: All voltage readings were taken with an 11 megohm input digital voltmeter. Voltages may vary as much as  $\pm 10\%$ .
8. A review of the Circuit Descriptions will help you to know where to look for trouble.
9. Check the power supply and antenna.

NOTE: To aid in servicing or troubleshooting the Transceiver, refer to the Circuit Board X-Ray Views (fold-out from Page 66) and Chassis Photos shown in Figures 7-1 through 7-3 on Pages 64, 65, and 66.

Breaks in the foil of the circuit board can be detected by placing a bright light under the foil side of the board and looking through the board from the lettered side. A break will appear as a hair-line crack in the foil.

## SHIPPING INFORMATION

If you should find it necessary to return your Transceiver to the Heath Company, refer to the Shipping Instructions in the Kit Builders Guide. Also, if you have the plug-in Crystal

Calibrator, some packing material should be placed around it to keep it in place in the kit. Otherwise it may work loose and break the tubes in the Transceiver during shipping.

## Troubleshooting Chart

TRANSMITTER DIFFICULTIES	POSSIBLE CAUSE
CARRIER NULL control changes carrier level, but not to a low enough level.	<ol style="list-style-type: none"> <li>1. FUNCTION switch in TUNE position, inserting carrier.</li> <li>2. Crystal diodes CR1 through CR4 installed backwards or are faulty.</li> <li>3. Transformer T1 incorrectly aligned.</li> <li>4. Microphone picking up noise.</li> </ol>
No relative power indication.	<ol style="list-style-type: none"> <li>1. Resistor R61 burned out, due to transmitting without antenna.</li> <li>2. Antenna shorted.</li> <li>3. TUNE LEVEL set too low.</li> <li>4. Faulty diode CR60.</li> </ol>
Chopped or broken modulation, especially on peaks.	<ol style="list-style-type: none"> <li>1. MIC GAIN control set too high.</li> <li>2. Faulty microphone cable or connections.</li> <li>3. Receiver cutoff bias line partially shorted. Check voltages and resistances.</li> </ol>
Radical change in BIAS SET reading.	<ol style="list-style-type: none"> <li>1. Function switch in TUNE position.</li> <li>2. Changed power supplies without rechecking transmitter adjustment.</li> <li>3. Faulty BIAS ADJ control.</li> </ol>
Transceiver locked in transmit mode.	<ol style="list-style-type: none"> <li>1. VOX-DELAY control set too high.</li> <li>2. Push-to-talk button stuck in depressed position.</li> <li>3. Tube V10 faulty.</li> </ol>
Plates of RF final amplifier tubes get red hot.	<ol style="list-style-type: none"> <li>1. No bias on tubes. Check voltage and resistances.</li> <li>2. No antenna, antenna open or shorted.</li> <li>3. Antenna plugged into wrong socket.</li> <li>4. Power supply voltage too high.</li> </ol>
Very low input to grids of RF final amplifier tubes from driver V5.	<ol style="list-style-type: none"> <li>1. Coils L2 and L3 improperly installed. Check color dot markings.</li> <li>2. T2 not aligned properly.</li> </ol>
Very low output, receiver works ok.	<ol style="list-style-type: none"> <li>1. Antenna plugged into RCVR socket instead of ANT socket.</li> </ol>

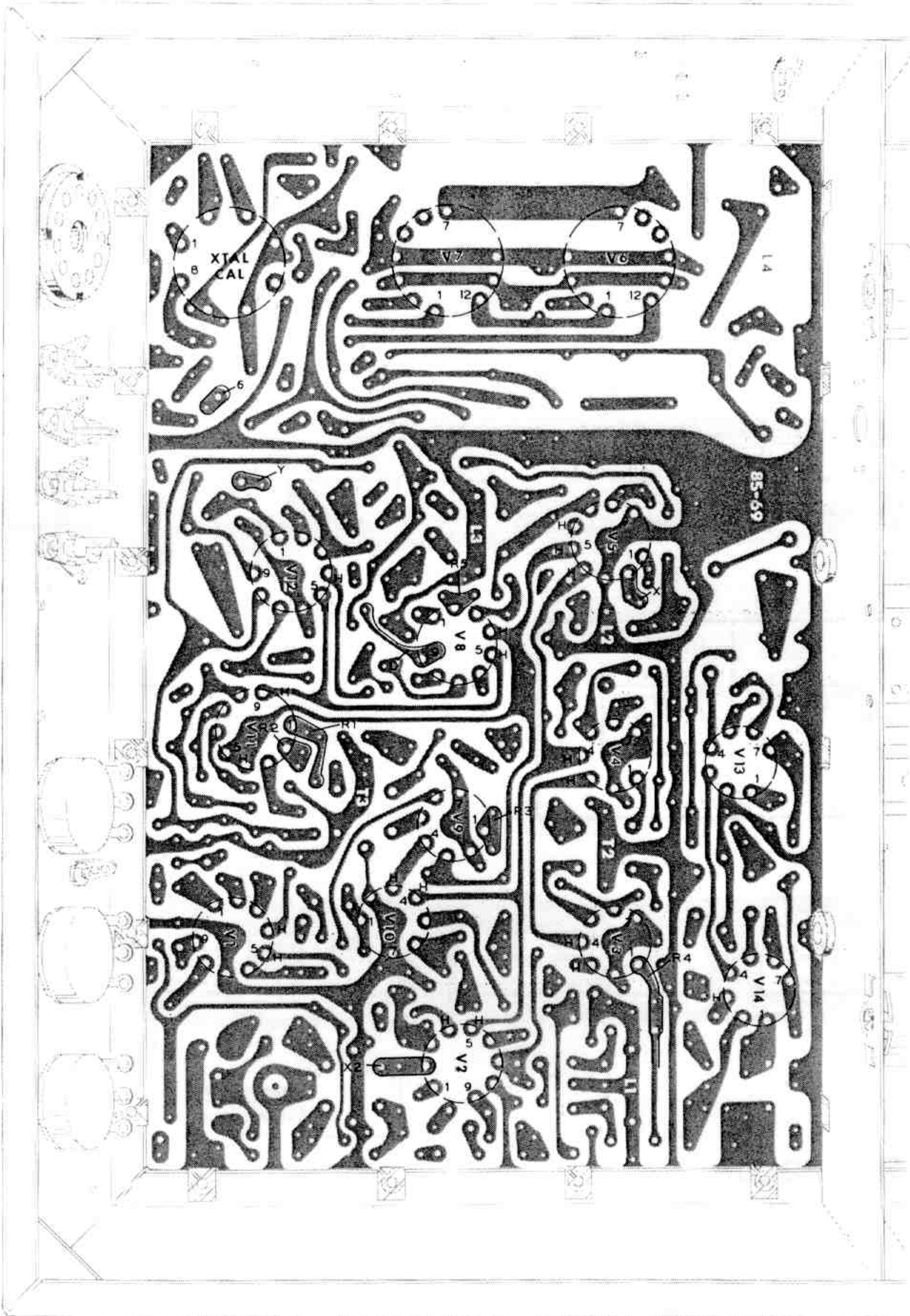




RECEIVER DIFFICULTIES	POSSIBLE CAUSE
Receiver squeals and oscillates with no antenna connected.	<ol style="list-style-type: none"> <li>1. Transmitter cutoff bias line partially shorted, turning on portions of the transmitter. Check voltages and resistances.</li> <li>2. Faulty capacitor C121.</li> </ol>
Received signals cannot be tuned in properly.	<ol style="list-style-type: none"> <li>1. Wrong sideband. Try other portions of the dial.</li> <li>2. Sideband switch in dead spot. Push switch to desired position.</li> </ol>
Poor sensitivity.	<ol style="list-style-type: none"> <li>1. Jumper wire between D and D installed wrong.</li> </ol>
No sound from speaker.	<ol style="list-style-type: none"> <li>1. RCVR GAIN controls turned down.</li> <li>2. Speaker unplugged or faulty.</li> <li>3. Unit is transmitting.</li> <li>4. Relay is not grounding receiver cut-off line.</li> <li>5. Tube V11 or V12 faulty.</li> </ol>
Sidebands reversed.	<ol style="list-style-type: none"> <li>1. Sideband switch assembly wired incorrectly.</li> </ol>

GENERAL DIFFICULTIES	POSSIBLE CAUSE
Receive RF burns when removing antenna connector.	<ol style="list-style-type: none"> <li>1. Transmitter tripped on by noise when in VOX operation.</li> <li>2. FUNCTION switch in TUNE position.</li> </ol>
Transceiver chassis "hot" causing electrical shock with linear amplifier connected.	<ol style="list-style-type: none"> <li>1. Ungrounded high voltage connected to external relay connection. See Installation section of manual.</li> </ol>
Filaments stay lit when Transceiver is turned OFF.	<ol style="list-style-type: none"> <li>1. Improper power supply connections.</li> </ol>
Meter reads backwards.	<ol style="list-style-type: none"> <li>1. Meter improperly wired.</li> <li>2. Meter switch improperly wired.</li> <li>3. S METER ADJ control not set properly.</li> </ol>
No output from VFO, V14.	<ol style="list-style-type: none"> <li>1. Wrong or faulty tube in socket V13 or V14.</li> <li>2. VFO capacitor shorted by improper installation of mounting screws.</li> </ol>
VOX cycles.	<ol style="list-style-type: none"> <li>1. VOX SENS control set too high.</li> <li>2. Faulty microphone cord or connection.</li> <li>3. Section C of relay making poor contact.</li> <li>4. Ambient noise level too high.</li> </ol>





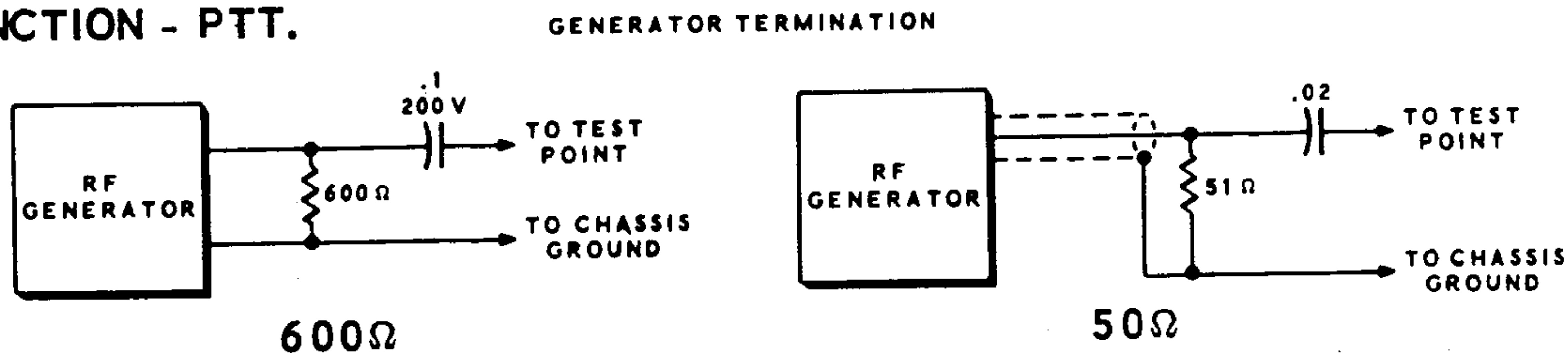
**SIGNAL VOLTAGE TEST POINTS**  
**FIGURE 6-4**



# RECEIVER AND TRANSMITTER SIGNAL VOLTAGE CHARTS

NOTES: Control and switch settings as in DC Voltage Chart except as follows:

1. Dial Frequency - 7.25
2. AF VOL - 9 o'clock.
3. VOX SENS - Counterclockwise.
4. RF ATTN - Clockwise.
5. SIDEBAND-LSB
6. FUNCTION - PTT.



## RECEIVER CHECK (NO ANTENNA CONNECTED)

INPUT			OUTPUT			
INPUT POINT	GENERATOR TERMINATION	INPUT FREQUENCY	INPUT LEVEL	OUTPUT POINT	VTVM OR S METER READING	NOTE
Y	600 $\Omega$	1000 Hz	1 V	SPKR	1.7 VAC	AF VOL - MAX Clockwise.
R1	"	"	0.1 V	-	S9	AF VOL - Affects reading.
"	"	"	"	6	+60 VDC	AF VOL - MAX Clockwise.
R2	50 $\Omega$	2305 kHz	30000 $\mu$ V	-	S9	VOX SENS - Counterclockwise.
R3	"	"	3000 $\mu$ V	-	"	AF VOL - 9 o'clock
R4	"	"	60 $\mu$ V	-	"	" " "
D	"	7250 kHz	100 $\mu$ V	-	"	" " "
R5	"	"	200 $\mu$ V	-	"	" " "
ANT	DIRECT	"	50 $\mu$ V	-	"	" " "
HEATH PLUG-IN CALIBRATOR	-	-	-	-	S9+20 db	FUNCTION-CAL

## TRANSMITTER CHECK (DUMMY LOAD CONNECTED)

Controls and switch settings as in DC Voltage Chart except as follows:

1. FUNCTION - TUNE.
2. Meter - Operate Tune.
3. Peak FINAL TUNE.

-	-	-	-	-	S7 MIN	TUNE LEVEL - Clockwise.
RCVR	DIRECT	7250 kHz	3 V	-	S4	TUNE LEVEL - Counterclockwise.
X1	50 $\Omega$	"	0.1 V	-	S9	" " "
R4	"	2305 kHz	6000 $\mu$ V	-	S9	" " "
X2	"	"	1500 $\mu$ V	-	S9	" " "

## SPECIFICATIONS

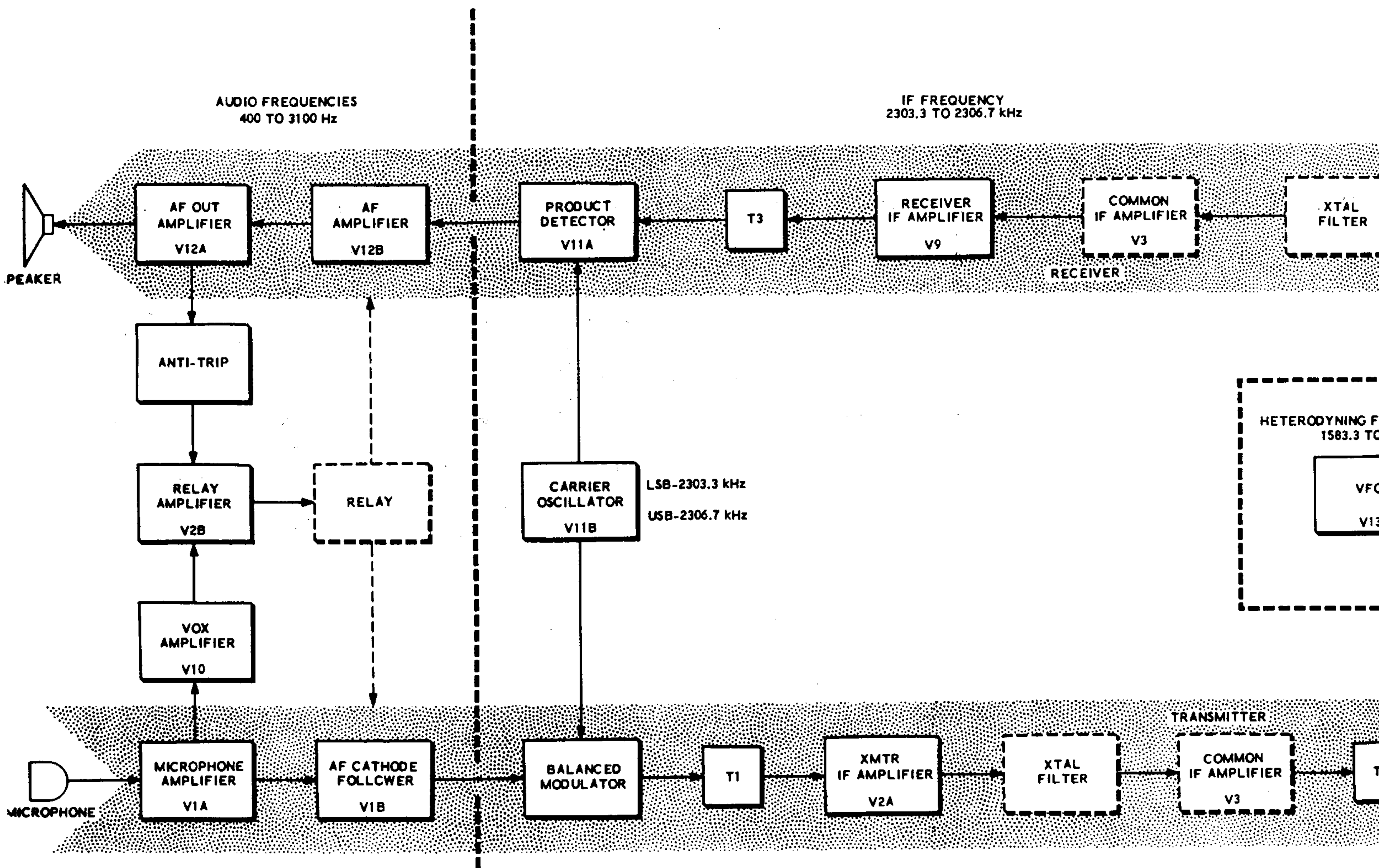
### RECEIVER SECTION

Frequency Coverage. . . . .	7.2 to 7.3 megahertz.
Receiving Mode. . . . .	Lower or upper sideband.
Sensitivity. . . . .	1 microvolt of input signal will provide at least a 15 db signal-plus-noise to noise ratio.
Selectivity. . . . .	2.7 kilohertz at 6 db. 6 kilohertz at 50 db.
Intermediate Frequency (IF). . . . .	2.305 megahertz.
Image Rejection. . . . .	100 db.
IF Rejection. . . . .	50 db.
Antenna Input Impedance. . . . .	50 $\Omega$ , unbalanced.
Receiver Audio Response. . . . .	400 to 3000 hertz.
Receiver Audio Power Output. . . . .	1 watt.
External Speaker Impedance. . . . .	8 $\Omega$ impedance.

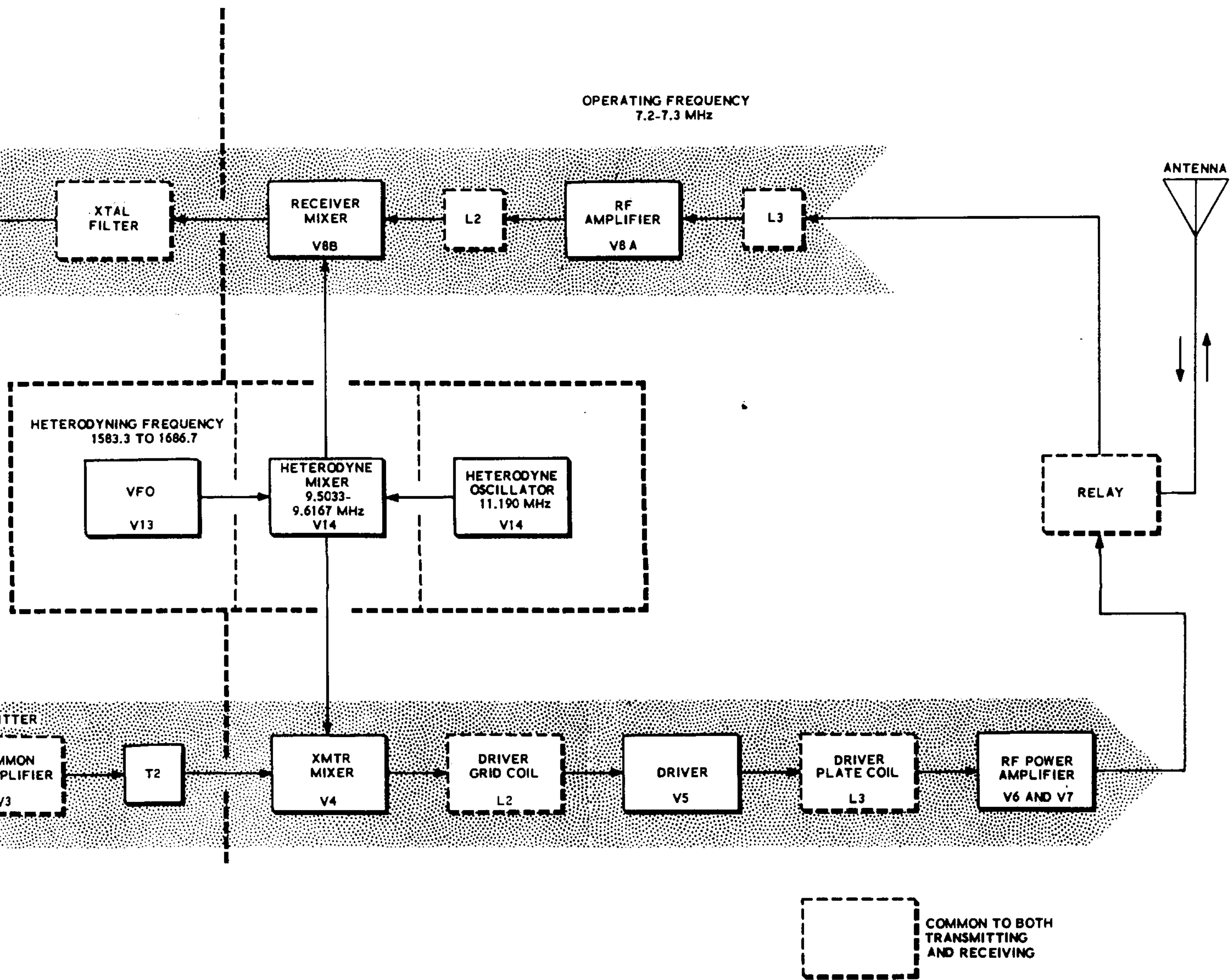
### TRANSMITTER SECTION

Frequency Coverage. . . . .	7.2 to 7.3 megahertz.
Transmitting Mode. . . . .	Lower or upper sideband.
Frequency Stability. . . . .	Drift less than 200 hertz per hour after warmup.
RF Power Input. . . . .	200 watt P.E.P.
Output Impedance. . . . .	50 $\Omega$ , unbalanced.
Transmitter Audio Response. . . . .	400 to 3100 hertz.
Microphone. . . . .	High impedance crystal, ceramic, or dynamic (between -45 db and -60 db output).
Unwanted Sideband Suppression. . . . .	45 db minimum below peak output with 1000 Hz modulation.
Carrier Suppression. . . . .	45 db minimum below peak output.





**BLOCK DIAG**



BLOCK DIAGRAM

RECEI

Frequ

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Sensiti

Selecti

Interm

Image

IF Reje

Antenn

Receiv

Receiv

Extern

TRANS

Frequ

Transm

Frequ

RF Pow

Output

Transm

Micro

Unwant

Carrie





CONTROLS

Front Panel. . . . . VFO tune.  
 FINAL TUNE.  
 Meter switch.  
 FUNCTION.  
 S METER ADJ.  
 RF ATTN.  
 AF VOL.  
 MIC GAIN.  
 BIAS ADJ.  
 Sideband.

Circuit Board. . . . . CARRIER NULL.

Chassis Rear. . . . . VOX DELAY.  
 VOX SENS.  
 TUNE LEVEL.

GENERAL

	12.6 V, AC or DC Filament	800 V DC B+	250 V DC B+	-130 V DC Bias
Power Requirements - Transmit. . . . .	3.75 amp	250 ma peak	100 ma	5 ma
Receive. . . . .	3.75 amp	-0-	65 ma	5 ma
Crystal Calibrator (Accessory). . . . .	.3 amp	-0-	2 ma	-0-

Tube Complement. . . . .

- 3 - 6EA8: Microphone amplifier and AF cathode follower - Transmitter IF amplifier and relay amplifier - RF amplifier and receiver mixer.
- 5 - 6AU6: VFO - VOX amplifier - IF amplifier (2) - Transmitter mixer.
- 1 - 6BE6: VFO cathode follower.
- 1 - 12BY7A: Transmitter driver.
- 1 - 12AT7: Product detector and carrier oscillator.
- 1 - 6EB8: AF amplifier and AF output.
- 2 - 6GE5: Transmitter RF output.

Cabinet Dimensions. . . . . 6-1/4" high x 12-1/4" wide x 10" deep. Add 1" to height, width, and dept for gimbal bracket, knobs, and connecting plugs.

Net Weight. . . . . 12 lbs.

Equipment Used To Prepare Specifications. . . .	Heathkit IM-11 VTVM with 309-C RF Probe. Heathkit HO-10 Monitorscope. Heathkit IG-72 Audio Generator. Heathkit IM-12 Distortion Meter. Heathkit HN-31 Antenna. Panoramic Radio Products, Inc. "Panalyzer," Model SB-12A. Hewlett Packard, Signal Generator, Model 606A. Tektronix Oscilloscope, Model 515A. Esterline Chart Recorder, Model AW. Boonton RF Voltmeter, Model 91-CA. Dynascan Digital Voltmeter, Model III.
Equipment Needed To Check And Calibrate. . .	VTVM and RF Probe. Frequency standard (100 kHz crystal calibrator). Crystal-calibrated receiver, covering the 40- meter band, or an accurate broadcast receiver.

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

The circuit of the Transceiver may be more easily understood if you refer to the Schematic Diagram (fold-out from Page 69) and Block Diagram (fold-out from Page 56) while reading the Circuit Description.

10 through 18 refer to wires with a white background and a single color stripe; and numbers 20 through 28 refer to wires with a white background and two identical color stripes. The numbers can be related to wire colors by using the same color code as used for resistors: brown = 1, red = 2, orange = 3, etc.

### SCHEMATIC DIAGRAM

The letter-number designations on the Schematic Diagram are used to identify resistors, capacitors, chokes, etc. Each of these designations is related by the first one or two numbers to the tube stage in which it is used. For instance, the resistors in the tube stage V1 are designated R10, R11, etc. In tube stage V12 they are marked R120, R121, etc. This system of circuit component designation is used throughout the Schematic.

Numbers in diamonds on the Schematic refer to the terminals on the circuit board and the color coding of the cable assembly wires. Numbers 1 through 9 indicate solid colors; numbers

### TRANSMITTER SECTION

#### Microphone Amplifier V1A

Voice signals from the microphone are coupled through capacitor C12 to the grid of microphone amplifier tube V1A. The amplified signal at the plate of V1A is coupled through C14 to the Mic Gain control, and through capacitor C102 to the VOX (voice operated transmitter) circuit. The setting of the Mic Gain control determines the amount of modulation. Since V1A supplies signals for modulation and for VOX, it operates during both receiving and transmitting. Capacitor C201 bypasses to ground





any RF signal picked up by the microphone push-to-talk switch lead.

### Audio Frequency Cathode Follower

The audio signal from the Mic Gain control is applied to AF (audio frequency) cathode follower stage V1B. This stage matches the tube impedance to that of the balanced modulator. Bypass capacitor C19 keeps the modulator RF voltages from reaching V1B. During receiving, the relay cuts off V1B and a number of other transmitter stages.

### Balanced Modulator

When the Audio signal from V1B and the RF signal from carrier oscillator V11B are applied to the 4-diode balanced modulator, two different frequencies are produced. This ring-type balanced modulator uses diodes CR1 through CR4.

One of the two signals produced by the balanced modulator is the sum of the audio and carrier frequencies; the other signal is the difference between the audio and carrier frequencies. These signals are the upper and lower sidebands.

The carrier signal is applied across the modulator diode ring in a balanced circuit, consisting of one winding of transformer T1, capacitors C1 and C2, resistors R3 and R4, and the Carrier Null control. The Carrier Null control is used to balance out the carrier signal in the modulator, leaving only the upper and lower sideband signals at the modulator output.

The output from the balanced modulator is the result of combining the audio and carrier signals. Neither the audio or carrier signals appear in the output, but the effect of the audio signals unbalancing the nulled circuit at an audio rate produces the sum-and-difference frequencies called sidebands. With no audio, there is no output from the balanced modulator.

With the Function switch in the Tune position, a DC voltage is applied to the balanced modulator through resistors R1 and R2. This voltage can be adjusted with the Tune Level control. This DC voltage is used to unbalance the modulator to provide a steady output signal for transmitter tuning purposes.

### Transmitter IF Amplifier

NOTE: Throughout the Circuit Description, it will be assumed that the sideband switch is in the LSB position.

The sideband signals from the balanced modulator are coupled through transformer T1 and then are amplified by transmitter IF amplifier V2A. These signals are then applied to a crystal filter, consisting of crystals Y2 through Y5, and coil L1. The crystal filter eliminates the upper sideband, and permits the lower sideband to pass through to common IF amplifier V3 for additional amplification. (If the Sideband switch were in the USB position, the lower sideband would have been eliminated and only the upper sideband would pass through the crystal filter.)

Stage V2A is turned off while receiving by applying additional negative DC voltage to its grid through the secondary of transformer T1. This control voltage is impressed on the ALC (automatic level control) line, which is also used to control the gain in a number of other transmitter stages to prevent overloading. Overloading can be detected by observing the action of the meter. Normally the meter rests at or slightly below zero; however, if the operator talks too loud or if the Mic Gain control is set too high, the transmitter section would overload. This causes a change in ALC voltage which increases the bias, reducing transmitter gain and causing meter deflection to indicate ALC action.

### Common IF Amplifier V3

When transmitting, V3 amplifies the lower sideband signal from the crystal filter, and then applies this signal to IF transformer T2. When receiving, the receiver IF signal is amplified by V3 and is then applied to receiver IF amplifier V9.

### Transmitter Mixer V4

Transmitter mixer V4 receives two signals simultaneously; one is the SSB signal from T2, and the other is the VFO (variable frequency oscillator) signal from V13 and V14, which is coupled through the secondary of transformer T2. Tube V4 produces the difference frequency between these signals, which is at the proper operating frequency. This difference signal is applied to the primary of coil L2. Tube V4 is cut off by bias voltage from the ALC line when receiving.



Coil L2, which has two windings, is broad-tuned to cover the 40-meter band. This coil is also used when receiving, and is then connected to receiver RF amplifier V8A and receiver mixer V8B.

### Driver V5

Driver V5 receives the signal voltage from coil L2 through parasitic suppressor resistor R50. The ALC line is also connected to V5 to control transmitter gain, and to cut off the driver when receiving. Single-tuned coil L3 and double-tuned coil L2 form a bandpass device that covers the frequencies of the 40-meter band without the necessity of tuning the driver stage. Voltage for bridge neutralization of final amplifier tubes V6 and V7 is fed through capacitors C63 and C64 to the bottom of coil L3, and across C55. The small winding of coil L3 is used for the input signal from the antenna when receiving.

### RF Final Amplifiers

RF final amplifiers V6 and V7 are connected in parallel. High voltage plate connections are under the chassis. The grids are connected by a long foil strip on the circuit board. This strip is bypassed at its ends by capacitors C61 and C71 to suppress VHF oscillations. Cathode resistor R71 is a meter shunt for measuring cathode current when the meter switch is in the BIAS SET position.

Tubes V6 and V7 are operated as linear amplifiers, with high power sensitivity. Grid load resistor R72 is connected to the Bias Adj control through R73, to allow adjustment of the grid voltage for proper operation. The Bias Adj control is grounded through resistors R75 and R203 when transmitting. When receiving, this control is grounded through resistors R76 and R77 to increase the grid bias to cut off the final tubes.

### Automatic Level Control (ALC)

No grid current is drawn by tubes V6 and V7 in normal linear operation; however, when higher than normal grid drive is applied, grid current will flow and change the bias voltage. This higher-than-normal grid drive, caused by too much audio signal, makes the bias voltage change at an audio rate. This varying bias voltage is coupled through capacitor C75 to diodes D70 and D71, which rectify the signal to develop

the negative ALC voltage, which is applied to V2A, V4, and V5. Resistors R78 and R79, along with capacitor C74, filter this voltage and provide the proper time delay for ALC action. The entire ALC circuit is biased above ground by resistors R76 and R77 to cut off the transmitter section when receiving.

### Transmitter Output Circuit

The plates of the RF amplifier tubes are connected to the supply voltage by choke RFC61. Their signal is coupled to the pi-section output circuit through capacitor C67. Output coil L4 is tuned by the Final Tune capacitor. Antenna loading is fixed by capacitor C77 for a 50  $\Omega$  load. With the Function switch in the Tune position, a sampling of the output voltage from resistors R61 and R62, and diode CR60, gives a meter indication to indicate proper adjustment of the Final Tune capacitor.

### RELAY TRANSMIT-RECEIVE SWITCHING

Switching between transmitting and receiving is done by the relay. Section A of the relay switches the antenna, and section C switches the bias voltages.

Section B of the relay, which is connected to the external relay connection at the Power plug, can be used to control external equipment, such as a linear amplifier or antenna relay. Because one side of the external relay connection is grounded to the Transceiver chassis, the connection must not be used to switch any voltage in a circuit that operates above ground, as the chassis would become "hot," causing a possible shock hazard.

### VOX AMPLIFIER V10 AND RELAY AMPLIFIER V2B

The Transceiver can be switched from receive to transmit by either the push-to-talk or the VOX method. VOX Amplifier V10 is normally operated in a saturated condition; that is, with very low plate voltage and maximum plate current. Positive half cycles of the voice signals from V1A have no effect on V10, however, the negative half cycles cause the plate current to drop, thus increasing plate voltage. This increased plate voltage fires the neon lamp providing a positive switching action. The voltage from the neon lamp is then amplified by relay amplifier V2B, which operates the relay. Capacitor C105 and resistor R107 form a delay





network that establishes the time the relay stays closed after being tripped. The length of time is determined by the setting of the VOX Delay control.

### ANTI-TRIP CIRCUIT

Because the VOX stages operate on both transmit and receive, the speaker signals during receive must be kept from tripping the relay when receiving. This is done by taking a portion of the audio signal from AF output stage V12A, rectifying it with diode D100 to produce a positive voltage, and feeding this voltage to the grid of V10 from the VOX SENS control. This voltage tends to increase the plate current of V10; signals from the microphone (picked up from the speaker) tend to decrease the plate current. Therefore with both signals present at the grid of V10, the signals cancel each other, preventing the speaker from tripping the VOX circuit. Speaking into the microphone produces signals not present in the speaker circuit, permitting the VOX circuit to function normally. The VOX SENS control not only adjusts for proper anti-trip voltage, but also determines the sensitivity of the VOX circuit.

### PUSH-TO-TALK CIRCUIT

With the Function switch in the PTT (push-to-talk) position, V10 is disabled by grounding its grid, and V2B is made to operate and close the relay when its grid is grounded (shorting the bias) by the push-to-talk switch in the microphone. The Function switch, in the PTT position, also makes the VOX delay circuit inoperative by removing C105 from ground. Push-to-talk operation with the Function switch in the VOX position uses the VOX delay circuit, causing the receiver to "delay" before coming on after the microphone button is released. The Function switch in the Tune position turns the transmitter on by grounding the grid of V2B.

### RECEIVER SECTION

#### Radio Frequency Amplifier V8A And Receiver Mixer V8B

The incoming signal is connected to RF amplifier V8A through coil L3. The amplified signal from V8A is then coupled through coil L2 to receiver mixer V8B. During receiving, cutoff bias is removed from the receiver section to permit tubes V8A, V8B, V9, and V12A to operate.

V8A is controlled by bias from the AVC (automatic volume control) circuit. AVC in the receiver is similar to ALC in the transmitter, in that it maintains a constant receiver output (gain) even though the incoming signal level may vary considerably. The cutoff voltage on the bias line is controlled by section C of the relay.

The RF ATTN control varies the cathode bias on RF amplifier V1, to permit receiver gain to be reduced to prevent overloading on very strong signals. This reduction in RF gain will also be reflected in lower meter indications. Operating at a reduced RF gain, however, does not disturb the AVC circuitry, nor will it cut off the receiver completely. It simply reduces strong signals to a level that can be handled by the receiver to provide minimum cross modulation or desensitization.

### Crystal Filter

The signal is coupled from mixer V8B to the crystal filter through C80, which is small in value to avoid upsetting the input impedance of the filter. The crystal filter exhibits the same characteristics in receiving as in transmitting; it shapes the IF passband to have steep sides, a flat top, and a narrow bandwidth. This permits good selectivity for SSB reception in crowded amateur bands.

#### Common IF Amplifier V3 And Receiver IF Amplifier V9

Signals from the crystal filter are amplified by common IF amplifier V3 and then fed to receiver IF amplifier V9. The cathode and screen of tube V9 are connected directly to those of tube V2A. The meter, which is connected in this circuit, indicates received signal strength in S units, as the AVC voltage changes the current in V9. The meter functions as an ALC indicator when transmitting, without any switching. The gain of V9 is controlled by the AVC voltage applied through resistors R91 and R92.

#### Product Detector V11A And Audio Frequency Amplifier V12B

The amplified signal from V9 is coupled through IF transformer T3 to the grid of product detector V11A. Also, a signal from carrier oscillator V11B is fed to the cathode of V11A. A heterodyne mixing action takes place in V11A, resulting in an output signal which is the difference

frequency of these two signals: an audio signal. Capacitors C111 and C112 bypass any RF signal coming from V11A, but permit the audio signal to pass through to AF amplifier V12B. The output from V12B is fed to the AF output amplifier V12A through the AF Vol control, and to the AVC circuit.

### Automatic Volume Control

Audio voltage is coupled to diodes D120 and D121 through resistor R128 and capacitor C128. The diodes and capacitor C129 form a voltage doubler, producing a negative DC voltage proportional to the signal strength. Full AVC voltage is applied to the grid of receiver RF amplifier V8A to prevent overloading by strong received signals.

Capacitor C129 in the AVC circuit charges quickly to furnish a fast AVC response time, while the charging of large capacitor C88 gives a slow AVC release time. Resistors R80, R122, R123, and R124, with capacitor C123, divide the AVC voltage applied to V9 and V12A and provide decoupling. To provide delayed AVC, resistor R123 is returned to the cathode of V12B rather than to ground. This balances the AVC voltage (which is caused by noise when no signal is being received) with a small positive voltage to improve receiver sensitivity at low signal levels.

### Audio Frequency Output Amplifier V12A

Amplified audio signals from V12A are fed to the speaker socket through output transformer T4 to provide maximum intelligibility, the frequency response of the output stage is limited to the voice frequency range by a sharp-cutoff, high frequency, degenerative feedback loop. High frequencies across RFC120 causes its impedance to rise. The high frequencies are thus returned out-of-phase to the grid of V12B by C126. This signal cancels out the incoming high frequency audio and noise signals at the grid of V12B. Capacitor C120 is a low frequency bypass to ground, and capacitor C127 serves as a parasitic oscillation suppressor.

### CARRIER OSCILLATOR

Carrier oscillator V11B supplies an RF signal to the balanced modulator, and a heterodyning signal to product detector V11A. Tube V11B is a Colpitts type oscillator. Crystal Y1 or Y7 determines the operating frequency to accurately maintain the proper frequency relationship with the crystal filter bandpass frequencies. Capacitors C119 and C118 provide feedback to maintain oscillation. The output is taken from the junction of capacitors C118 and C119. The crystal for the desired sideband is selected by the Sideband switch.





## VFO

Variable frequency oscillator V13 is also a Colpitts type oscillator, which operates at low frequencies for maximum stability. Coil L6 provides the necessary inductance, while capacitors C132, C133, and C134 form a divider for oscillator feedback and output connections. C130 is a negative temperature coefficient capacitor for temperature correction. The oscillator output is taken from the junction of capacitor C133 and C134, and is applied to V14. The harmonics are suppressed by capacitor C134.

The heterodyne oscillator-mixer stage consists of a fixed crystal-oscillator circuit using part of V14, crystal Y6, capacitors C141, C146, and R143. Choke RFC140 and resistor R140 provide a DC path to ground, and cathode bias for V14. Capacitor C146 provides feedback to maintain the circuit in an oscillating condition, and resistor R143 provides the DC return for the fixed crystal-oscillator grid circuit. The internal tube elements connected to pin #6 of V14 provide B+ voltage (plate) for this oscillator circuit.

The VFO heterodyne coil, L5, is essentially a bandpass filter which passes the "difference" signal produced by VFO stage V13 and the fixed crystal-oscillator section of V14. This resultant beat frequency signal is applied through coil L5 and capacitor C142 to receiver-mixer V8B, and to the grid of transmitter-

mixer V4 through one-half of common IF transformer T2.

## ACCESSORY CRYSTAL CALIBRATOR

The accessory plug-in crystal calibrator is turned on by applying B+ to it. This occurs when the Function switch is in the CAL position. The calibrator filament circuit is grounded internally to the calibrator chassis. For this reason, the calibrator chassis must not be grounded to the Transceiver chassis. Resistor R6 is the calibrator plate current return; resistor R5 drops the calibrator filament voltage to 6 volts.

## FILAMENTS

The filament wiring of the Transceiver is a series-parallel arrangement that balances the filament voltage without wasting power in dropping resistors. This filament arrangement allows the use of both 6 volt and 12 volt filament tubes in the Transceiver design. The filaments of RF power amplifiers V6 and V7 are isolated by choke RFC60 to prevent RF energy from getting to the other tube filaments.

## POWER SUPPLY

Operating voltages for the Transceiver are provided by an external power supply. The power supply is turned on or off by the Function switch, which is wired through the Transceiver Power plug to the external power supply.

# CHASSIS PHOTOGRAPHS

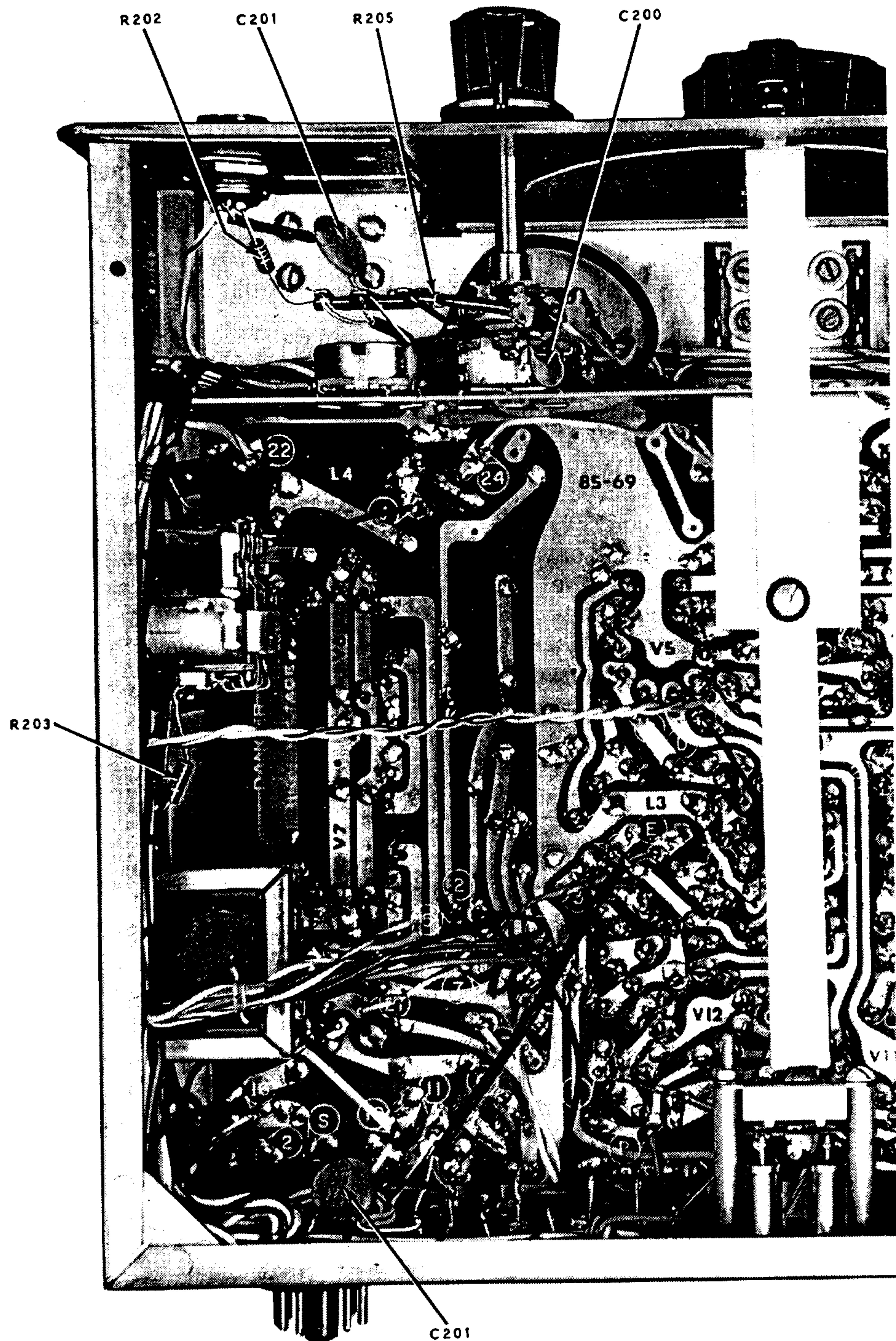


FIGURE 7-1



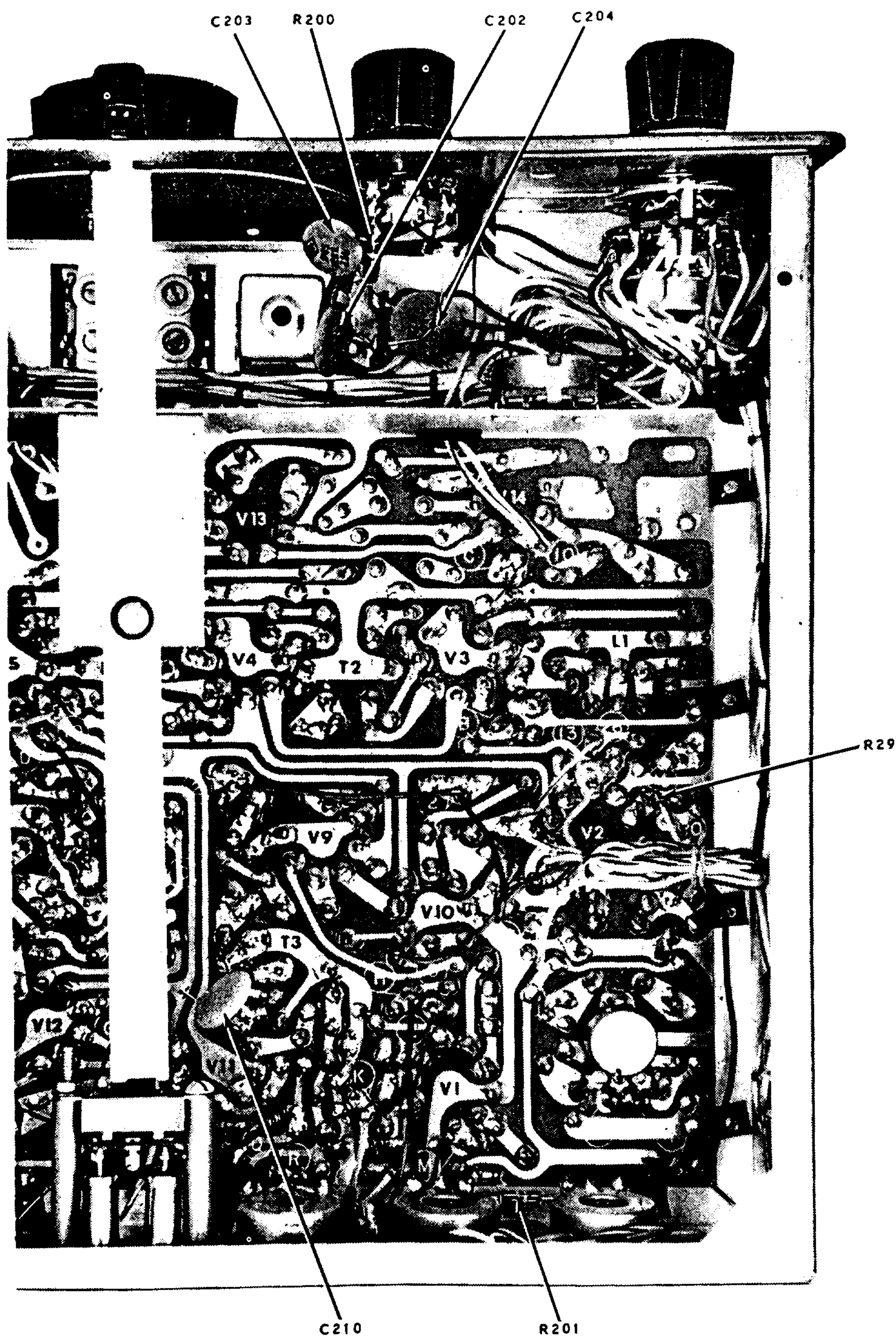


FIGURE 7-2



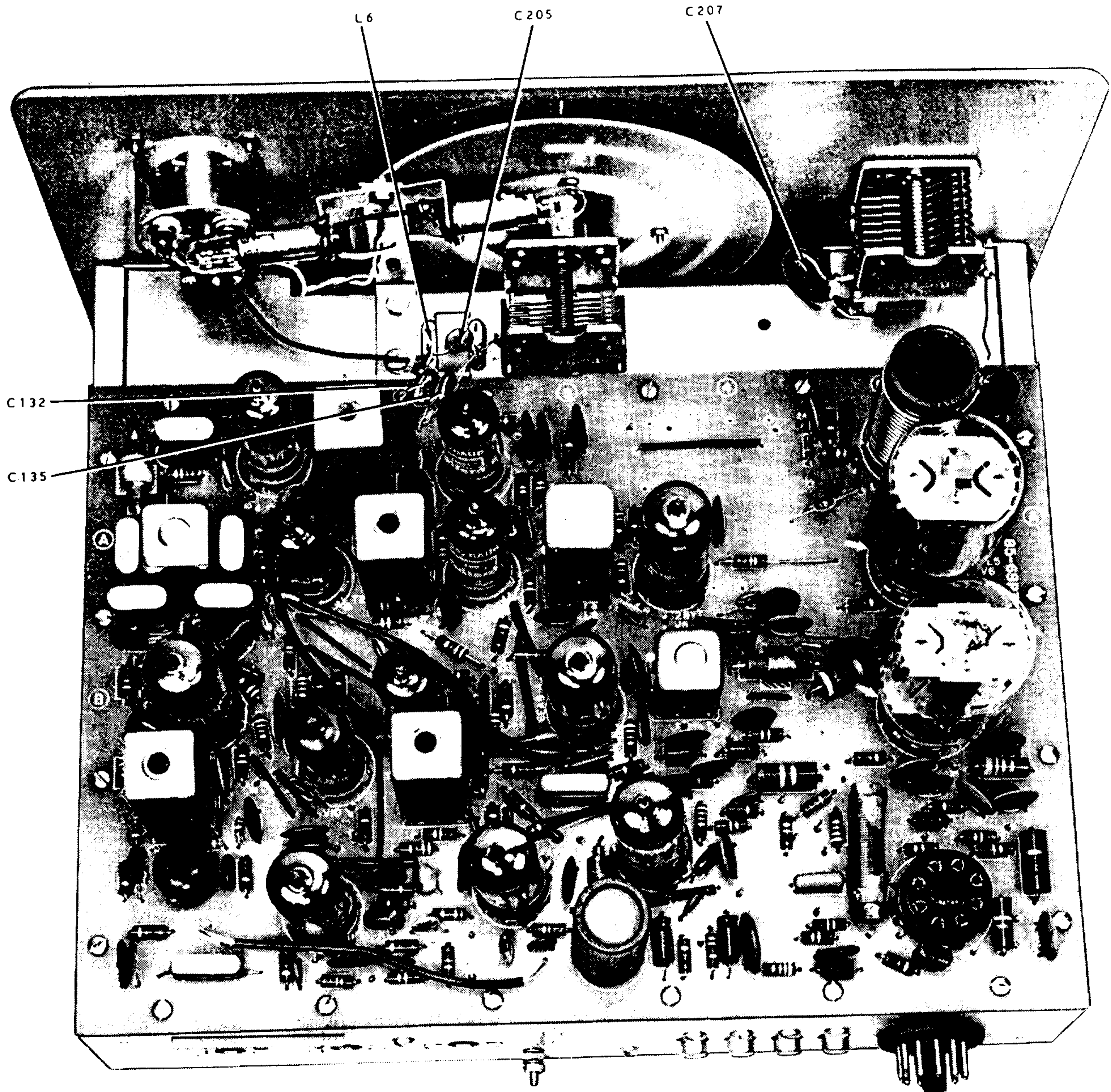


FIGURE 7-3

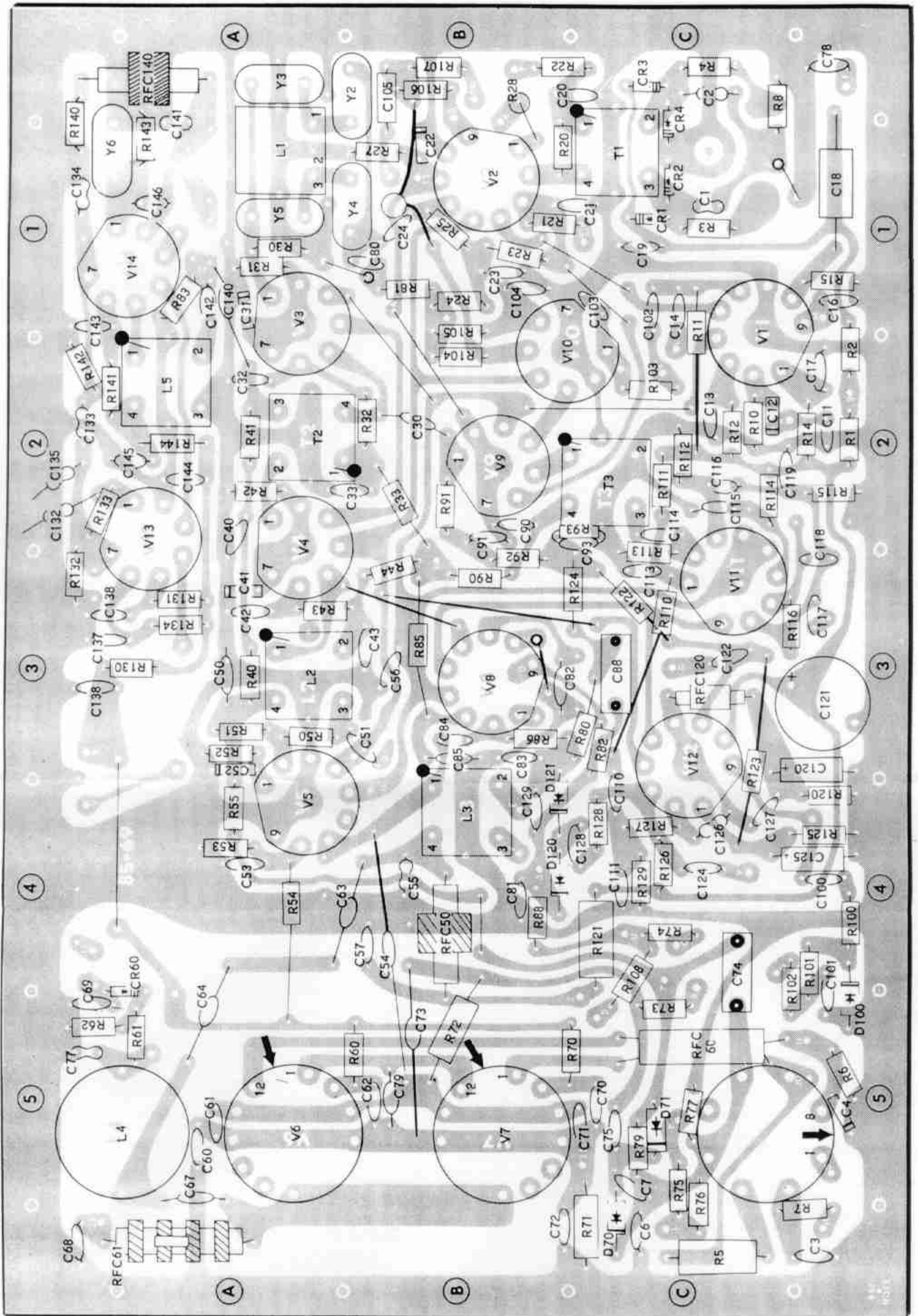
## REPLACEMENT PARTS PRICE LIST

PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
<b>RESISTORS</b>					
<b>1/2 Watt</b>					
1-1	.10	47 $\Omega$	1-16	.10	4700 $\Omega$
1-3	.10	100 $\Omega$	1-20	.10	10 K $\Omega$
1-66	.10	150 $\Omega$	1-22	.10	22 K $\Omega$
1-45	.10	220 $\Omega$	1-25	.10	47 K $\Omega$
1-4	.10	330 $\Omega$	1-26	.10	100 K $\Omega$
1-9	.10	1000 $\Omega$	1-29	.10	220 K $\Omega$
1-14	.10	3300 $\Omega$	1-35	.10	1 megohm
			1-37	.10	2.2 megohm
			1-70	.10	22 megohm

1/2 Watt (cont'd.)



# CIRCUIT BOARD X-RAY VIEWS (VIEWED FROM FOIL SIDE)





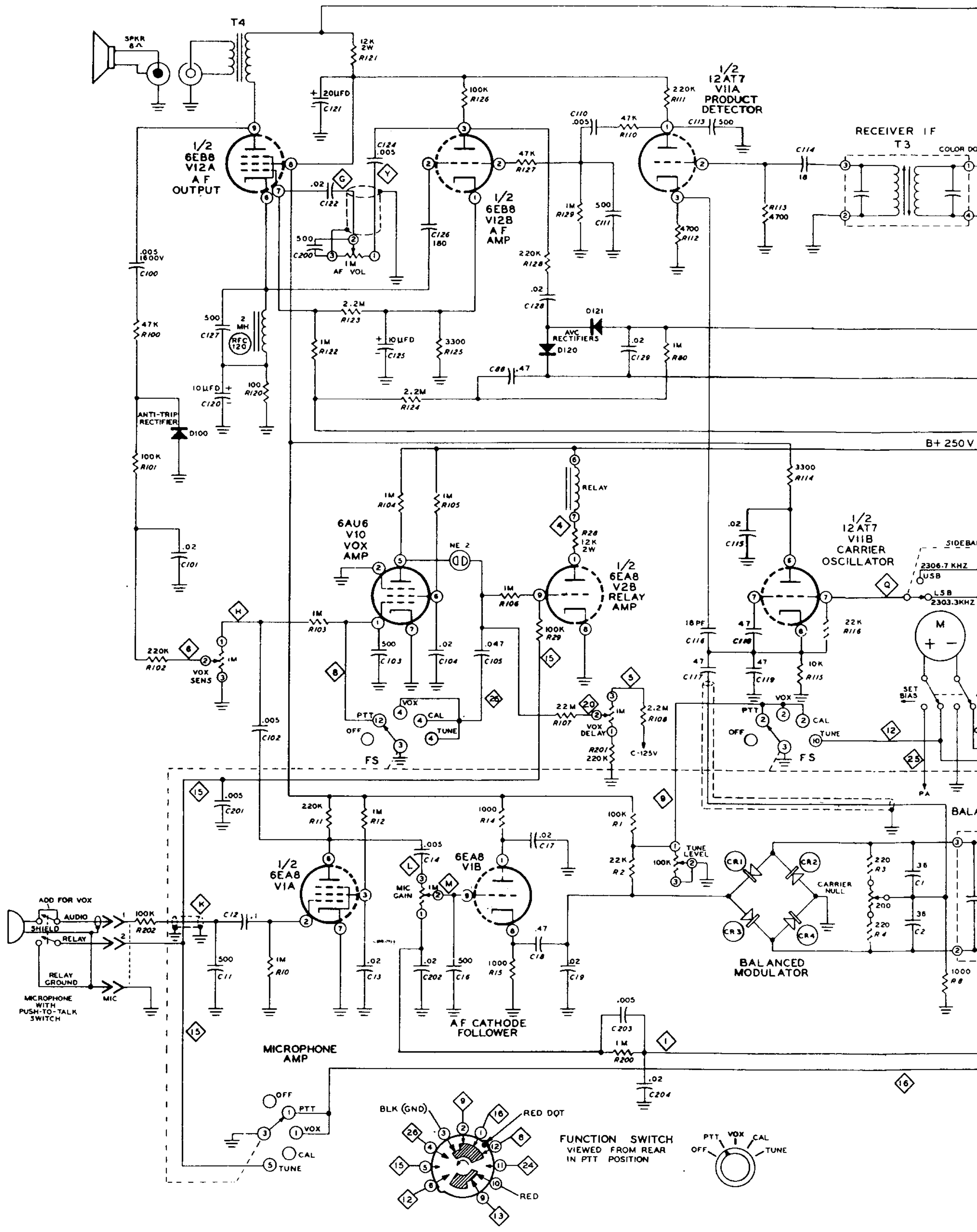


PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
<b>Other Resistors</b>			<b>CONTROLS-SWITCHES</b>		
1-28-1	.10	100 K $\Omega$ 1 watt	10-130	.75	200 $\Omega$ bushing-mount control
3-2-2	.25	.33 $\Omega$ 2 watt	10-17	.55	1 megohm bushing-mount control
1-21-2	.35	20 $\Omega$ 2 watt	10-57	.35	10 K $\Omega$ tab-mount control
1-2-2	.20	4700 $\Omega$ 2 watt	10-58	.35	100 K $\Omega$ tab-mount control
1-22-2	.20	12 K $\Omega$ 2 watt	10-127	.35	1 megohm tab-mount control
<b>CAPACITORS</b>			12-73	1.70	1 megohm/25 K $\Omega$ dual tab-mount control
<b>Mica</b>			60-13	.20	DPDT slide switch
20-96	.15	36 pf	63-427	3.40	5-position rotary with/snap switch
20-102	.15	100 pf	<b>CRYSTALS</b>		
20-105	.20	180 pf	404-196	3.75	2303.3 kHz
20-134	.50	680 pf	404-197	3.75	2306.7 kHz
20-122	.30	1000 pf	404-198	3.75	11.190 MHz
20-127	.40	1300 pf	404-203	16.25	Package
20-137	.45	1800 pf	consisting of the following:		
<b>Disc</b>			404-191		2305.100 kHz
21-60	.10	18 pf	404-192		2303.500 kHz
21-32	.10	47 pf	<b>DIODES-TUBES-LAMPS</b>		
21-49	.20	68 pf	56-26-1	.35	Germanium diode (brown-white-brown)
21-13	.10	500 pf	57-27	.60	Silicon diode
21-35	.15	.005 $\mu$ fd 1.6 KV	411-11	1.00	6AU6 tube
21-57	.10	.005 $\mu$ fd	411-91	1.20	6BE6 tube
21-31	.10	.02 $\mu$ fd	411-124	1.50	6EA8 tube
<b>Mylar</b>			411-161	2.20	6EB8 tube
27-46	.15	.047 $\mu$ fd	411-185	1.95	6GE5 tube
27-48	.25	.22 $\mu$ fd	411-24	1.45	12AT7 tube
27-61	.45	.47 $\mu$ fd	411-69	1.55	12BY7A tube
27-47	.20	.1 $\mu$ fd	412-1	.15	#47 pilot lamp
<b>Other Capacitors</b>			412-11	.20	NE-2 neon lamp
25-54	.40	10 $\mu$ fd tubular electrolytic	<b>CONNECTORS-SOCKETS-PLUGS</b>		
25-135	.75	20 $\mu$ fd vertical electrolytic	432-38	1.10	Male connector
26-35	1.65	Variable	432-39	1.10	Female connector
26-89	2.05	Variable	434-42	.10	Phono socket
<b>COILS</b>			434-44	.15	Pilot lamp socket
40-509	.75	Crystal filter	434-112	.10	7-pin tube socket
40-514	1.20	Driver plate	434-105	.15	8-pin tube socket
40-517	1.80	Driver grid	434-79	.15	9-pin tube socket
40-778	1.00	VFO heterodyne	434-140	.20	12-pin tube socket
40-511	.85	Final plate	434-118	.40	11-pin tube socket
52-25	.65	VFO	438-4	.10	Phono plug
<b>CHOKES-TRANSFORMERS</b>			438-29	.40	11-pin plug
45-58	.55	13 $\mu$ h bifilar choke	440-1	.20	11-pin plug cap
45-3	.30	1 mh choke	<b>CABLE-WIRE-SLEEVING</b>		
45-4	.40	1.1 mh choke	134-140	5.90	Cable assembly
45-47	.30	2 mh choke	343-7	.05/ft	Coaxial cable
51-55	1.75	Audio output transformer			
52-63	1.10	2.305 MHz IF transformer			

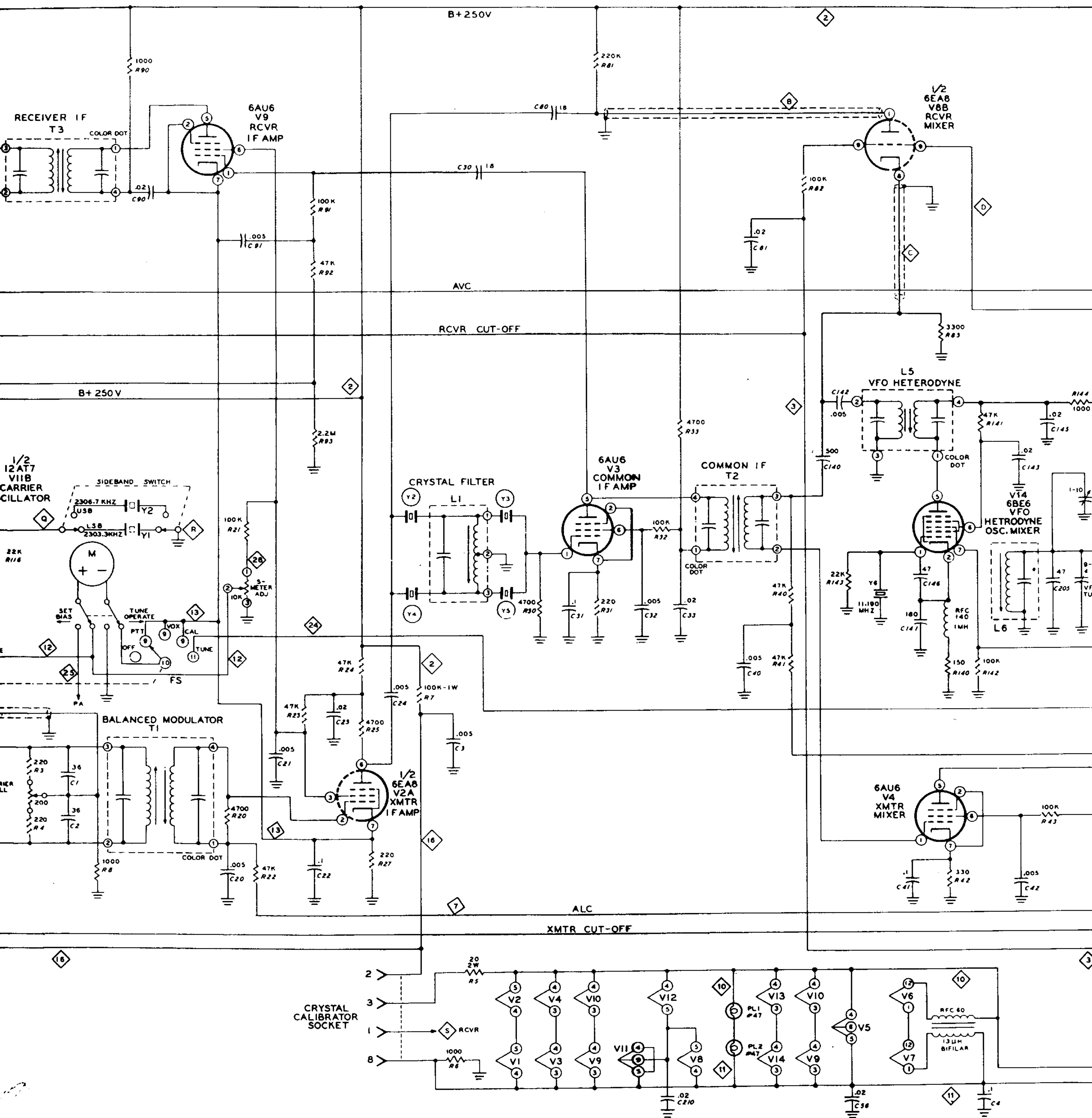




PART No.	PRICE Each	DESCRIPTION	PART No.	PRICE Each	DESCRIPTION
<b>Cable-Wire-Sleeving (cont'd.)</b>			<b>#4 Hardware</b>		
344-50	.05/ft	Black hookup wire	250-213	.05	4-40 x 5/16" screw
344-52	.05/ft	Red hookup wire	250-273	.05	4-40 x 3/8" screw
346-1	.05/ft	Small sleeving	252-15	.05	4-40 nut
346-2	.05/ft	Large sleeving (clear)	252-89	.10	4-40 push-on nut
			254-9	.05	#4 lockwasher
<b>KNOBS</b>			<b>#6 Hardware</b>		
462-7	.10	Push-on	250-170	.05	#6 x 1/4" sheet metal screw
462-106	.10	11/16" diameter	250-56	.05	6-32 x 1/4" screw
462-191	.70	1-1/8" diameter	250-89	.05	6-32 x 3/8" screw
462-210	1.05	2" diameter	250-13	.05	6-32 x 1" screw
462-218	.25	Lever	250-27	.05	6-32 x 2" screw
<b>GENERAL</b>			252-3	.05	6-32 nut
69-34	5.00	Relay	253-2	.05	#6 fiber shoulder washer
73-1	.10	Rubber grommet	254-1	.05	#6 lockwasher
75-52	.10	Slide switch insulator	255-5	.10	#6 x 3/4" spacer
85-69-5	5.00	Circuit board	255-10	.15	#6 x 1-1/2" spacer
259-20	.05	Terminal	259-1	.05	#6 solder lug
260-7	.05	IF transformer mounting clip	<b>#8 Hardware</b>		
261-4	.05	Small rubber foot	250-43	.05	8-32 x 1/4" setscrew
261-9	.05	Medium rubber foot	253-9	.05	#8 flat washer
261-21	.20	Large rubber foot	<b>#10 Hardware</b>		
407-99	7.90	Meter	250-83	.05	#10 x 1/2" sheet metal screw
431-14	.10	2-lug terminal strip	250-54	.05	10-32 x 5/8" screw
431-10	.10	3-lug terminal strip	252-49	.45	10-32 x 1-1/4" knurled nut
435-1	.10	11-pin mounting ring	253-19	.05	#10 flat washer
455-11	.10	Split bushing	254-3	.05	#10 lockwasher
455-52	.10	Lever knob bushing	255-44	.10	#10 shoulder spacer
464-29-2	1.15	Plastic dial	<b>1/4" Control Hardware</b>		
490-1	.10	Alignment tool	252-39	.05	1/4-32 nut
490-5	.10	Nut starter	253-39	.05	1/4" flat washer
331-6	.10	Solder	253-36	.05	1/4" spring washer
595-830	2.00	Manual	254-14	.05	1/4" lockwasher
<b>METAL PARTS</b>			<b>3/8" Control Hardware</b>		
204-576	1.45	Gimbal bracket	252-7	.05	3/8-32 nut
90-265	6.60	Cabinet	253-10	.05	3/8" flat washer
206-312	1.05	Final shield	254-5	.05	3/8" lockwasher
204-182	.10	Final shield mounting bracket	<b>The above prices apply only on purchases from the Heath Company where shipment is to a U.S. destination. Add 10% (minimum 25 cents) to the price when ordering from an authorized Service Center or Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates exchange.</b>		
204-453	.10	Pilot lamp mounting bracket			
100-596-2	.50	Chassis			
100-43	.25	Dial mounting plate			
204-732	.10	Switch lever mounting bracket			
266-90	.10	Switch lever			
100-597	1.35	Front panel			
<b>HARDWARE</b>					
<b>#3 Hardware</b>					
250-49	.05	3-48 x 1/4" screw			
252-1	.05	3-48 nut			
254-7	.05	#3 lockwasher			







# SCHEMATIC OF THE HEATHKIT® 40-METER SSB TRANSCEIVER MODEL HW-22A

**NOTES:**

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS:  
 1-9 PARTS MOUNTED ON THE CIRCUIT BOARD NOT ASSOCIATED TO A TUBE STAGE.  
 10-149 PARTS MOUNTED ON THE CIRCUIT BOARD.  
 200-299 PARTS ON THE CHASSIS.
2. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1,000, MEG=1,000,000).
3. CAPACITOR VALUES LESS THAN 1 ARE IN  $\mu\text{M}$ . VALUES OF 1 AND ABOVE ARE IN  $\mu\text{F}$ , UNLESS THEY ARE MARKED OTHERWISE.
4. RESISTORS AND CAPACITORS ARE NUMBERED ACCORDING TO THE ASSOCIATED TUBES. EXAMPLES:  

R43

RESISTOR PART OF TUBE CIRCUIT V4

THE NUMBER FOR THIS PARTICULAR RESISTOR

C141

CAPACITOR PART OF TUBE CIRCUIT V14

THE NUMBER FOR THIS PARTICULAR CAPACITOR
5. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.
6. SEE FIGURES 6-1, 6-2, 6-3, and 6-4 FOR RESISTANCE AND VOLTAGE MEASUREMENTS.
7.  $\diamond$  DENOTES WIRE COLOR CODE OR CIRCUIT BOARD TERMINAL.

