

HEATHKIT[®] MANUAL

for the

REMOTE VFO

Model SB-644A

595-2055-02



HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information (616) 982-3411
Credit (616) 982-3561
Replacement Parts (616) 982-3571

Technical Assistance Phone Numbers

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YOUR HEATHKIT 90-DAY LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic Center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

TECHNICAL CONSULTATION — You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORSEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

SHIPPING UNITS — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

Heathkit® Manual

for the

REMOTE VFO

Model SB-644A

595-2055-02



HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit SB-644A Remote VFO is an all-solid-state variable oscillator. It was designed in the new, modern Heathkit SB-series style specifically as an accessory to the Heathkit SB-104A Transceiver, and it may be used with the SB-104A Transceiver in a number of operating modes.

Simple, front panel switches select the desired mode of operation with the SB-104A Transceiver. You can transceive using the Remote VFO frequencies, receive using the Remote VFO while transmitting on the Transceiver, transmit using the Remote VFO while receiving on the Transceiver, transceive with the Transceiver only, or select either of two Remote VFO crystal frequencies with any of the preceding operations. The operating frequency is always displayed on the Transceiver readout.

While the Transceiver provides complete 80-to 10-meter band coverage, the Remote VFO allows complete coverage within any selected amateur band. The same 36:1 vernier drive as found in the SB-104A makes pinpoint spotting of any desired frequency an easy operation.

Other features include: excellent stability, freedom from excessive dial backlash, and lack of internal power circuits (all power comes from the SB-104A Transceiver).

The Remote VFO is a worthwhile addition to any ham shack and will provide many hours of enjoyment during which you can work DX stations, in split-frequency operation, that might otherwise be inaccessible. Also, its up-to-date styling permits the VFO to blend in with your other ham shack equipment.

UNPACKING

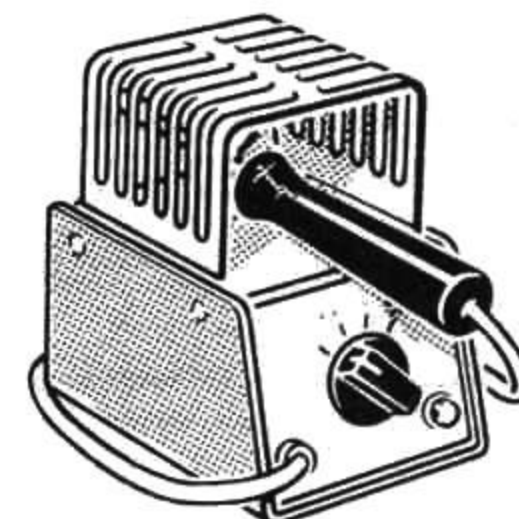
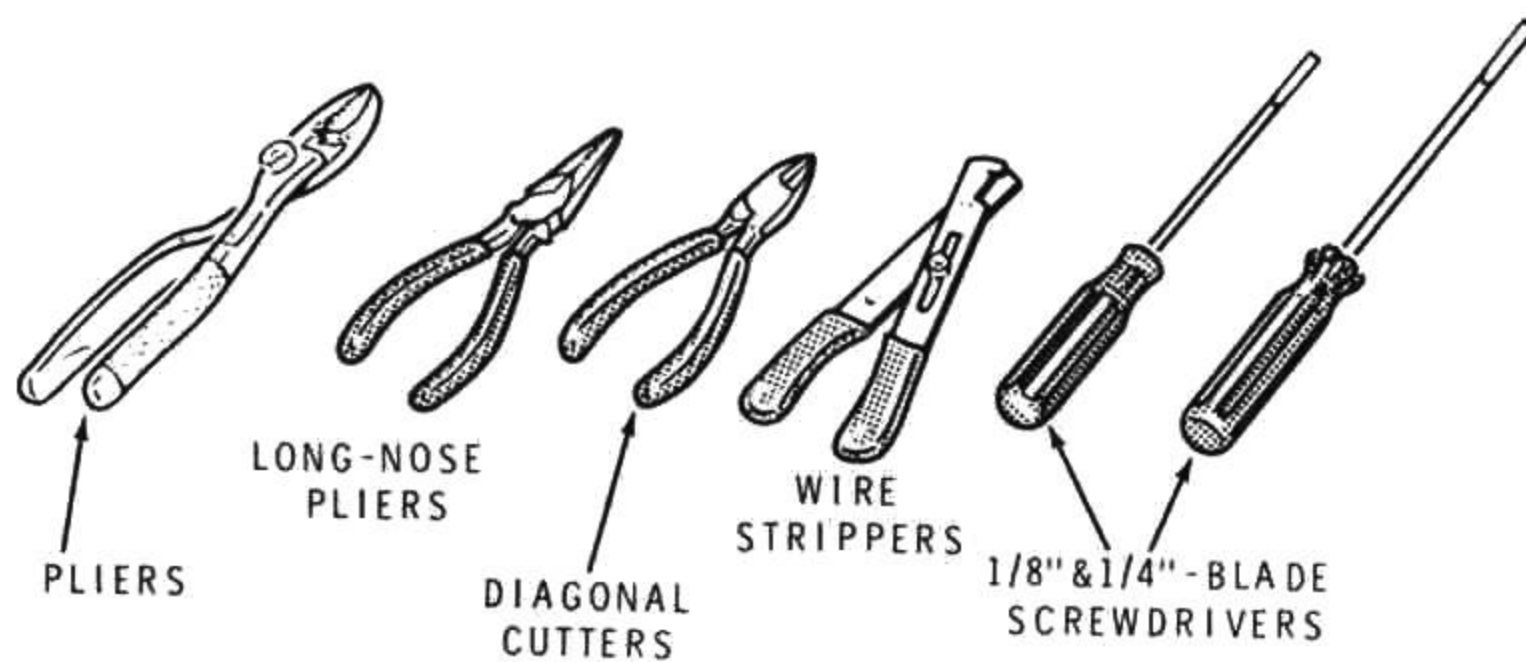
When you opened the shipping carton in which your kit was packed, you found this Manual and other papers. Locate the cardboard box marked "Packs 1 — 2 TOP", which contains most of the parts for Packs #1 and #2 as called for in this Manual. Remove this box from the shipping carton, but don't open it yet. After this box is removed, the parts which remain in the shipping carton form Parts Pack #3, which consists principally of larger items and parts used in the chassis assembly.

Now open the cardboard box marked "Packs 1-5 TOP." You will see a "Pack Index Sheet" with lines on it which correspond to packing separators and parts packs underneath. **IMPORTANT:** To avoid intermixing parts, **DO NOT** remove anything from a Parts Pack until directed to do so at the beginning of a Parts List. Return any part that is packed in an individual envelope with a part number on it back in its envelope after you identify it until that part is called for in a step.

ASSEMBLY NOTES

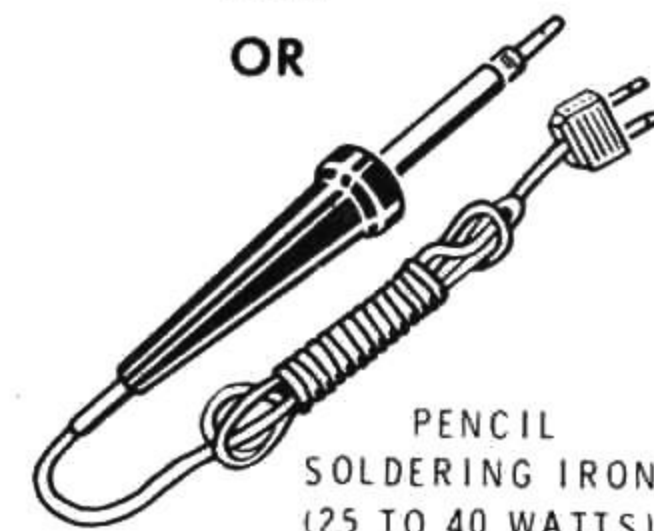
TOOLS

You will need these tools to assemble your kit.



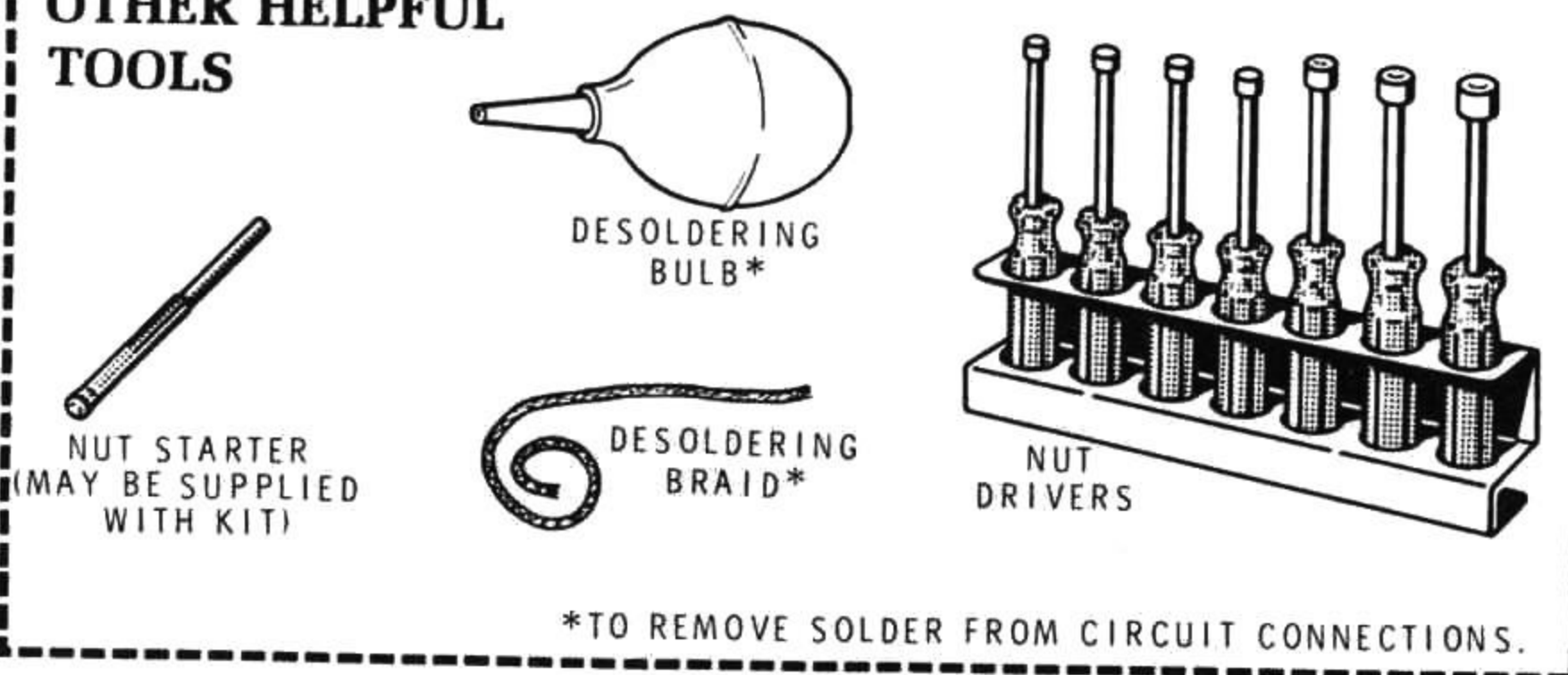
HEATHKIT
SOLDERING
IRON

OR



PENCIL
SOLDERING IRON
(25 TO 40 WATTS)

OTHER HELPFUL TOOLS



ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.
2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.
3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.
4. Position all parts as shown in the Pictorials.
5. Solder a part or a group of parts only when you are instructed to do so.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:
- In the Parts List,
 - At the beginning of each step where a component is installed,
 - In some illustrations,
 - In the Schematic,
 - In the section at the rear of the Manual.
7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

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

SOLDERING

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

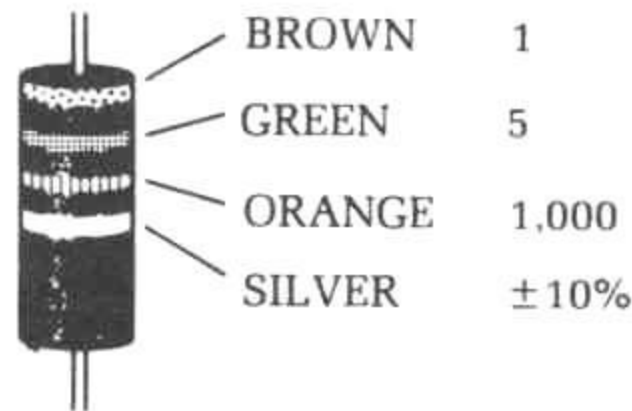
It is easy to make a good solder connection if you follow a few simple rules:

1. Use the right type of soldering iron. A 25 to 40-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.
2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

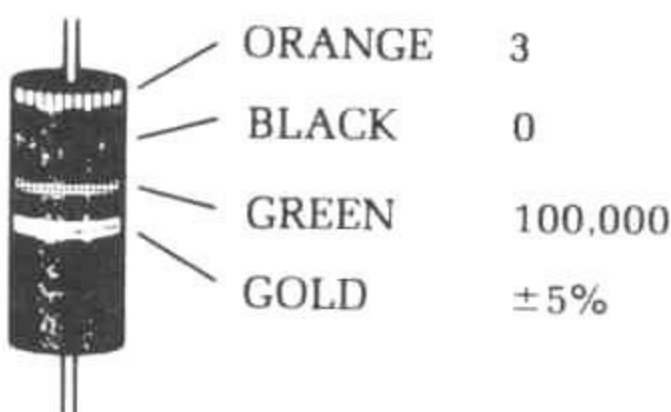
PARTS

Resistors will be called out by their resistance value in Ω (ohms), $k\Omega$ (kilohms), or $M\Omega$ (megohms). Certain types of resistors will have the value printed on the body, while others will be identified by a color code. The colors of the bands and the value will be given in the steps, therefore the following color code is given for information only.

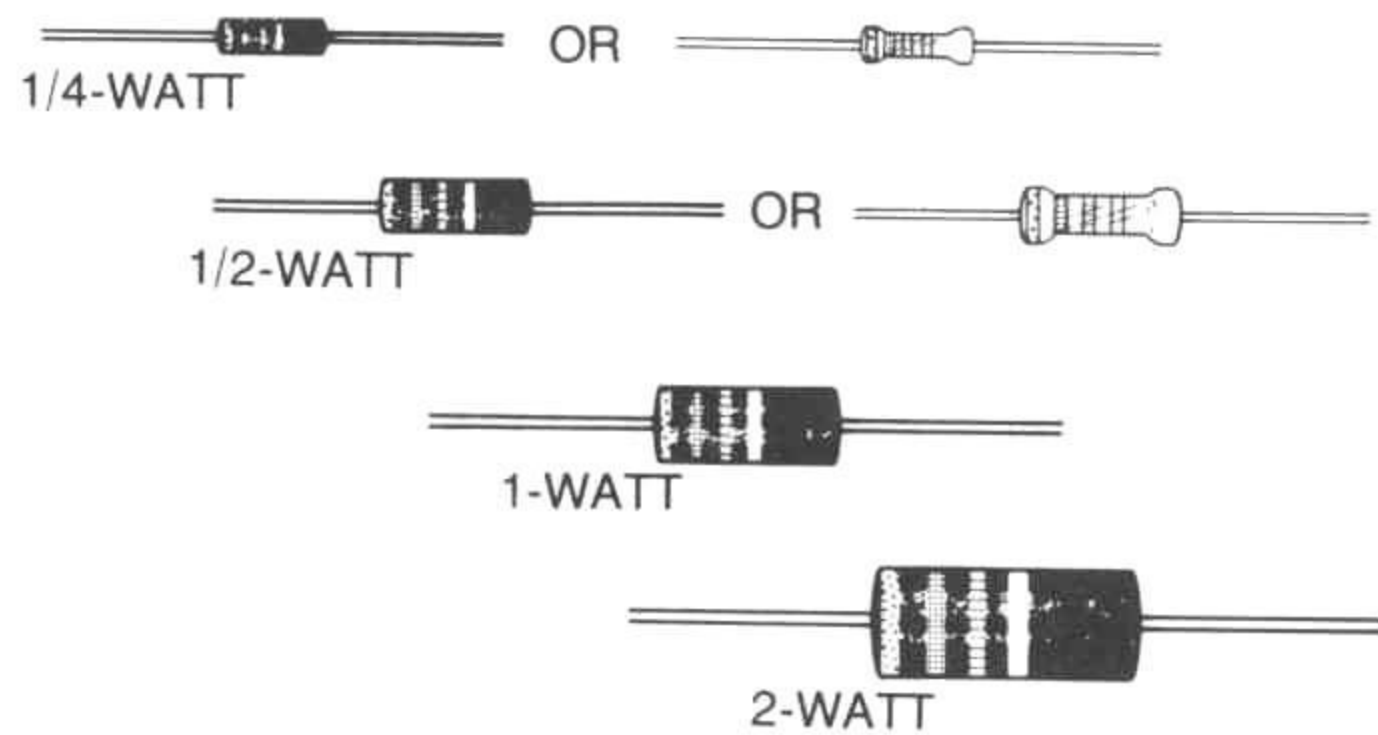
EXAMPLES:



$15 \times 1,000 = 15,000 \Omega$ (15,000 OHMS),
or "15 $k\Omega$ "



$30 \times 100,000 = 3,000,000 \Omega$ (or 3 $M\Omega$)
3 $M\Omega = 3$ MEGOHMS



RESISTOR COLOR CODE TOLERANCE
Gold 5%
Silver 10%

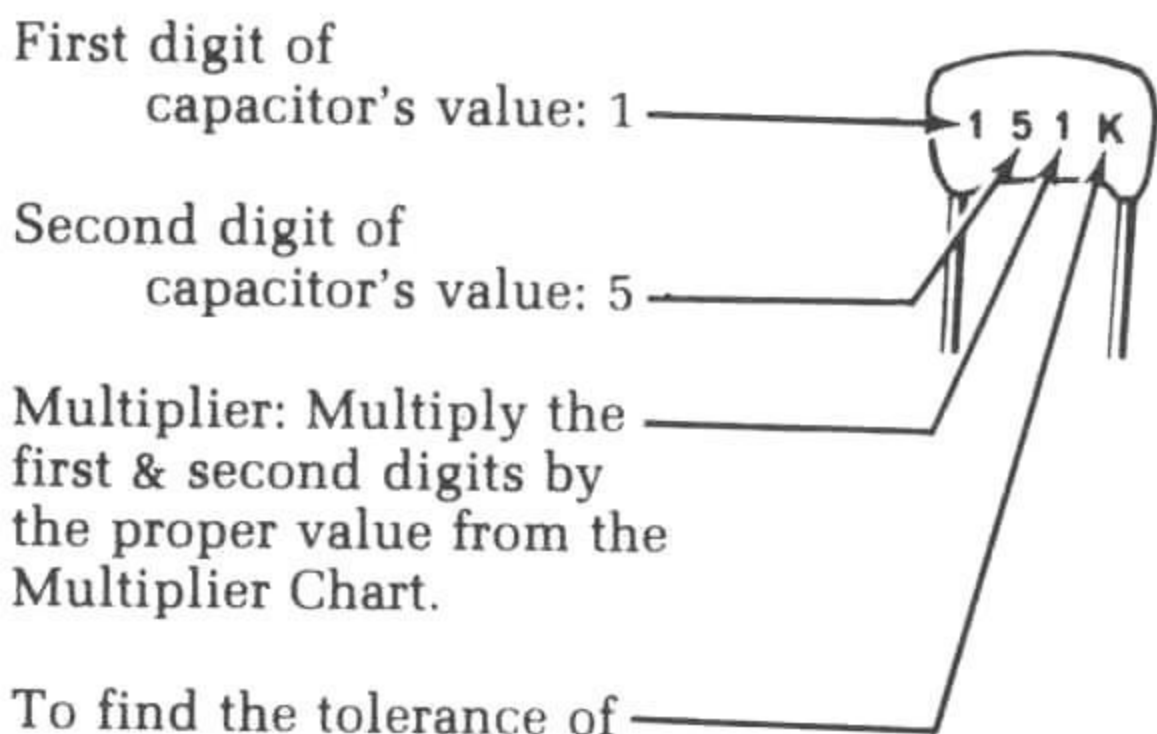
COLOR	1st DIGIT	2nd DIGIT	MULTIPLY BY
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD			.1
SILVER			.01

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

EXAMPLES:

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

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



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

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10pF OR LESS	LETTER	OVER 10pF
0	1	$\pm 0.1 \text{ pF}$	B	
1	10	$\pm 0.25 \text{ pF}$	C	
2	100	$\pm 0.5 \text{ pF}$	D	
3	1000	$\pm 1.0 \text{ pF}$	F	$\pm 1\%$
4	10,000	$\pm 2.0 \text{ pF}$	G	$\pm 2\%$
5	100,000		H	$\pm 3\%$
			J	$\pm 5\%$
8	0.01		K	$\pm 10\%$
9	0.1		M	$\pm 20\%$

*DuPont Registered Trademark

XTAL OSC/SW CIRCUIT BOARD

Refer to the Pack Index Sheet and locate Pack #1.

Unpack these parts and check each part against the following list. Return any part that is packed in an individual envelope, with the part number on it, to the envelope after you identify it until that part is called for in a step. Do not discard any packing materials until all parts are accounted for. The key num-

bers correspond to the numbers on the "XTAL OSC/SW Circuit Board Parts Pictorial" (Illustration Booklet, Page 1).

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

PARTS LIST

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS				
NOTE: The following resistors are 1/2-watt and have a tolerance of 5% (gold fourth color band).				
A1	6-220	1	22 Ω (red-red-black)	R1261
A1	6-391	1	390 Ω (orange-white-brown)	R1262
A1	6-471	1	470 Ω (yellow-violet-brown)	R1268
A1	6-152	4	1500 Ω (brown-green-red)	R1252, R1253, R1254, R1265
A1	6-332	4	3300 Ω (orange-orange-red)	R1251, R1255, R1256, R1259
A1	6-104	5	100 k Ω (brown-black-yellow)	R1257, R1258, R1264, R1266, R1267

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
CAPACITORS				
B1	20-103	1	150 pF mica	C1256
B1	20-107	1	680 pF mica	C1257
B1	20-172	2	1000 pF mica	C1259, C1267
B2	27-47	1	.1 μ F Mylar	C1262
B3	21-176	8	.01 μ F ceramic	C1251, C1252, C1253, C1258, C1261, C1264, C1265, C1266
B4	25-117	1	100 μ F electrolytic	C1263
B5	31-78	2	10-75 pF trimmer	C1254, C1255

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

DIODES-TRANSISTORS

C1	56-24	2	1N458 diode	D1251, D1252
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NOTE: Transistors may be marked for identification in any of the following four ways:

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

C2	417-134	1	MPS6520 transistor	Q1255
C3	417-154	1	2N2369 transistor	Q1254
C3	417-205	2	2N3866 transistor	Q1256, Q1257
C4	417-244	1	2N5089 transistor	Q1253
C2	417-864	2	MPSA05 transistor	Q1251, Q1252

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

MISCELLANEOUS

D1	10-314	1	100 Ω control	R1263
D2	40-1869	4	1.31 μ H toroid coil (green dot)	L1251, L1252, L1253, L1254
	85-2037-3	1	Circuit board	
D3	432-878	4	Crystal socket pin	
D4	215-63	1	Heat sink Solder	

PARTS FROM PACK #3 (Parts in the Main Shipping Carton)

D5	391-34	1	Blue and white label	
	597-260	1	Parts Order Form	
		1	Manual (See Page 1 for part number.)	

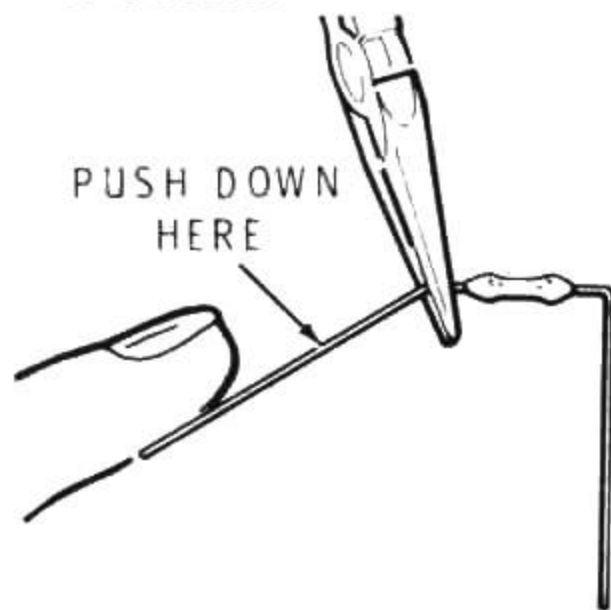
STEP-BY-STEP ASSEMBLY

START

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

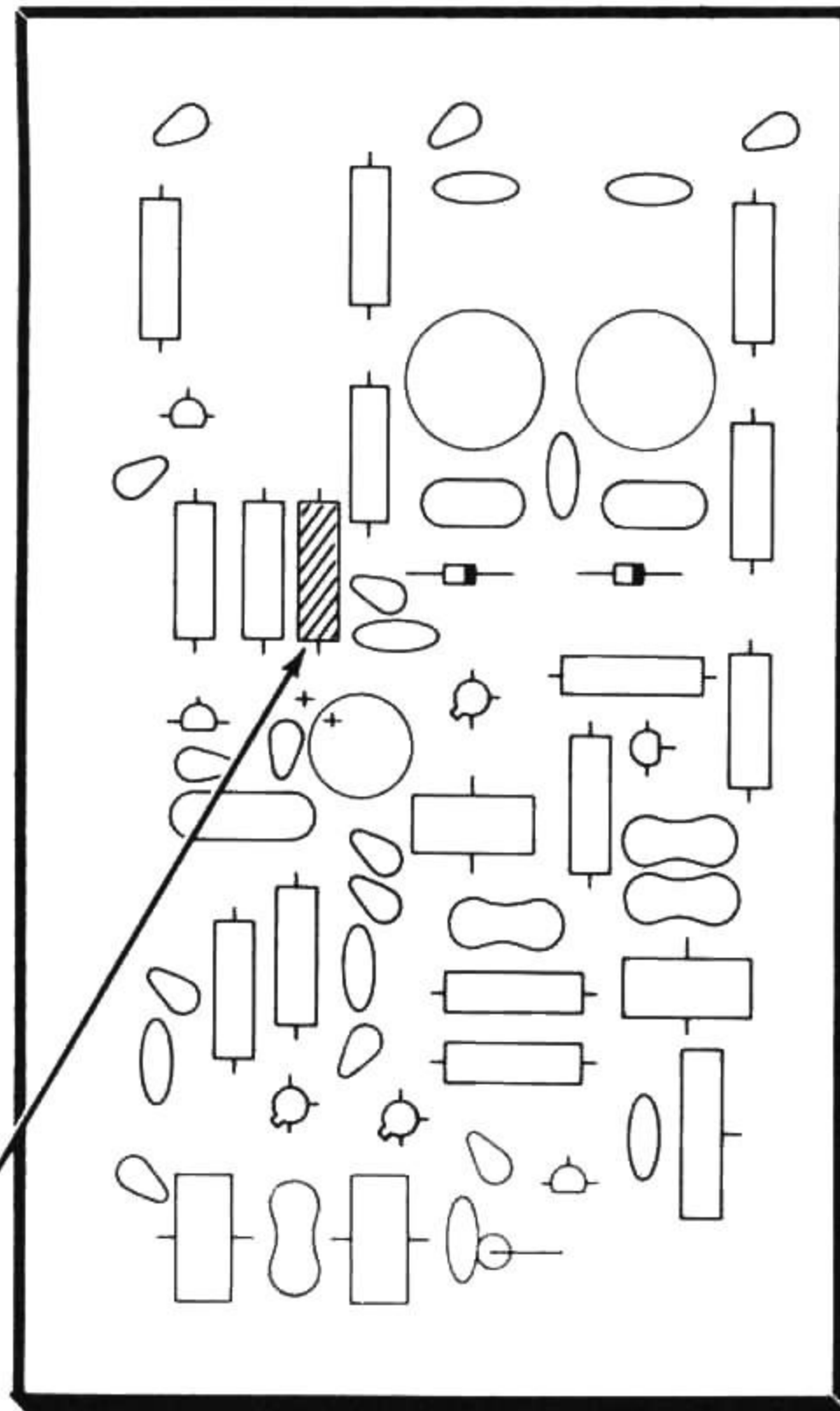
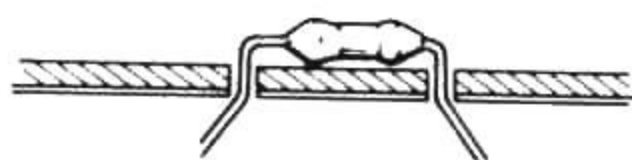
- () Position the circuit board as shown with the printed side (not the foil side) up.

- () R1254: Hold a 1500 Ω (brown-green-red) resistor as shown and bend the leads straight down with long-nose pliers to fit the hole spacing on the circuit board.



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

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

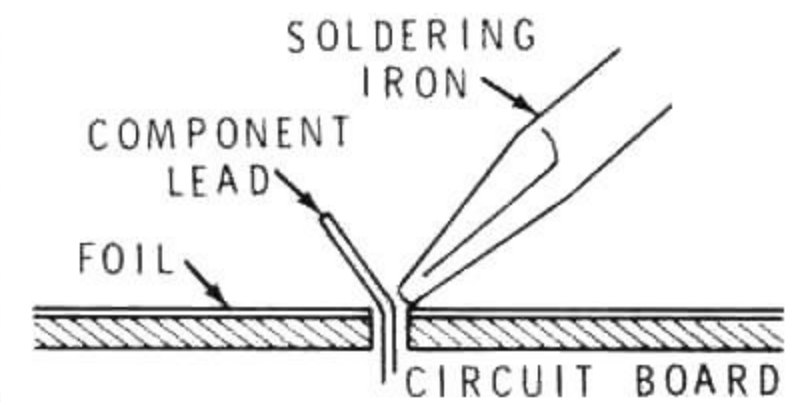


PICTORIAL 1-1

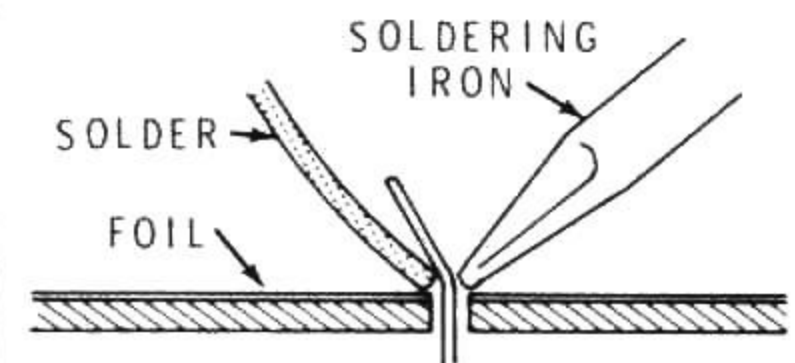
CONTINUE

- () Solder the resistor leads to the circuit board as follows:

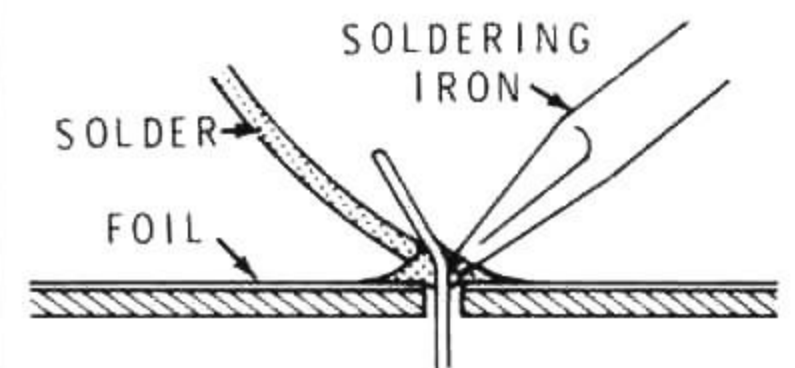
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.



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



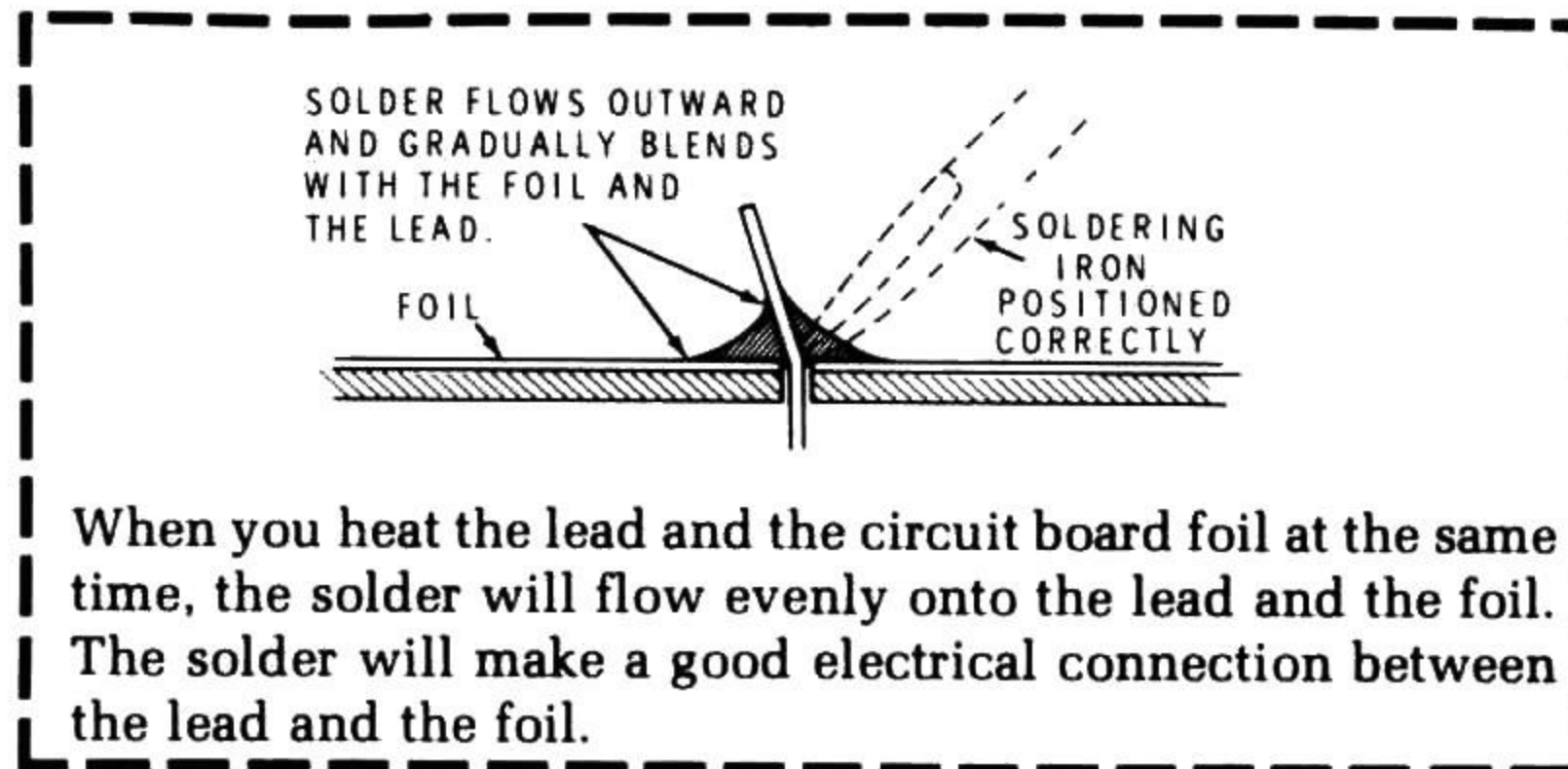
3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.



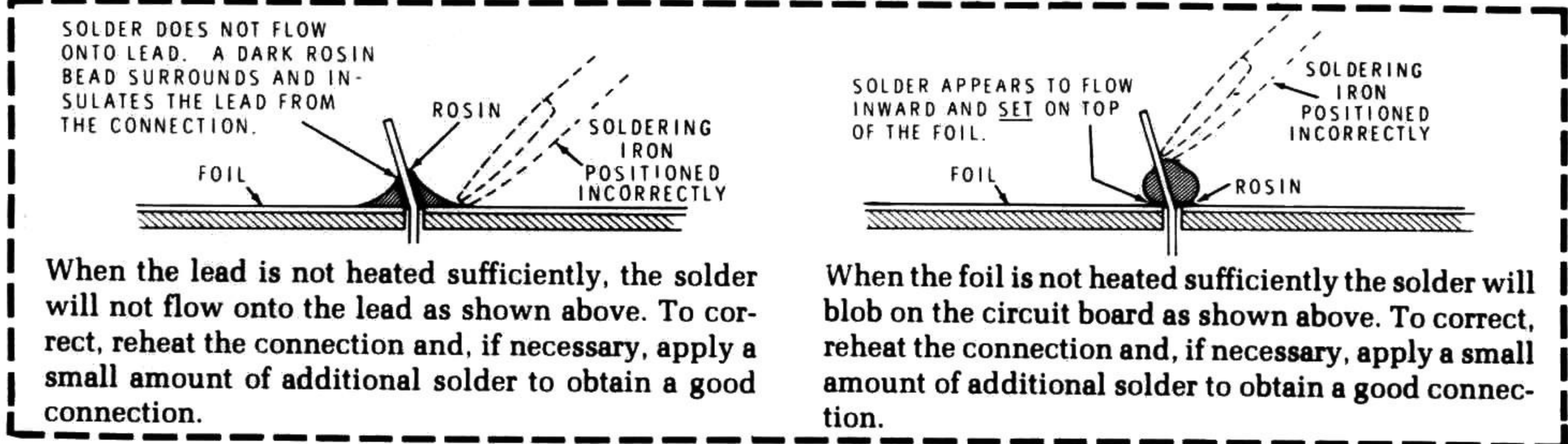
- () Cut off the excess lead lengths close to the connection. **WARNING:** Clip the leads so the ends will not fly toward your eyes.

- () Check each connection. Compare it to the illustrations on Page 11. After you have checked the solder connection, proceed with the assembly on Page 12. Use the same soldering procedure for each connection.

A GOOD SOLDER CONNECTION



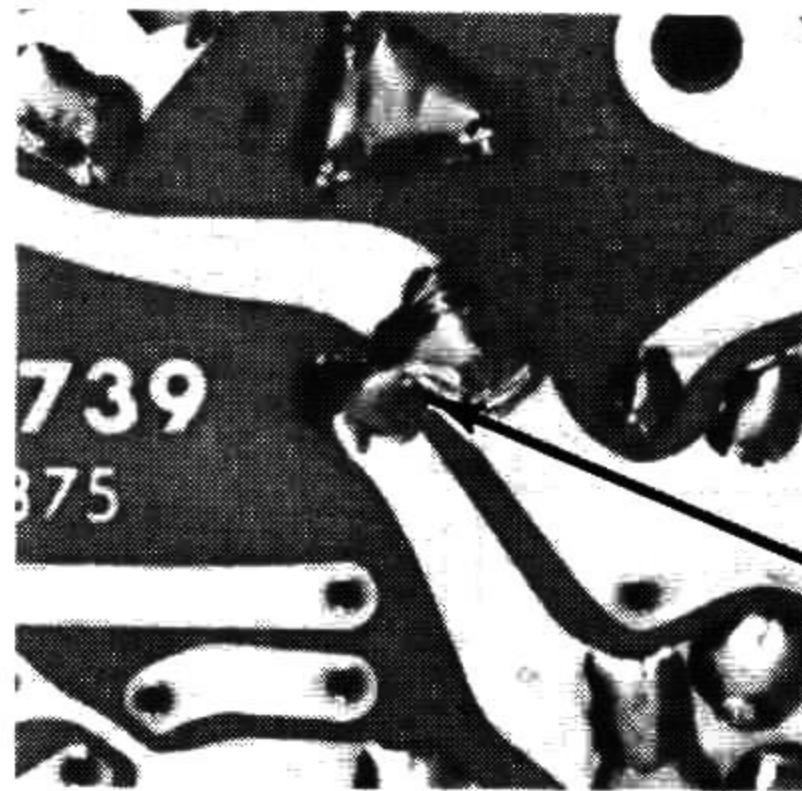
POOR SOLDER CONNECTIONS



SOLDER BRIDGES

A solder bridge between two adjacent foils is shown in photograph A. Photograph B shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.

Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.



A

SOLDER BRIDGE

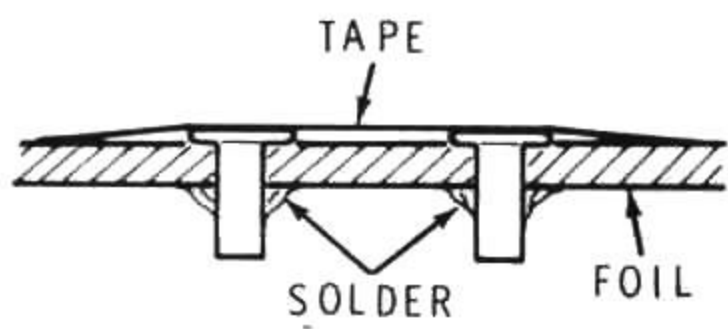


B

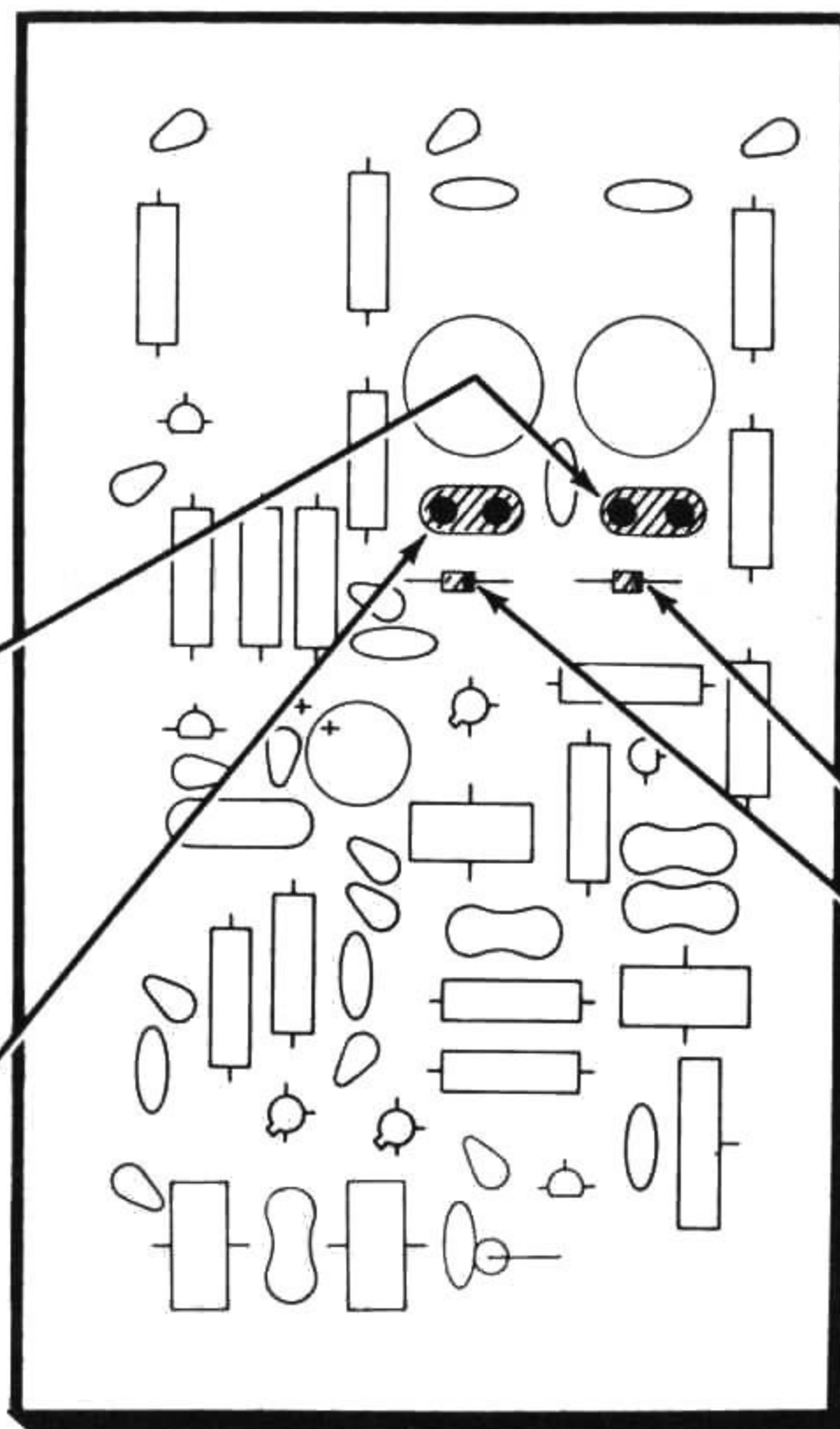
START ↘

NOTE: Make sure you have installed the resistor in Pictorial 1-1.

() Install 2 crystal socket pins at Y1251. Insert each pin until it is seated against the circuit board. Place a length of tape over the pins to hold them against the circuit board. Turn the circuit board over and solder the pins to the foil. Remove the tape after the connections have cooled.



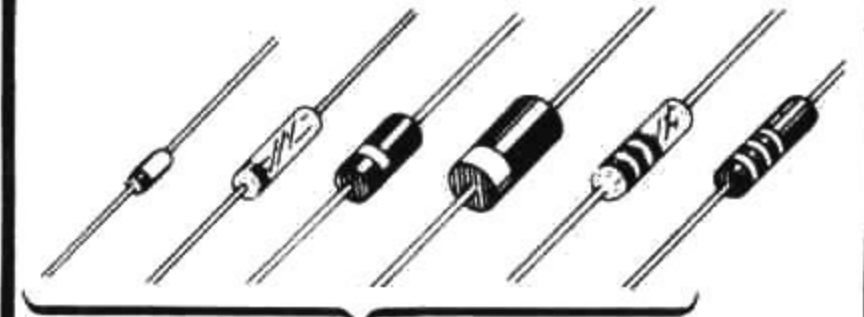
() Similarly, install two crystal socket pins at Y1252.



CONTINUE ↙

NOTE: When you install a diode, position its banded end as shown in the Pictorial. A circuit will not operate properly if the diode is installed backward.

IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.



BANDED END

() D1251: 1N458 diode (#56-24).

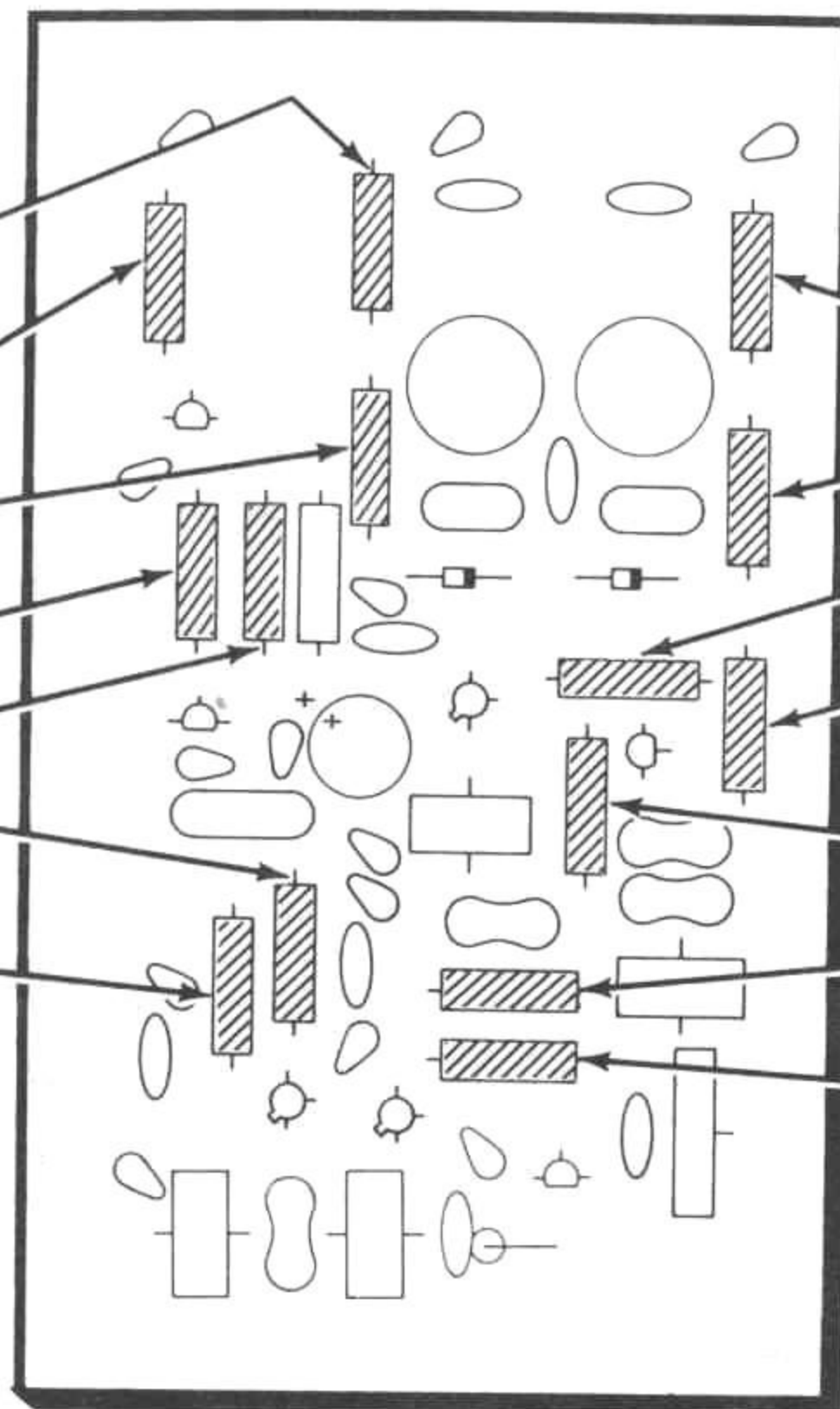
() D1252: 1N458 diode (#56-24).

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

PICTORIAL 1-2

START ↘

- () R1255: 3300 Ω (orange-orange-red).
- () R1251: 3300 Ω (orange-orange-red).
- () R1258: 100 kΩ (brown-black-yellow).
- () R1253: 1500 Ω (brown-green-red).
- () R1252: 1500 Ω (brown-green-red).
- () R1267: 100 kΩ (brown-black-yellow).
- () R1266: 100 kΩ (brown-black-yellow).
- () Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE ↘

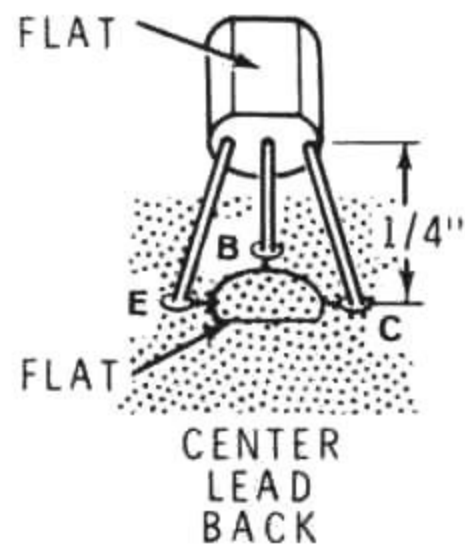
- () R1256: 3300 Ω (orange-orange-red).
- () R1257: 100 kΩ (brown-black-yellow).
- () R1261: 22 Ω (red-red-black).
- () R1259: 3300 Ω (orange-orange-red).
- () R1262: 390 Ω (orange-white-brown).
- () R1265: 1500 Ω (brown-green-red).
- () R1264: 100 kΩ (brown-black-yellow).
- () Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-3

START →

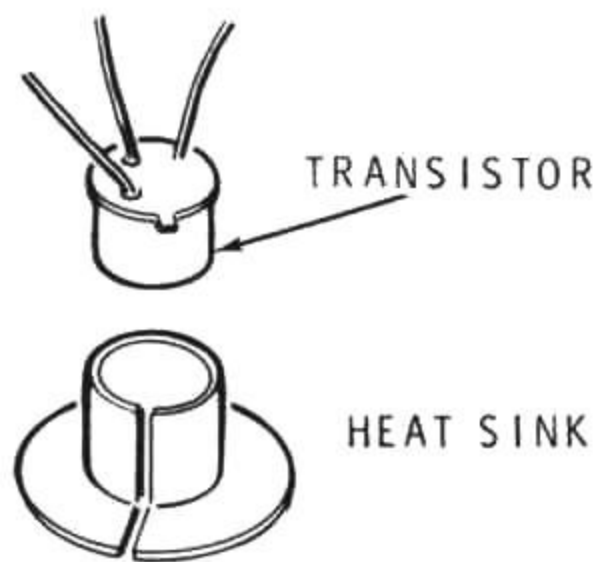
NOTE: When you install each of the following transistors, line up the **flat** or **tab** on the transistor with the **outline of the flat or tab** on the circuit board. Then insert the leads in the corresponding holes in the circuit board. Position it 1/4" above the circuit board; then solder the leads to the foil and cut off the excess lead lengths.

Install two MPSA05 transistors (#417-864) at:

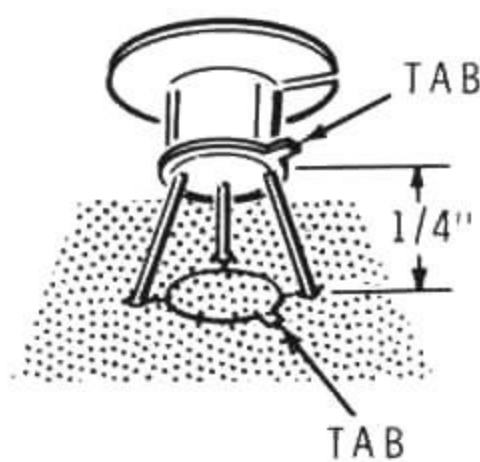


- () Q1251.....
- () Q1252.....

() Push a heat sink onto a 2N2369 transistor (#417-154). Place the heat sink on your work area as shown, and press the transistor into it.

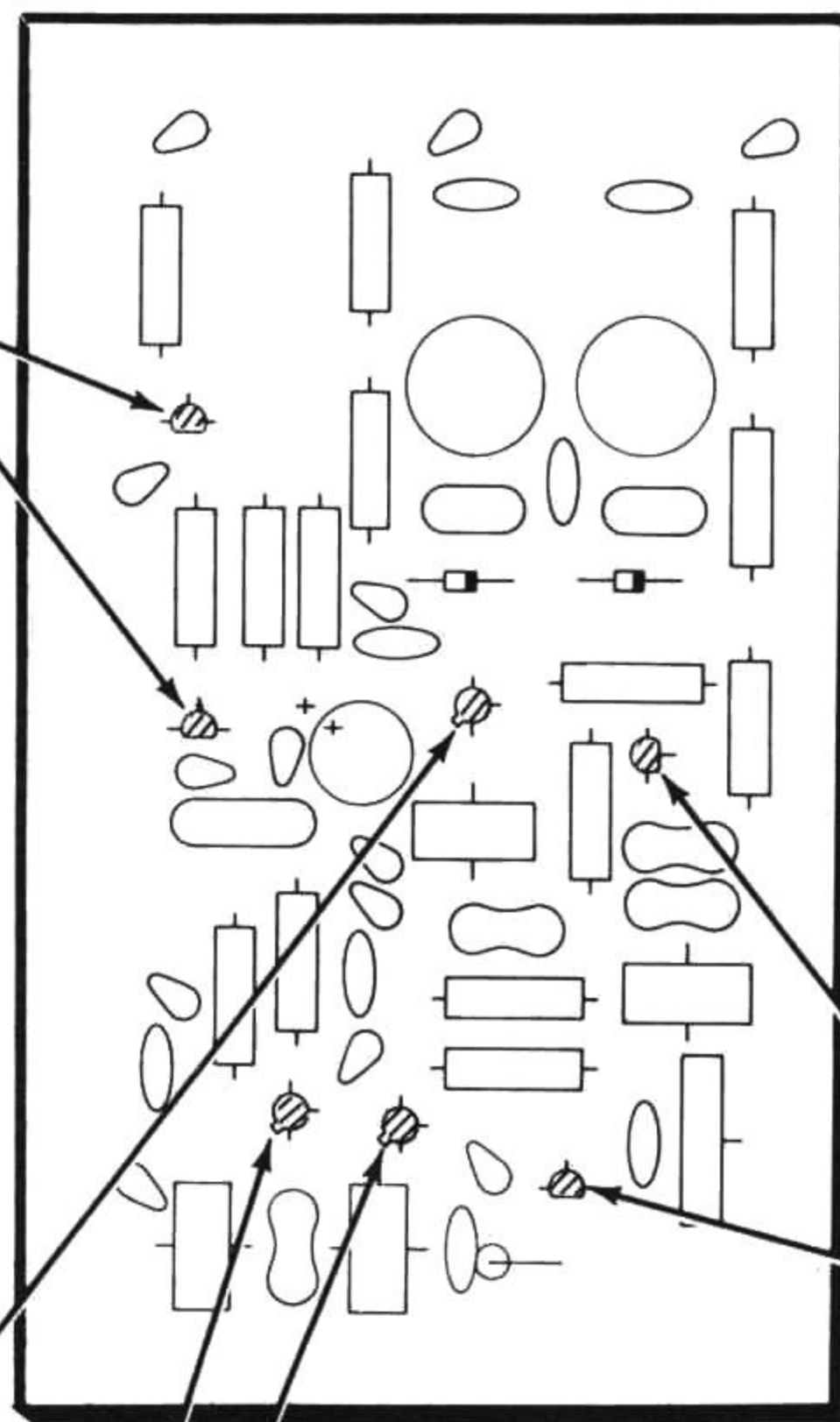


- () Q1254: 2N2369 transistor (#417-154).



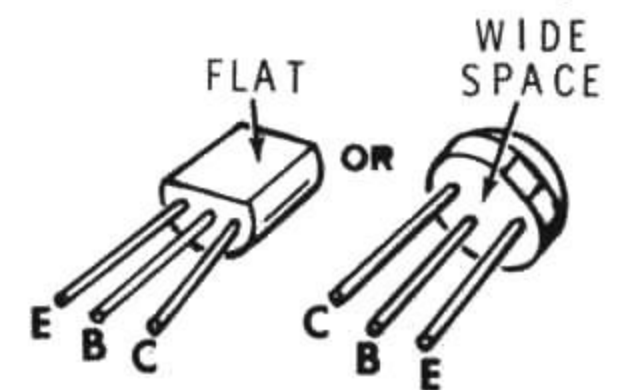
Install two 2N3866 transistors (#417-205) at:

- () Q1256.....
- () Q1257.....

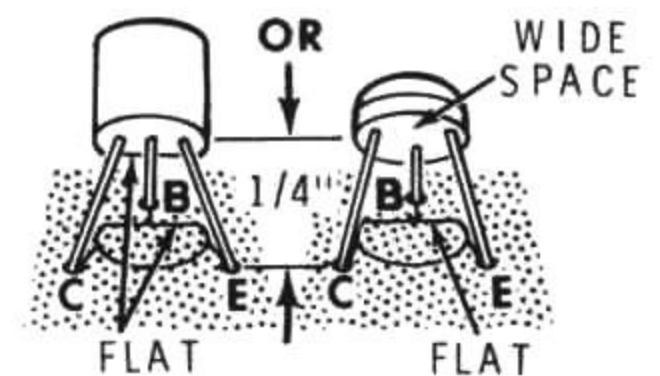


CONTINUE →

NOTE: The following transistor may appear in one of two case styles.



First identify the C, B, and E leads. Then insert the leads into their correct C, B, and E holes in the circuit board. NOTE: THE LEADS ON ONE TYPE ARE IN REVERSE ORDER FROM THE LEADS ON THE OTHER TYPE. Solder the leads to the foil and cut off the excess lead lengths.



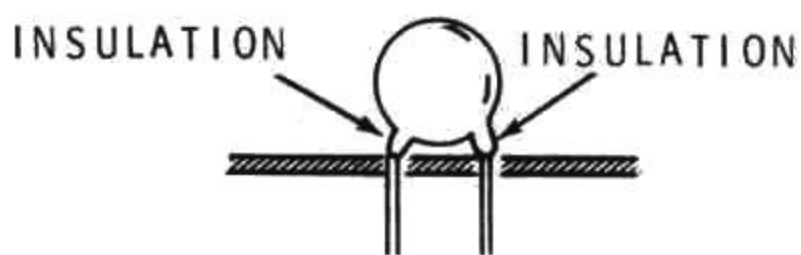
- () Q1253: 2N5089 transistor (#417-244).

- () Q1255: MPS6520 transistor (#417-134). Be sure to bend the center lead back away from the flat on the transistor.

PICTORIAL 1-4

START ↘

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



() C1251: .01 μ F ceramic.

() C1258: .01 μ F ceramic.

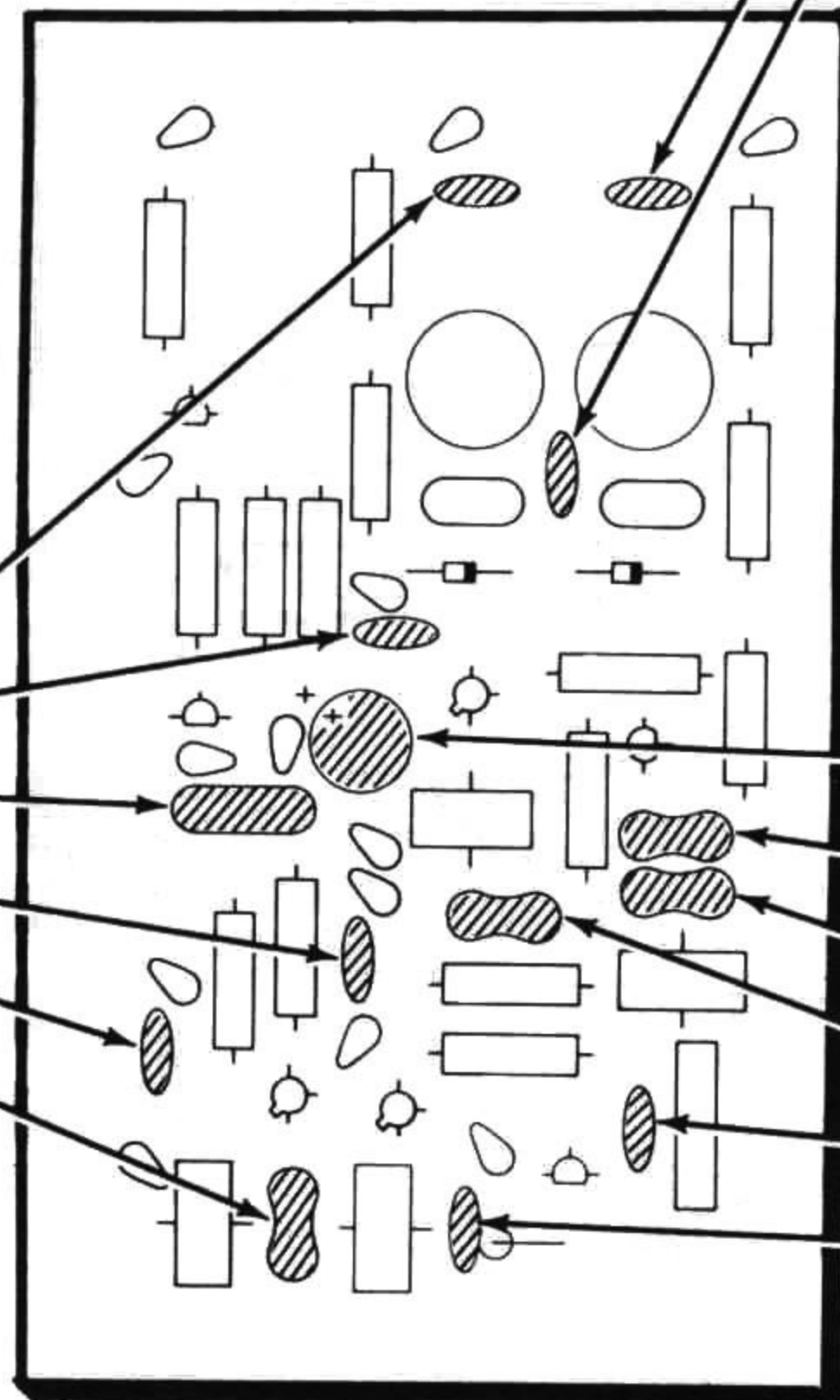
() C1262: .1 μ F Mylar.

() C1265: .01 μ F ceramic.

() C1264: .01 μ F ceramic.

() C1267: 1000 pF mica.

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



CONTINUE ↘

() C1252: .01 μ F ceramic.

() C1253: .01 μ F ceramic.

CAUTION: Before you install an electrolytic capacitor, note the polarity (+ or -) of the identified lead. Be sure you always connect the positive (+) lead to the positive (+) marked point on the circuit board.

IDENTIFIED
LEAD IS
NEGATIVE (-)



IDENTIFIED
LEAD IS
POSITIVE (+)



() C1263: 100 μ F electrolytic.

() C1256: 150 pF mica.

() C1257: 680 pF mica.

() C1259: 1000 pF mica.

() C1261: .01 μ F ceramic.

() C1266: .01 μ F ceramic.

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

PICTORIAL 1-5

START ↘

() C1254: 10-75 pF trimmer capacitor. First look at the bottom of the trimmer and identify lug 1. Be sure to install lug 1 in the indicated hole in the circuit board. Solder the lugs to the foil and cut off the excess lug lengths.



() C1255: 10-75 pF trimmer capacitor. Install this trimmer in a similar manner as above.

() L1251: 1.31 μH toroid coil (#40-1869, green dot). Position the coil down against the circuit board.



() L1252: 1.31 μH toroid coil (#40-1869, green dot).

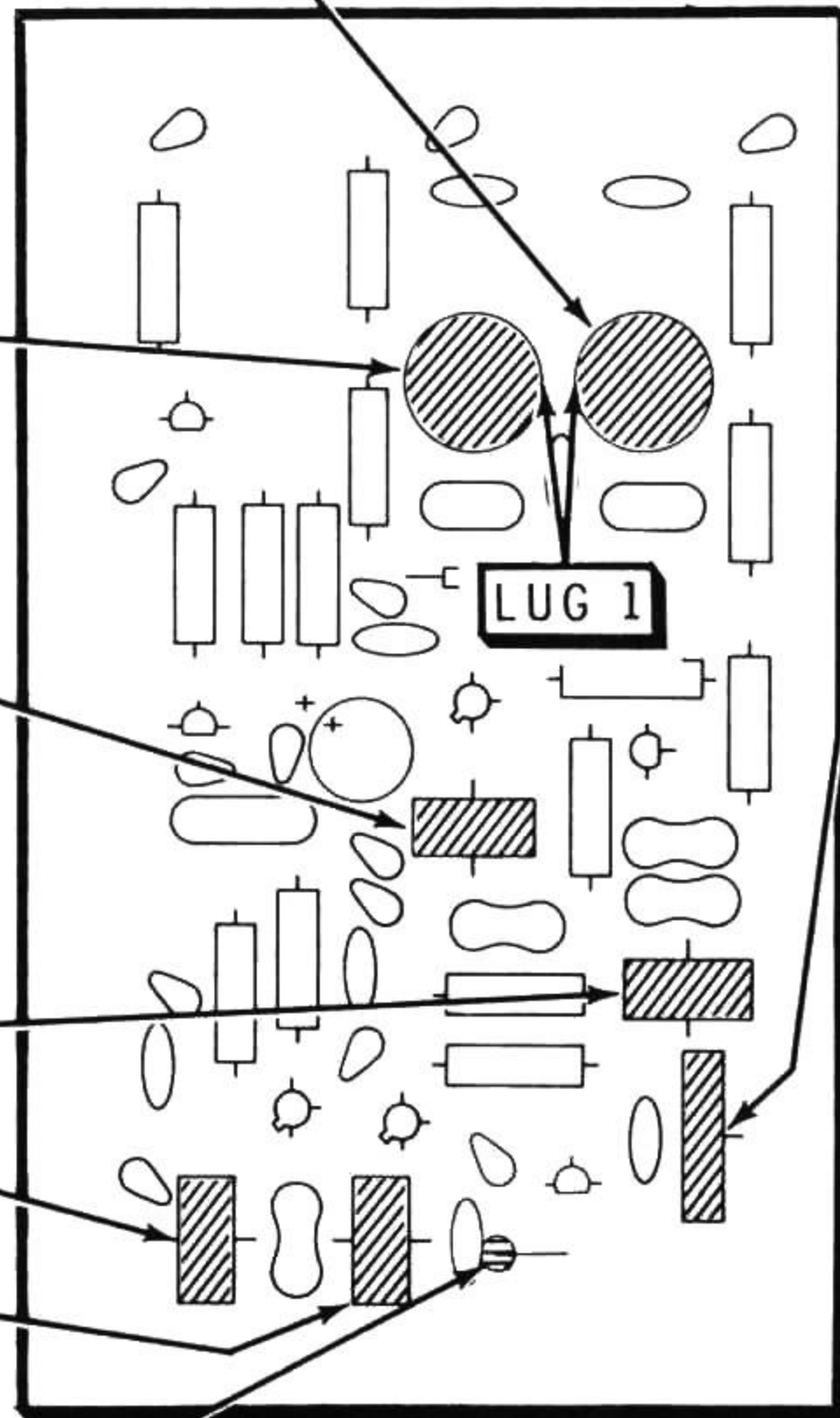
() L1254: 1.31 μH toroid coil (#40-1869, green dot).

() L1253: 1.31 μH toroid coil (#40-1869, green dot).

() R1268: 470 Ω (yellow-violet-brown). Mount this resistor vertically to the circuit board as shown. Be sure the lead from the top of the resistor is toward the right as shown.



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



PICTORIAL 1-6

CONTINUE ↘

() R1263: 100 Ω control. Solder the lugs to the foil and cut off the excess lug lengths.



CIRCUIT BOARD CHECKOUT

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

- () Unsoldered connections at leads that have foil.
- () Poor solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads which could touch together.

Refer to the illustrations where the parts were installed as you make the following visual checks.

- () Transistors for the proper **type** and **installation**.
- () Electrolytic capacitor for the correct position of the positive (+) mark.
- () Diodes for the correct **type** and **position** of the banded end.

Set the circuit board aside until it is called for in a step.

FINISH

VARIABLE FREQUENCY OSCILLATOR (VFO)

PARTS LIST

Refer to the Pack Index Sheet and locate Pack #2.

Unpack these parts and check each part against the following list. Return any part that is packed in an individual envelope, with the part number on it, to the envelope after you identify it until that part is called for in a step. Do not discard any packing materials until all parts are accounted for. The key num-

bers correspond to the numbers on the "VFO Parts Pictorial" (Illustration Booklet, Page 2).

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

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

RESISTORS

NOTE: The following resistors are 1/2-watt and have a tolerance of 5% (gold fourth color band).

A1	6-470	2	47 Ω (yellow-violet-black)	R1205, R1237
A1	6-101	2	100 Ω (brown-black-brown)	R1226, R1228
A1	6-151	1	150 Ω (brown-green-brown)	R1206
A1	6-471	3	470 Ω (yellow-violet-brown)	R1203, R1233, R1236
A1	6-122	1	1200 Ω (brown-red-red)	R1201
A1	6-332	2	3300 Ω (orange-orange-red)	R1231, R1234
A1	6-392	1	3900 Ω (orange-white-red)	R1227
A1	6-223	2	22 k Ω (red-red-orange)	R1229, R1235
A1	6-224	1	220 k Ω (red-red-yellow)	R1225
A1	6-105	1	1 M Ω (brown-black-green)	R1204

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

CAPACITORS

Mica

B1	20-130	1	12 pF	C1209
B1	20-116	1	400 pF	C1233
B1	20-128	2	470 pF	C1229, C1231
B1	20-107	1	680 pF	C1234

Ceramic

B2	21-29	1	4.7 pF	C1212
B3	21-169	1	6 pF, N470	C1202
B3	21-3	1	10 pF, NPO	C1214
B3	21-111	1	15 pF, NPO	C1216
B3	21-190	1	50 pF, N150	C1203
B3	21-160	1	56 pF, N75 or N80	C1204
B3	21-56	1	470 pF	C1227
B3	21-159	2	510 pF, N750	C1205, C1206
B3	21-191	1	510 pF, N1500	C1207
B3	21-140	1	.001 μ F	C1225
B3	21-46	1	.005 μ F	C1208
B3	21-47	5	.01 μ F	C1213, C1215, C1226, C1228, C1232

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

Other Capacitors

B4	26-148	1	Tuning capacitor	C1201
B5	31-63	1	15-60 pF trimmer	C1211

INDUCTORS

C1	40-1720	1	Variable inductor	L1201
C2	40-1684	2	3.7 μ H toroid coil	L1202, L1203
C3	45-82	2	350 μ H choke	RFC1201, RFC1202

DIODES-TRANSISTORS

D1	56-24	1	1N458 diode	D1201
D1	56-56	3	1N4149 diode	D1202, D1203, D1204
D1	56-97	1	VR7.5 zener diode	ZD1201

NOTE: Transistors may be marked for identification in any of the following four ways:

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

D2	417-118	1	2N3393 transistor	Q1204
D2	417-169	2	MPF105 transistor	Q1202, Q1203
D2	417-234	1	2N3638A transistor	Q1205

METAL PARTS

E1	206-1104	1	VFO chassis
E2	206-1168	1	VFO shield
E3	204-1962	1	VFO bracket

HARDWARE

NOTE: Hardware packets are marked to show the size of the hardware they contain (HDW #4, or, HDW #2 & #6, etc.). You may have to open more than one packet-in this pack-to locate all of the hardware of any one size (#6, for example).

#4 Hardware

F1	250-323	4	4-40 \times 5/8" screw
F2	252-2	4	4-40 nut
F3	254-9	4	#4 lockwasher

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

#6 Hardware

G1	250-138	4	6-32 \times 3/16" screw
G2	250-475	18	#6 \times 3/8" sheet metal screw
G3	250-11	2	6-32 \times 1/2" flat head screw
G4	254-1	2	#6 lockwasher
G5	259-1	2	#6 solder lug
G6	259-6	2	#6 plain solder lug

Other Hardware

H1	252-7	1	Control nut
H2	255-1	8	1/8" spacer
H3	255-2	2	3/16" spacer

CONNECTORS

J1	432-855	4	Female terminal
J2	432-817	1	Male connector housing

MISCELLANEOUS

K1	10-398	1	2000 Ω control	R1232
K2	75-90	2	Fish paper (2-3/4" \times 2-3/4")	
K3	215-63	1	Heat sink	
	350-12	1	Cement (tube)	
K4	490-5	1	Nut starter	
	85-1205-7	1	Oscillator circuit board	
	85-1206-3	1	Buffer circuit board	

PARTS FROM PACK #3

NOTE: Remove the wire bundle. Cut off lengths when an assembly step directs you to do so.

The wire bundle consists of:

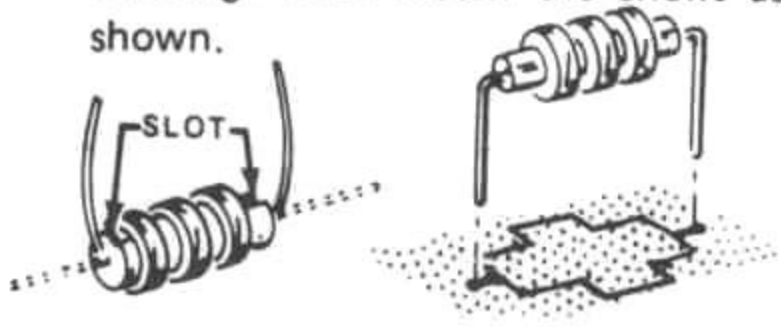
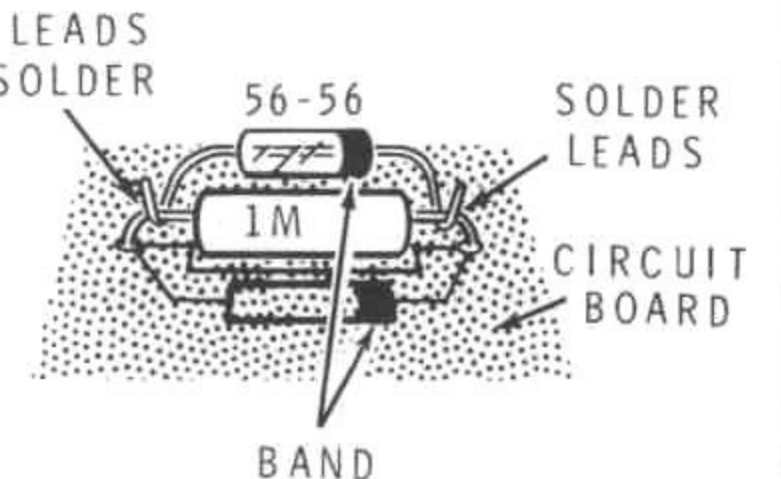
343-2	4'	Large shielded cable
343-15	14"	Small shielded cable
344-51	3'9"	Brown wire
344-52	7'3"	Red wire
344-53	3'2"	Orange wire
344-54	1'8"	Yellow wire
344-55	1'8"	Green wire
344-56	1'8"	Blue wire
344-57	1'6"	Violet wire
344-58	4'3"	Gray wire
344-59	1'11"	White wire
346-5	11"	Large sleeving
346-20	1'4"	Small sleeving
347-39	3'	5-wire cable

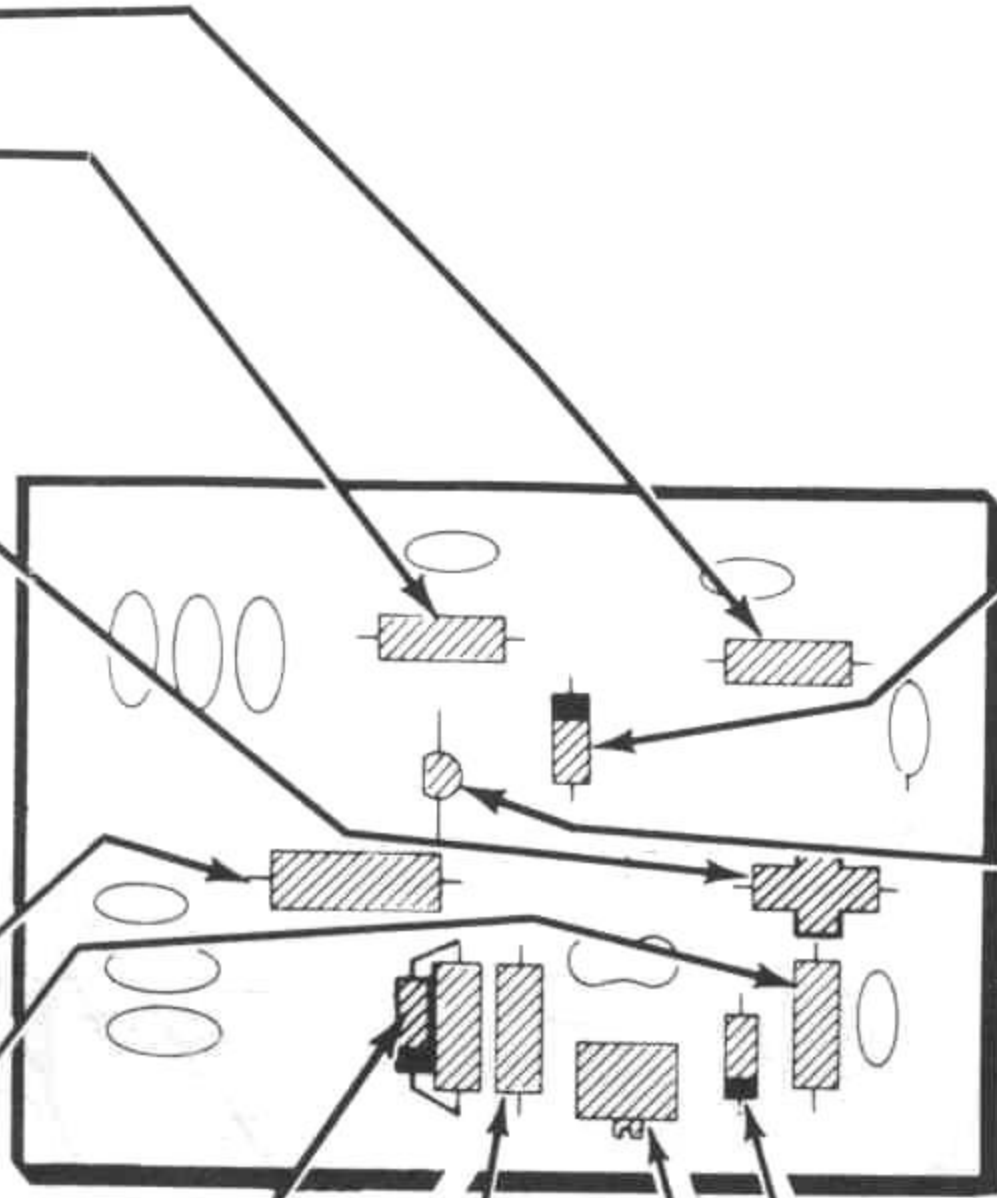


STEP-BY-STEP ASSEMBLY

OSCILLATOR CIRCUIT BOARD


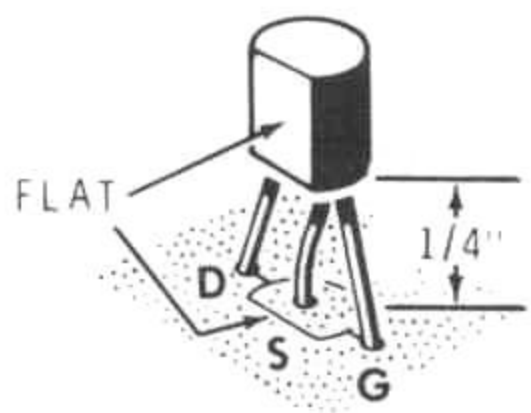


START

- Position the oscillator circuit board (#85-1205-7) as shown. Then complete each step in the order listed.
- () R1206: 150 Ω (brown-green-brown).
 - () R1205: 47 Ω (yellow-violet-black)
 - () RFC1202: 350 μH choke (#45-82). Bend the leads toward the slot in the choke body to avoid placing any strain on the leads of the choke winding. Then install the choke as shown.
 
 - () C1212: 4.7 pF ceramic. (May be marked 4.7 MMF.)
 - () R1201: 1200 Ω (brown-red-red).
 - () Wrap the leads of a 1N4149 diode (#56-56) around both leads of the 1 MΩ (brown-black-green) resistor as shown. Solder the leads together at the indicated locations.
 
 - () R1204, D1204: 1 MΩ 1N4149 resistor-diode assembly. Position the banded end of the diode as shown.
 - () R1203: 470 Ω (yellow-violet-brown).
 - () Solder the leads to the foil and cut off the excess lead lengths.



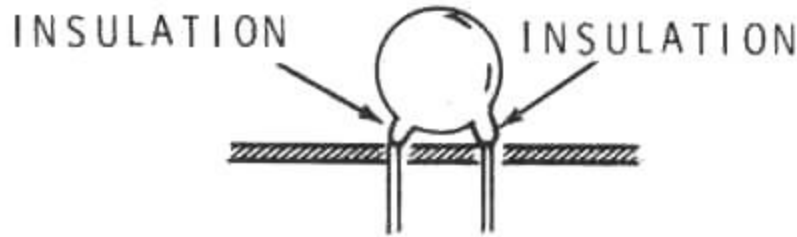
PICTORIAL 2-1

CONTINUE

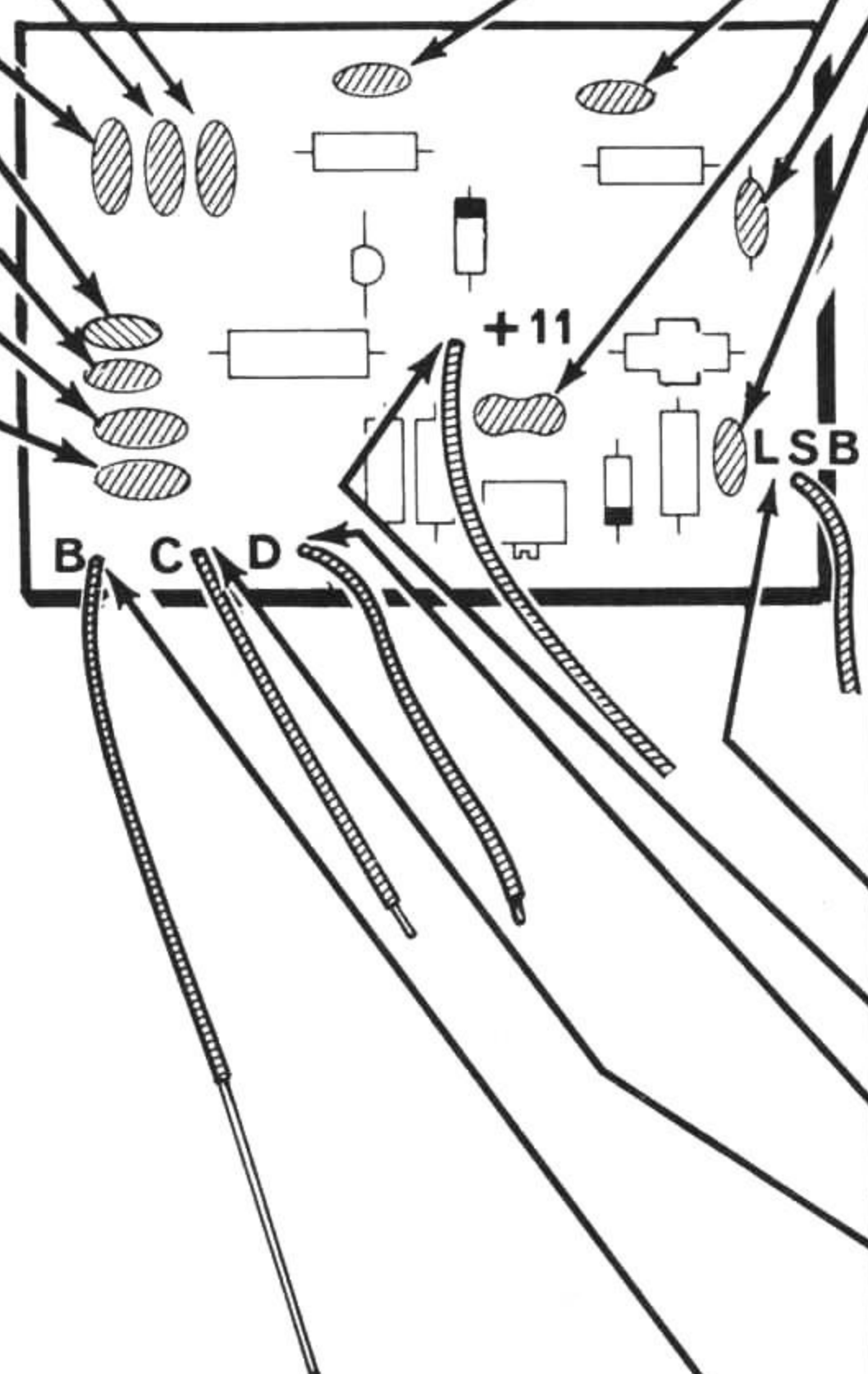
- NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board.
- 
- () ZD1201: VR7.5 zener diode (#56-97).
 - () Q1202: MPF105 transistor (#417-169). Line up the flat of the transistor with the outline of the flat on the circuit board. Then insert the leads into their correct D, S, and G holes. Solder the leads to the foil and cut off the excess lead lengths.
 
- NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board.
- 
- () D1201: 1N458 diode (#56-24).
 - () C1211: 15-60 pF trimmer.
 
 - () Solder the leads to the foil and cut off the excess lead lengths.

START ↘

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



- () C1207: 510 pF (N1500) ceramic. Be sure this is the N1500 capacitor.
- () C1206: 510 pF (N750) ceramic.
- () C1205: 510 pF (N750) ceramic.
- () C1216: 15 pF ceramic.
- () C1202: 6 pF ceramic.
- () C1203: 50 pF ceramic.
- () C1204: 56 pF ceramic.
- () Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE ↘

- () C1214: 10 pF ceramic.
- () C1213: .01 μF ceramic.
- () C1209: 12 pF mica.
- () C1215: .01 μF ceramic.
- () C1208: .005 μF ceramic.
- () Solder the leads to the foil and cut off the excess lead lengths.

NOTES:

1. Cut the following wires to the proper lengths and remove 1/4" of insulation from each end unless directed otherwise in a step. Then solder each wire as it is connected and cut off the excess lead length.
2. Only one end of each wire will be connected at this time.

- () Connect a 6" orange wire to hole LSB.
- () Connect a 5" red wire to hole +11.
- () Connect a 2" orange wire to hole D.
- () Connect a 1-3/4" gray wire to hole C.
- () Cut a 3-3/8" red wire. Then remove 1/4" of insulation from one end and 1-1/8" of insulation from the other end.
- () Connect the 1/4" bare end of the red wire to hole B.

Set this circuit board aside temporarily.

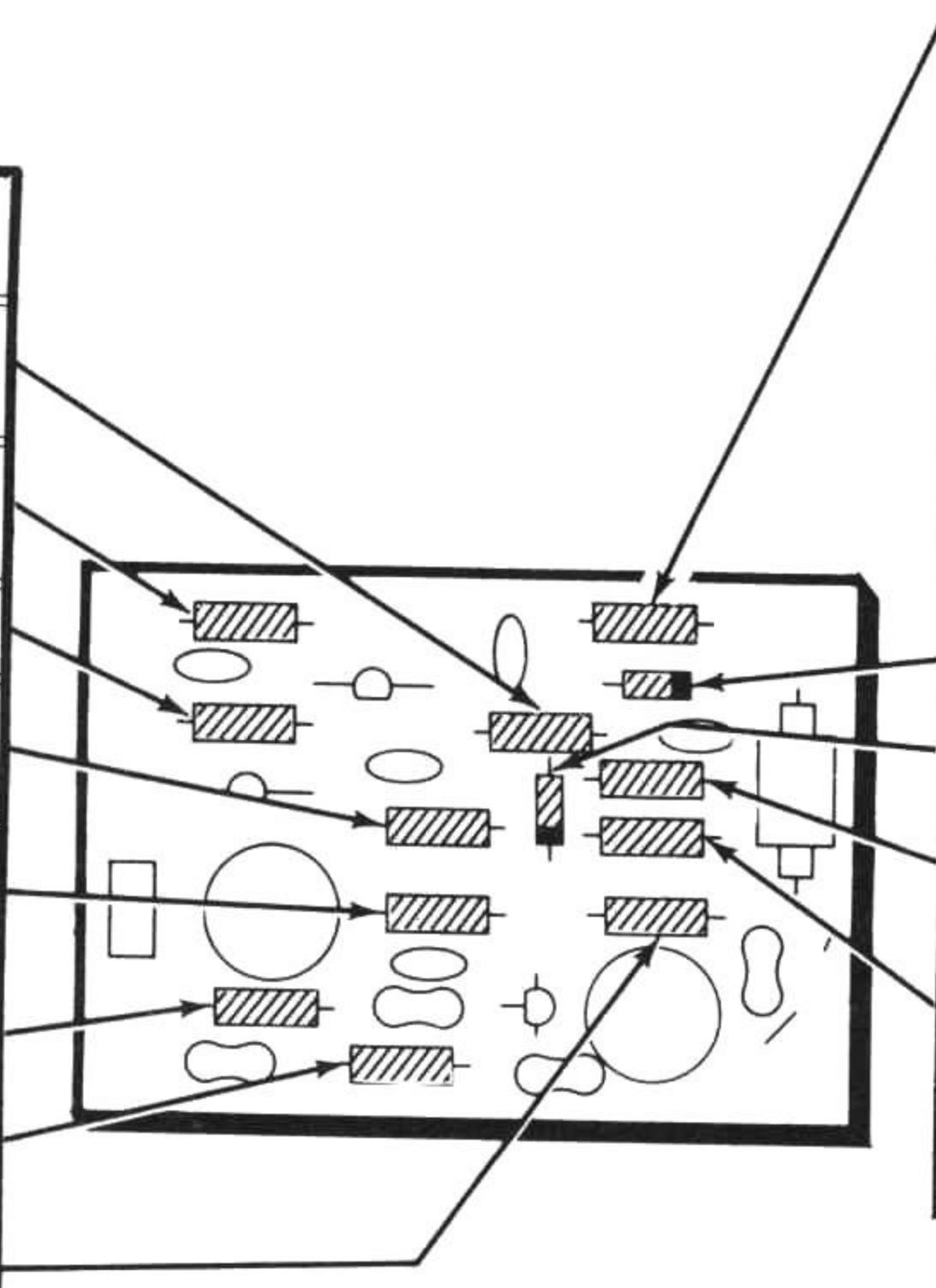
PICTORIAL 2-2




BUFFER CIRCUIT BOARD

START ↘

- Position the buffer circuit board (#85-1206-3) as shown.
- () R1231: 3300 Ω (orange-orange-red).
- () R1227: 3900 Ω (orange-white-red).
- () R1229: 22 kΩ (red-red-orange).
- () R1226: 100 Ω (brown-black-brown).
- () R1228: 100 Ω (brown-black-brown).
- () R1233: 470 Ω (yellow-violet-brown).
- () R1235: 22 kΩ (red-red-orange).
- () R1236: 470 Ω (yellow-violet-brown).
- () Solder all leads to the foil and cut off the excess lead lengths.



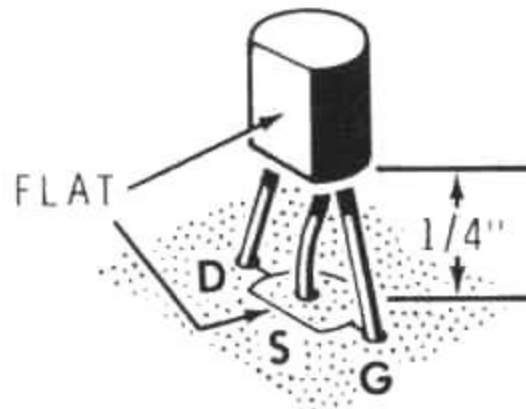
CONTINUE ↘

- () R1225: 220 kΩ (red-red-yellow).
- NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board.
- 
- () D1202: 1N4149 diode (#56-56).
- () D1203: 1N4149 diode (#56-56).
- () R1234: 3300 Ω (orange-orange-red).
- () R1237: 47 Ω (yellow-violet-black).
- () Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-1

START ↘

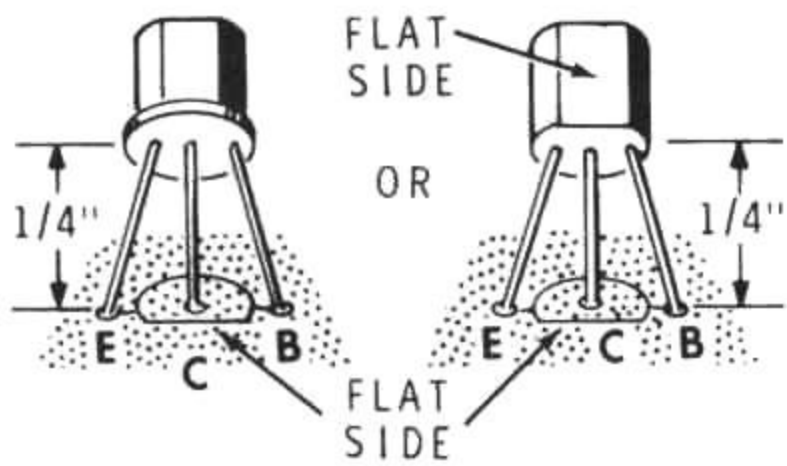
() Q1203: MPF105 transistor (#417-169). Line up the flat of the transistor with the outline of the flat on the circuit board. Then insert the leads into their correct D, S, and G holes. Solder the leads to the foil and cut off the excess lead lengths.



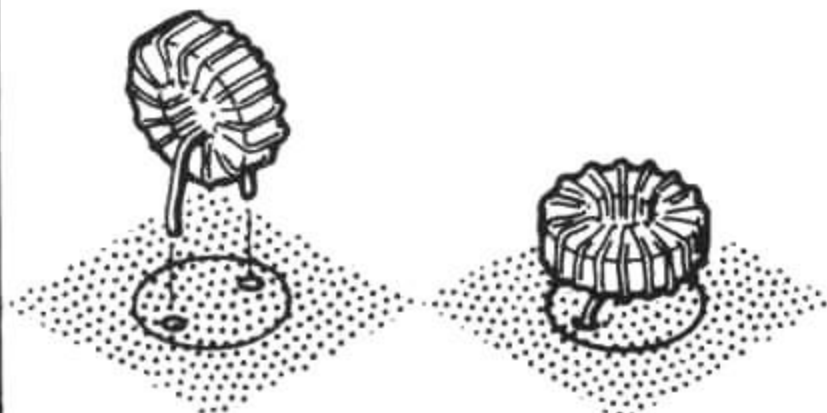
() C1226: .01 μ F ceramic.

() C1227: 470 pF ceramic.

() Q1204: 2N3393 transistor (#417-118). The transistor may be one of the two types shown below. Insert the transistor leads into the corresponding E, C, and B holes in the circuit board as shown. Solder the leads to the foil and cut off the excess lead lengths.



() L1202: 3.7 μ H toroid coil (#40-1684). Insert the leads in the holes and then bend the coil over as shown. Solder the leads to the foil and cut off the excess lead lengths.



() C1231: 470 pF mica.

() C1229: 470 pF mica.

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

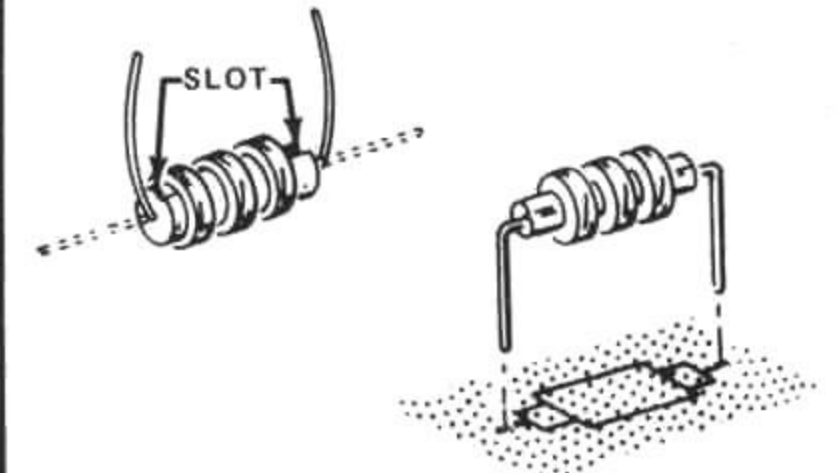
CONTINUE ↘

() C1225: .001 μ F ceramic.

() C1228: .01 μ F ceramic.

() C1232: .01 μ F ceramic.

() RFC1201: 350 μ H choke (#45-82). Bend the leads toward the slot in the choke body to avoid placing any strain on the leads of the choke winding. Then install the choke as shown.



() C1234: 680 pF mica.

() L1203: 3.7 μ H toroid coil (#40-1684).

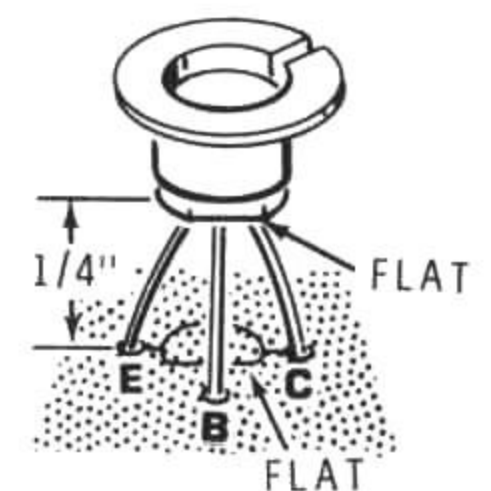
() C1233: 400 pF mica.

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

() Push a heat sink onto a 2N3638A transistor (#417-234). The bottom of the heat sink must not project below the transistor body or its leads might be shorted.



() Q1205: 2N3638A transistor (#417-234). Identify the leads from the drawing below. Then insert the leads into the indicated circuit board holes as shown. Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 3-2

OSCILLATOR
CIRCUIT
BOARD

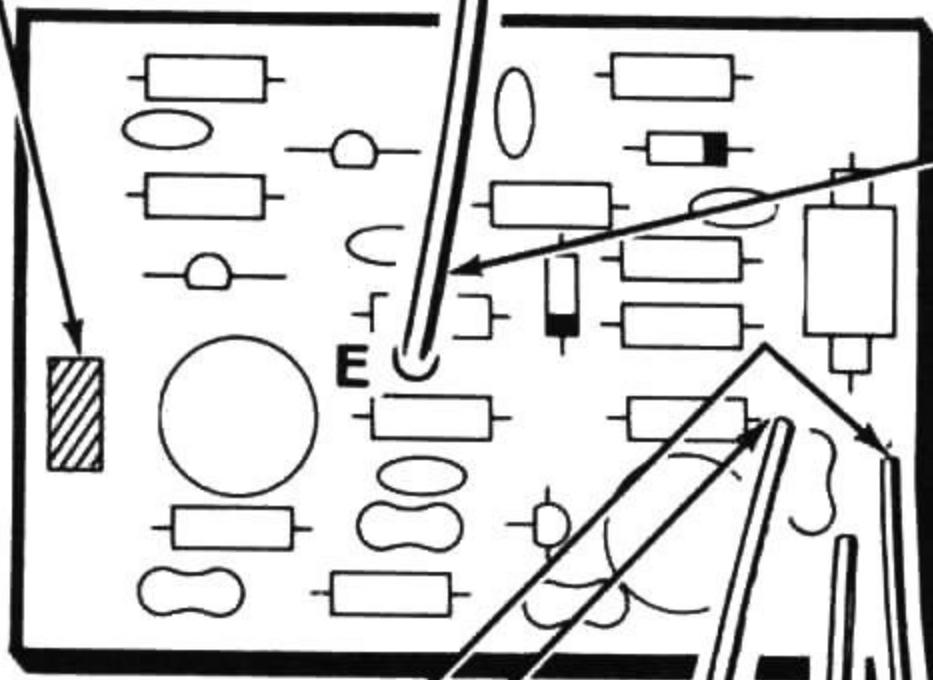
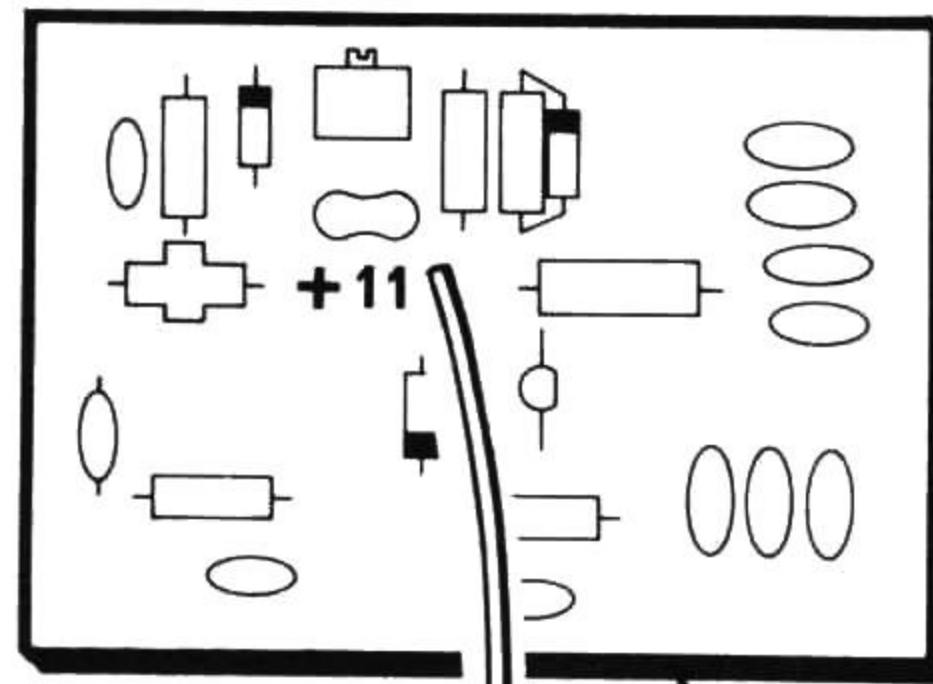
START ↘

- () R1232: 2000 Ω, variable. Solder the leads of the control when you install it. Be sure the control is pushed down tight against the circuit board and that the leads on the control extend through the circuit board holes before you solder the pins to the foil.



NOTES:

1. Cut the following wires to the proper lengths and remove 1/4" of insulation from each end. Solder each wire as it is connected and cut off the excess lead lengths.
 2. Only one end of each wire will be connected at this time.
- () Remove the insulation from a 1-1/2" gray wire. Use this wire in the next step.
 - () 1-1/2" bare wire to GND.
 - () 1-3/4" red wire to +11.
 - () 1-3/4" gray wire to OUTPUT.



5" RED

CONTINUE ↘

- () Position the oscillator circuit board near the buffer circuit board as shown.
- () Connect and solder the free end of the red wire coming from +11 on the oscillator circuit board, to hole E on the buffer circuit board.

CIRCUIT BOARD CHECKOUT

Carefully inspect the two circuit boards for the following conditions.

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil patterns.
- () Protruding leads. No lead should be longer than 1/8".
- () Transistors for the proper **type** and **installation**.
- () Diodes for the correct position of the banded end.

FINISH

PICTORIAL 3-3



VFO ENCLOSURE

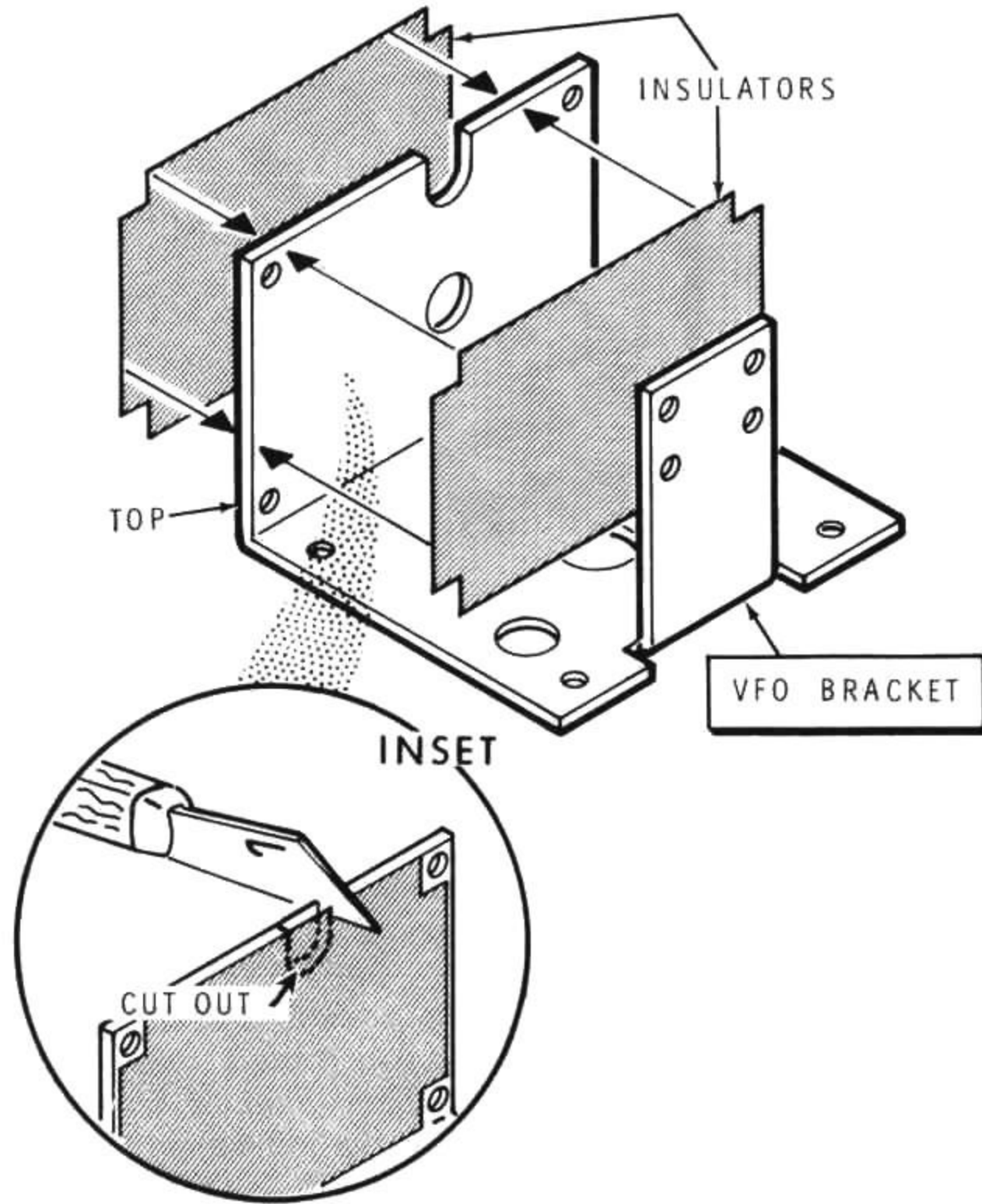
Refer to Pictorial 4-1 for the following steps.

- () Refer to Detail 4-1A and prepare two insulators from two pieces of fish paper.
- () Remove the backing paper from one of the prepared insulators and install it on the top surface of the VFO bracket.
- () Refer to the inset drawing of Pictorial 4-1 and use a small, sharp, cutting tool to remove the paper from the opening at the top of the bracket.
- () Remove the backing paper from the other insulator and install it on the bottom surface of the VFO bracket. Then cut out the paper from the opening at the top of the bracket.

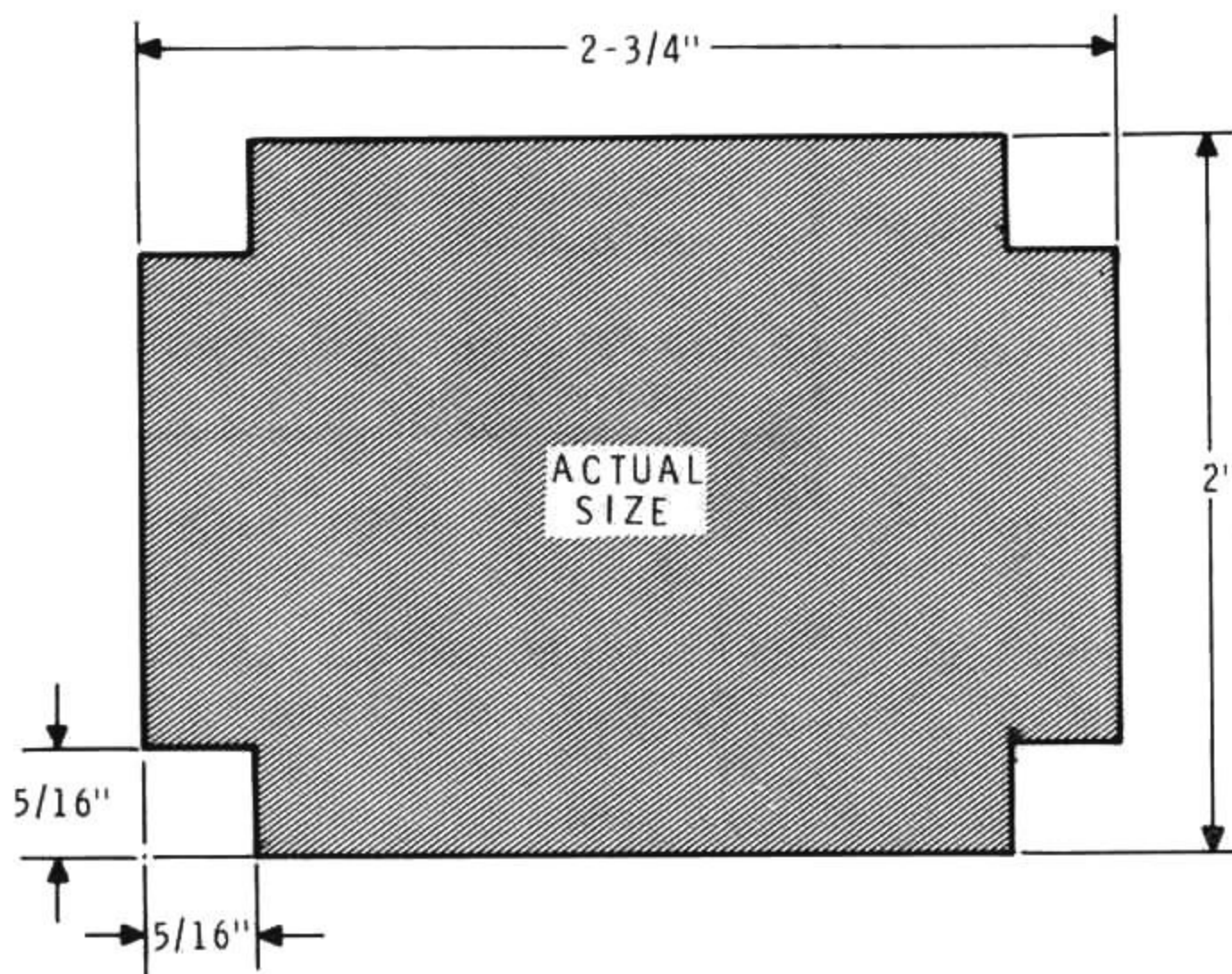
Refer to Pictorial 4-2 (Illustration Booklet, Page 3) for the following steps.

NOTES:

1. When hardware is called for in a step, only the screw size will be given. For instance, if "6-32 × 3/8" hardware" is called for, it means that a 6-32 × 3/8" screw, one or more #6 lockwashers, and a 6-32 nut should be used for each mounting hole. The Detail referred to in the step will show the proper number of lockwashers to use.
 2. The circuit boards must be positioned so the red wire between the two boards is positioned as shown.
- () Refer to Detail 4-2A and mount the oscillator circuit board and the buffer circuit board on the VFO mounting bracket. Use 4-40 × 5/8" hardware and two 1/8" spacers at each corner, with #6 plain solder lugs (#259-6) under the heads of the screws at holes FM and FW. Form and position the solder lugs as shown in the Pictorial. (Use the plastic nut starter to hold and start 4-40 and 6-32 nuts on screws.)
 - () Refer to Detail 4-2B, Part 1, and mount two #6 solder lugs on the front of the tuning capacitor frame with 6-32 × 3/16" screws. Position the lugs at 45 degrees as shown. Keep the capacitor plates fully meshed with each other to avoid damage while handling.

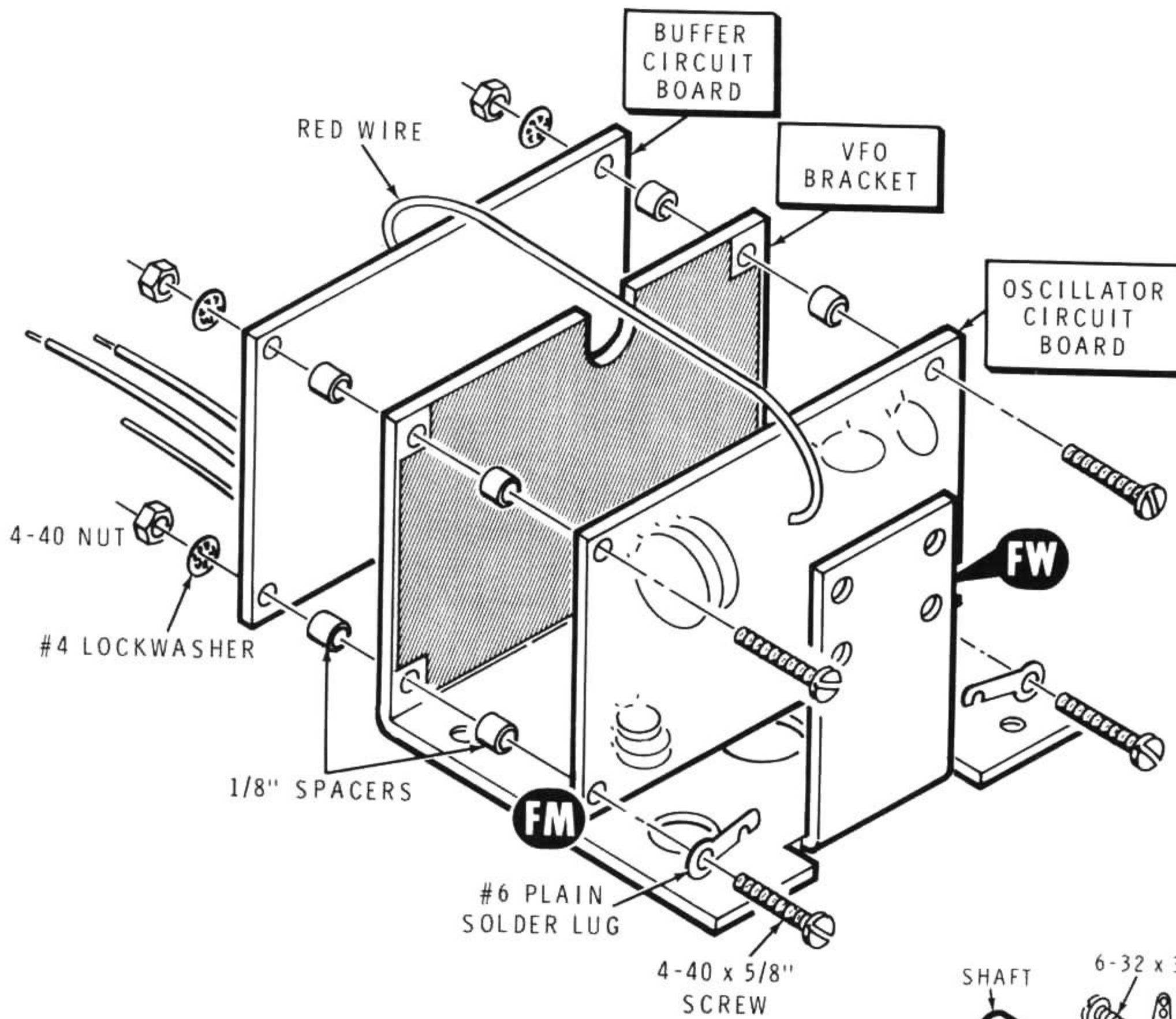


PICTORIAL 4-1



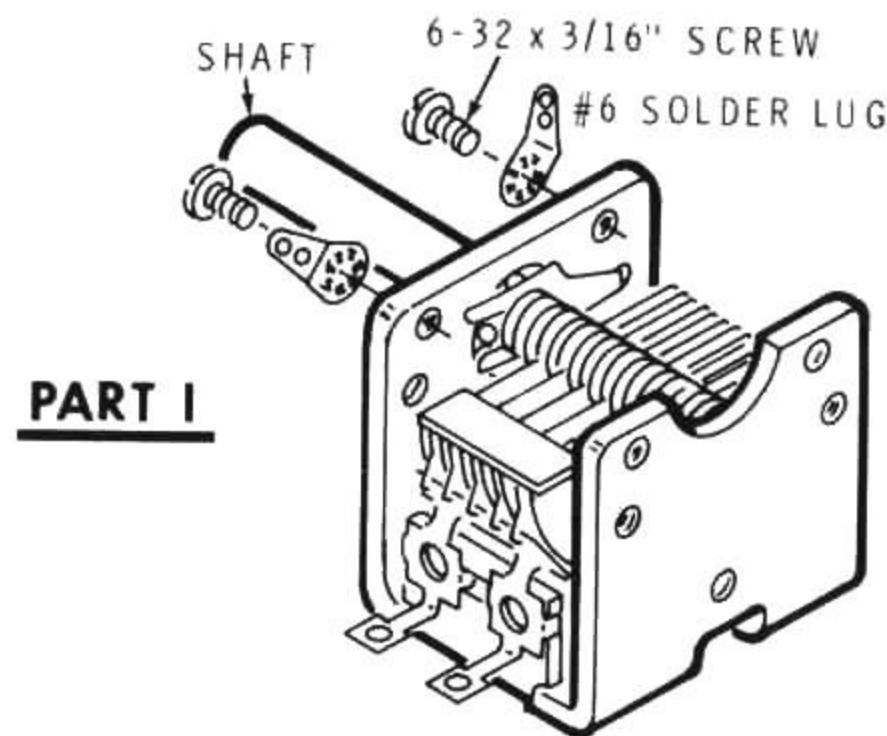
Detail 4-1A



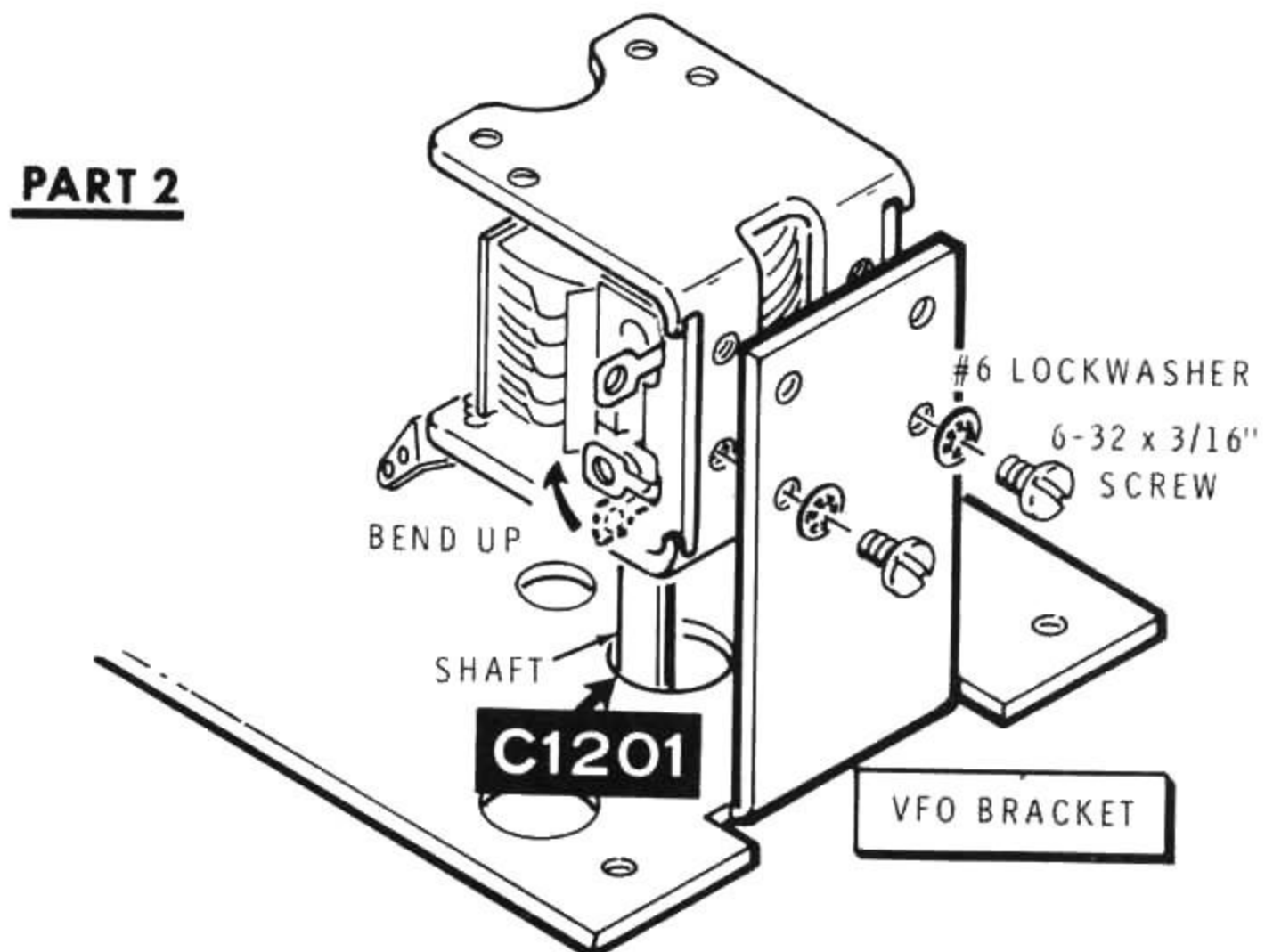


Detail 4-2A

- () C1201: Refer to Part 2 of Detail 4-2B and insert the shaft of the variable capacitor through hole C1201 in the VFO bracket. Then mount the variable capacitor on the VFO bracket with 6-32 x 3/16" hardware. NOTE: Be sure you use the front holes in the bottom of the capacitor and the two front holes in the VFO bracket as shown.
- () Refer to the Detail and bend one lug of the capacitor out of the way as shown.
- () Remove the insulation from two 1-1/2" gray wires. Use these wires in the next step.
- () Refer to Pictorial 4-2 and connect a 1-1/2" bare wire from each solder lug on the front of the variable capacitor to corresponding solder lugs FM and FW on the circuit board mounting screws. Solder the two wires to the four solder lugs and cut off any excess wire lengths.

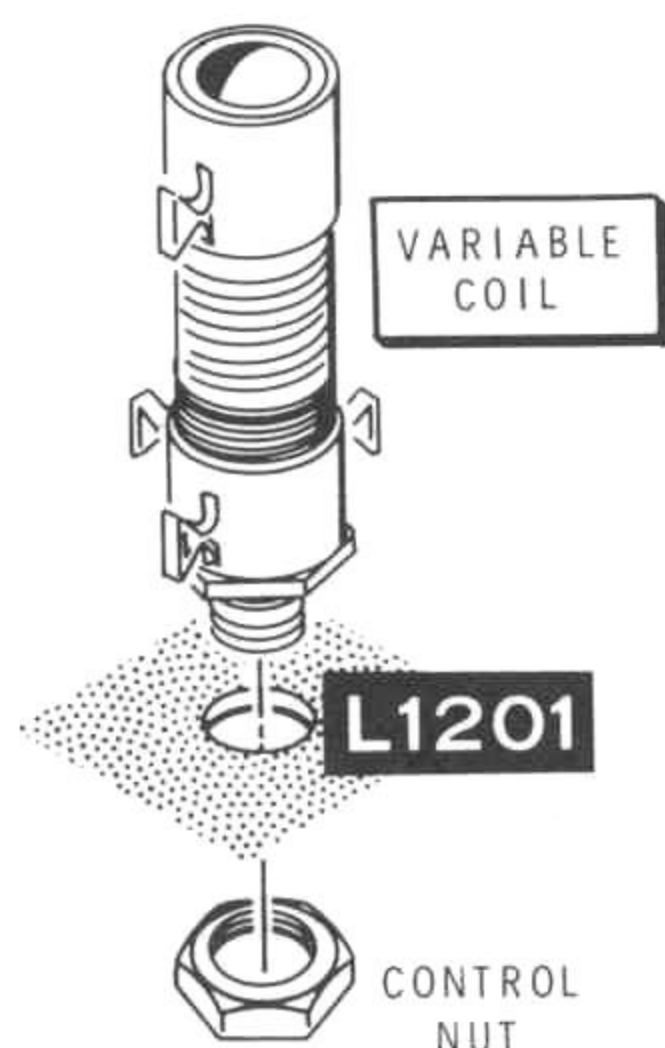


PART I

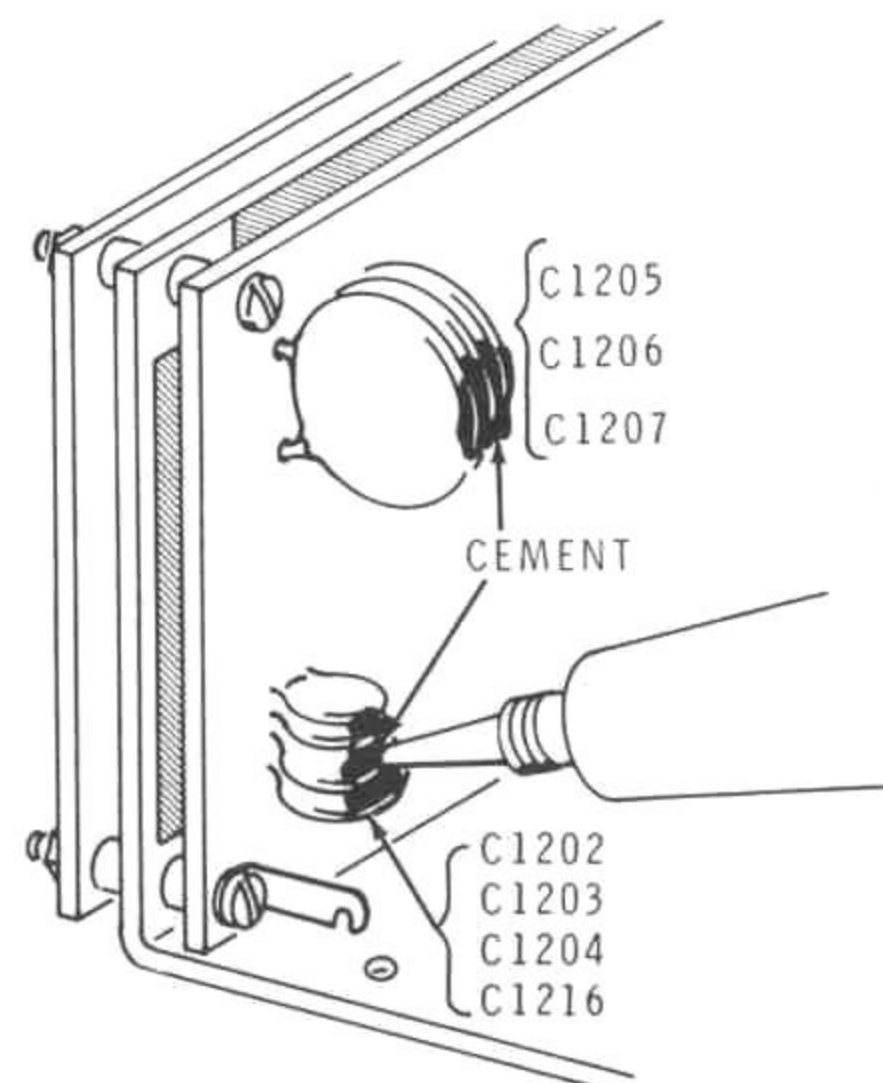


PART 2

Detail 4-2B



Detail 4-2C



Detail 4-2D

- () L1201: Refer to Detail 4-2C and temporarily mount the VFO coil in hole L1201 in the VFO bracket. Use a control nut. Position the coil as shown in the Pictorial.

Refer to Pictorial 4-2 and connect the wires coming from the oscillator circuit board as follows. **Remove all slack from the wires but do not strain the connections.**

NOTE: In the following steps, the letter "S" with a number such as (S-1) means to solder the connection. The number following the "S" tells how many wires are at the connection. If (NS) is used in a step, it means not to solder because other wires will be added later.

- () Gray wire to coil L1201 lug 2 (S-1).
- () Short orange wire to coil L1201 lug 1 (S-1).

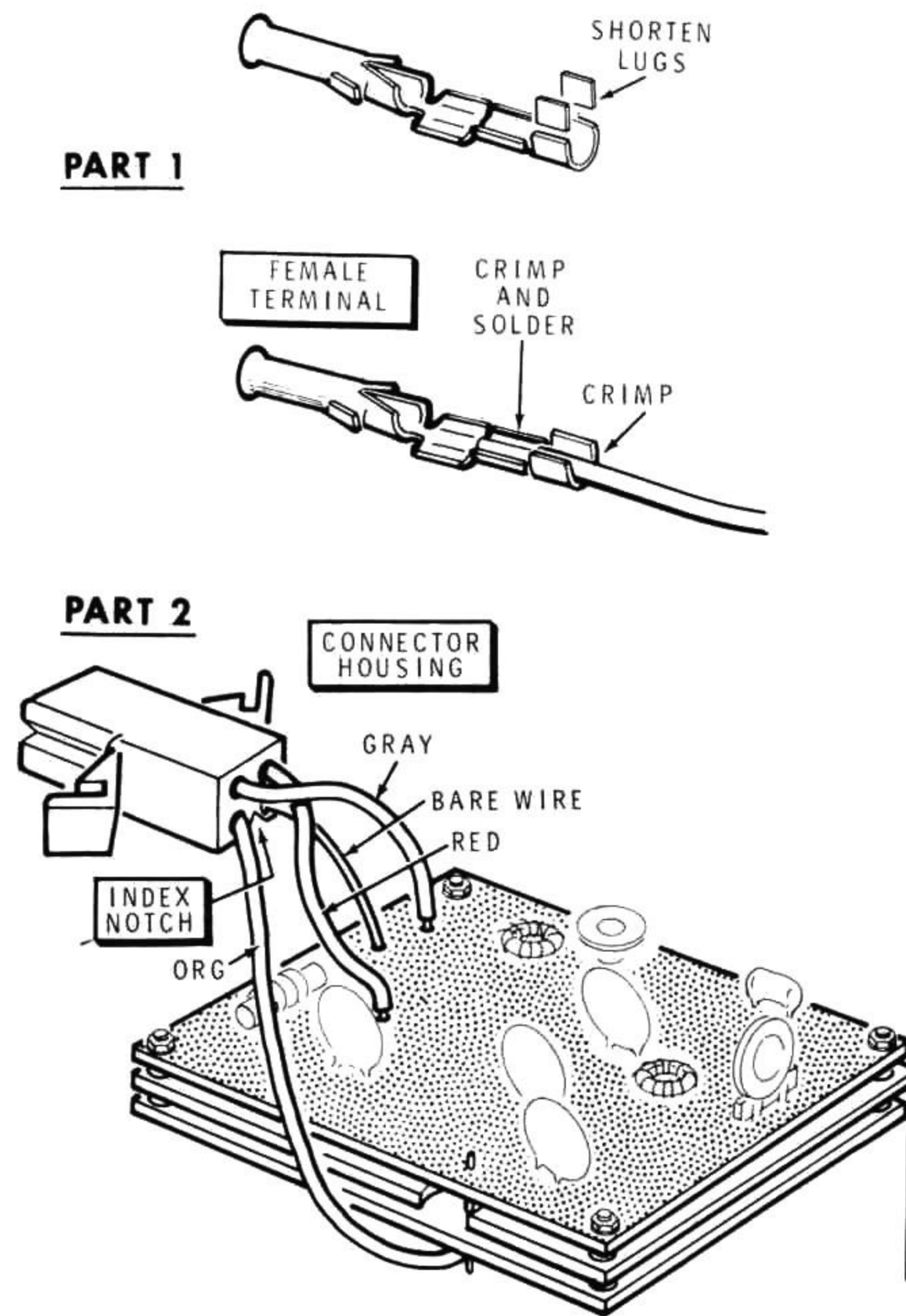
NOTE: Where a wire passes through a connection and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection. Be especially careful when you solder these connections that you apply enough solder and heat to properly solder these "through wires."

- () Red wire through coil L1201 lug 4 (S-2) to capacitor C1201 lug 2 (S-1).

NOTE: There is no connection to lug 3.

The long orange wire will be connected later.

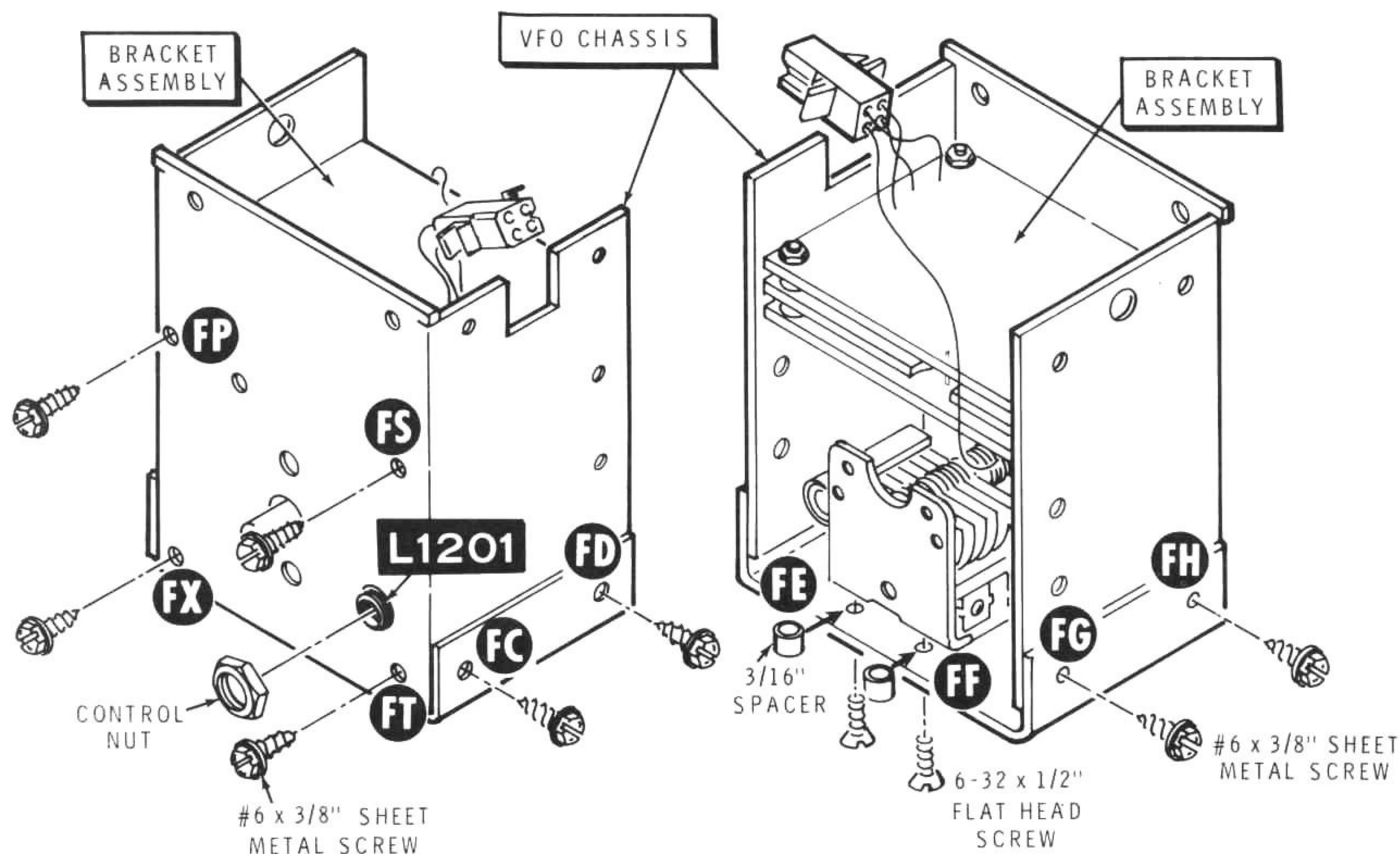
- () Remove the insulation from a 1" gray wire. Use this wire in the next step.
- () Connect a 1" bare wire between the two circuit boards as shown. Solder the wire to the foil side of each board. Then cut off the excess wire ends.
- () Refer to Detail 4-2D and press the top edges of ceramic capacitors C1205, C1206, and C1207 together. In a similar manner, press ceramic capacitors C1202, C1203, C1204, and C1216 together.
- () Remove the cap from the tube of cement (#350-12) and, using a suitable small pointed tool, punch a hole in the end of the tube nozzle. CAUTION: This cement is very soft and sticky; handle it with care.
- () Squeeze a sufficient amount of cement on the top edges of the two groups of ceramic capacitors to cement the capacitors together. Take care not to move these capacitors during the following steps as it will require several hours for the cement to set.
- () Squeeze a few drops of cement into the centers of the two toroid coils on the buffer circuit board so the coils will be fixed in position on the board. NOTE: Save the remaining cement for use later.



Detail 4-3A

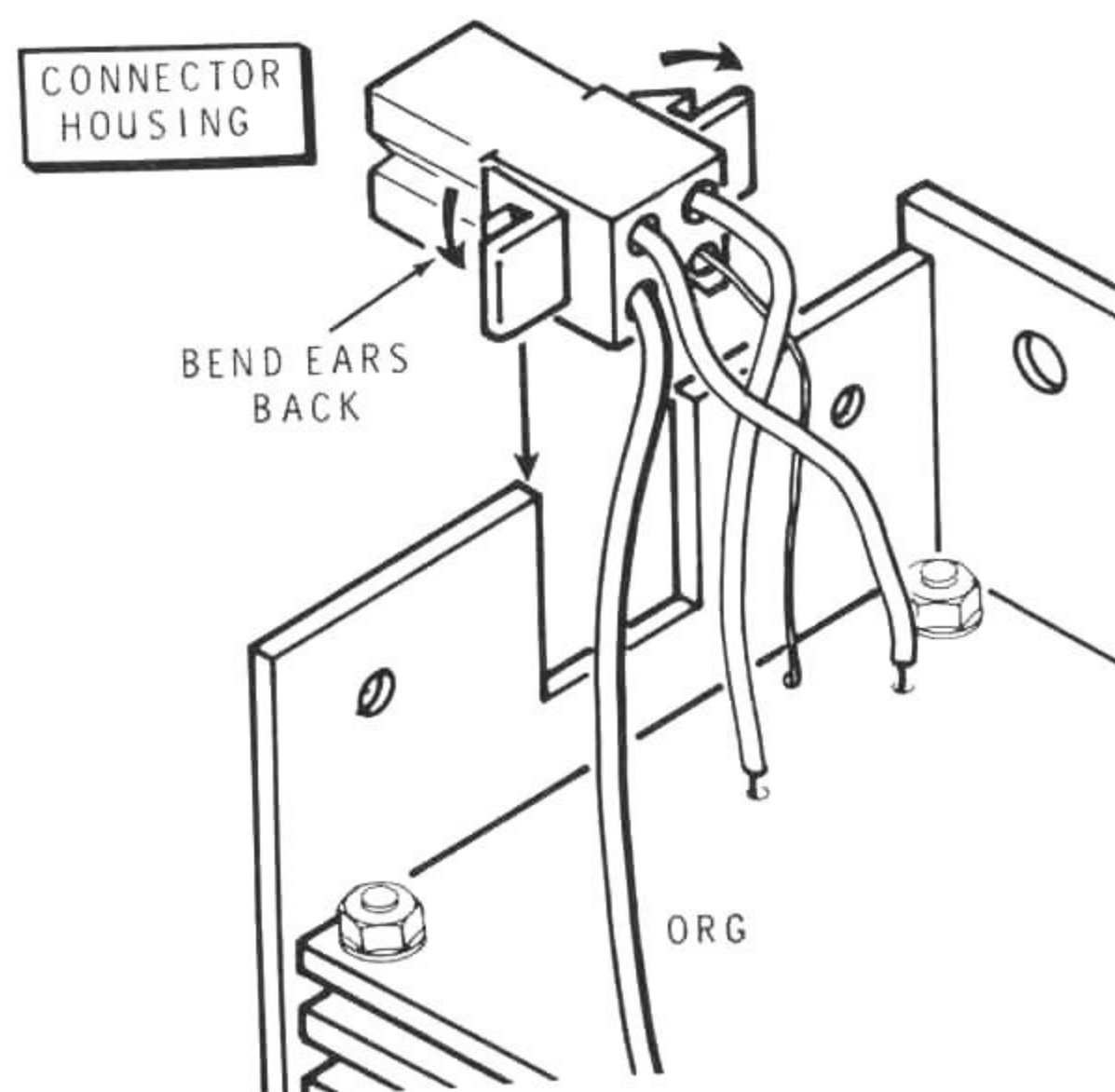
Refer to Pictorial 4-3 for the following steps.

- () Cut four female terminals from the metal strip.
- () Refer to Part 1 of Detail 4-3A and install female terminals on the free end of the bare wire and on the free ends of the orange, gray, and red wires coming from the VFO.
- () Position the male connector housing with the ears and index notch as shown; then refer to Part 2 of Detail 4-3A and insert the female terminals into the holes in the connector housing. Push each connector into the housing until it snaps into place. **Select the hole for each wire according to its position relative to the index notch.** Be sure to use the correct hole, as the connectors cannot be removed after they are inserted. Tug gently on each wire to make sure the terminals have locked into place.
- () Position the orange wire toward the rear of the VFO and the red, gray, and bare wires straight up from the buffer circuit board.
- () Temporarily remove the nut that secures L1201 to the VFO bracket.
- () Carefully slide the VFO bracket assembly into the VFO chassis.

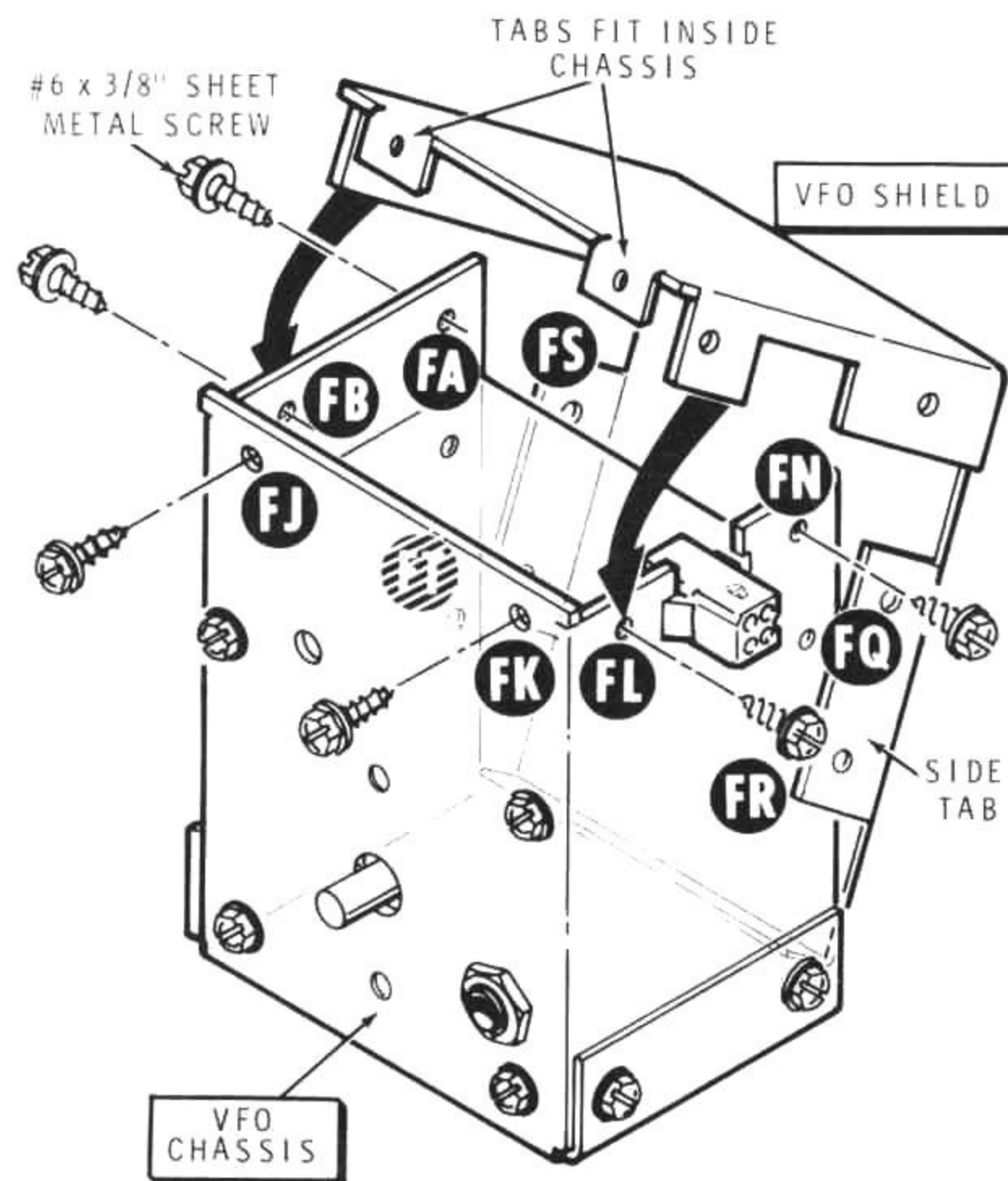


Detail 4-3B

- () Refer to Detail 4-3B and secure the VFO bracket to the VFO chassis with four #6 × 3/8" sheet metal screws at FP, FS, FT, and FX.
- () Secure coil L1201 with the control nut previously removed.
- () Secure the lower part of the VFO bracket to the VFO chassis with 6-32 × 3/8" flat head screws and 3/16" spacers at FE and FF. Position the spacers between the bracket and the chassis as shown.
- () Secure the bottom sides of the VFO chassis at FC, FD, FG, and FH with #6 × 3/8" sheet metal screws.
- () Refer to Detail 4-3C and bend the ears of the connector housing, then insert the housing down into the slot in the side of the VFO chassis.



Detail 4-3C



PICTORIAL 4-4

- () Refer to Pictorial 4-4 and secure the VFO shield to the chassis with six #6 × 3/8" sheet metal screws at FA, FB, FJ, FK, FL, and FN. Be sure the two top tabs of the shield fit inside the VFO chassis. The side shield tabs fit outside the chassis.
- () Place the VFO assembly in an oven, set at no greater than **150°F**, for two hours. Then turn the oven off and allow the VFO to cool naturally while it is still in the oven. This will reduce stress in the VFO so it will be more stable during operation.
- () Secure the shield side tabs to the chassis at FQ, FR, FS, and FT with #6 × 3/8" sheet metal screws.

This completes the assembly of the VFO. Set it aside until it is called for in a step.

CHASSIS

PARTS LIST

Remove all of the parts from Pack #3 (the parts left in the main shipping carton).

Unpack these parts and check each part against the following list. Return any part that is packed in an individual envelope, with the part number on it, to the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for. The key numbers corre-

spond to the numbers on the "Chassis Parts Pictorial" (Illustration Booklet, Page 4).

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

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

A1	90-1127-2	1	Cabinet bottom	
A2	90-1103-2	1	Cabinet top	
A3	100-252	1	Dial pulley	
A4	100-1041	1	Vernier drive (short shaft)	
A5	100-1608	1	Vernier drive (long shaft)	
A6	200-1239-2	1	Chassis	
A7	203-1611-1	1	Front panel	
A8	204-1937	2	Window bracket	
A9	204-1978	2	U-bracket	
A10	204-2006-1	1	Slide bracket	
A11	204-2007	1	Reflector bracket	
A12	204-2018	1	Dial drive bracket	
A13	205-1448-5	1	Trim plate	
A14	204-1939	2	Inner side strip	
A15	205-1576	2	Outer side strip	
A16	205-1577	2	Angle brace	
A17	453-265	1	Dial shaft	
A18	456-7	1	Shaft coupler	

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

B1	73-45	1	Grommet	
B2	255-59	2	Large spacer	
B3	261-9	4	Foot	
B4	266-824	2	Lamp holder	
B5	432-818	1	4-pin socket	
B6	432-836	1	6-pin socket	
B7	432-837	1	6-pin plug	
B8	446-620-1	1	Red window	
B9	446-633-1	1	Dial window	

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

NOTE: Hardware packets are marked to show the size of the hardware they contain (HDW #4, or, HDW #2 & #6, etc.) You may have to open more than one packet-in this pack-to locate all of the hardware of any one size (#6, for example).

#2 Hardware

C1	250-175	4	2-56 × 3/8" screw	
C2	252-51	4	2-56 nut	
C3	254-26	4	#2 lockwasher	

#4 Hardware

D1	250-213	8	4-40 × 5/16" screw	
D2	250-1194	7	4-40 × 1/2" square head screw	
D3	252-2	11	4-40 nut	
D4	254-9	14	#4 lockwasher	
D5	255-151	2	7/8" spacer	

#6 Hardware

E1	250-230	2	6-32 × 3/16" setscrew	
E2	250-89	11	6-32 × 3/8" screw	
E3	250-475	5	#6 × 3/8" sheet metal screw	
E4	250-32	2	6-32 × 3/8" flat head screw	
E5	250-11	2	6-32 × 1/2" flat head screw	
E6	250-26	4	6-32 × 5/8" screw	
E7	250-40	2	6-32 × 1-1/2" screw	
E8	251-1	2	6-32 spade bolt	
E9	252-3	22	6-32 nut	
E10	252-27	1	6-32 locknut	
E11	254-1	19	#6 lockwasher	
E12	259-1	4	#6 solder lug	

Other Hardware

F1	250-43	3	8-32 × 1/4" setscrew	
F2	250-456	4	10-32 × 1/2" screw	
F3	253-9	2	#8 flat washer	
F4	258-1	1	Dial spring	
F5	205-778	1	Metal blade	

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

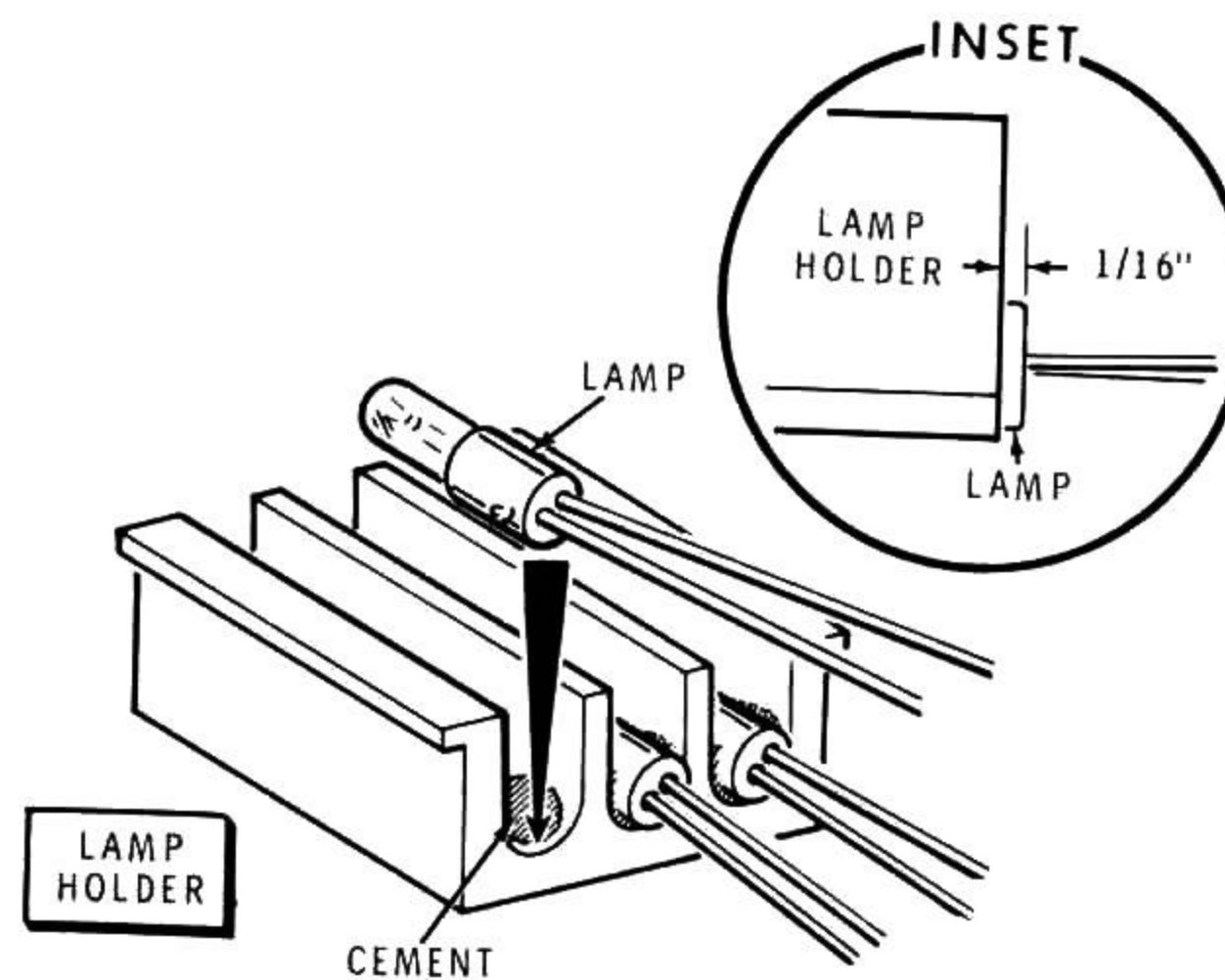
NOTE: The following resistors are 1/2-watt and have a tolerance of 5% (gold fourth color band).

G1	6-470	1	47 Ω (yellow-violet-black) resistor	R1276
G1	6-332	1	3300 Ω (orange-orange-red) resistor	R1275
G2	21-48	1	.05 μF ceramic capacitor	C1275
G3	56-26	1	1N191 (brown-white-brown) diode	D1275
G4	412-82	6	Indicator light	I1275, I1276, I1277, I1278, I1279, I1281
G5	412-55	3	#1815 lamp	PL1275, PL1276, PL1277
G6	434-83	2	Lamp socket (long foot)	
G7	434-88	1	Lamp socket (angle foot)	

MISCELLANEOUS

H1	64-677	1	4-section switch	SW1275
H2	64-678	1	4-section switch	SW1276
H3	100-1660	1	Dial cord assembly	
H4	432-854	9	Male terminal	
H5	432-855	6	Female terminal (1 extra)	
H6	434-42	2	Phono socket	
H7	438-4	4	Phono plug	
H8	462-906	1	Knob	
H9	463-62	1	Dial pointer	
H10	490-1	1	Alignment tool	
H11	490-14	1	Allen wrench	

STEP-BY-STEP ASSEMBLY



PICTORIAL 5-1

LAMP ASSEMBLIES

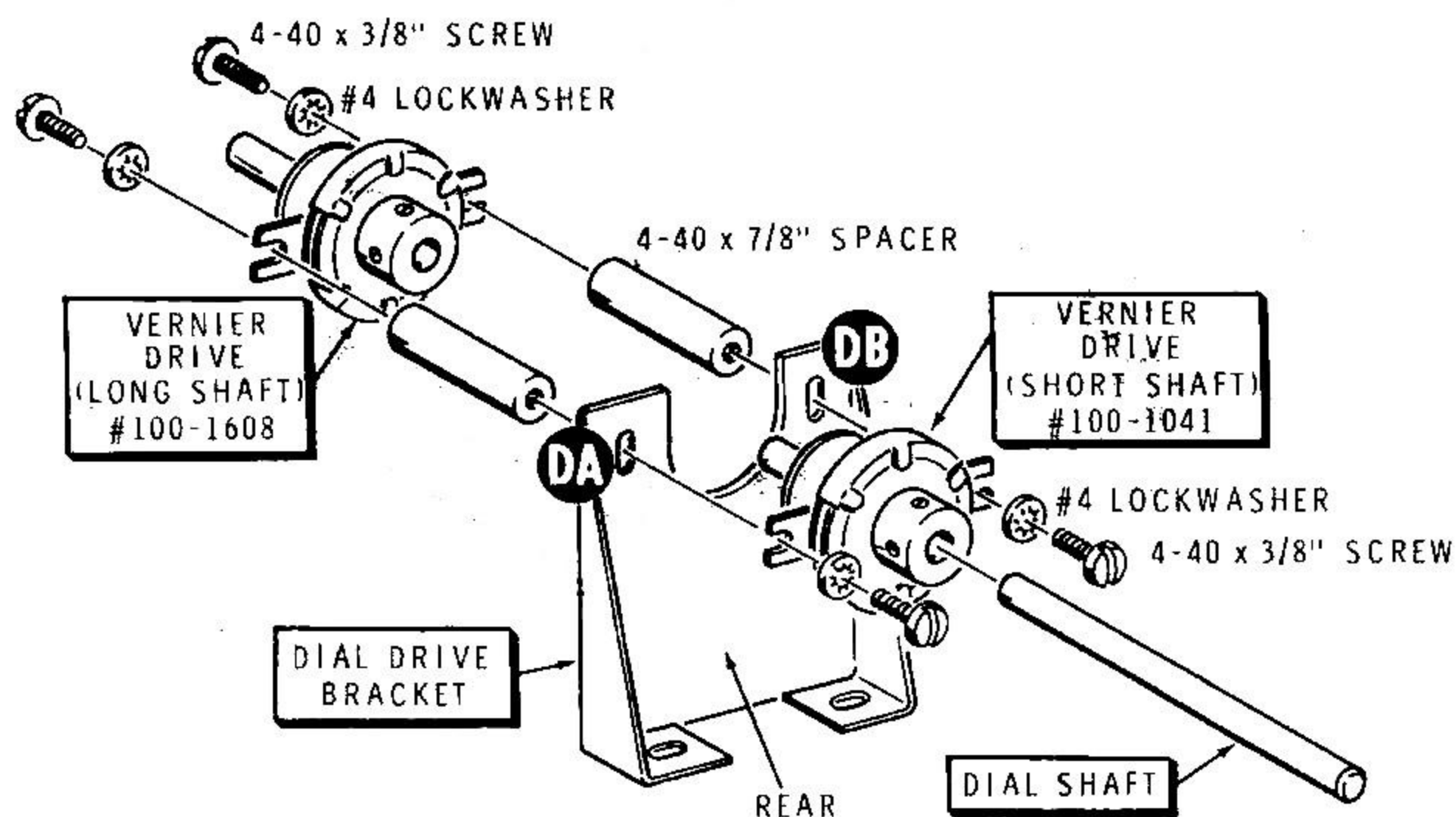
Refer to Pictorial 5-1 for the following steps.

NOTE: In the following steps, you will cement indicator lamps (#412-82) into their lamp holders (#266-824). These operations are performed next to give the cement time to set firmly before you install the assemblies into the front panel. As you apply cement into the lamp holder slots, keep the cement close to the outer edges to avoid getting cement onto the glass bulb portion of the lamps.

- () Squeeze a small amount of cement left from the VFO assembly into the sides of the three slots in either of the lamp holders.
- () Press the base section of an indicator lamp into one of the three slots. Refer to the inset drawing on Pictorial 5-1 and position the outer end of the

base portion of the lamp 1/16" outside the edge of the lamp holder as shown. Press the lamp base firmly down into the cement.

- () In the same manner, press two more indicator lamps into the remaining two slots in the lamp holder.
- () Carefully set this lamp housing aside where it cannot be disturbed until the cement is firmly set. This assembly should be left undisturbed for at least eight hours.
- () In the same manner, apply a small amount of cement in the slots of the other lamp holder. Press the remaining three indicator lamps into the cement. Set this assembly aside with the first one until they are called for later.

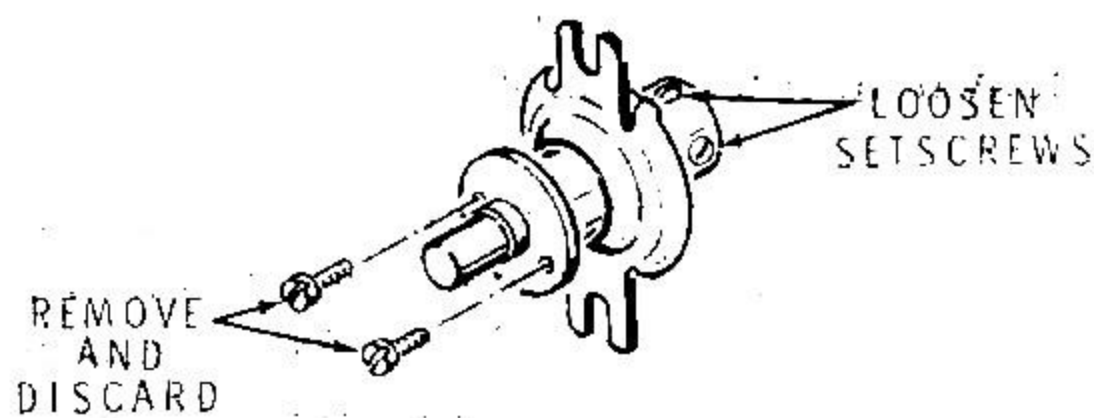


PICTORIAL 6-1

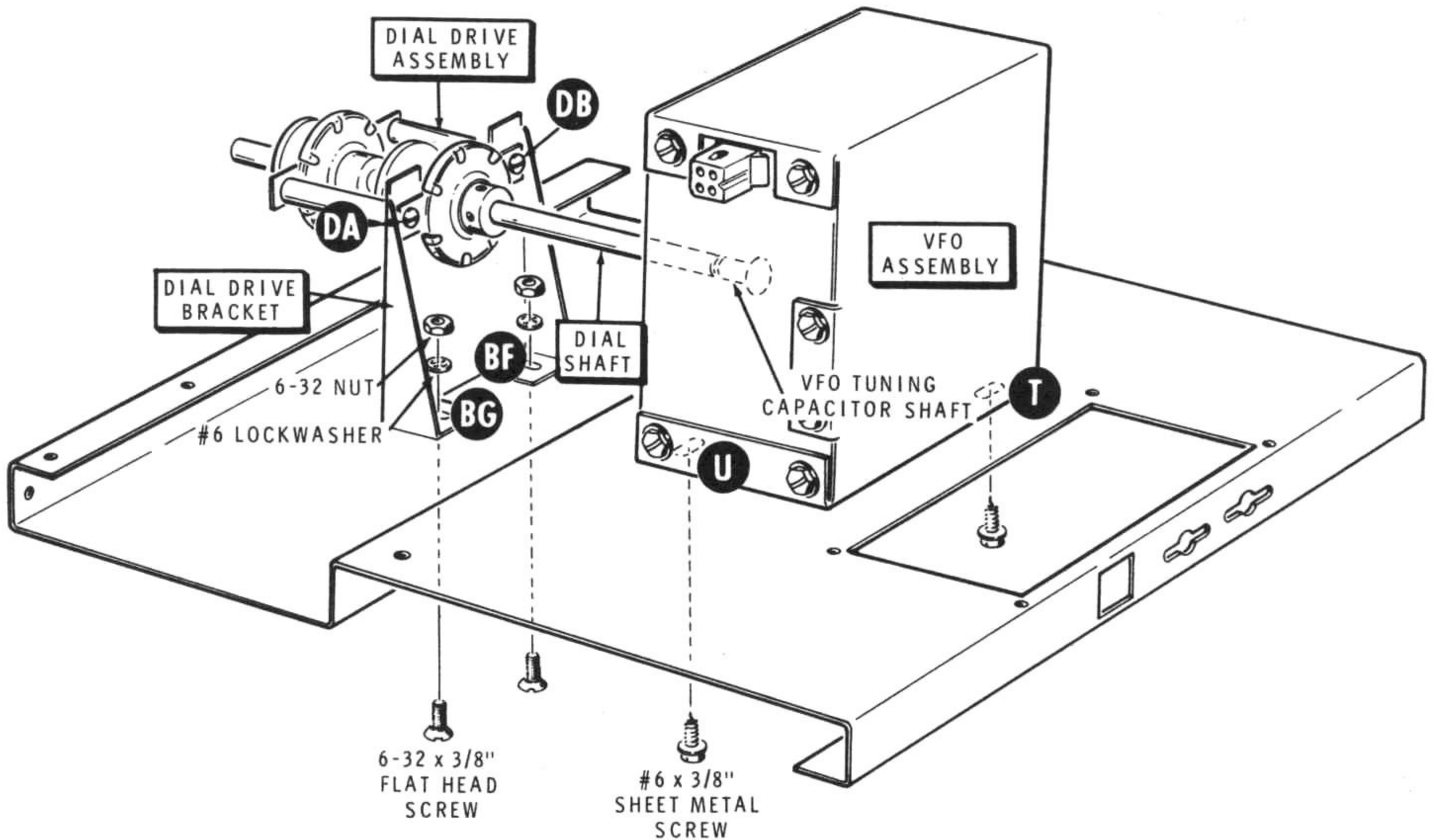
VFO DRIVE ASSEMBLY

Refer to Pictorial 6-1 for the following steps.

- () Refer to Detail 6-1A and remove and discard the two brass screws in the collar of each of the vernier drives as shown.
- () Remove any tape or band from the bushings of the vernier drives. Then loosen the two setscrews in the bushing of each vernier drive just enough to allow a 1/4" shaft to be inserted in the bushing.
- () Position the dial drive bracket as shown.
- () Position the short-shaft vernier drive (#100-1041) onto the rear of the dial drive bracket as shown. Secure the vernier drive to the bracket at DA and DB with two 4-40 x 3/8" screws, two #4 lockwashers, and two 4-40 x 7/8" spacers.
- () Position the long-shaft vernier drive (#100-1608) on the short shaft of the other vernier drive. Secure the long-shaft vernier drive to the 7/8" spacers with two 4-40 x 3/8" screws and two #4 lockwashers.
- () Tighten the two setscrews in the bushing of the long-shaft vernier drive.
- () Place the dial shaft into the bushing of the short-shaft vernier drive. Tighten the bushing setscrews onto the dial shaft.
- () Slightly loosen bracket mounting screws DA and DB to allow for height adjustment in following steps.



Detail 6-1A

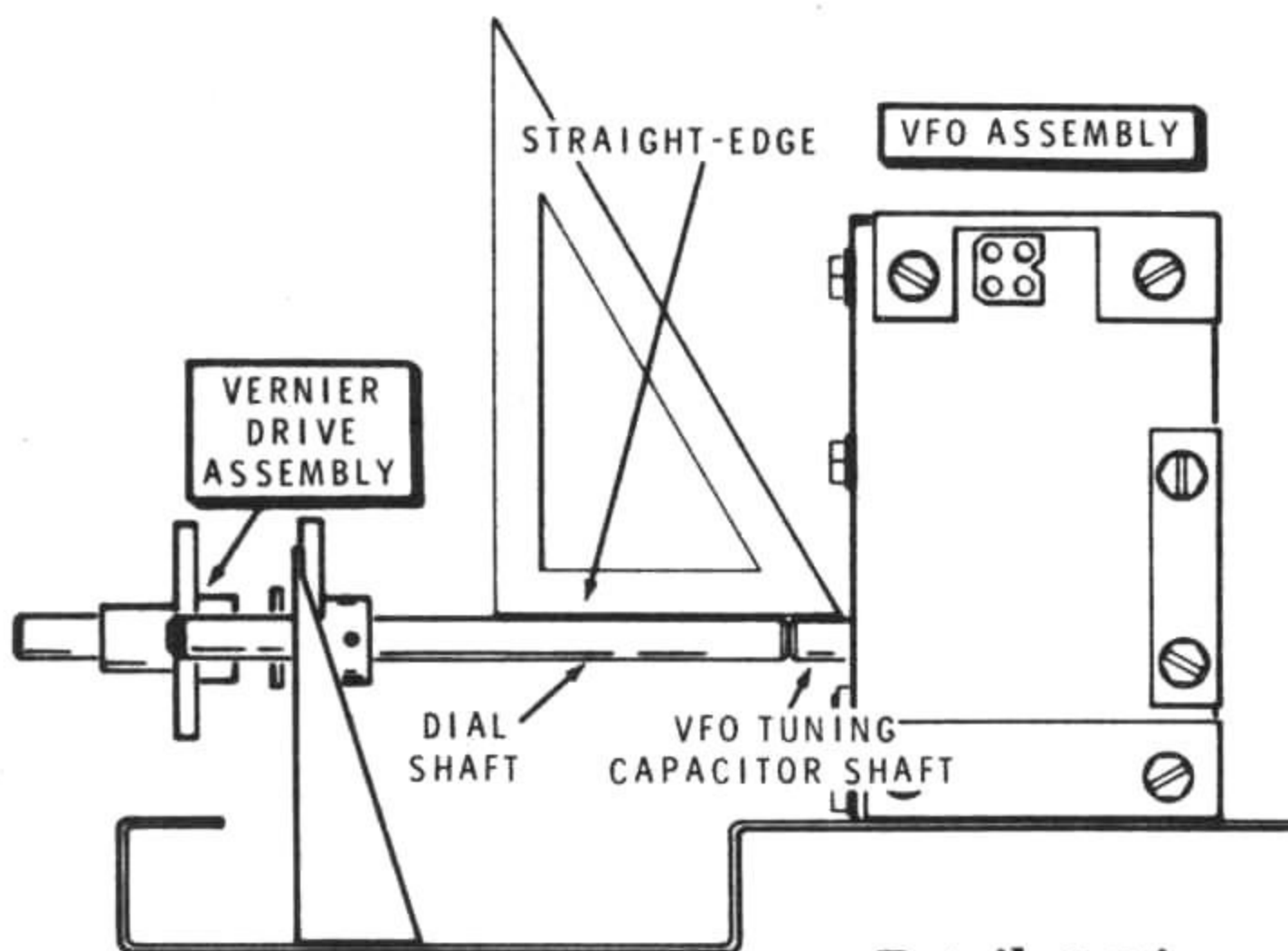


PICTORIAL 6-2

Refer to Pictorial 6-2 for the following steps.

NOTE: In the following steps, you will temporarily mount the VFO assembly and the dial drive assembly onto the chassis. This will allow you to adjust the dial shaft for its proper height. Other adjustments will be performed later.

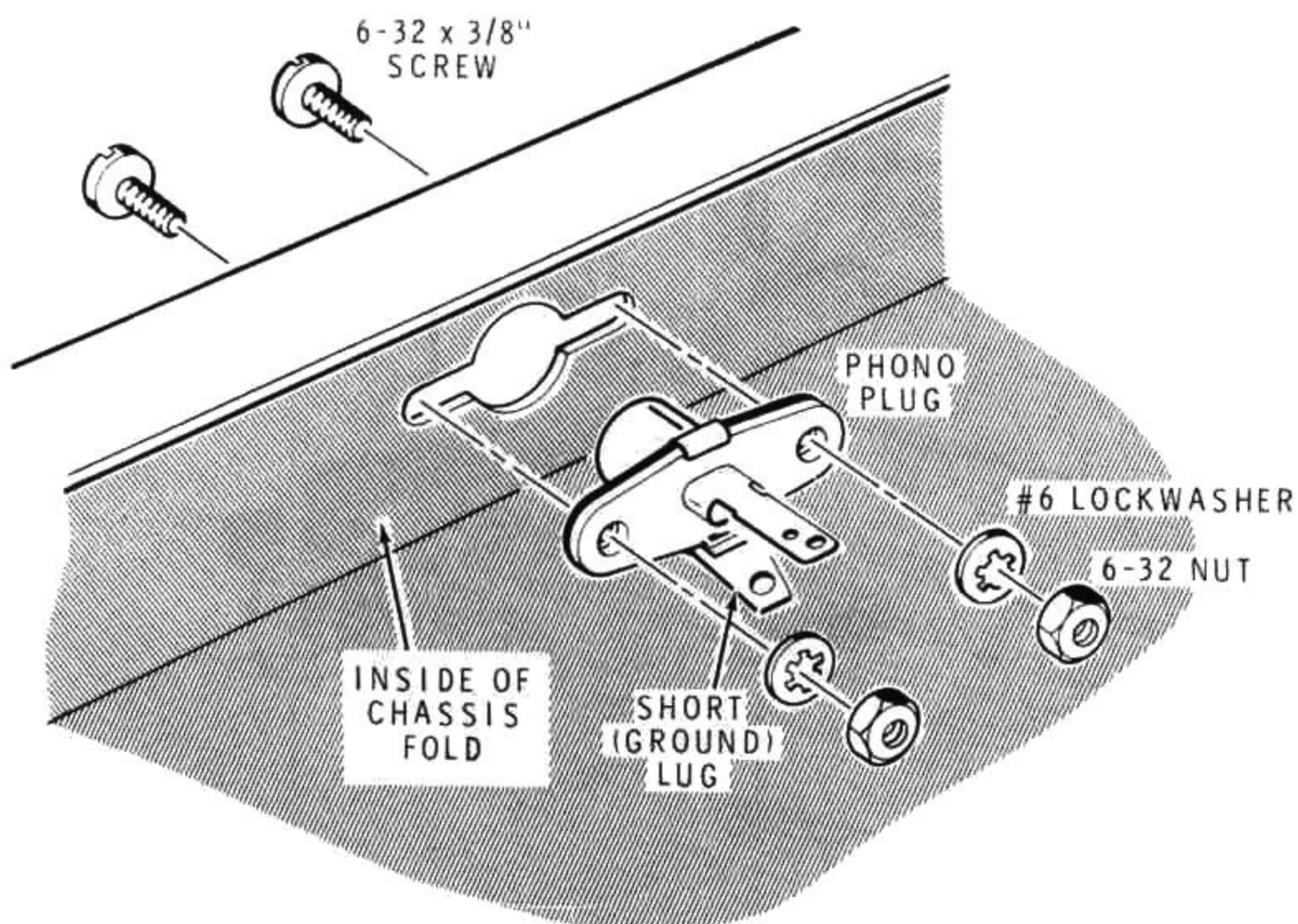
- () Temporarily secure the VFO assembly onto the chassis at T and U (diagonal corners) with #6 × 3/8" sheet metal screws.
- () Temporarily secure the dial drive bracket to the chassis at BG and BF with 6-32 × 3/8" flat head hardware. Position the dial drive assembly as far forward (away from the VFO assembly) in the bracket slots as possible.



Detail 6-2A

Refer to the Pictorial and to Detail 6-2A for the following steps.

- () Position the chassis with its side toward you as shown in the Detail. This will permit you to observe the relative heights of the dial shaft and the VFO tuning capacitor shaft. **NOTE:** A short straightedge placed along the top of either shaft may help you to accurately align the two shafts.
- () Slightly adjust the vernier drive upward or downward in dial drive bracket slots DA and DB until the height of the VFO shaft and the dial drive shaft are equal. Refer to the Pictorial and tighten bracket screws DA and DB.



Detail 7-1A



POSITION THE SMALL PORTION OF THE GROMMET INTO THE CHASSIS HOLE.

BEND THE LARGE PORTION OF THE GROMMET OVER AND INTO THE SMALL PORTION. PRESS IT FIRMLY INTO PLACE.

Detail 7-1B

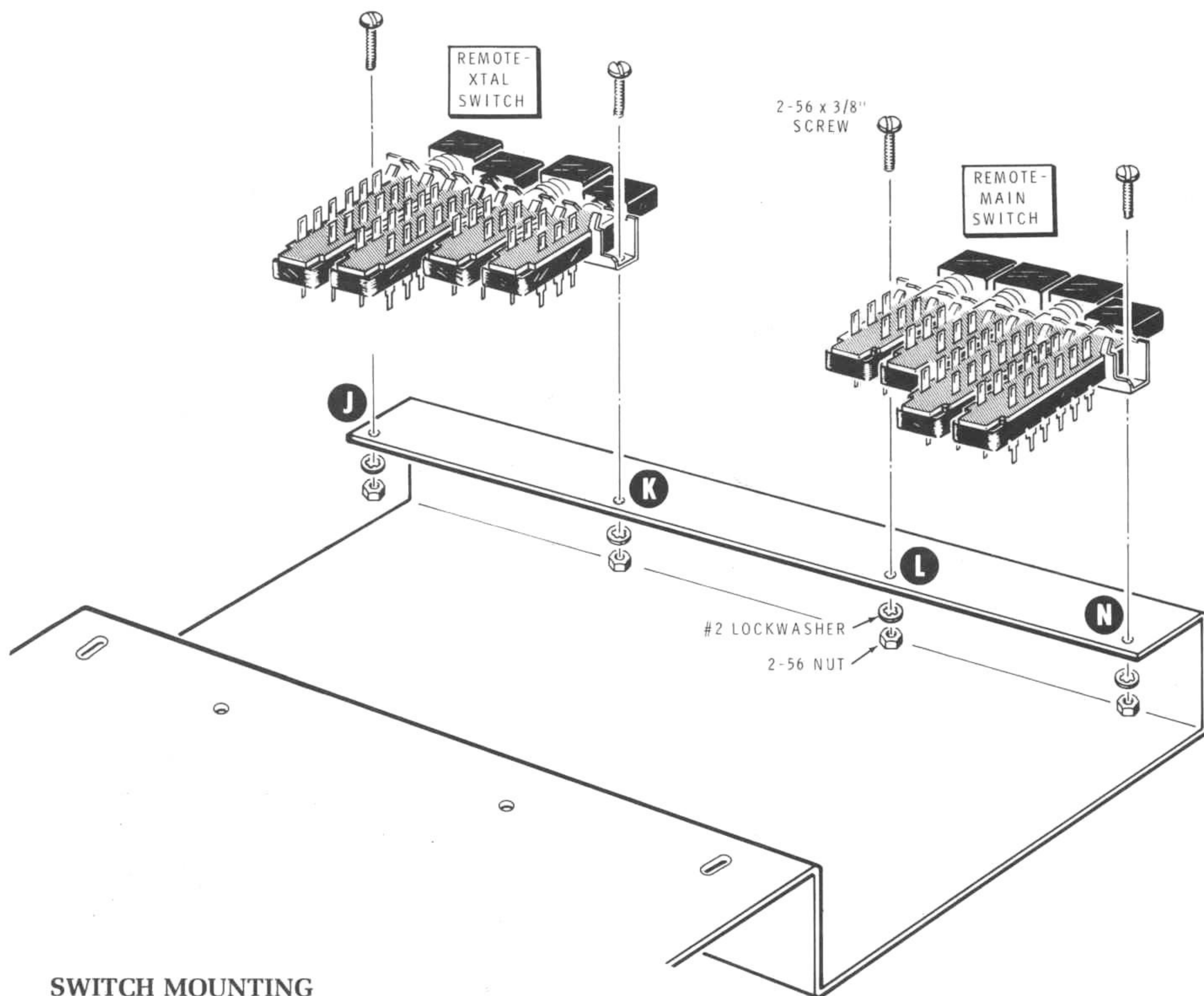
- () Loosen and remove VFO mounting screws T and U. Set these and the VFO assembly aside temporarily.
- () Loosen and remove dial drive bracket mounting screws BF and BG. Set these screws and the dial drive assembly aside temporarily.

Refer to Pictorial 7-1 (Illustration Booklet, Page 5) for the following steps.

- () Refer to Detail 7-1A and mount a phono socket at F with 6-32 \times 3/8" hardware. Position the short (ground) lug toward the inner chassis fold as shown.

- () In the same manner, mount a phono socket at G.
- () Mount the crystal osc/switch circuit board on the chassis as shown. Use 4-40 \times 5/16" hardware to secure the board at C, D, and E. Use a 4-40 \times 5/16" screw, a #6 solder lug, and a 4-40 nut at B. Position the solder lug as shown.

- () Refer to Detail 7-1B and push the small portion of the plastic grommet into hole A. Secure the grommet by pushing the large portion firmly into the small portion.



SWITCH MOUNTING

Refer to Pictorial 8-1 for the following steps.

- () Position the chassis on your work surface as shown.

NOTE: Refer to Detail 8-1A and Detail 8-1B. It is very important that the two 4-section switch assemblies (#64-678) be properly identified. In the following steps they will be referred to by their functional names, according to the lettering on the front panel. Position both switch assemblies side-by-side with the looped lugs upward as shown. When they are mounted onto the chassis, the assembly shown in Detail 8-1A (#64-678) is the Remote-Main switch. The assembly shown in Detail 8-1B (#64-677) is the Remote-Xtal switch. In the following steps, you will install wires on the switch assemblies.

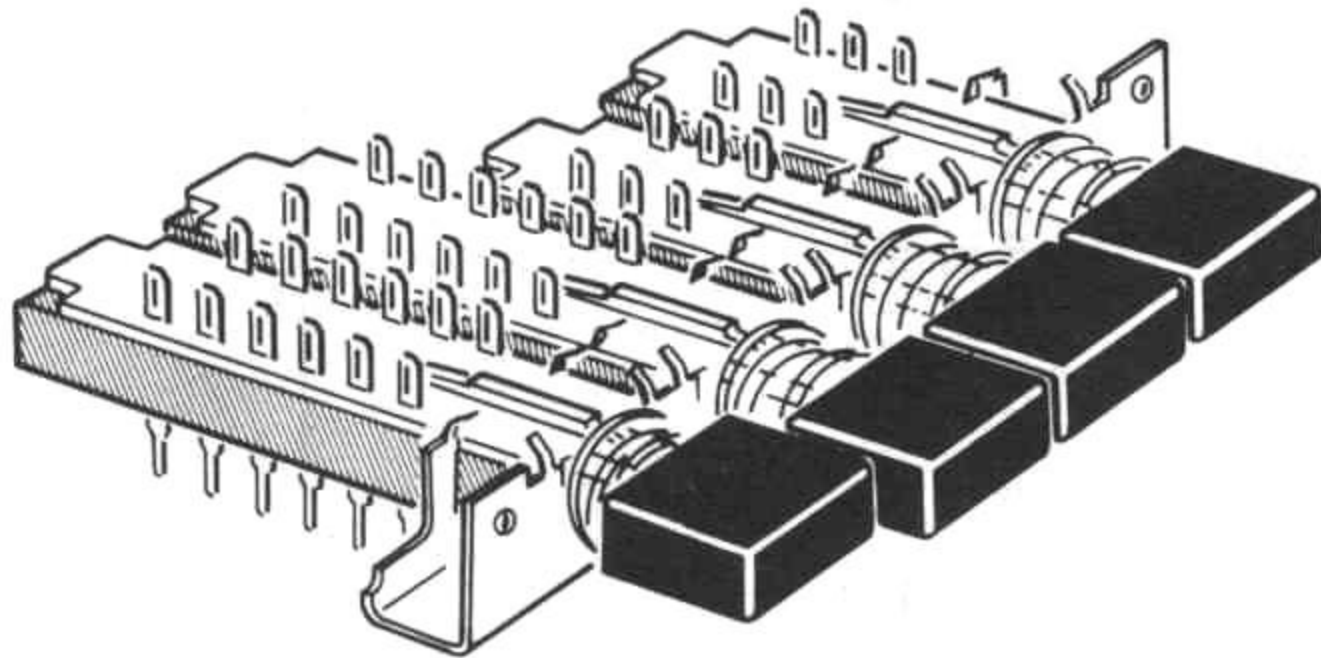
PICTORIAL 8-1

- () SW1276: Mount the Remote-Main switch assembly (#64-678) at L and N on the front of the chassis with 2-56 × 3/8" hardware. Be sure to mount the switch with the looped lugs up as shown.

SW1275: In the same manner, mount the Remote-Crystal switch assembly on the chassis at J and K with 2-56 × 3/8" hardware.

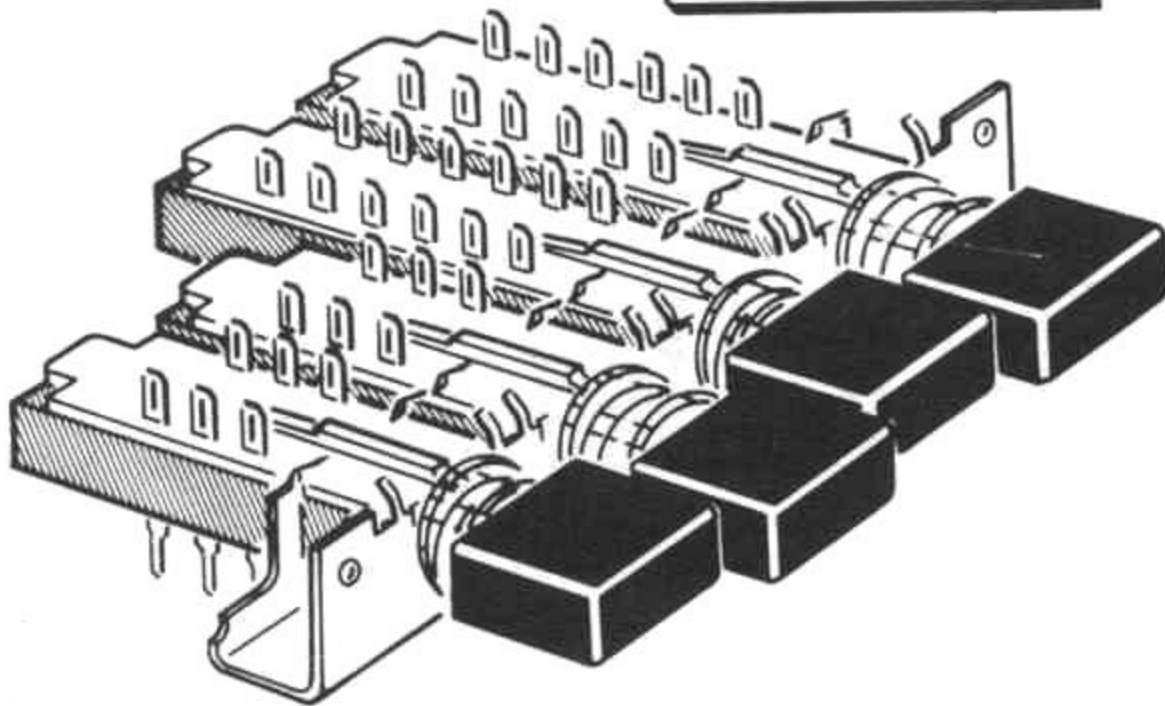


REMOTE-MAIN
SWITCH #64-678



Detail 8-1A

REMOTE-XTAL
SWITCH #64-677



Detail 8-1B

Carefully note the switch lug numbering and connect the prepared wires to the switch lugs as follows:

- () 3/4" gray from switch section A lug 4 (S-1) to section A lug 12 (NS).
- () 3/4" gray from section A lug 10 (S-1) to section A lug 6 (NS).
- () 2-1/4" red from section A lug 3 (S-1) to section B lug 11 (NS).
- () 1-1/2" red from section B lug 11 (NS) to section C lug 5 (NS).
- () 1-1/2" red from section C lug 5 (S-2) to section D lug 5 (NS).
- () 1-1/4" gray from section C lug 2 (NS) to section D lug 2 (S-1).
- () Connect one end of the 2-1/2" red wire to section C lug 4 (S-1). The other end will be connected later.
- () Remove all of the insulation from a 2" gray wire. Use the wire in the next two steps.
- () Connect a 1-1/4" bare wire from section A lug 9 (S-1), through section B lugs 3 (S-2) and 9 (S-2), to section C lug 2 (NS).
- () Connect a 3/4" bare wire from section A lug 8 (S-1), through section B lug 2 (S-2), to section B lug 8 (NS).
- () R1275: Connect a 3300 Ω (orange-orange-red) resistor from section B lug 11 (S-3) to section D lug 3 (S-1).

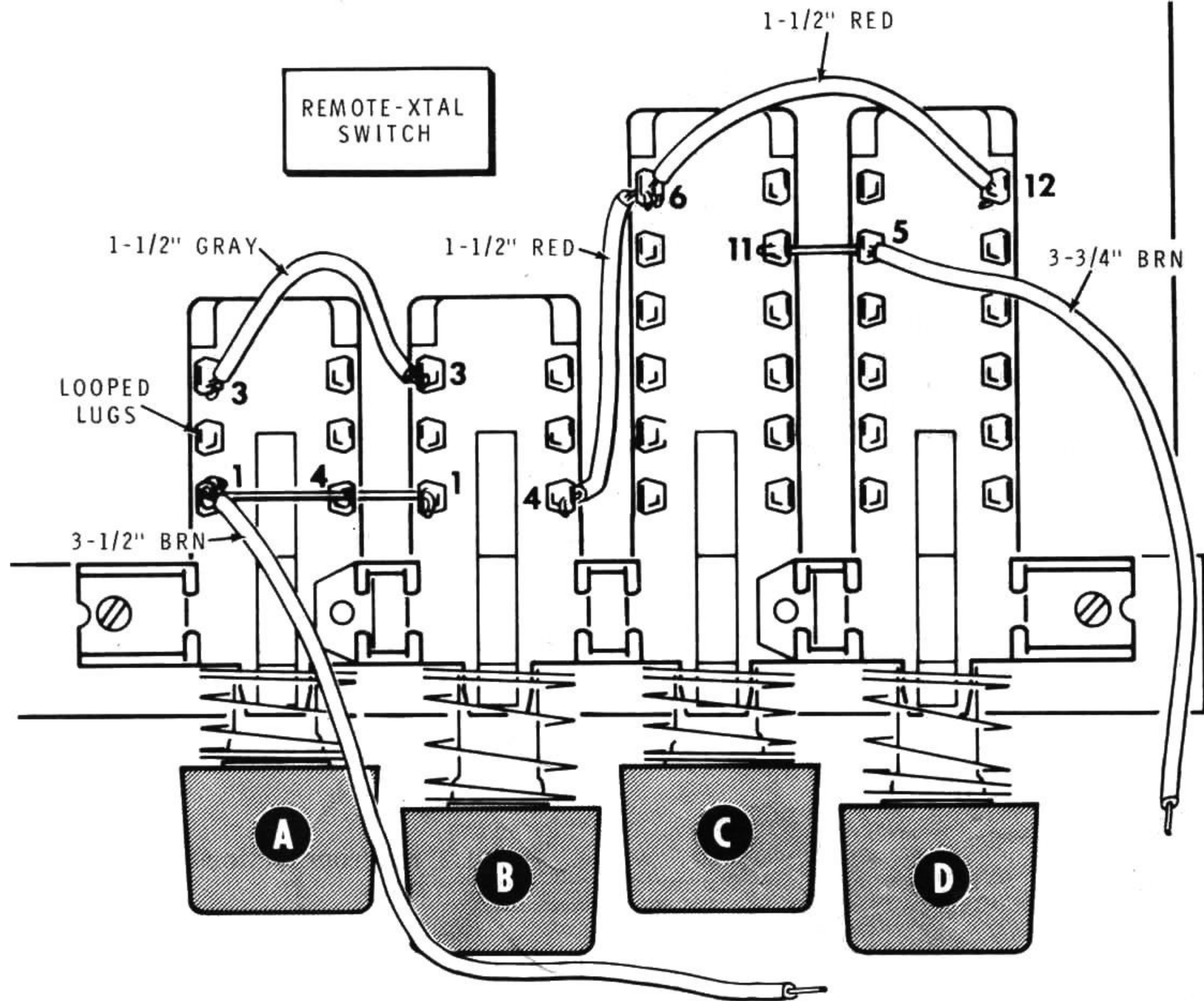
REMOTE-MAIN SWITCH WIRING (#64-678)

Refer to Pictorial 8-2 for the following steps.

- () Prepare the following wires:

two 3/4" gray	one 1-1/4" gray
one 2-1/4" red	one 2-1/2" red
two 1-1/2" red	





PICTORIAL 8-3

REMOTE-CRYSTAL SWITCH WIRING (#64-677)

Refer to Pictorial 8-3 for the following steps.

() Prepare the following wires:

one 1-1/2" gray	two 1-1/2" red
one 3-1/2" brown	one 3-3/4" brown

Carefully note the switch lug numbering and connect the prepared wires to the switch lugs as follows:

- () 1-1/2" gray from section A lug 3 (S-1) to section B lug 3 (NS).
- () 1-1/2" red from section B lug 4 (S-1) to section C lug 6 (NS).
- () 1-1/2" red from section C lug 6 (S-2) to section D lug 12 (S-1).
- () Remove an additional 1/4" of insulation (total 1/2") from one end of the 3-3/4" brown wire. Then connect this end of the wire through section D lug 5 (S-2) to section C lug 11 (S-1). The other end will be connected later.
- () Remove all of the insulation from a 1" gray wire. Use the wire in the next step.
- () Connect one end of the 3-1/2" brown wire to section A lug 1 (NS). The other end will be connected later.
- () Connect a 1" bare wire from section A lug 1 (S-2) through section A lug 4 (S-2), to section B lug 1 (S-1).

CHASSIS WIRING

Refer to Pictorial 8-4 for the following steps.

- () Position the chassis assembly as shown in the Pictorial.
- () Prepare the following wires:

17-1/2" yellow	18-3/4" blue
18" orange	16" violet
11" red	17" brown
17-3/4" green	7-1/2" red

Connect one end of the prepared wires to switch SW1276 as follows. NOTE: Dress the wires down under the switch assembly as shown.

- () 17-1/2" yellow to section A lug 6 (S-2).
- () 18" orange to section A lug 5 (S-1).
- () 11" red to section A lug 2 (S-1).
- () 17-3/4" green to section A lug 12 (S-2).
- () 18-3/4" blue to section A lug 11 (S-1).
- () 16" violet to section B lug 8 (S-2).
- () 17" brown to section C lug 2 (S-3).
- () 7-1/2" red to section D lug 5 (S-2).
- () Cut a 4" length of large sleeving. Then slide the sleeving over the free ends of the 8 wires just connected to switch SW1276 as shown.
- () Connect the shorter red wire coming from the sleeving to switch SW1275 section B lug 6 (S-1).
- () Connect the longer red wire coming from the sleeving to switch SW1275 section D lug 7 (NS).

The other wires coming from the sleeving will be connected later.

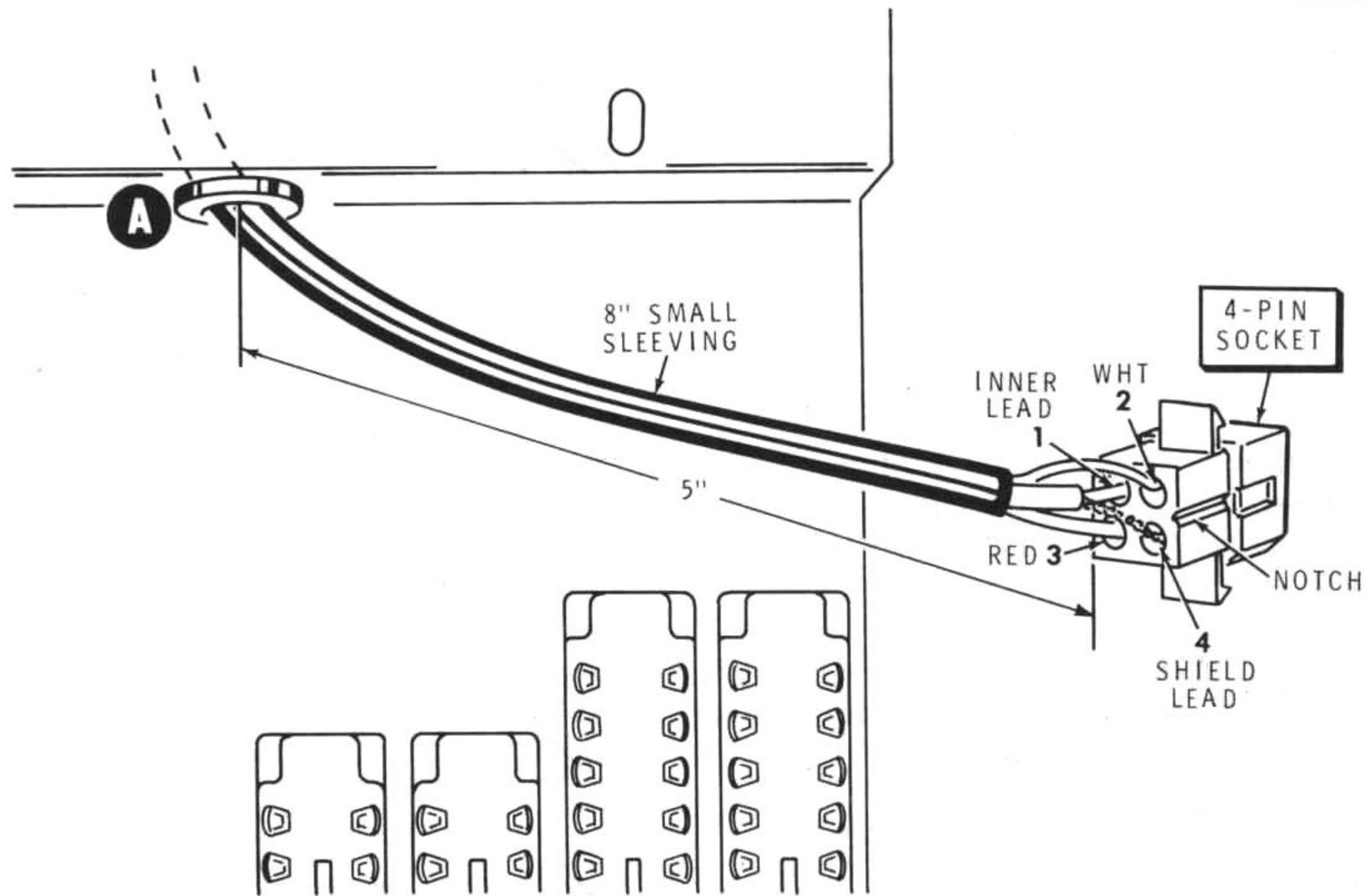
- () Prepare the following wires:

10" gray	Remove the insulation from one end only.
10-3/4" gray	
11" gray	
10-1/2" red	
8-3/4" white	
9-3/4" orange	

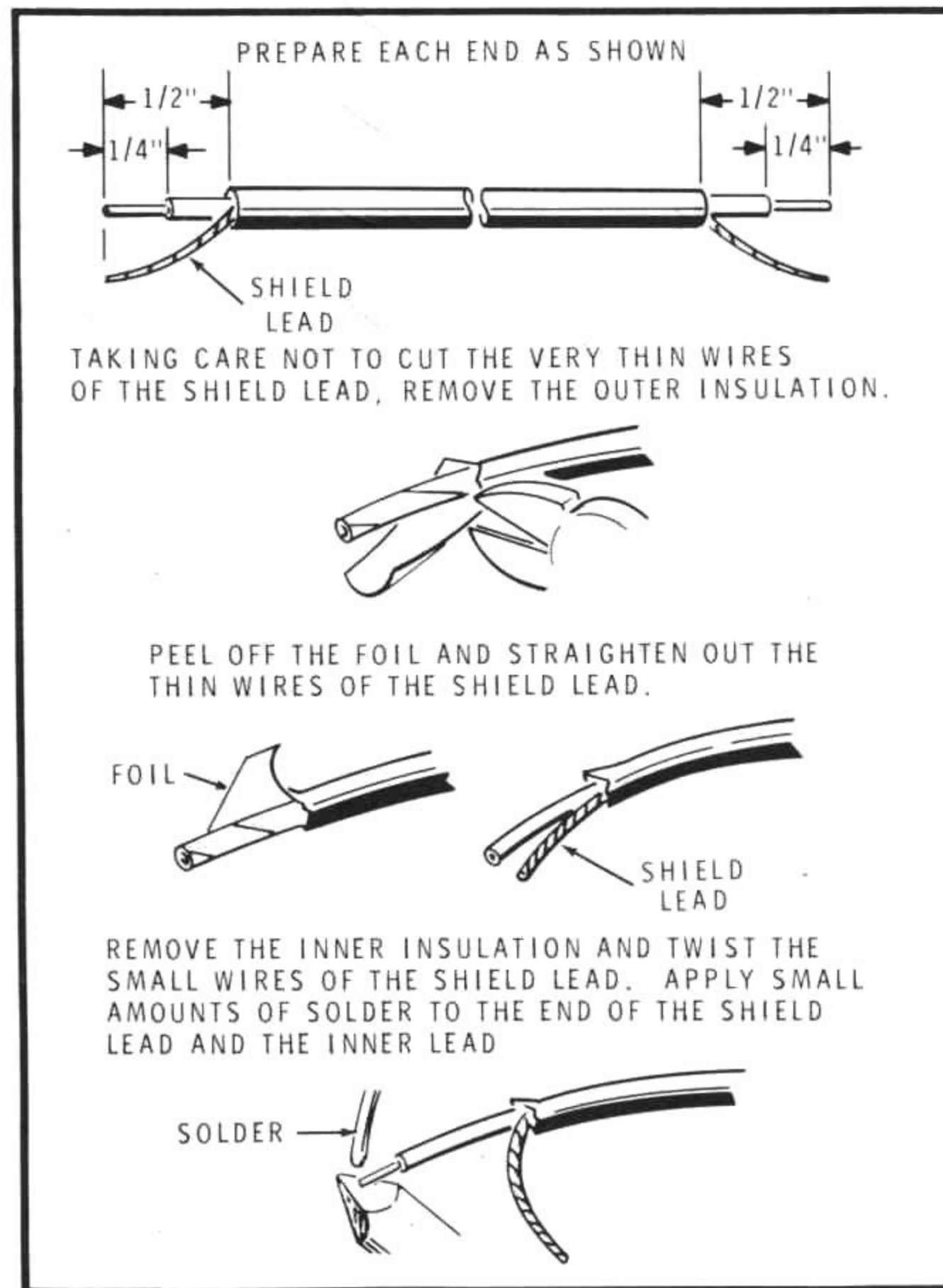
Connect one end of the prepared wires to switch SW1275 as follows. NOTE: Dress the wires down under the switch assembly as shown.

- () 10" gray to section A lug 2 (S-1). Push the other end of this wire through grommet A.
- () 10-3/4" gray to section B lug 3 (S-2).
- () 11" gray to section B lug 2 (S-1).
- () 10-1/2" red to section B lug 5 (S-1).
- () 8-3/4" white to section C lug 12 (S-1).
- () 9-3/4" orange to section D lug 6 (S-1).
- () Cut a 5-1/2" length of large sleeving. Then slide the sleeving over the free ends of the wires coming from switches SW1276 and SW1275 (except for the gray wire that you previously pushed through grommet A).
- () Carefully route the ends of the wires, coming from the sleeving, and the sleeving through grommet A as shown. The other end of the wires will be connected later.

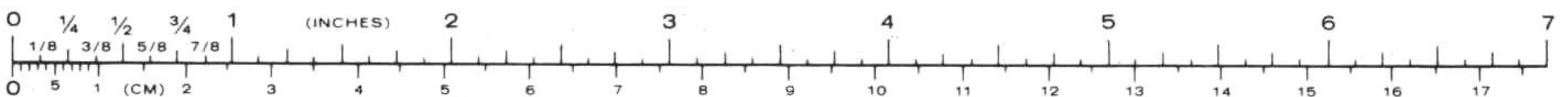


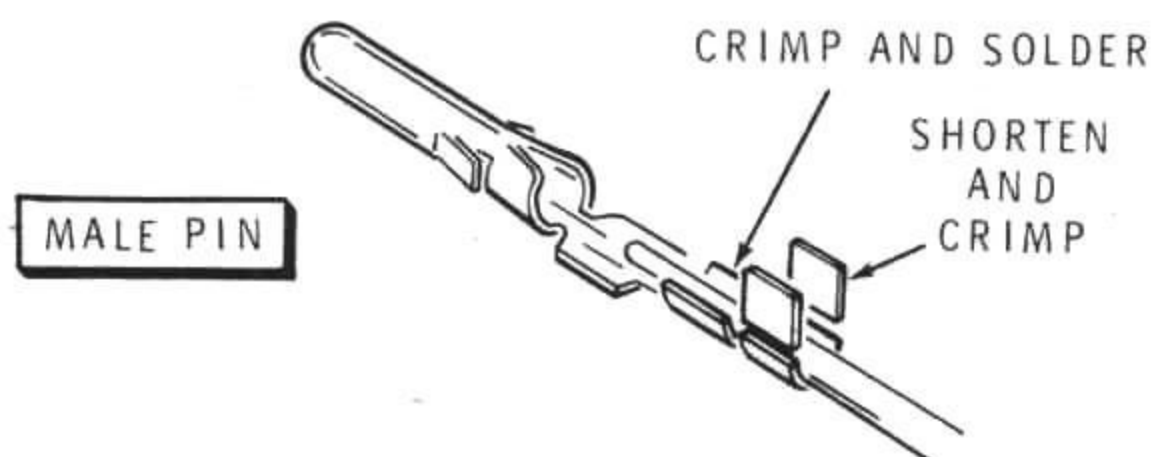


PICTORIAL 8-5

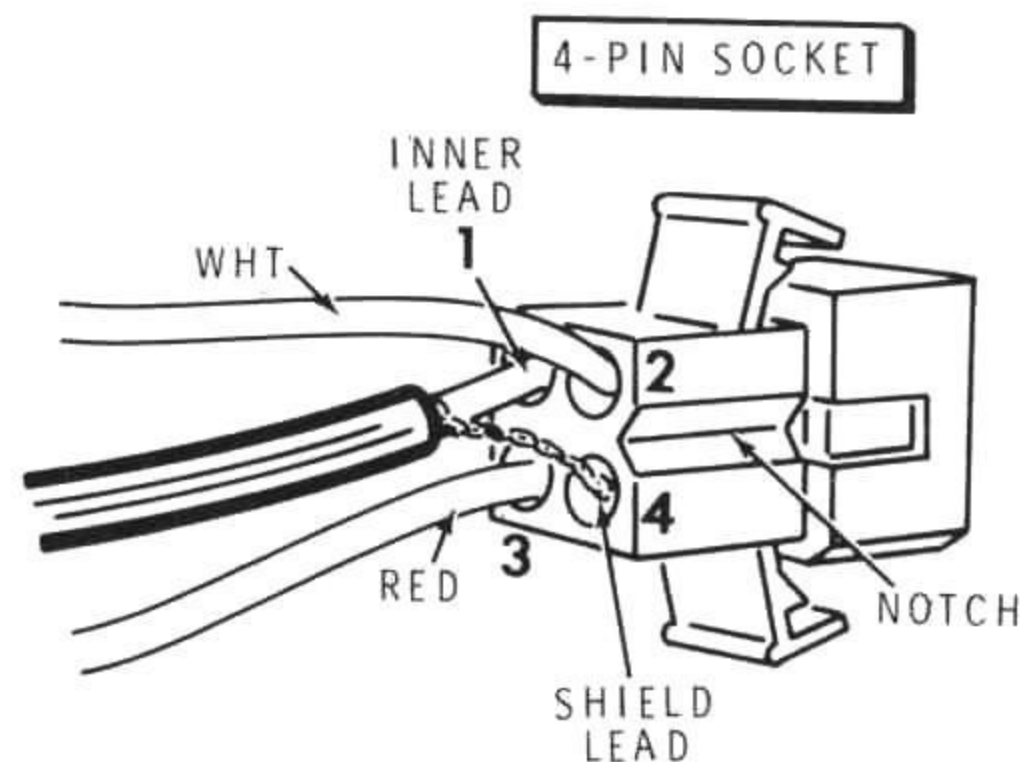


Detail 8-5A





Detail 8-5B



Detail 8-5C

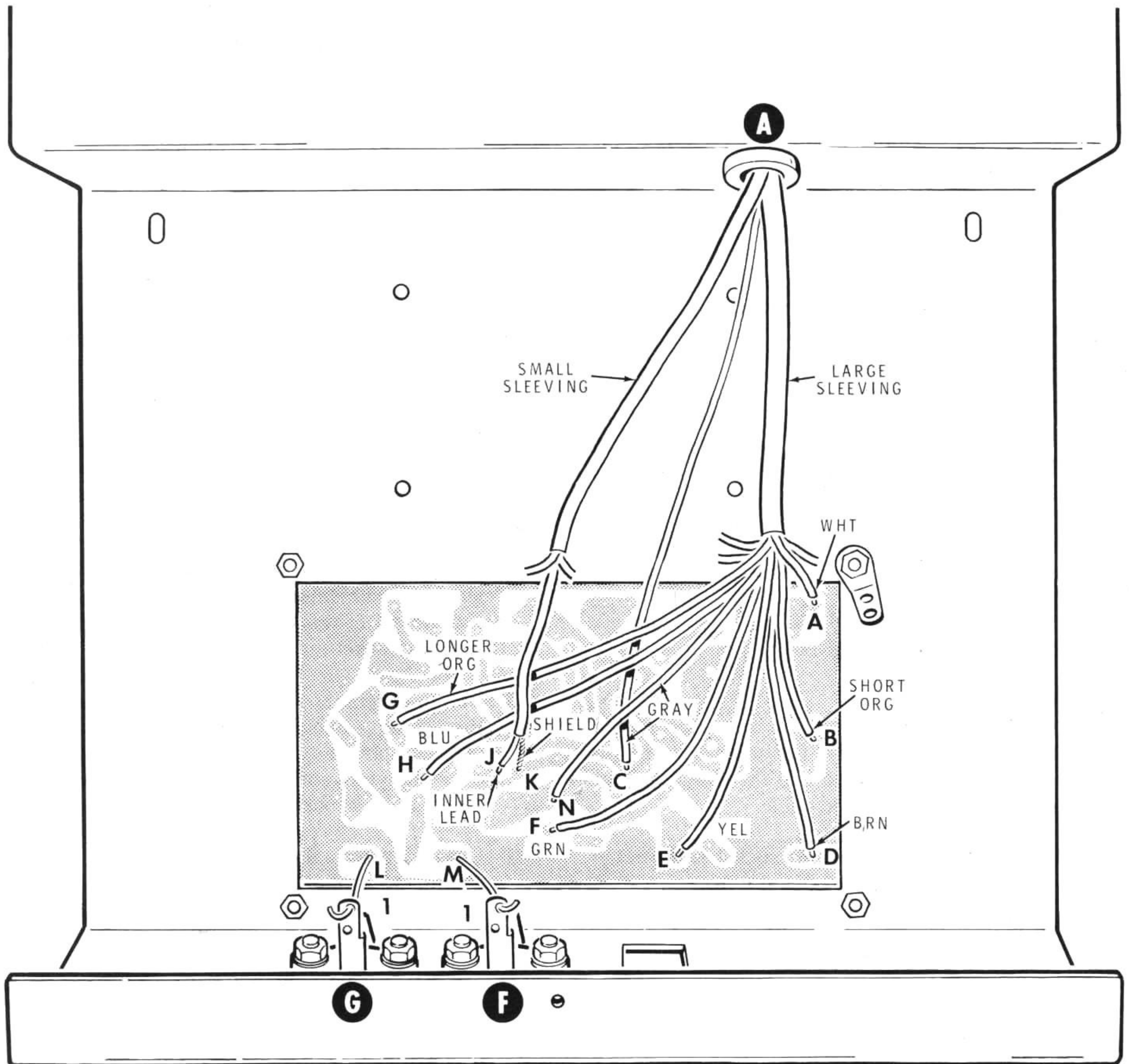
VFO CABLE PREPARATION

Refer to Pictorial 8-5 for the following steps.

- () Refer to Detail 8-5A and prepare an 11-1/2" length of small shielded cable as shown.
- () Prepare a 12-1/2" white wire and a 12-1/2" red wire.
- () Refer to Detail 8-5B and crimp and solder a male terminal onto one end of the prepared white wire.
- () In the same manner, crimp and solder a male terminal onto one end of the prepared red wire and onto the inner lead and the shield lead at one end of the shielded cable.
- () Carefully position the 4-pin socket so the notch is upward as shown in Detail 8-5C.
- (✓) Push the male terminal on the end of the white wire into hole 2 in the socket. Push the terminal into the socket until it locks in place.
- () In the same manner, push the terminal on the red wire into hole 3 of the socket.

NOTE: You will install the ends of the shielded cable in the 4-pin socket in the following step. Start the terminals of both leads at the same time as the leads are not long enough to permit them to be installed separately.

- () Push the terminal on the inner lead of the shielded cable into hole 1 and the shielded lead into hole 4 of the 4-pin socket. Push each pin into the socket until it locks in place.
- () Cut an 8" length of small sleeving. Then slide the sleeving over the free ends of the wires coming from the 4-pin socket. Push the sleeving over the wires until the end of the sleeving is 1/2" from the socket.
- () Use the heat of a flame from a match, lighter, or candle to shrink the sleeving around the wires. Be sure to keep the flame moving so you don't burn the sleeving.
- () Carefully route the ends of the wires, coming from the sleeving, and the sleeving through grommet A until the end of the socket is 5" from the grommet as shown.



PICTORIAL 8-6



UNDER CHASSIS WIRING

Refer to Pictorial 8-6 for the following steps.

- Remove all of the insulation from a 2" gray wire. Use the bare wire in the next two steps.
- Connect a 1" bare wire from phono socket F lug 1 (S-1) to circuit board hole M (S-1).
- Connect a 1" bare wire from phono socket G lug 1 (S-1) to circuit board hole L (S-1).

NOTE: In the following steps, you will connect several wires to the foil side of the XTAL OSC/SW circuit board. To do this, push the end of the wire through the indicated hole in the foil, leave 1/16" of the bare wire exposed at the foil. Then solder the wire to the foil. DO NOT cut the excess wire ends from the top side of the circuit board. Some of these wire ends will be used for test points later.

- Connect the single gray wire coming from grommet A to circuit board hole C (S-1).

Connect the wires coming from the **larger** sleeving to the circuit board as follows:

- White wire to hole A (S-1).

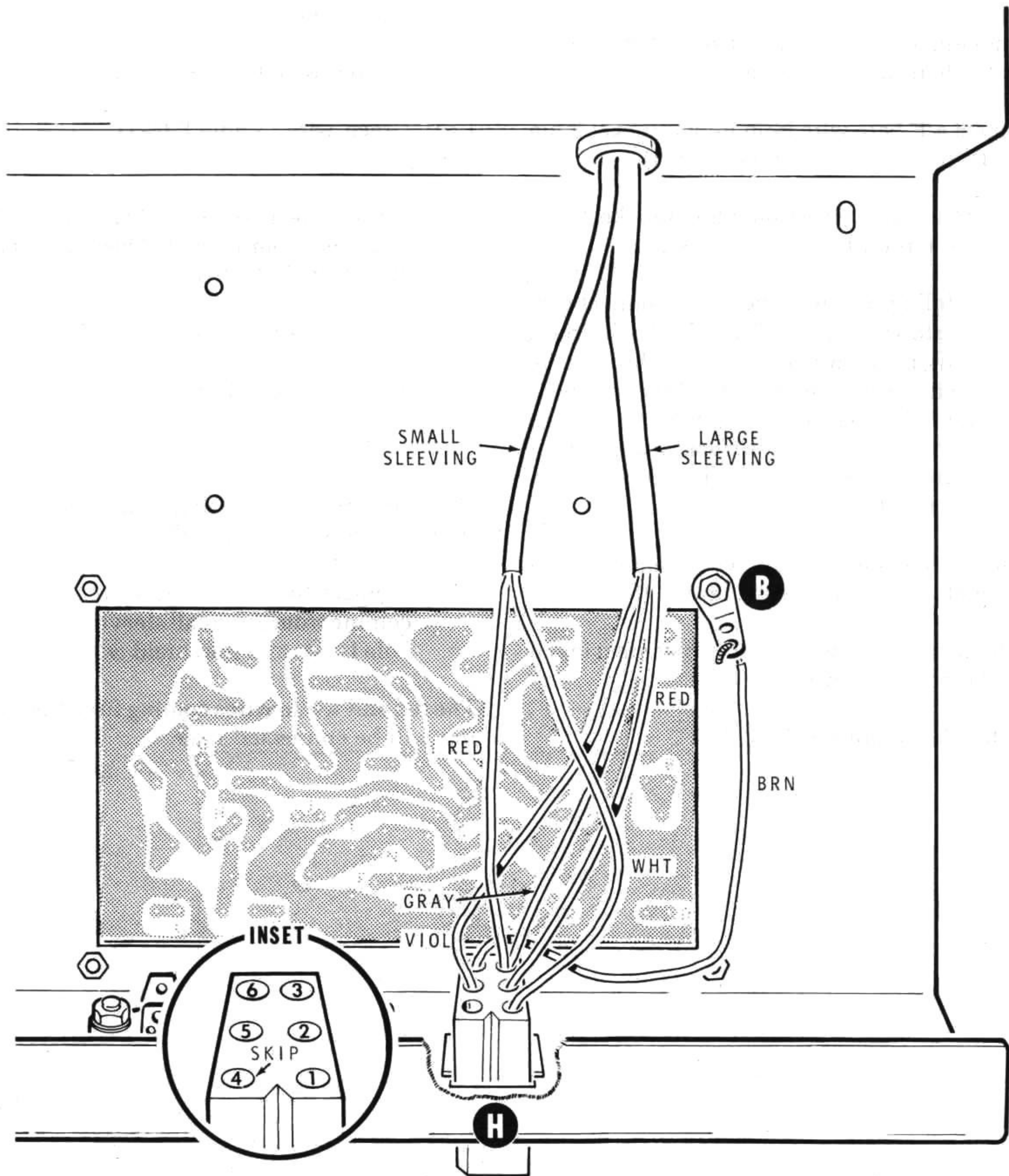
- Shorter orange wire to hole B (S-1).
- Brown wire to hole D (S-1).
- Yellow wire to hole E (S-1).
- Green wire to hole F (S-1).
- Locate the gray wire that has the insulation removed from its end. Then connect this gray wire to hole N (S-1).
- Longer orange wire to hole G (S-1).
- Blue wire to hole H (S-1).

The remaining red, violet, and gray wires coming from the large sleeving will be connected later.

- Connect the inner lead of the shielded cable, coming from the small sleeving, to circuit board hole J (S-1) and the shield wires to hole K (S-1).

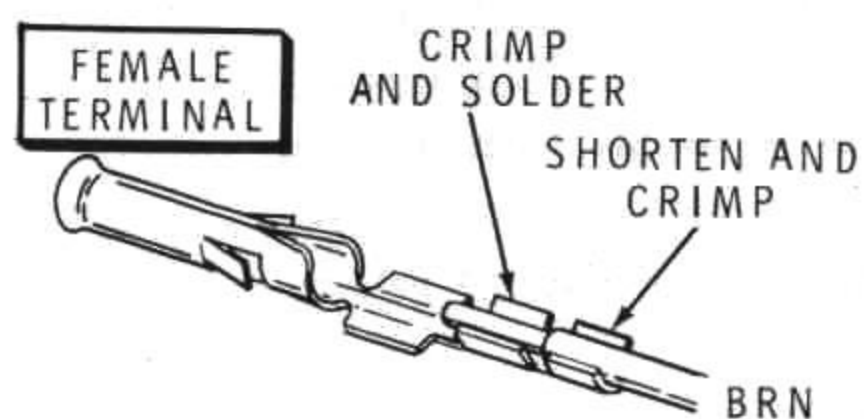
The red and white wires coming from the small sleeving will be connected later.





PICTORIAL 8-7

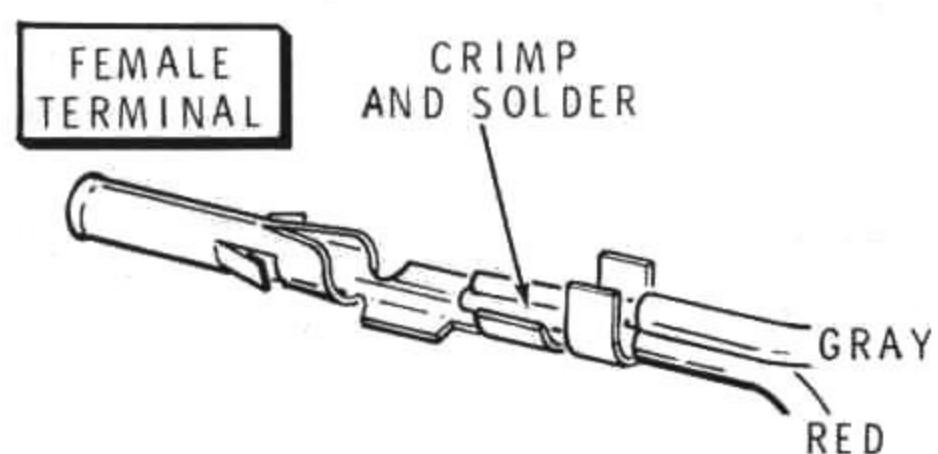




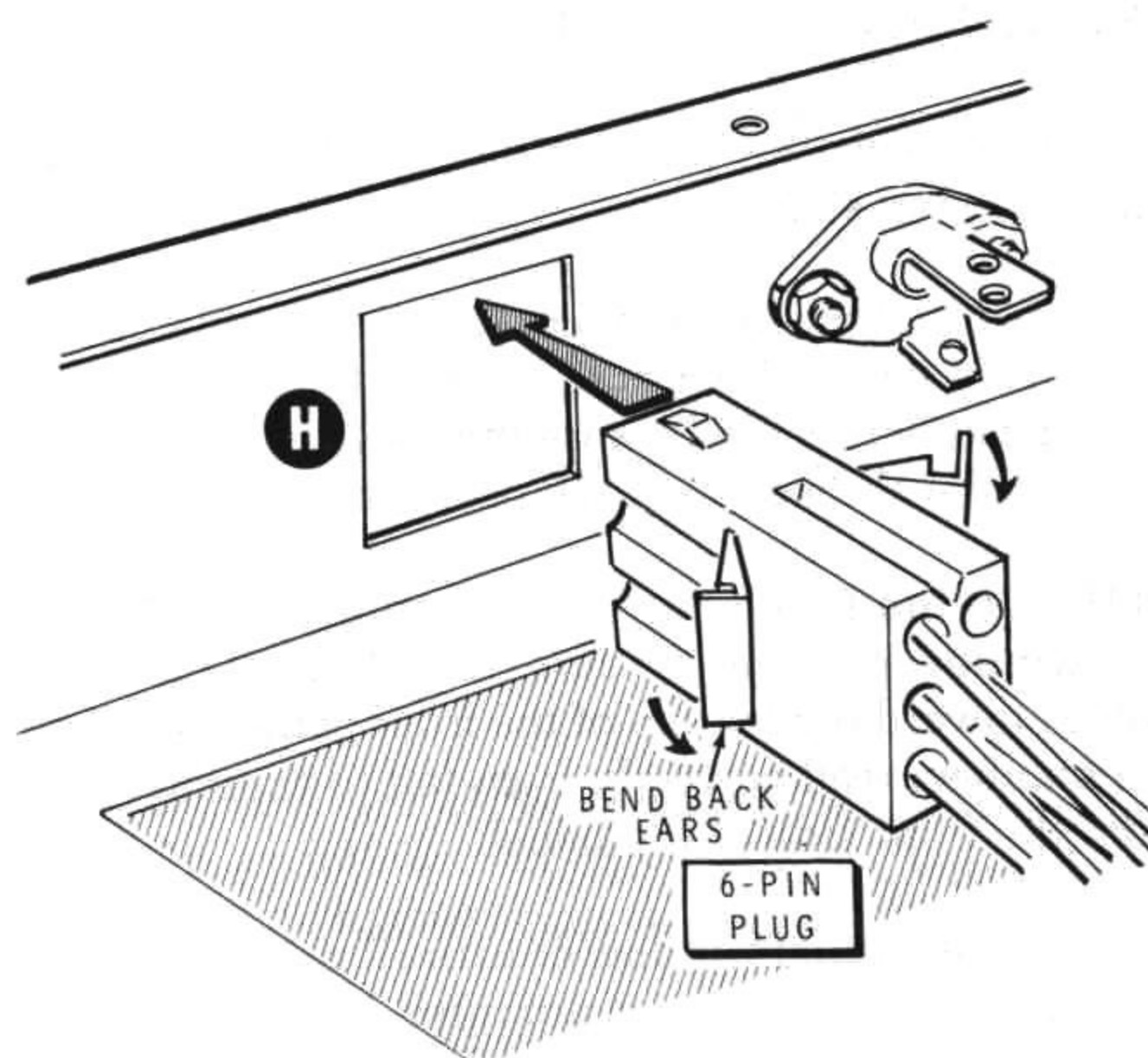
Detail 8-7A

Refer to Pictorial 8-7 for the following steps.

- () Prepare a 4-1/2" brown wire.
- () Refer to Detail 8-7A and crimp and solder a female terminal onto one end of the prepared brown wire.
- () In the same manner, crimp and solder female connectors onto the free ends of the red and violet wires coming from the large sleeving and the white wire coming from the small sleeving.
- () Remove 1/4" of insulation from the end of the gray wire coming from the large sleeving. Then refer to Detail 8-7B and crimp the end of this wire **and** the end of the red wire coming from the small sleeving into a female terminal. Carefully solder the wires to the terminal.



Detail 8-7B



Detail 8-7C

Carefully study the 6-pin plug and locate the numbered holes as shown on the inset drawing in Pictorial 8-7. Then push the female terminals into the plug from the rear in the following steps. Push each terminal into the plug until it locks in place.

- () Brown wire terminal to hole 6. Connect the other end of this wire to solder lug B (S-1).
 - () Violet wire terminal to hole 5.
- NOTE: Be sure to skip hole 4.
- () Terminal on the gray and red wires to hole 3.
 - () Red wire terminal to hole 2.
 - () White wire terminal to hole 1.
 - () Refer to Detail 8-7C and position the 6-pin plug as shown. Then bend the ears of the plug rearward and push the plug firmly into opening H in the chassis until it locks in place.

Set the chassis assembly aside temporarily.

FRONT PANEL ASSEMBLY

Refer to Pictorial 9-1 (Illustration Booklet, Page 6) for the following steps.

- () Secure the slide bracket to the rear side of the front panel at AA and AB with 6-32 \times 1/2" flat head hardware. Be sure the pulleys on the rear of the slide bracket are positioned as shown.

NOTE: In the following step, carefully observe the dial window printing. Be sure the bottom of the window is toward the bottom of the front panel, and that the numbers read correctly from left to right as seen from the front side of the panel.

- () Place the dial window onto the threaded ends of the flat head screws mounted in the previous step. Loosely secure the dial window (finger tight plus 1/8 turn) with a #8 flat washer and a 6-32 nut on screw AA.
- () Secure the window at AB with a #8 flat washer and a 6-32 locknut. Tighten the nut until it is snug; then loosen the nut 1/2 turn.

Refer to Pictorial 9-2 for the following steps.

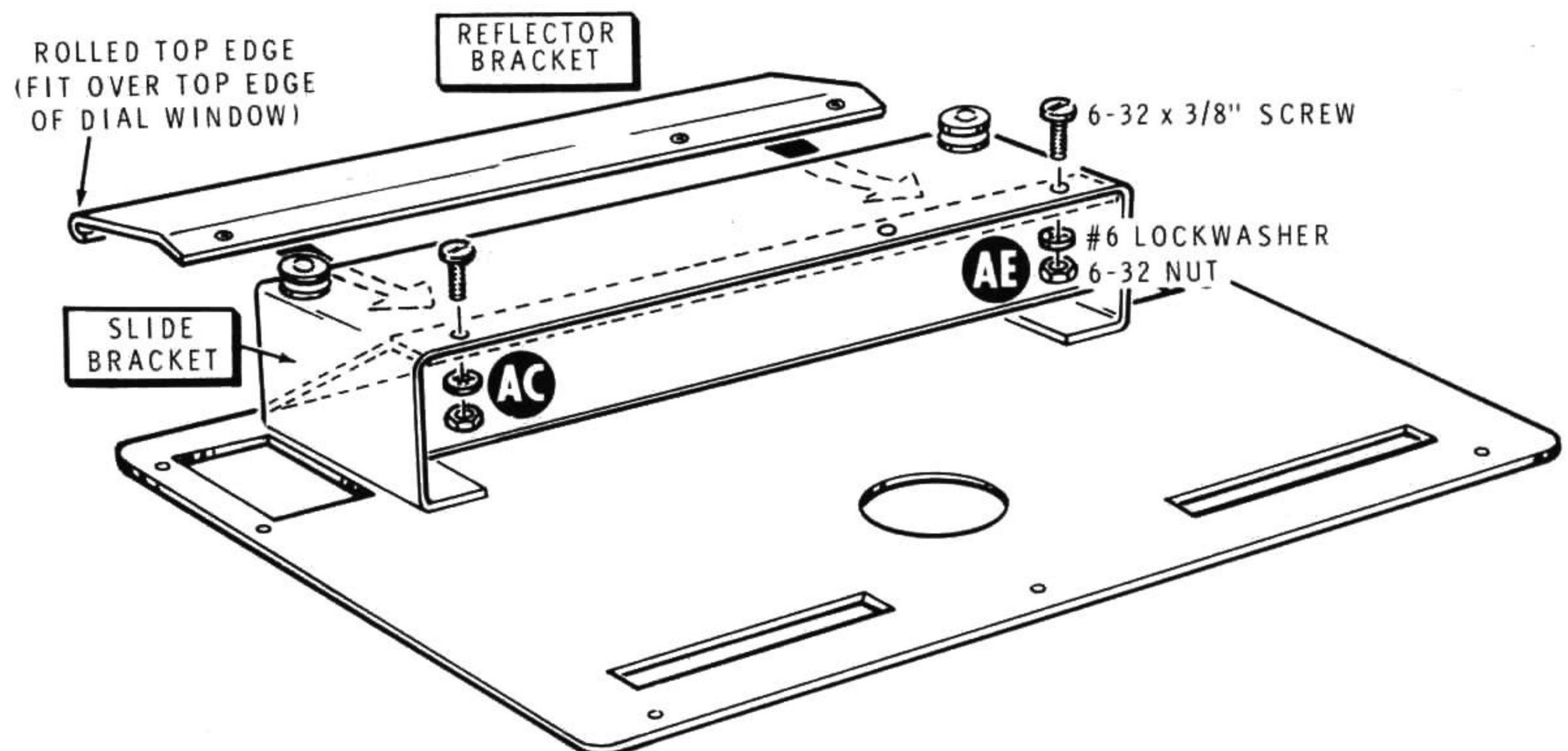
- () Refer to Detail 9-2A and secure the reflector bracket to the lower edge of the slide bracket with 6-32 \times 3/8" hardware as shown. Be sure to position the rolled top edge **over** the top edge of the dial window to hold it in place.

- () Prepare the following wires:

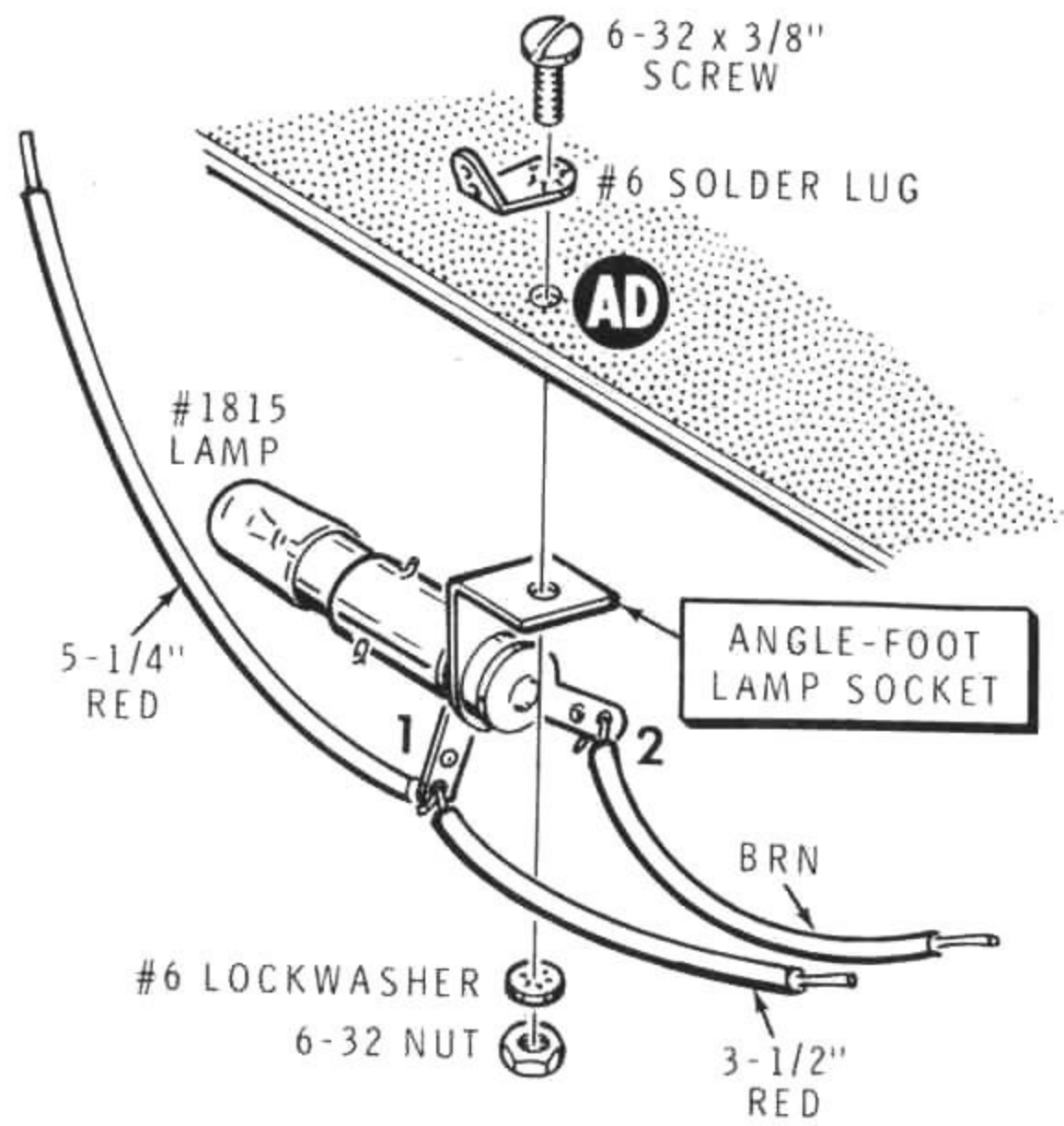
2" brown
3-1/2" red
5-1/4" red

Refer to Detail 9-2B for the following steps.

- () Connect the 2" brown wire to lug 2 of the angle foot lamp socket (#434-88) as shown (S-1).
- () Connect one end of a 3-1/2" red wire and one end of a 5-1/4" red wire to lug 1 of the same lamp socket (S-2). NOTE: The free ends of the brown wire and the two red wires will be connected later.
- () PL1275: Install a #1815 pilot lamp in the lamp socket.
- () Secure the lamp assembly to the slide bracket and the reflector bracket at AD with a #6 solder lug and 6-32 \times 3/8" hardware as shown in the Detail. Position the lamp socket housing parallel to the bottom edge of the slide bracket.



Detail 9-2A

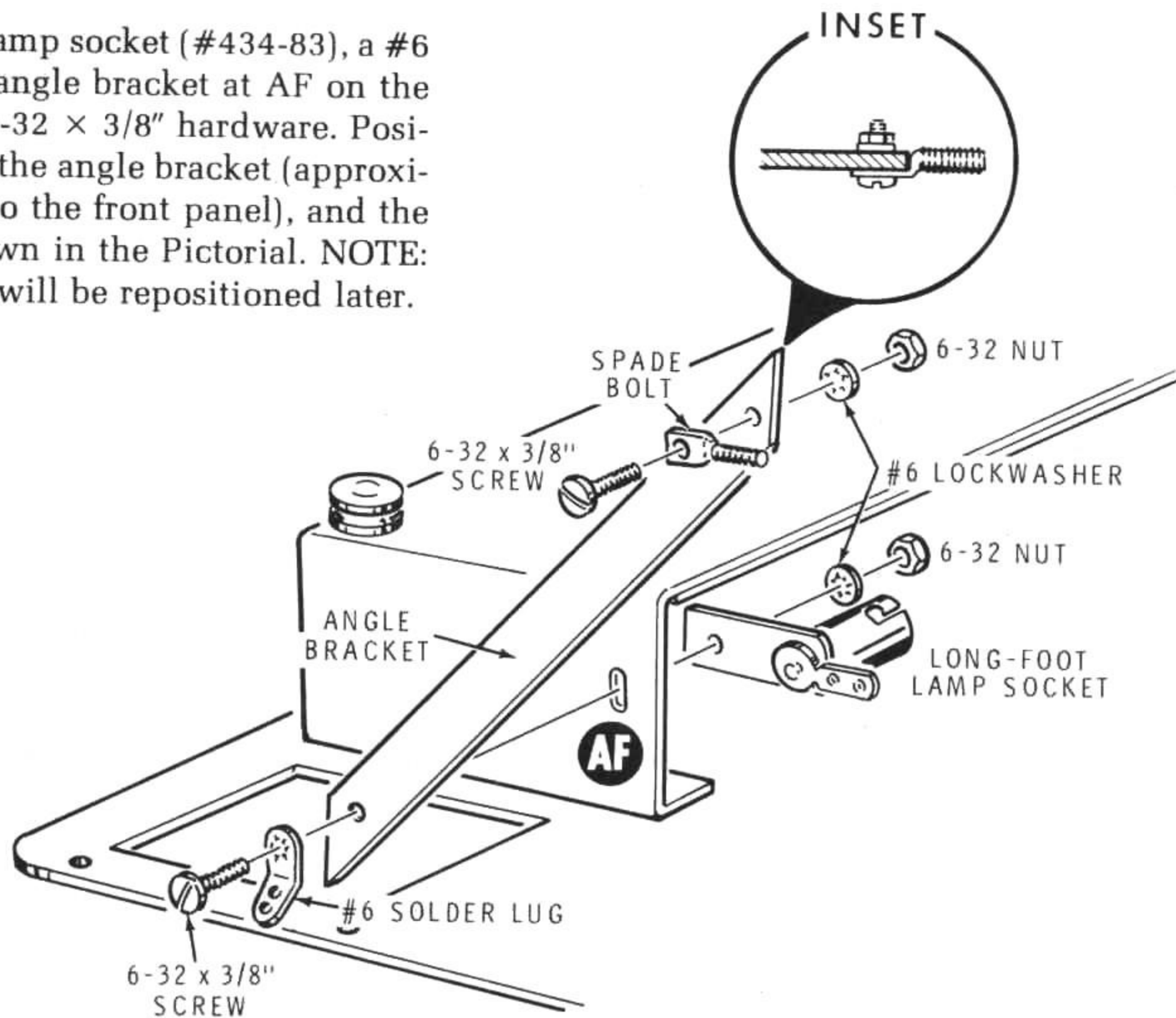


Detail 9-2B

- () In the same manner, mount the remaining long-foot lamp socket, a #6 solder lug, and the other angle bracket at AG on the slide bracket as shown. Use 6-32 x 3/8" hardware. Position the components as shown in Pictorial 9-2.
- () Refer to the inset drawing on Detail 9-2C and mount a spade bolt on the lower angled edge of each of the angle brackets as shown. Use 6-32 x 3/8" hardware.
- () Connect the brown wire coming from lug 2 of lamp socket AD to solder lug AD (S-1).
- () Connect the shorter red wire coming from lug 1 of socket AD to lug 1 of lamp socket AG (NS).
- () Connect the longer red wire coming from lug 1 of socket AD to lug 1 of lamp socket AF (S-1).
- () PL1276 & PL1277: Install #1815 pilot lamps in lamp sockets AF and AG.

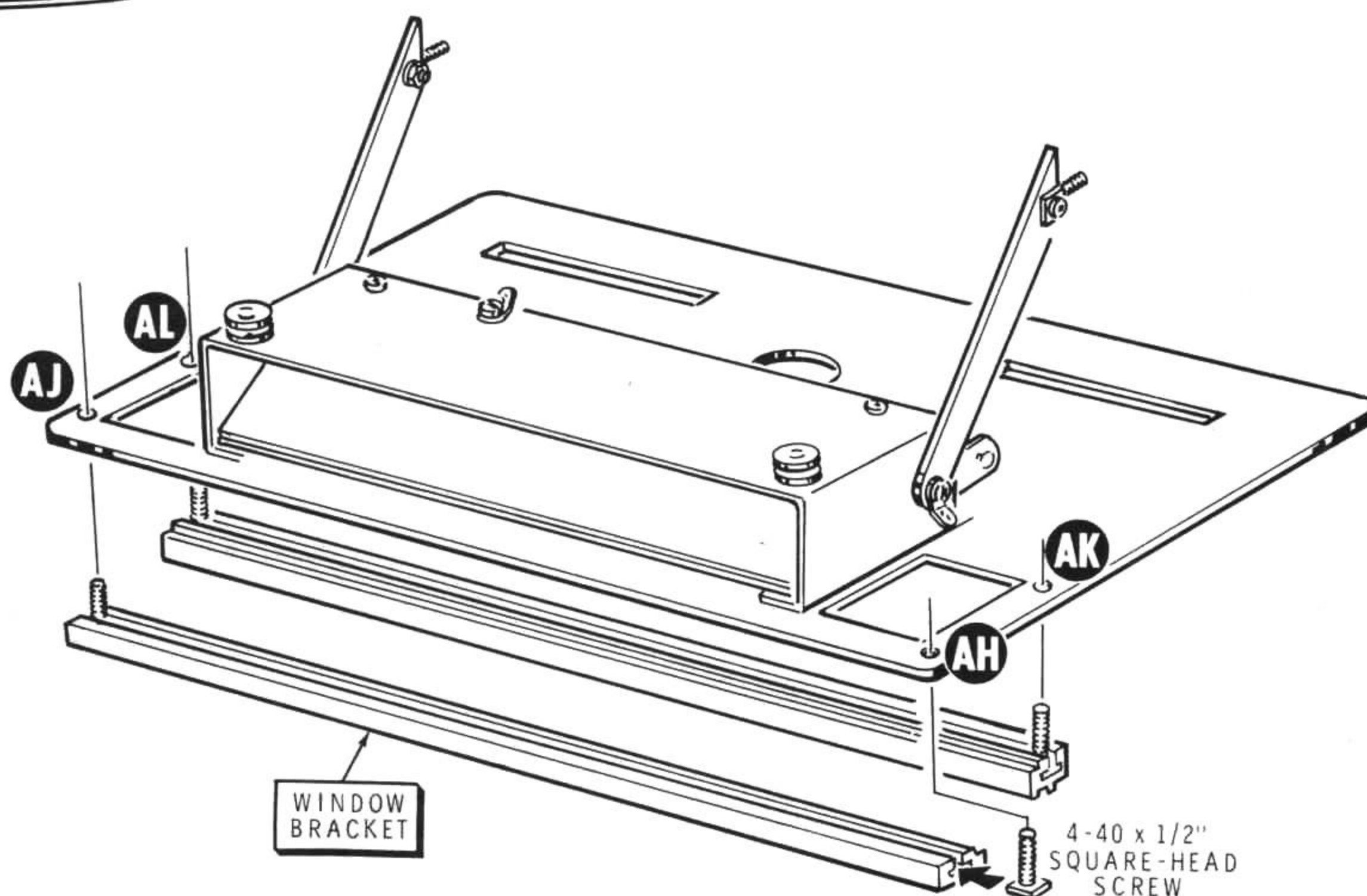
Refer to Detail 9-2C for the following steps.

- () Mount a long-foot lamp socket (#434-83), a #6 solder lug, and an angle bracket at AF on the slide bracket. Use 6-32 x 3/8" hardware. Position the solder lug, the angle bracket (approximately 45 degrees to the front panel), and the lamp socket as shown in the Pictorial. NOTE: These components will be repositioned later.



Detail 9-2C





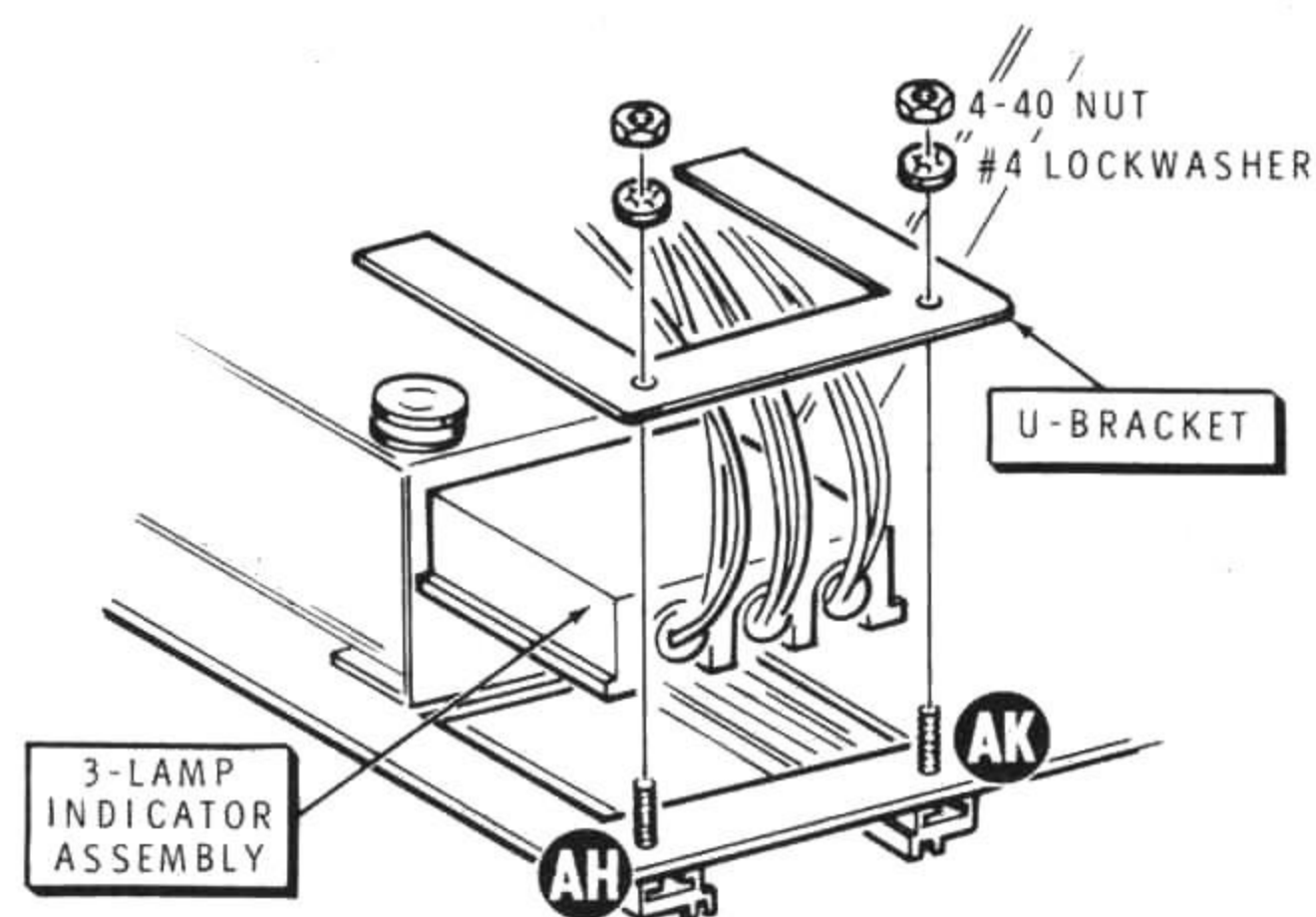
Detail 9-3A

Refer to Detail 9-3B for the following steps.

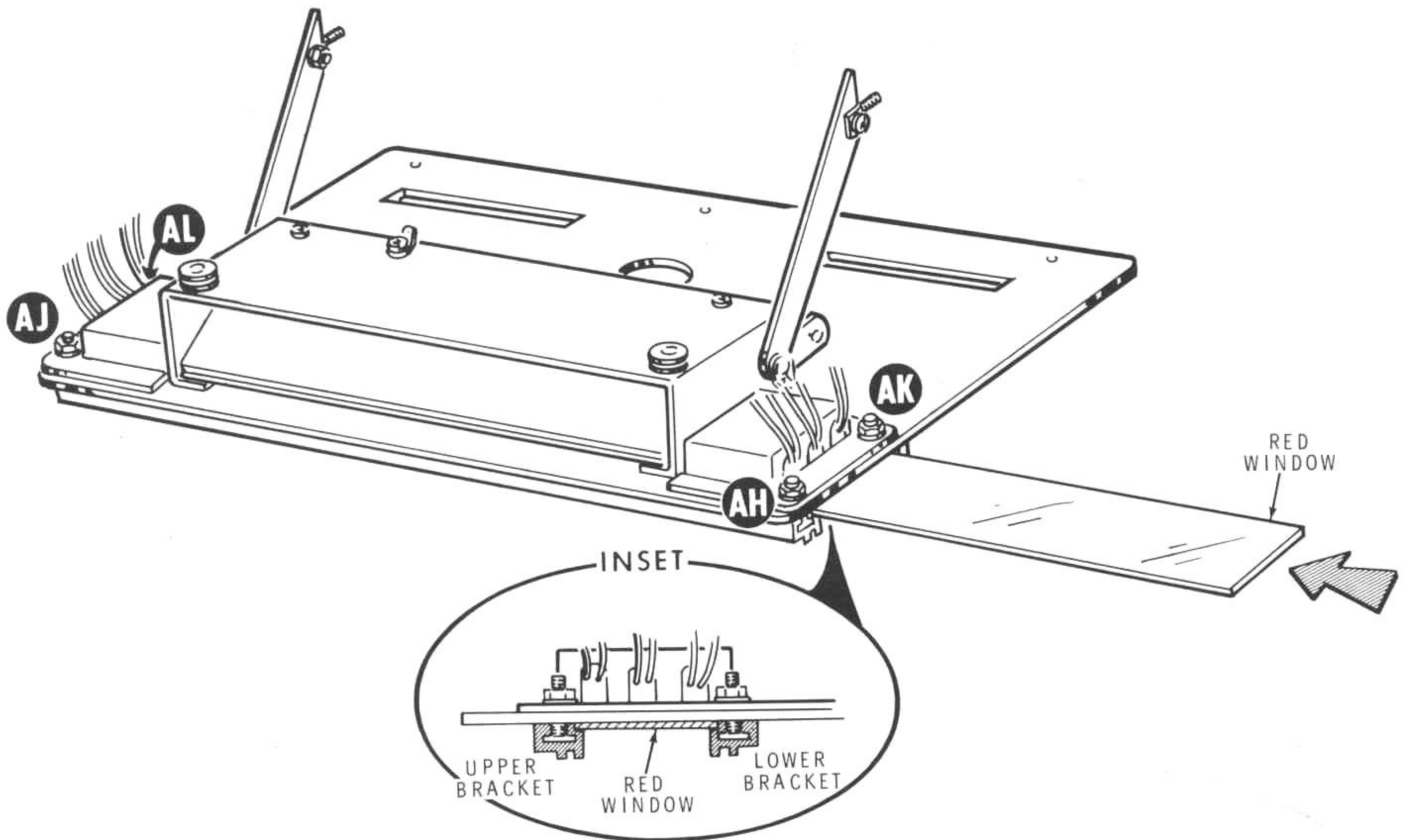
- () Place the two 3-lamp indicator assemblies into the front panel openings at both ends of the slide bracket assembly. Position each so the lamp leads are toward the outer edges of the front panel as shown.
- () Slide a U-bracket under the lamp leads and over the upper and lower flanges of each of the lamp housings. Then position the bracket onto the screw studs at AH and AK, and at AJ and AL.
- () Loosely secure the trim strips, lamp housings, and U-brackets to the front panel with #4 lockwashers and 4-40 nuts at AH, AK, AJ, and AL.
- () There may be paper backing or a thin protective film on the red window. If so, remove the paper or film from the window.

NOTE: Hold the red window to the light and observe the position in which it will be correctly installed. If necessary, carefully wash the window in warm, mild detergent water, rinse it, and then dry it with a soft cloth. Perform the following step slowly and carefully to avoid scratching the window screening.

- () Hold the red window upright and slide it into the notches in the upper and lower window brackets on the front panel. NOTE: It may be necessary to loosen the window bracket nuts slightly to perform this step.
- () When you are certain the window is installed correctly, tighten the window bracket nuts at AH, AK, AJ, and AL.



Detail 9-3B



PICTORIAL 9-3

Refer to Pictorial 9-3 for the following steps.

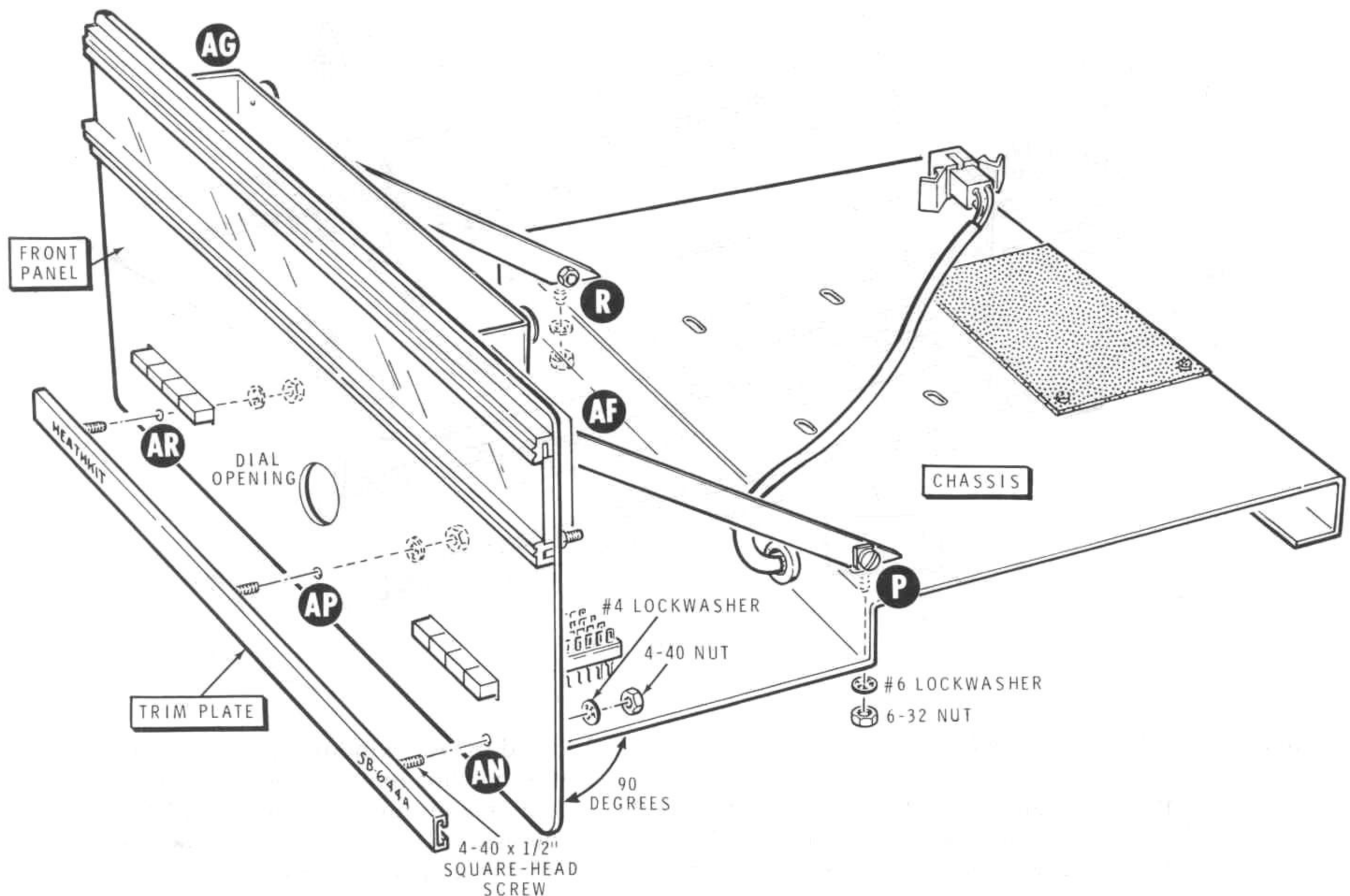
NOTE: Carefully study the inset drawing on Pictorial 9-3 and note how the upper and lower window brackets are positioned as they are installed. It is important that they are positioned exactly as shown to hold the red window securely to the front panel.

Refer to Detail 9-3A for the following steps.

() Slide two 4-40 × 1/2" square head screws into the slot in one of the window brackets as shown. Position one bolt at each end of the strip.

() Turn the bracket so it will be positioned on the front panel as the upper strip. Then lower the front panel onto the screws so they enter holes AH and AJ in the front panel. Do not secure these screws at this time.

() In the same manner, slide and position two more 4-40 × 1/2" square head screws into the other window bracket. Position the bracket as shown in the inset drawing as the lower bracket. Pick up the front panel while holding the top bracket in place and lower the panel onto the lower bracket so the screw studs pass through front panel holes AK and AL.



PICTORIAL 9-4

Refer to Pictorial 9-4 for the following steps.

- () Slide three 4-40 \times 1/2" square head screws into the trim plate as shown. Slide one screw to the center of the strip and the other two at opposite ends of the strip.
- () Hold the trim plate right side up and pass the screw threads through holes AN, AP, and AR in the front panel.
- () Position the chassis against the front panel and push the screws through holes AN, AP, and AR. Secure the screws, the trim plate, and the front panel to the chassis with 4-40 nuts and #4 lockwashers. Be sure to center the trim plate on the front panel. NOTE: Be especially careful not to pinch any wires between the chassis and the front panel.
- () Slightly loosen the screws at the top end of the angle brackets (at AF and AG).
- () Position the spade bolts on the end of the angle bracket into holes P and R in the chassis. Loosely secure the spade bolts with 6-32 nuts and #6 lockwashers.
- () Check to be sure the front panel is 90 degrees to the bottom panel of the chassis. Then tighten bracket nuts P and R.
- () Tighten bracket screws AF and AG.



Indicator Lamp Wiring

Refer to Pictorial 9-5 (Illustration Booklet, Page 7) for the following steps.

- () Connect the free end of the red wire coming from switch SW1276 section C to lamp socket AG lug 1 (S-2).
- () Connect the free end of the brown wire coming from switch SW1275 section A to solder lug AF (NS).
- () Connect the free end of the brown wire coming from switch SW1275 section D to solder lug AF (NS).
- () Cut **one** lead on each indicator lamp to the following lengths:

I1275 — 4-1/2"	I1278 — 4-1/2"
I1276 — 4-1/4"	I1279 — 4-1/4"
I1277 — 4"	I1281 — 4"

NOTE: In the next two steps, the three wire ends twisted together will be counted as **one wire** at the solder connection.

- () Remove 1/4" of insulation from the ends of the leads you shortened at I1275, I1276, and I1277. Tightly twist the three lead ends together and add a small amount of solder to hold them. Connect this twisted end to solder lug AG (S-3).
- () In the same manner, prepare and twist the shortened lead ends together coming from I1278, I1279, and I1281. Add solder to the lead ends. Connect the twisted end to solder lug AF (S-5).

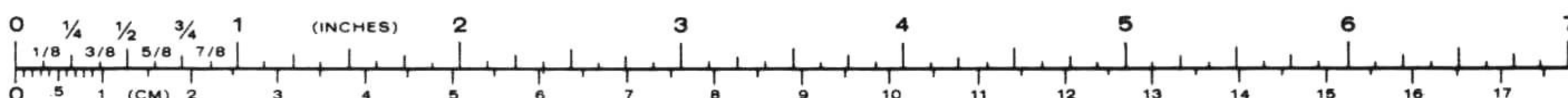
NOTE: In the following steps, cut each remaining indicator lamp lead to the indicated length. Then, remove 1/4" of insulation from the end of the lead and add a small amount of solder to hold the small strands together.

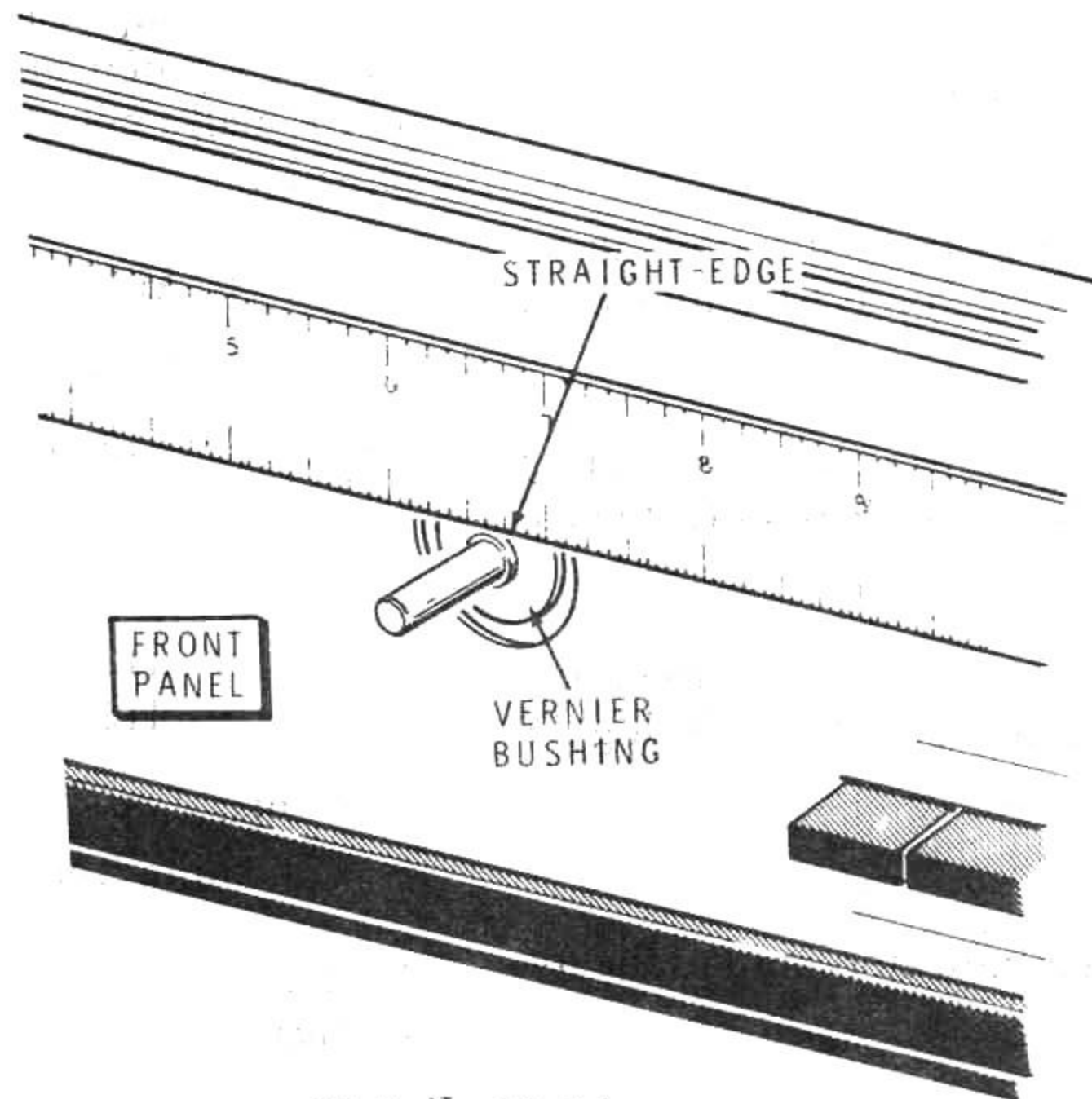
LAMP LEAD FROM:	CUT TO:
() I1275	5"
() I1276	6"
() I1277	4-1/2"
() I1278	5"
() I1279	5-1/2"
() I1281	4-1/2"

- () Place a 3" piece of small sleeving on the leads coming from I1275, I1276, and I1277.

NOTE: In the following steps, be sure you connect the correct wire to each designated switch lug.

- () Connect the lead coming from I1275 to SW1276 section C lug 6 (S-1).
- () Connect the lead coming from I1276 to SW1276 section D lug 6 (S-1).
- () Connect the lead coming from I1277 to SW1276 section B lug 12 (S-1).
- () Place a 3" piece of small sleeving on the leads coming from I1278, I1279, and I1281.
- () Connect the lead coming from I1278 to SW1275 section D lug 7 (S-2).
- () Connect the lead coming from I1279 to SW1275 section C lug 5 (S-1).
- () Connect the lead coming from I1281 to SW1275 section D lug 11 (S-1).





Detail 10-1A

Refer to Pictorial 10-1 (Illustration Booklet, Page 8) for the following steps.

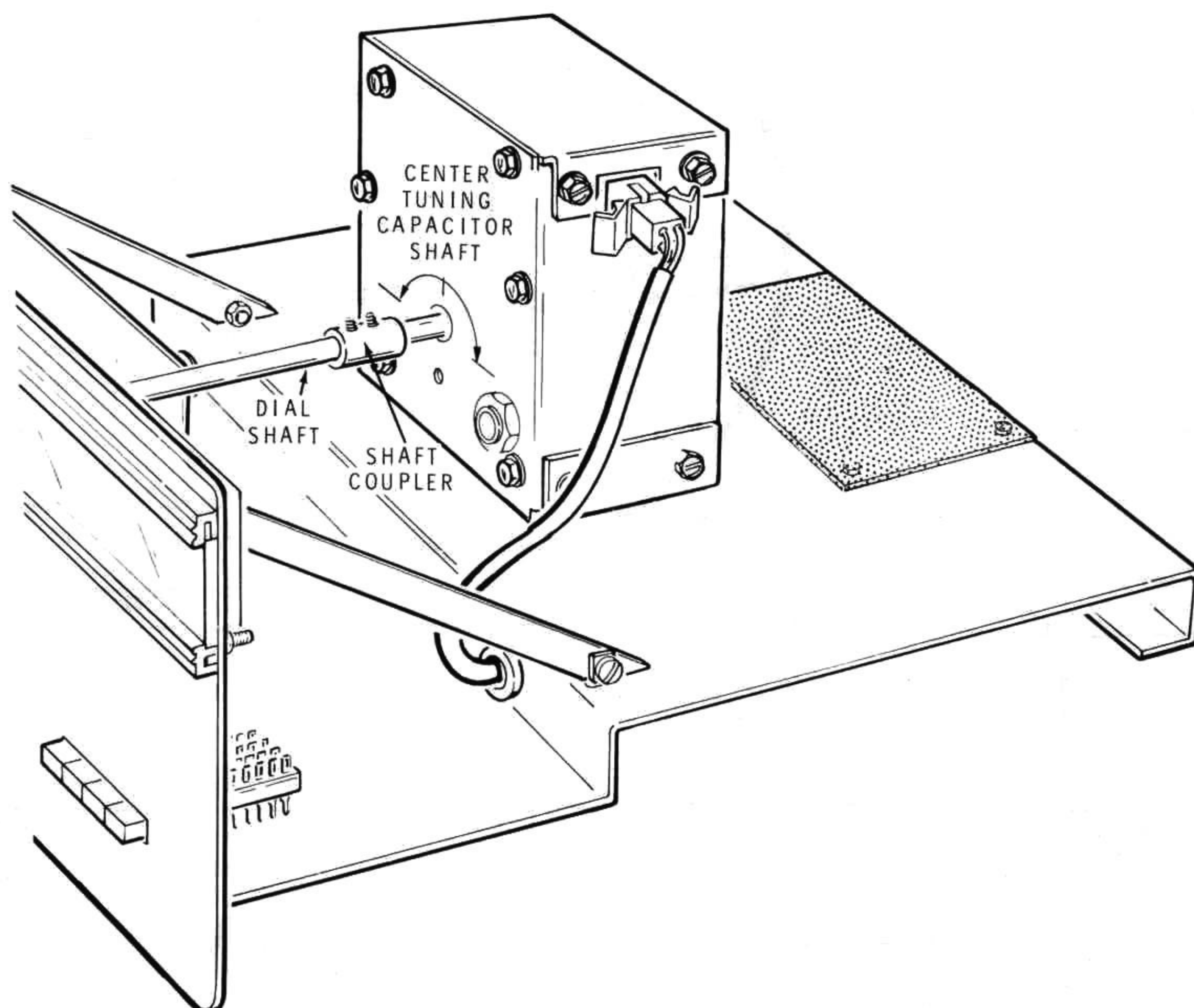
- () Start an 8-32 \times 1/4" setscrew into the bushing of the dial pulley.
- () Place the dial pulley onto the dial shaft as shown in the Pictorial. Be sure the "flush" side of the pulley is toward the front panel. Do not tighten the setscrew at this time.
- () Position the dial drive assembly into the chassis as shown. Loosely secure the drive assembly to the chassis at BF and BG with 6-32 \times 3/8" flat head hardware.
- () Refer to Detail 10-1A. Place a straightedge across the top of the dial opening in the front panel as shown. Carefully position the dial drive assembly forward or rearward so the large portion of the vernier bushing is flush with the straightedge.
- () Secure dial drive bracket screws BF and BG.
- () Start two 6-32 \times 3/16" setscrews into the shaft coupler as shown. Place the coupler onto the dial shaft. Do not tighten the coupler setscrews.
- () Refer to Detail 10-1B and loosely mount the VFO assembly on the chassis with four #6 \times 3/8" sheet metal screws at S, T, U, and V. Position the VFO as shown in the Pictorial.

NOTE: In the following steps, you will position the VFO assembly to line up with the dial shaft from side to side. Do this as you observe the two shafts from directly above.

Carefully move the VFO assembly toward one side of the chassis or the other until the VFO capacitor shaft is **directly in line** with the dial shaft. NOTE: A short straightedge may be helpful.

- () Secure VFO mounting screws S, T, U, and V. Recheck the alignment of the shafts. If necessary, loosen the screws S, T, U, and V and carefully reposition the VFO assembly. Again, tighten the mounting screws.

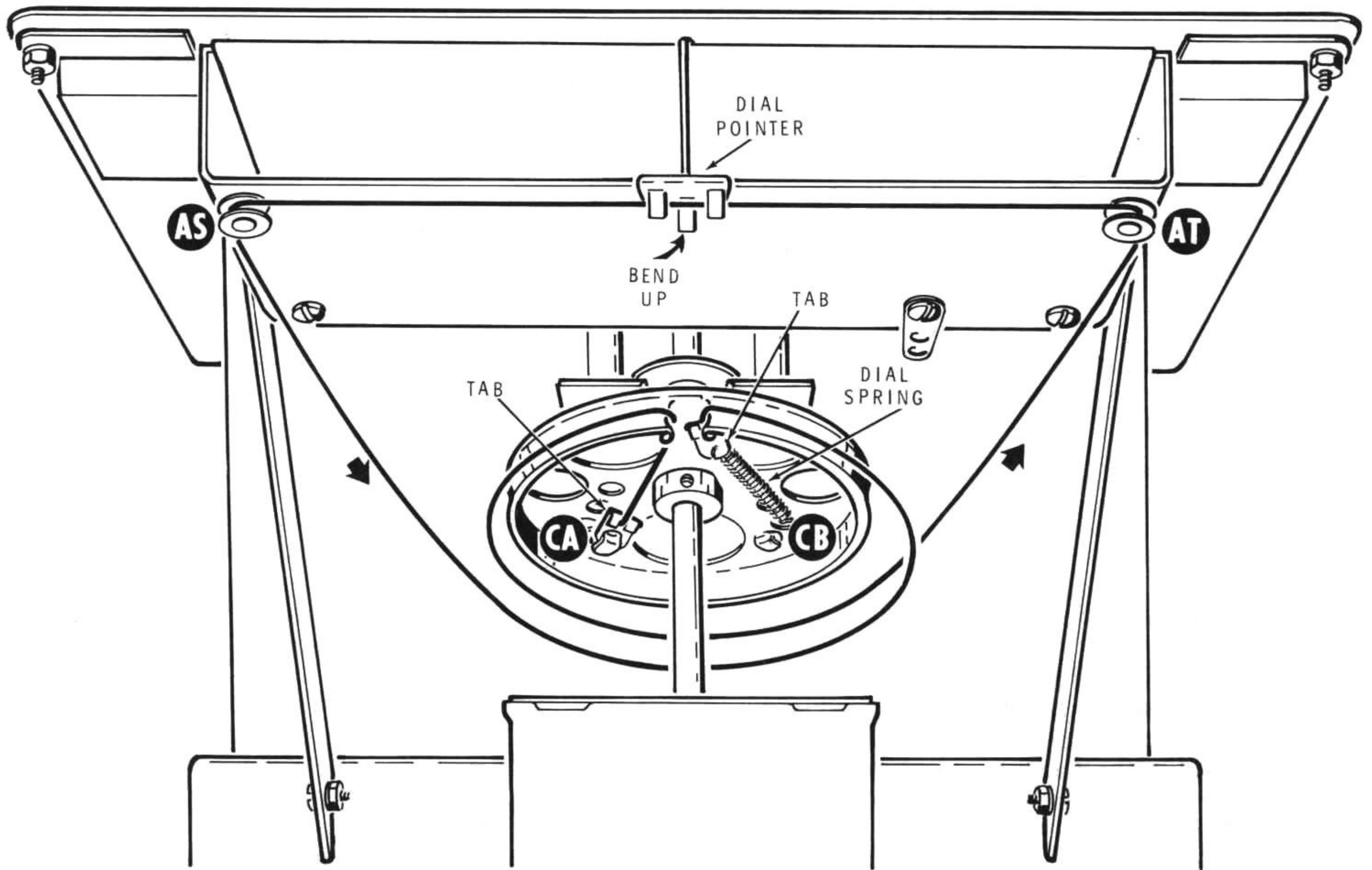
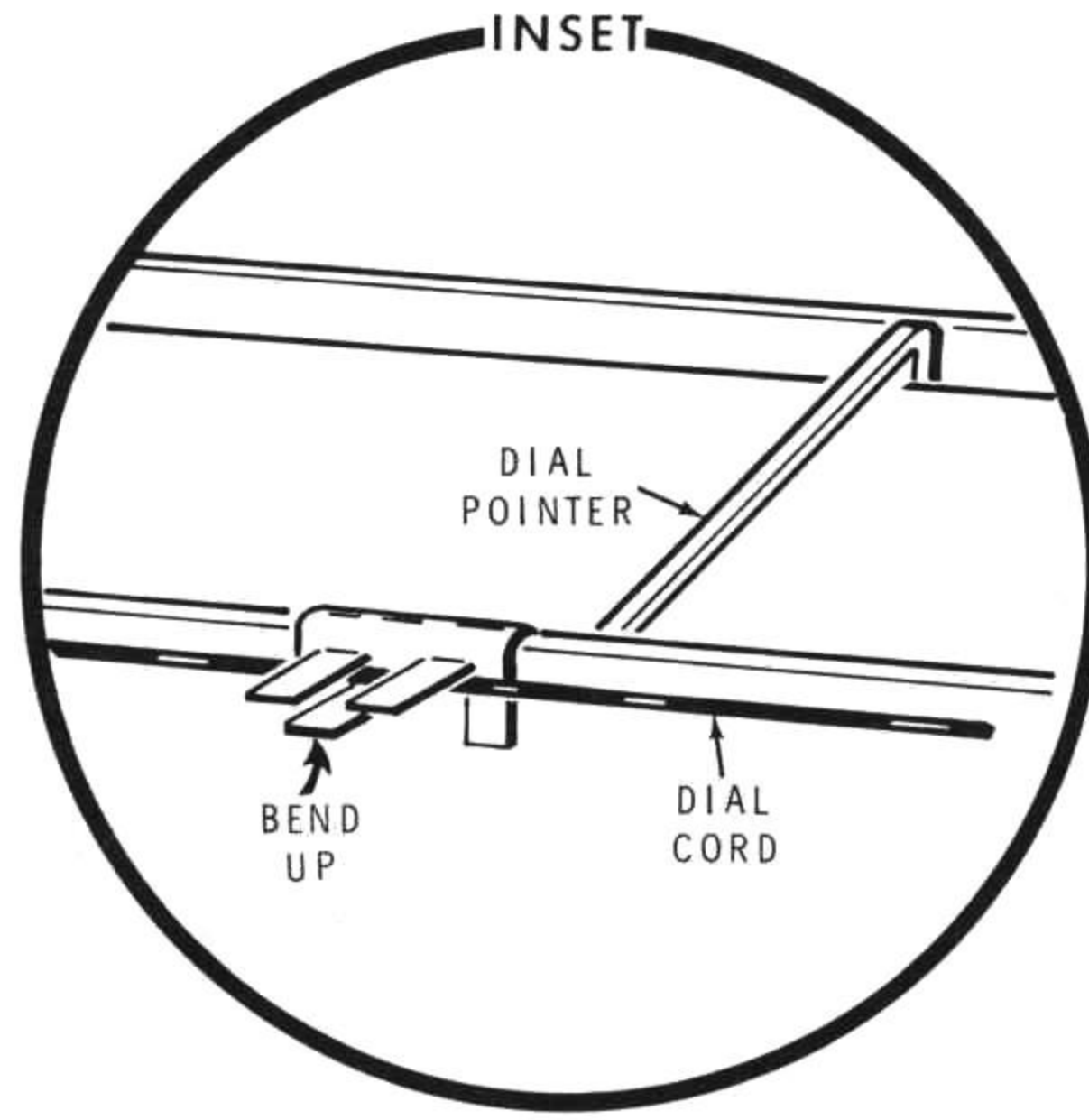
- () Plug the VFO socket onto the VFO plug as shown.



Detail 10-1C

Refer to Detail 10-1C for the following steps.

- () Slide the shaft coupler rearward onto the VFO tuning capacitor shaft. Position the coupler so it is half onto the capacitor shaft and half on the dial shaft. Use the allen wrench to secure the 6-32 \times 3/16" setscrew on the **tuning capacitor** shaft.
- () Rotate the tuning capacitor shaft in both directions; then position it at a point midway between the two extremes.
- () Loosen the coupler setscrew and retighten it so it is straight up as shown in the Pictorial.
- () Tighten the other 6-32 \times 3/16" coupler setscrew onto the dial shaft.
- () Position the dial pulley against the vernier drive bushing so the opening in the edge of the pulley is straight up as shown in the Pictorial. Tighten the setscrew.



PICTORIAL 10-2

Refer to Pictorial 10-2 for the following steps.

- () Be sure the opening in the dial pulley is straight up as shown. Proceed to string the dial cord as follows:
 1. Form an open hook in both ends of the dial spring.
 2. Connect one dial cord tab around lug CA in the pulley.
 3. Pass the dial cord upward, and then down and under the dial pulley in a counterclockwise direction as viewed from the rear.
 4. Over the top of pulley AT on the slide bracket.
 5. Over the top of pulley AS on the slide bracket.
 6. Down under the dial pulley, counterclockwise, to the top slot in the pulley.
 7. Connect one open hook of the dial spring to the hole in the free dial cord tab.
 8. Connect the free end of the dial cord spring to hole CB in the dial pulley.

- () Place the dial pointer onto the top rear edge of the slide bracket as shown in the Pictorial. Check to see that the pointer slides freely back and forth without rubbing between the front panel and the dial window.

If necessary, adjust the pointer slightly so it will slide freely and smoothly on its bracket.

- () Position the pointer midway between the two pulleys AS and AT. Refer to the inset drawing on Pictorial 10-2 and position the dial cord into the tabs on the rear of the dial pointer. Carefully bend the center tab upward until the pointer is just snugged at that position on the cord. CAUTION: Do not crimp the tabs too tightly. This could cut the dial cord.
- () Start two 8-32 \times 1/4" setscrews into the knob.
- () Place the knob onto the vernier shaft protruding through the front panel. Secure the knob by tightening the two setscrews with a small screwdriver. Leave approximately 1/32" of space between the knob skirt and the front panel. Rotate the knob and be sure it does not rub on the front panel. If it does, loosen the setscrews, position the knob outward slightly, and then retighten the setscrews.

Set the chassis assembly aside temporarily.

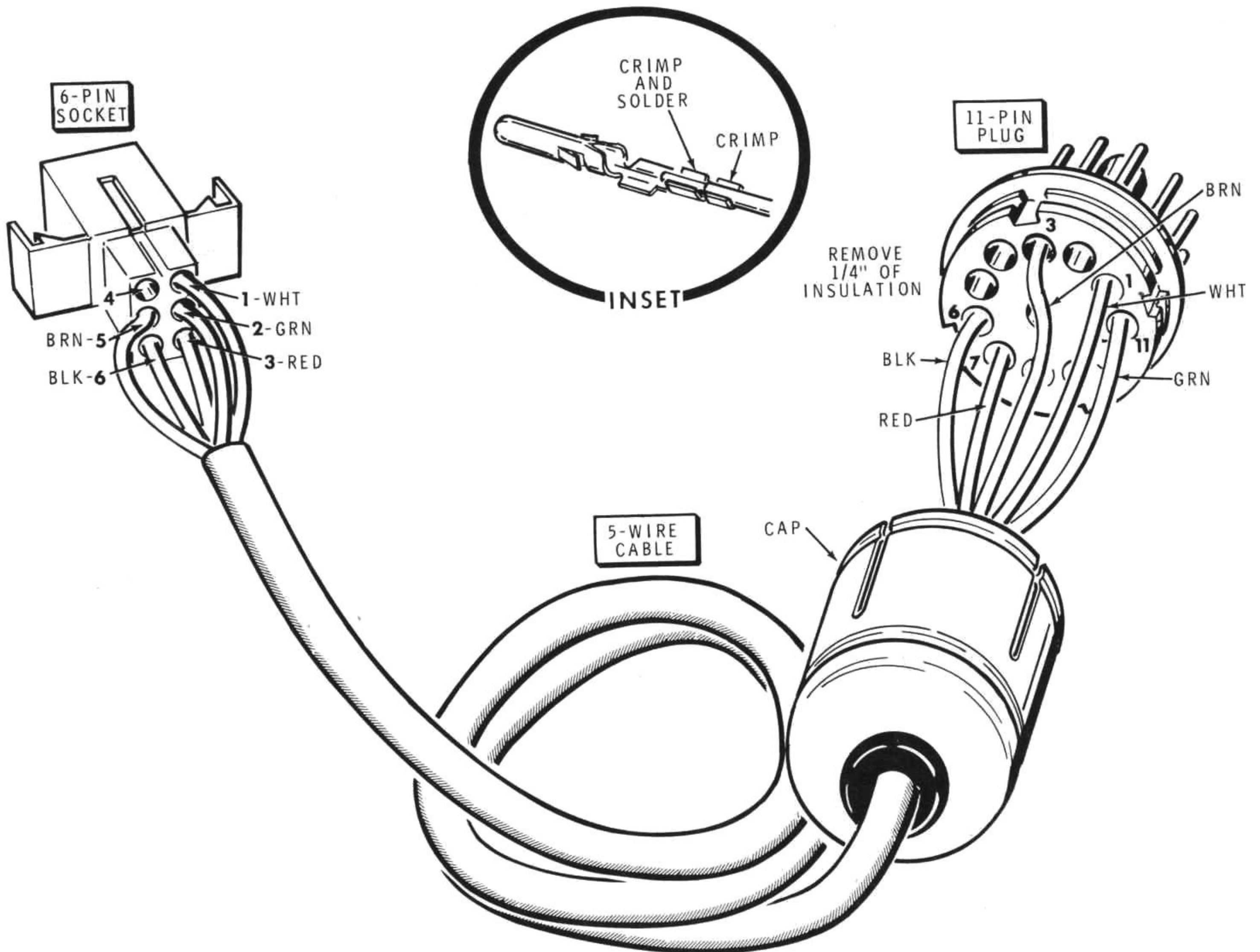
CABLE PREPARATION

Refer to Pictorial 11-1 for the following steps.

- () Remove the accessory plug and cap from the Accessory socket on your SB-104A Transceiver.
- () Remove the cap from the plug.
- () Remove 1-1/4" of the outer insulation from each end of the 5-wire cable.
- () Remove 1/4" of insulation from the wires at both ends of the cable. Tightly twist each wire end and apply a small amount of solder to hold the strands together.

NOTE: As you install the wires in the 11-pin plug in the following steps, push each wire into its designated pin; then, heat the pin and allow a small amount of solder to flow into the pin. When the solder has cooled, make sure the wire is secure by tugging on it.

- () Push the green wire into 11-pin socket pin 11 (S-1).
- () Push the white wire into pin 1 (S-1).
- () Push the brown wire into pin 3 (S-1).
- () Push the black wire into pin 6 (S-1).
- () Push the red wire into pin 7 (S-1).



PICTORIAL 11-1

- () Slide the open end of the cap onto the free end of the 5-wire cable as shown in the Pictorial. Then snap the cap onto the socket.
- () At the free end of the 5-wire cable, solder a male terminal onto the end of the black wire as shown in the inset drawing on Pictorial 11-1.
- () In the same manner, solder male pins onto the ends of the red, brown, white, and green wires.
- () Push the pin on the black wire into 6-pin socket hole 6. Push the pin in until it locks in place.
- () In the same manner, push the pin on the red wire into hole 3.
- () Push the pin on the brown wire into hole 5.
- () Push the pin on the green wire into hole 2.
- () Push the pin on the white wire into hole 1.

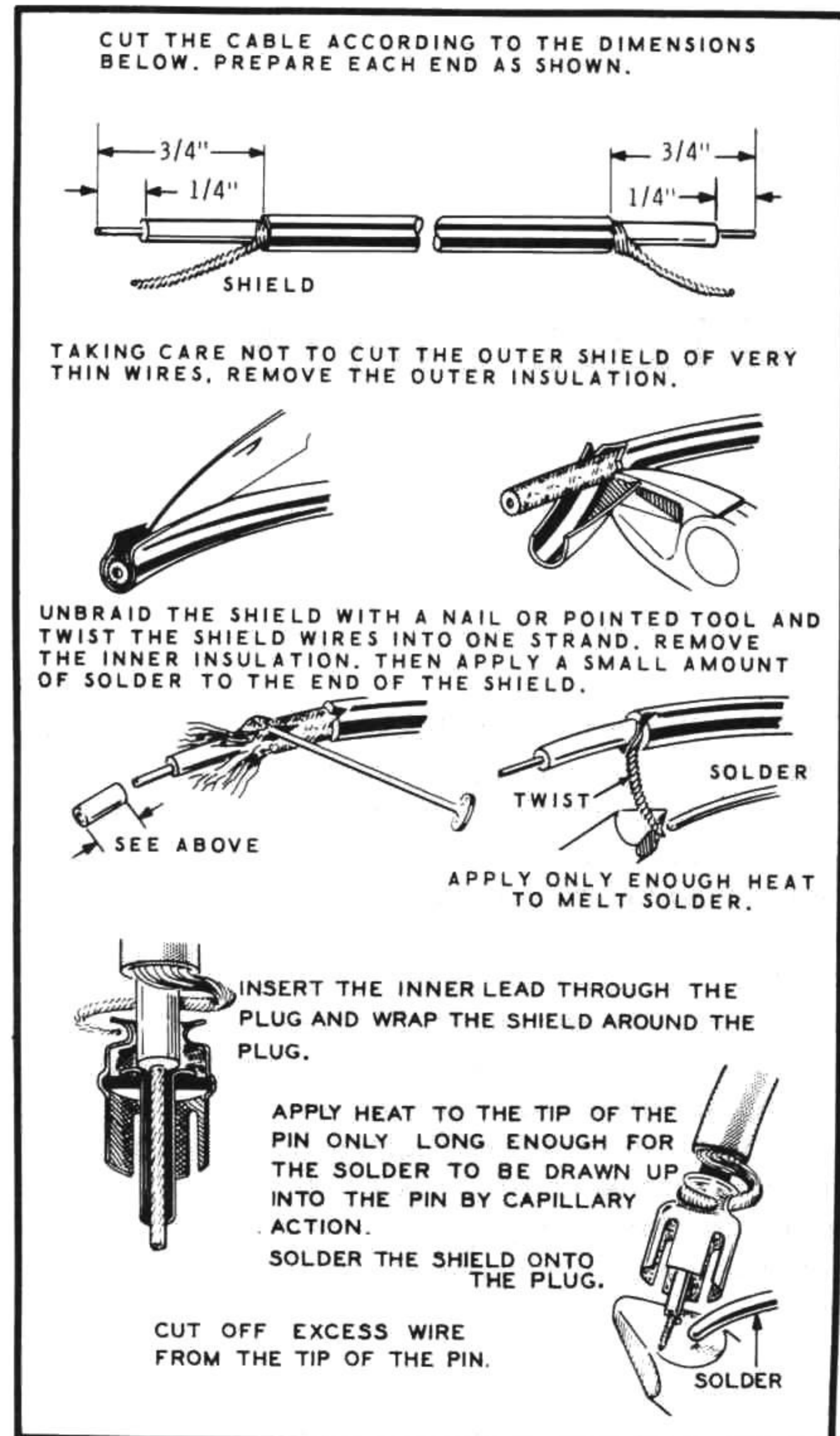
NOTE: There is no wire going to hole 4 of the 6-pin socket.

Refer to Pictorial 11-2 (Illustration Booklet, Page 9) for the following steps.

- () Push the 6-pin socket onto the plug H on the chassis.

Refer to Detail 11-2A for the following steps.

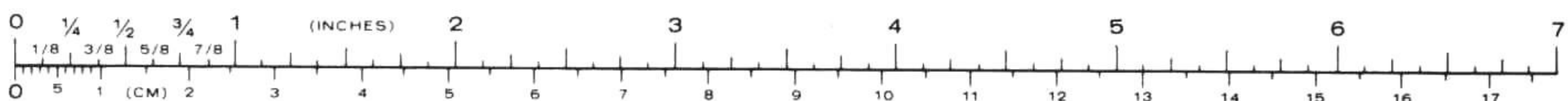
- () Cut the length of large shielded cable into two equal lengths.
- () Refer to the Detail and prepare both cables as shown. Connect and solder phono plugs to both ends of both cables.
- () Plug one end of one cable into the phono socket labeled IN, and the end of the other cable into the phono socket labeled OUT on the rear of the chassis. The free ends of the cables will be connected later.
- () Remove the paper backing from the blue and white label. Press the label in place on the rear of the VFO assembly as shown in the Pictorial.



Detail 11-2A

NOTE: The blue and white label shows the Model Number and the Production Series Number of your kit. Refer to these numbers in any communications you have with the Heath Company about this kit. This assures you that you will receive the most complete and up-to-date information in return.

This completes the "Step-by-Step Assembly" of your Remote VFO, except for "Final Assembly" which will follow the "Tests and Adjustments" section of the Manual.



INITIAL TESTS

The following resistance checks will check for wiring errors in the power supply circuits of the Remote VFO. If you do not obtain the proper results, refer to the "Possible Cause" chart which follows and correct the problem before you continue.

NOTE: The internal wiring of most ohmmeters is such that the positive terminal of the meter battery is connected to the positive lead and the negative battery terminal is connected to the negative (common) test lead. In some ohmmeters, this wiring is reversed and will give erroneous readings in the following measurements. Interchange the ohmmeter leads if the measurements do not check out properly the first time.

- () Connect the common or ground lead of your meter to the Remote VFO chassis.
- () Be sure the meter is in the $R \times 1$ position.

Refer to Figure 1 for front panel switch locations and functions.

- () Depress the REMOTE-T/R switch (fourth from the left) on the front panel of the Remote VFO.
- () Depress the REMOTE-ON switch (third from the right).

Refer to Figure 2 (Illustration Booklet, Page 10) for the locations on the rear of the Remote VFO. Then make the following checks.

NOTE: When you are directed to make connections to socket S1275, be sure you make contact with the terminal inside the socket.

- () Push your meter probe into S1275 hole 2 (green wire). The meter should indicate between $.8 \Omega$ and 1.2Ω .



PROBLEM	POSSIBLE CAUSE
1. Incorrect reading.	A. Check for wiring error. B. PL1275, PL1276, or PL1277. C. SW1276C or SW1276D.

- () Change the meter range to $R \times 100$.
- () Push the meter probe into S1275 hole 5 (brown wire). The meter should indicate an infinite reading.

PROBLEM	POSSIBLE CAUSE
1. Low reading.	A. Check for short between SW1276A or SW1276B lugs 8 and 9.

- () Push the meter probe into S1275 hole 3 (red wire). The meter should indicate between 560Ω and 840Ω .

PROBLEM	POSSIBLE CAUSE
1. Incorrect reading.	A. Check for wiring error. B. Check for a solder bridge on the XTAL OSC/SW circuit board. C. Capacitor C1262 or C1263.

- () Disconnect the meter leads from the Remote VFO.

This completes the "Initial Tests." Proceed to "Test and Adjustments."

TESTS AND ADJUSTMENTS

NOTE: If you do not get the proper results in any of the following steps, turn the Transceiver power off and refer to the "In Case of Difficulty" section of the Manual on Page 69.

Refer to Figure 1 (Illustration Booklet, Page 9) for front panel switch locations and functions and refer to Figure 2 (Illustration Booklet, Page 10) for locations on the rear of the Remote VFO.

NOTE: You will need your Transceiver to perform the following "Tests and Adjustments."

- () Turn your Transceiver off, if this has not already been done.
- () Locate the REMOTE-OFF switch (third from the left) on the front panel of the Remote VFO. Depress this switch.
- () Depress the XTAL-OFF switch (third from the right).
- () Connect the 11-pin plug coming from the Remote VFO to the Accessory socket on the rear of the Transceiver.
- () Remove the jumper cable from the Transceiver VFO IN and OUT sockets.
- () Connect the shielded cable coming from the Remote VFO OUT socket to the VFO IN socket on the Transceiver.
- () Connect the shielded cable coming from the Remote VFO IN socket to the VFO OUT socket on the Transceiver.

- () Turn the Transceiver on and tune it to approximately 14.200 MHz. Then push the Remote VFO RX switch (first switch on the left) to the ON position. NOTE: Do not key the Transceiver except into a properly terminated load.

NOTE: At this time, the three pilot dial lights should be on, and the upper right indicator light, "R/REM T/MAIN," should be on.

- () Push the following switches and observe that all indicator lights are properly illuminated:

SWITCH	SCALE LIGHT	INDICATOR LIGHT
SW1276A	ON	R/REM — T/MAIN
SW1276B	ON	R/MAIN — T/REM
SW1276C	OFF	MAIN
SW1276D	ON	REMOTE
SW1275A	OFF	
SW1275B	ON if SW1276A, SW1276B, or SW1276D selected	
SW1275C*	OFF	XTAL 1 (ON)
SW1275D*	OFF	XTAL (ON)

* Be sure SW1275A is also pushed.

NOTE: Carefully observe the illumination of the dial. If it appears to be unevenly lit, the pilot lamps at each end of the slide bracket may be adjusted forward or rearward slightly. Do this in the following steps.

- () Slightly loosen the 6-32 screws at AF and AG. (See Pictorial 9-5 Illustration Booklet, Page 7). Position each of these pilot lamps until the dial is evenly illuminated all the way across. Then retighten both screws securely.

VFO FREQUENCY ADJUST (L1201)

- () Depress the REMOTE ON switch (third from right) and the REMOTE T/R switch (fourth from left).
- () Make sure the dial pointer is adjusted to travel to points at each end of the dial equally distant from the end of the scale. Then, turn the dial to 2.00 on the scale.
- () Depress the Transceiver POWER button.
- () Refer to Figure 2 (Illustration Booklet, Page 10) and use the plastic alignment tool furnished with the kit to adjust coil L1201 in the VFO. Place the alignment tool into the coil slug and adjust the coil in either direction for a reading of 14.200 on the Transceiver. NOTE: The correct slug position will be when you see the reading 14.200 and the slug is furthest forward from the panel opening. Or, the slug will be in the most clockwise position to obtain the reading.
- () Turn the VFO to "0". The Transceiver should read out "14.000." If it does not, adjust coil L1201 to obtain that reading.
- () Turn the Remote VFO dial to "5." The Transceiver should read out "14.500." If not, carefully adjust coil L1201 for 1/2 the difference between 14.500 and the readout on the Transceiver.
- () This completes the "VFO Frequency Adjust." Proceed to "LSB Offset Adjustment."

LSB OFFSET ADJUSTMENT (C1211)

Refer to Figure 3 for the following steps.

- () Push the narrow metal blade into the small end of the nut starter as shown. Leave 1/2" of the blade exposed from the nut starter.
- () Cut the nut starter in half with a sharp tool.

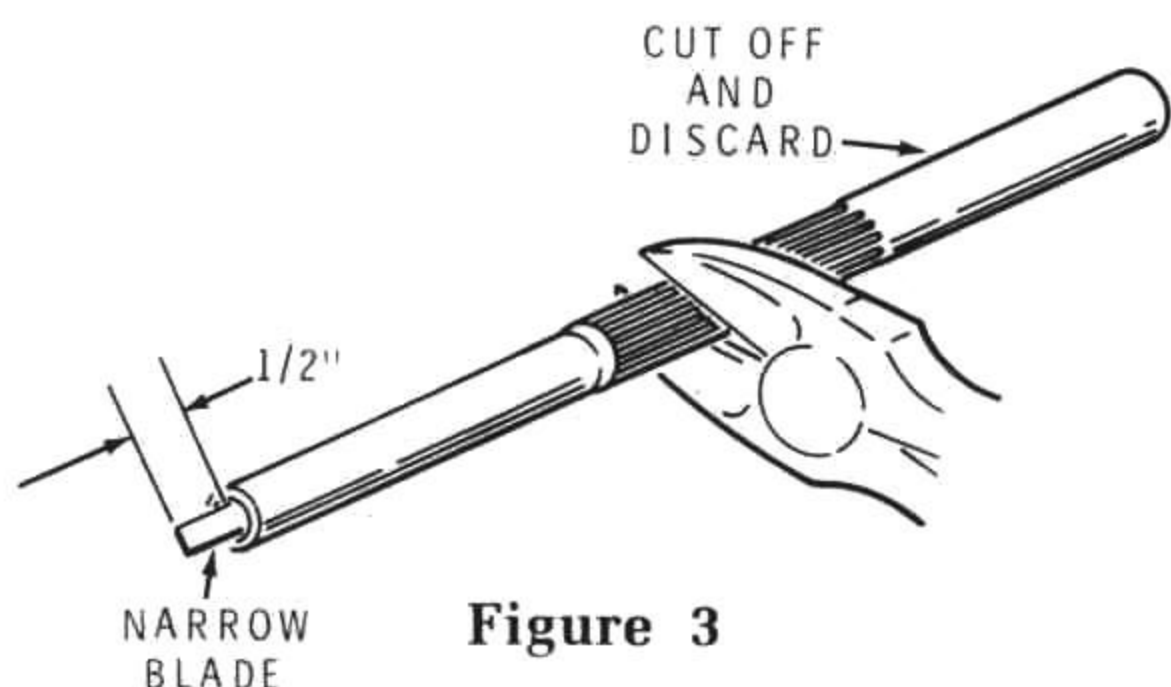


Figure 3

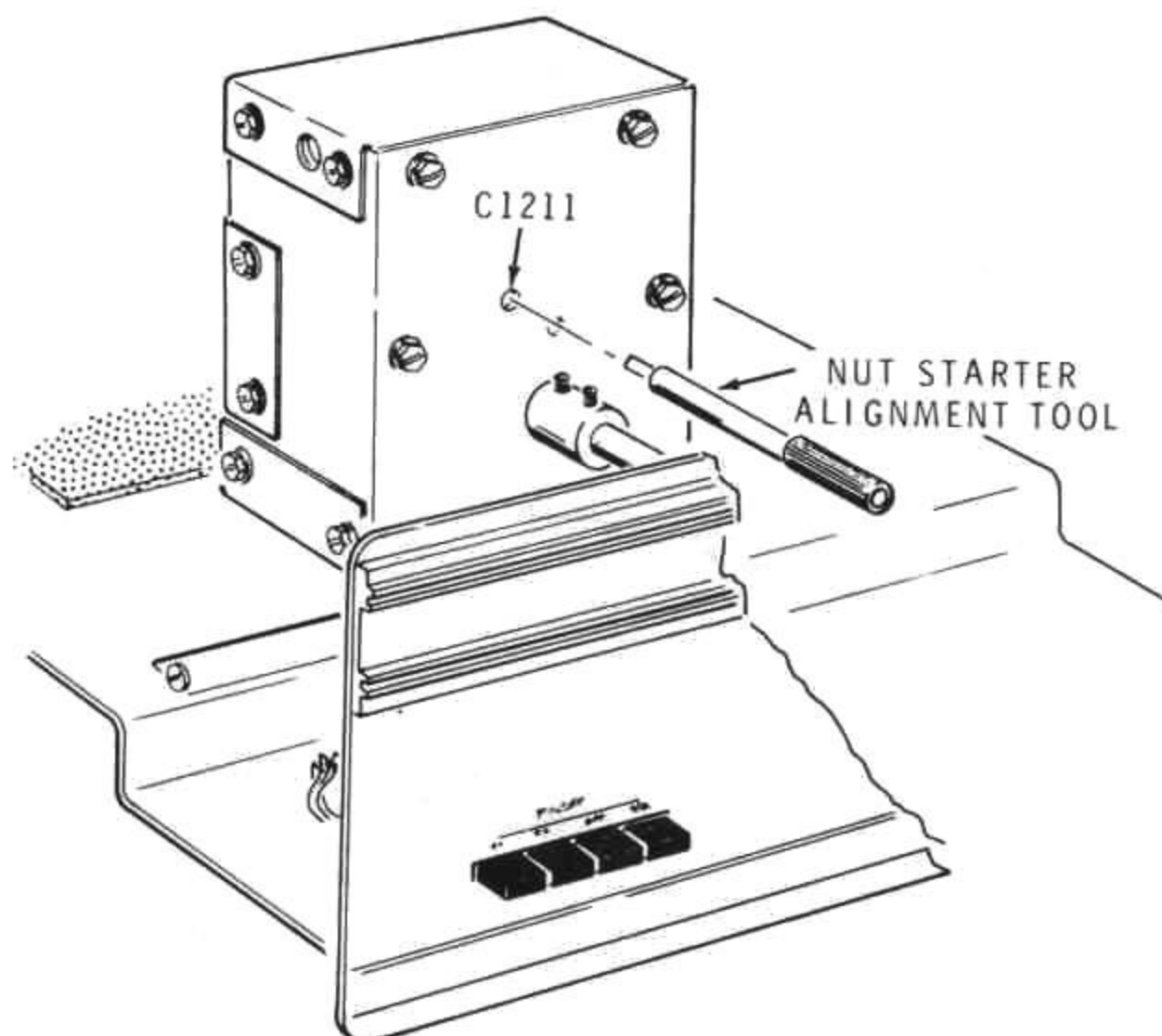


Figure 4

Refer to Figure 4 for the following steps.

NOTE: Use the nut starter alignment tool to make the following adjustments.

1. Turn the Transceiver and the Remote VFO on. Set the Transceiver control to USB. Depress the Remote VFO T/R switch (SW1276D). Allow 30 minutes for both units to stabilize.
2. Position the Remote VFO dial pointer to 3.
3. Record the digital display readout on the Transceiver.
4. Depress the LSB control on the Transceiver.
5. Adjust trimmer C1211 until the same readout is displayed on the Transceiver as you recorded in Step 3.
6. Depress the Transceiver USB control and check for the reading recorded in Step 3.
7. Repeat Steps 3 through 6 until identical readings are obtained on the upper and lower sidebands.

This completes the "LSB Offset Adjustment." Proceed to "VFO Level Adjust."

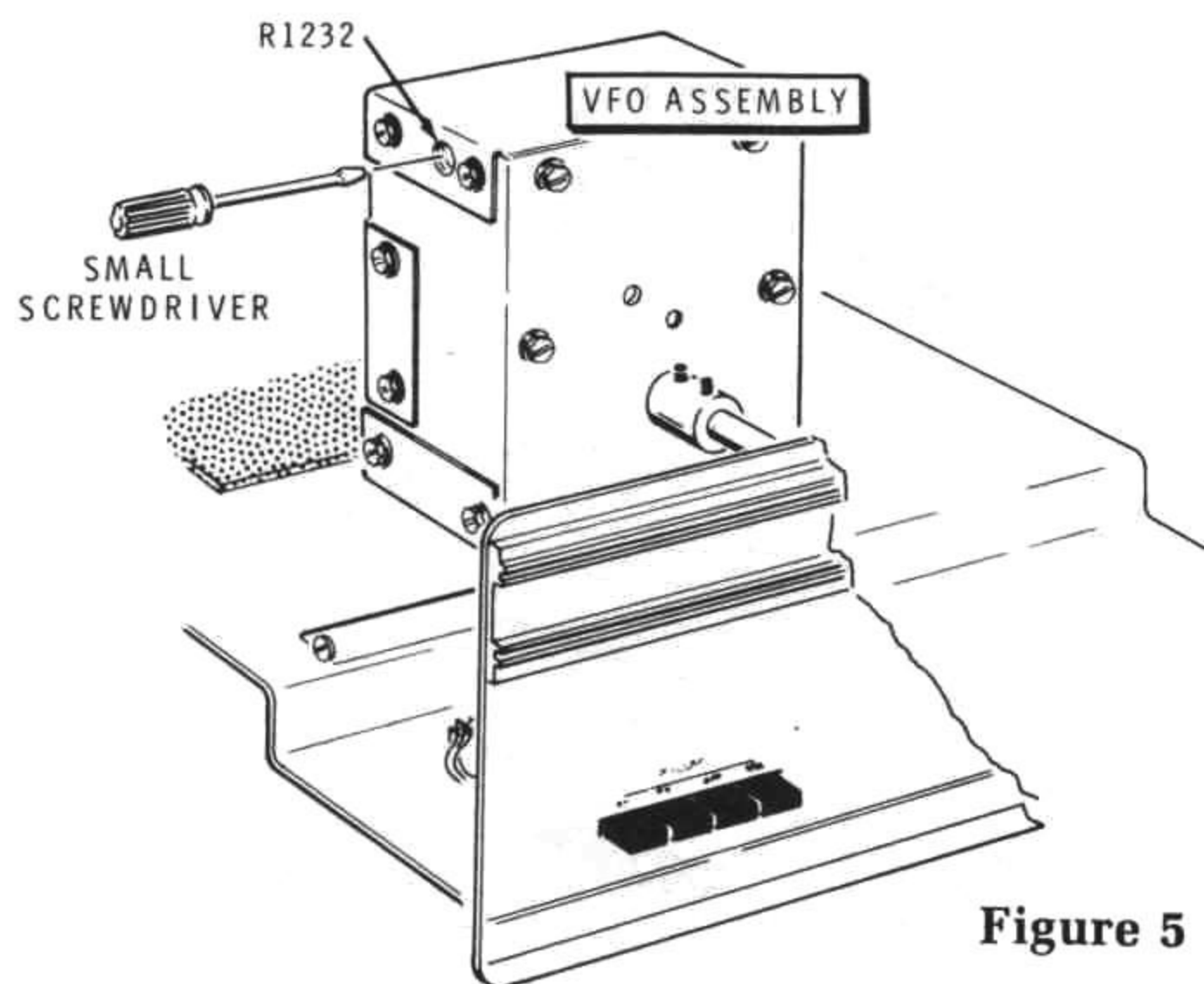


Figure 5

VFO LEVEL ADJUST (R1232)

Refer to Figure 5 for the following steps.

- () Make sure your Transceiver is off.
- () Remove the covers from the Transceiver. Then locate the end of the test lead, that should be tack-soldered to terminal G5, and temporarily solder it to terminal G4.
- () Set the Transceiver controls as follows:

BAND switch	:	3.5
13.8 button	:	Released.
ALC button	:	Released.
PWR button	:	Released.
POWER button	:	Pushed in.
MAIN TUNING	:	3900 kHz.

The position of the other controls and switches is not important.

- () Set the Remote VFO pushbuttons as follows:

Main T/R button (SW1276C)	:	Pushed in.
Remote On button (SW1275B)	:	Pushed in.
- () Adjust control R1232 in the **Transceiver VFO** assembly for an indication of 9 on the Transceiver's bottom meter scale. NOTE: You may have to readjust this control if you ever decide to operate the Transceiver without the Remote VFO connected to it.

- () Push the Remote T/R button (SW1276D) in.
- () Readjust control R1232 in the **Remote VFO** assembly for an indication of 9 (.27VRMS) on the Transceiver's bottom meter scale.

NOTE: If you have a crystal that you intend to use with the Remote VFO (see "Special Crystal Considerations" on Page 67), skip the next three steps and proceed directly to "Crystal Level Adjust."

- () Release the Transceiver Power button.
- () Unsolder the test lead from terminal G4 and solder it to terminal G5.
- () Replace the bottom cover onto the Transceiver.

This completes the "VFO Level Adjust." Proceed to "Crystal Level Adjust."

CRYSTAL LEVEL ADJUST (R1263)

- () Be sure the test lead in your Transceiver is still connected to terminal G4.
- () Install a crystal in the socket pins at Y1251.
- () Depress the following buttons on the Remote VFO:
 - Remote Off/XTAL On (SW1275A)
 - XTAL 1 (SW1275C)
- () Adjust control R1263 on the XTAL OSC/SW circuit board (see Figure 2) for an indication of 9 on the Transceiver's bottom meter scale.
- () Push the Transceiver POWER button to OFF.
- () Unsolder the test lead from terminal G4 and solder it to terminal G5.
- () Replace the bottom cover on the Transceiver.

This completes the "Crystal Level Adjust." Proceed to "Crystal Trimmer Adjustment."



CRYSTAL TRIMMER ADJUSTMENT

NOTE: Perform the following adjustment only if you have crystals installed at Y1251 and/or Y1252.

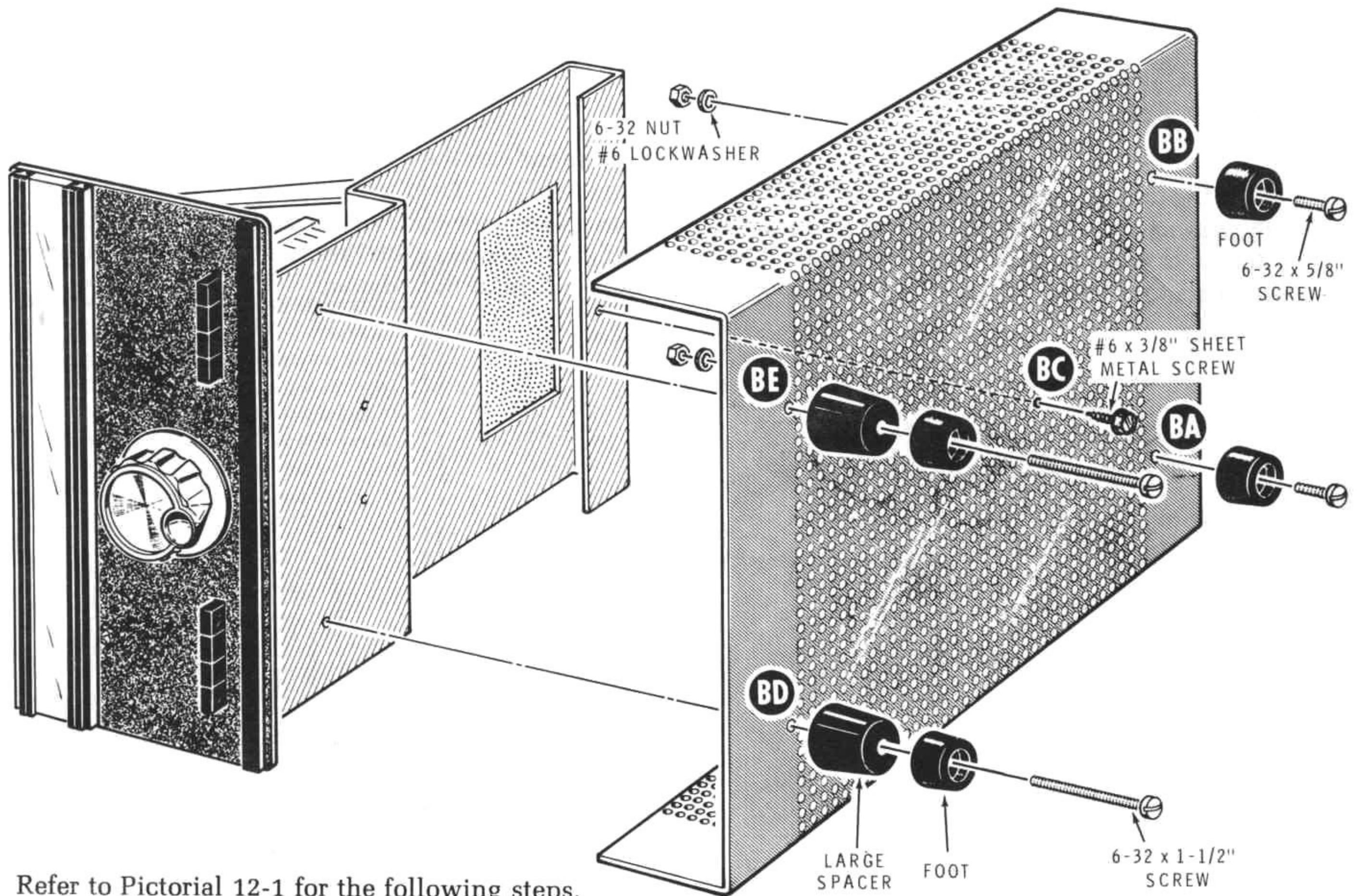
- () Turn the Transceiver on and adjust the tuning for the approximate frequency of the crystal.
- () Depress the REMOTE T/R switch, the XTAL ON switch, and the XTAL 1 switch.
- () Note the frequency indicated on the readout on the Transceiver as the transmitter is keyed. If the exact frequency of the desired net is not indicated, proceed with the following steps.

NOTE: Refer to Figure 2 (Illustration Booklet, Page 10) when you make the following adjustments.

- () While you key the transmitter, slowly adjust trimmer C1254 on the switch circuit board until the desired frequency is obtained.
- () In the same manner, depress the XTAL 2 switch. Key the transmitter and then slowly adjust trimmer C1255 on the switch circuit board until the desired frequency is shown on the Transceiver dial readout.

This completes the "Tests and Adjustments" of your Remote VFO. Turn off the Remote VFO and the Transceiver and remove the cables connected to the rear of the Remote unit. Proceed to the "Final Assembly" section of this Manual.

FINAL ASSEMBLY



Refer to Pictorial 12-1 for the following steps.

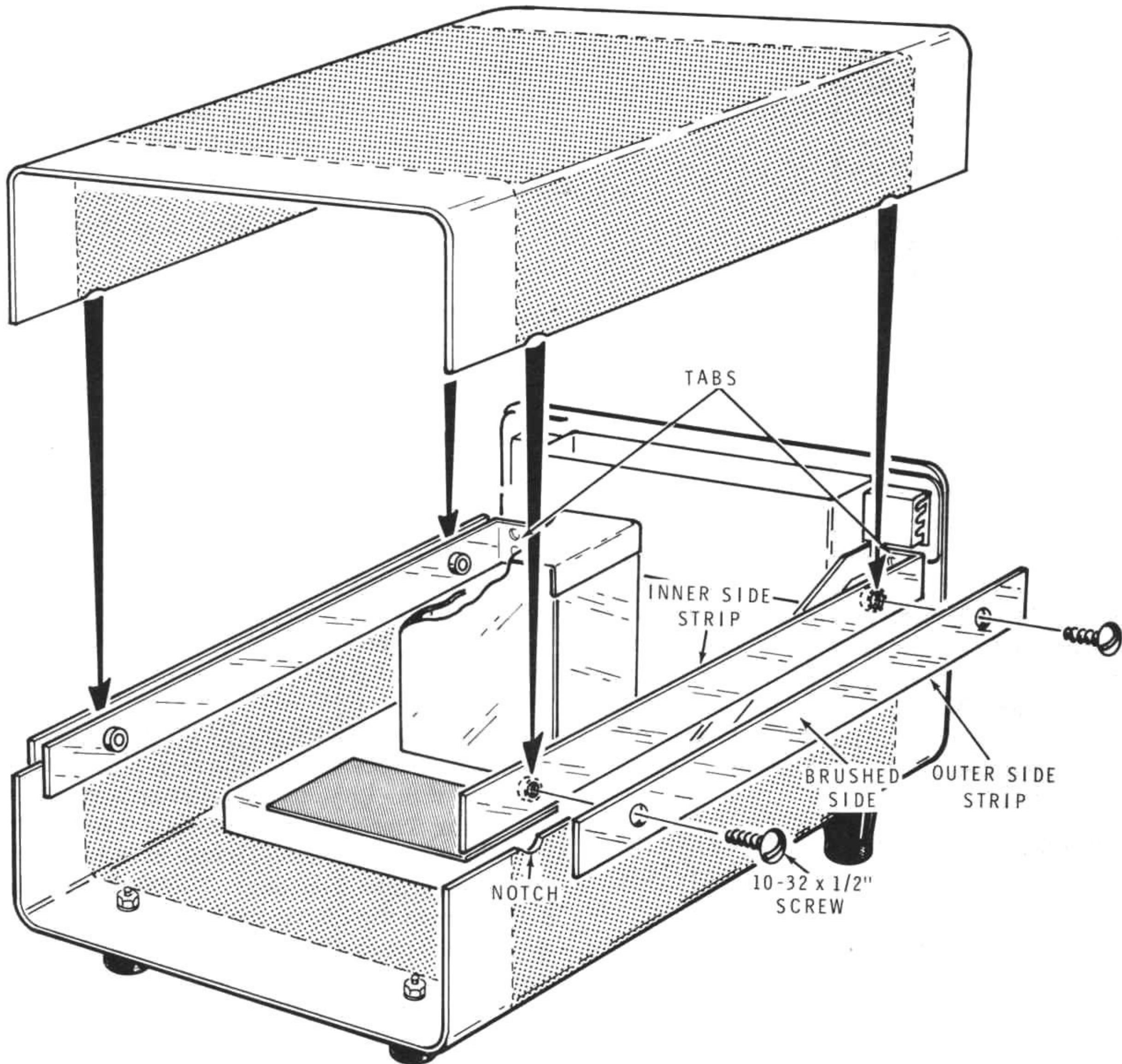
- () Place the chassis assembly into the cabinet bottom as shown. Secure the chassis to the bottom at BC with a #6 × 3/8" sheet metal screw.

NOTE: In the following steps, you have the option of mounting feet and spacers to tilt the Remote VFO up at the front: or you may leave off the large spacers and install the VFO level. If you choose the level option, use the two extra 6-32 × 5/8" screws in the next two steps instead of the 1-1/2" screws, and leave out the large spacers.

- () Pass a 6-32 × 1-1/2" screw through a foot and then through a large spacer as shown in the Pictorial. Secure the foot and the spacer to the chassis at BD.

PICTORIAL 12-1

- () In the same manner, mount a foot and a spacer onto the chassis at BE.
- () Mount a foot on the rear of the cabinet bottom at BA. Use a 6-32 × 5/8" screw, a #6 lockwasher, and a 6-32 nut.
- () In the same manner, mount the remaining foot on the rear of the cabinet bottom at BB. Use 6-32 × 5/8" hardware as shown.



PICTORIAL 12-2

Refer to Pictorial 12-2 for the following steps.

- () Mount one outer side strip to an inner side strip with two 10-32 \times 1/2" screws. Position the tab on the inner side away from the outer strip as shown in the Pictorial. Also be sure the brushed side of the outer strip is on the outside.
- () In the same manner, mount the remaining inner and outer side strips.
- () Place the two side-strip assemblies onto the upper edges of the cabinet bottom as shown in the Pictorial. Position the tabs on the inner strips toward the front panel. Position each side strip assembly so the retaining screws fit down into the cabinet edge notches.
- () Mount the cabinet top so the side edges fit down into the slots formed by the side strips on each side of the cabinet bottom. Tighten the four 10-32 \times 1/2" side strip screws.

This completes the "Final Assembly" of your Remote VFO.

OPERATION

The Remote VFO is designed for use with the Model SB104A Transceiver. Refer to Figure 2 (Illustration Booklet, Page 10) and make the remote VFO connections to the Transceiver as follows: Shielded cable from Remote OUT to Transceiver VFO IN, shielded cable from Remote IN to Transceiver VFO OUT, and the 5-wire cable 11-pin plug to the Transceiver ACC (Accessory) socket. NOTE: Whenever power is applied to the Transceiver, power will also be supplied to the Remote VFO.

Refer to Figure 1 (Illustration Booklet, Page 9) for the location and functions of front panel controls and switches.

Frequency coverages of 0.5 MHz (total) increments are indicated by the dial. When the Transceiver is switched to the indicated bands, the VFO dial coverages are as follows:

<u>BAND</u>	<u>FREQUENCY</u>	
	<u>Low</u>	<u>High</u>
3.5	3.500 MHz	4.000 MHz
7.0	7.000 MHz	7.500 MHz
14.0	14.000 MHz	14.500 MHz
21.0	21.000 MHz	21.500 MHz
28.0-29.5	28.000 MHz	30.000 MHz*

When the Transceiver is in operation, its digital readout will always indicate the transmitting or receiving frequency of operation at that moment.

*Continuous, 4-segment band coverage as determined by Transceiver controls.

VARIABLE FREQUENCY OPERATION

Push the REMOTE ON-XTAL OFF (SW1275B) switch in. This enables the variable oscillator and disables the crystal circuits. NOTE: Approximate frequencies are shown on the Remote VFO dial. Exact frequencies are always shown on the Transceiver digital display.

When the REMOTE RX-MAIN TX switch (SW1276A) is depressed, receive frequencies are indicated by the position of the Remote VFO dial pointer. For example, if the Transceiver Band switch is in the 14.0 position, the Remote VFO will select any desired 20-meter receive frequency. This frequency will be displayed on the digital readout on the Transceiver. When the Transceiver is keyed to transmit a signal, even if on a different frequency than that to which the Remote VFO is tuned, the transmitting frequency will then be displayed.

When the REMOTE TX-MAIN RX switch (SW1276B) is depressed, the opposite of the preceding operation takes place. **Receive or transmit frequencies are always displayed on the Transceiver's digital readout.** However, in this case, the frequency of the transmitted signal is selected by the Remote unit and displayed on the Transceiver, while the receive signal frequency is determined by the setting of the Transceiver controls. Once again whether transmitting or receiving, the frequency of operation is always displayed by the Transceiver.

When the REMOTE OFF-MAIN T/R switch (SW1276C) is depressed, the entire process of frequency selection is determined by the setting of the Transceiver's VFO and is displayed on the digital readout. The Remote VFO is bypassed.

When the REMOTE T/R-MAIN OFF switch (SW1276D) is depressed, the transceive frequency is shown by the position of the VFO dial pointer. The exact frequency of the signals is indicated on the Transceiver display. The Transceiver VFO is bypassed in this configuration.

CRYSTAL FREQUENCY OPERATION

When you operate in the crystal mode, the REMOTE T/R-MAIN OFF switch (SW1276D) must be depressed. The transceive frequency will be determined by the frequency of the crystals in the Remote VFO unit.

To enable the crystal circuit, depress the REMOTE OFF-XTAL ON switch (SW1275A); then select the desired crystal frequency by depressing either the XTAL 1 or the XTAL 2 switch (SW1275C or SW1275D). Receive and transmit frequencies will now always be the same, as determined by the crystal selected. As with the variable mode of operation, the digital readout on the Transceiver will indicate the frequency of operation.

When a variable mode of operation is again desired, depress the REMOTE ON-XTAL OFF switch (SW1275B). The crystal circuit in the Remote VFO will be disabled, and the previously described modes of variable frequency operation will be enabled.

SPECIAL CRYSTAL CONSIDERATIONS

CRYSTAL SELECTION FOR NET OPERATION

When the controls of the Transceiver and the Remote VFO are in the crystal (Xtal) mode of operation, the transmitted and received signals will be at a fixed frequency determined by a crystal in the Remote unit. Provisions are made on the switch circuit board for the use of two crystals, Y1251 and Y1252. These crystals are independent of one another and are selected by separate switches on the front panel of the Remote VFO.

IMPORTANT: Because of the steep-sided characteristics of the bandpass filter operation of the Transceiver using a crystal at Y1251 and Y1252 will be limited to approximately 25 kHz outside of each band.

Definition of terms:

f_x = Crystal frequency in MHz for crystals Y1251 or Y1252.

f_h = heterodyne crystal frequency, different for each band:

<u>BAND</u>	<u>f_h</u>
3.5	12.3950
7.0	15.8950
14.0	22.8950
21.0	29.8950
28.0	36.8950
28.5	37.3950
29.0	37.8950
29.5	38.3950

f_m = carrier frequency of desired SSB operation, further specified by LSB or USB designations. This is the operating frequency for SSB.

f_n = exact transmitter frequency for CW Nets. Use this where CW only is used on a specific frequency. This operation is not compatible with USB operation as the receiver of the receiving station would have to be retuned 1 kHz lower to receive SSB, and this would be impossible if it were crystal controlled.



Select the crystal frequency for Y1251 or Y1252 for the sideband to be used, or for CW operation. The examples below are for one of the MARS channels located at 7.305 MHz.

For USB and compatible USB-CW operation:

$$f_x (\text{USB}) = f_h - f_m - 3.3964$$

For LSB operation:

$$f_x (\text{LSB}) = f_h - f_m - 3.3936$$

For CW Net operation:

$$f_x (\text{CW}) = f_h - f_n - 3.3957$$

When using crystal control, switching modes will cause the transmitting frequency to change, except for compatible USB-CW operation. Therefore, be careful. Avoid out-of-band operation by inadvertently switching to the wrong mode.

Example: MARS SSB on USB at 7.305 MHz.

$$\begin{array}{r} f_h (7.0) = 15.8950 \\ f_m (\text{USB}) = \underline{7.3050} \\ \phantom{f_m (\text{USB}) = } 8.5900 \\ \phantom{f_m (\text{USB}) = } \underline{-3.3964} \\ f_x (\text{USB}) = 5.1936 \text{ MHz} \end{array}$$

CAUTION: Always be sure to use the correct heterodyne crystal frequency.

When purchasing crystals for Y1251 or Y1252, specify the frequency and the following characteristics:

Frequency Range	5.0 — 5.5 MHz.
Operation Mode	Fundamental.
Tolerance005%.
Holder	HC-25U.
Pin Diameter040".
Pin Spacing192".
Load Capacity	42 pF.
Series Resistance	40 Ω maximum.
Reference Series Resistance	13 Ω.
Drive Level @ Ref. R _s	5.2 milliwatts @ 20 milliamperes

Trimmer capacitors across each of the crystals can be adjusted for an exact MARS or Net frequency.

Heterodyne oscillator crystals that are supplied with the Transceiver provide coverage from 3.5 to 4.0 MHz, 7.0 to 7.3 MHz, 14.0 to 14.5 MHz, 21.0 to 21.5 MHz, and 28.0 to 30.0 MHz.

If you have previously purchased crystals for your Remote VFO, install them in their sockets at this time.

IN CASE OF DIFFICULTY

Begin your search for any trouble that occurs after assembly by carefully following the steps listed below in the "Visual Tests." After the "Visual Tests" are completed, refer to the Troubleshooting Chart.

NOTE: Refer to the "Circuit Board X-Ray Views" on Page 80 for the physical location of parts on the circuit boards.

VISUAL TESTS

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the kit builder.
2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all connections to make sure they are soldered as described on Pages 10 and 11. Be sure there are no solder bridges between circuit board foils.
3. Check to be sure that all transistors and diodes are in their proper locations. Make sure each lead is connected to the proper point. Make sure that each diode band is positioned above the band printed on the circuit board.
4. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial Diagrams. It would be easy, for example, to install a 22 k Ω (red-red-orange) resistor where a 3300 Ω (orange-orange-red) resistor should have been installed.
5. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.
6. Look under each circuit board to be sure all leads have been cut off. Be sure that none of the wire ends touch each other or the chassis.
7. A review of the "Circuit Description" may also help you determine where the trouble is.

If the trouble is still not located after the "Visual Tests" are completed, and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram. Read the "Precautions for Troubleshooting" before you make any measurements. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary $\pm 20\%$.

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

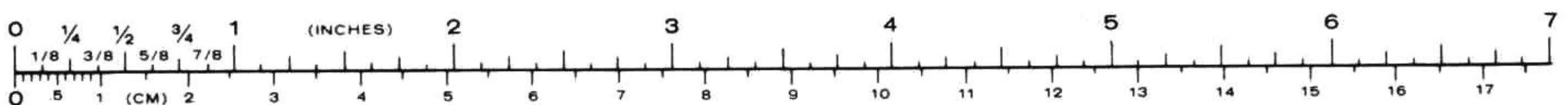
PRECAUTIONS FOR TROUBLESHOOTING

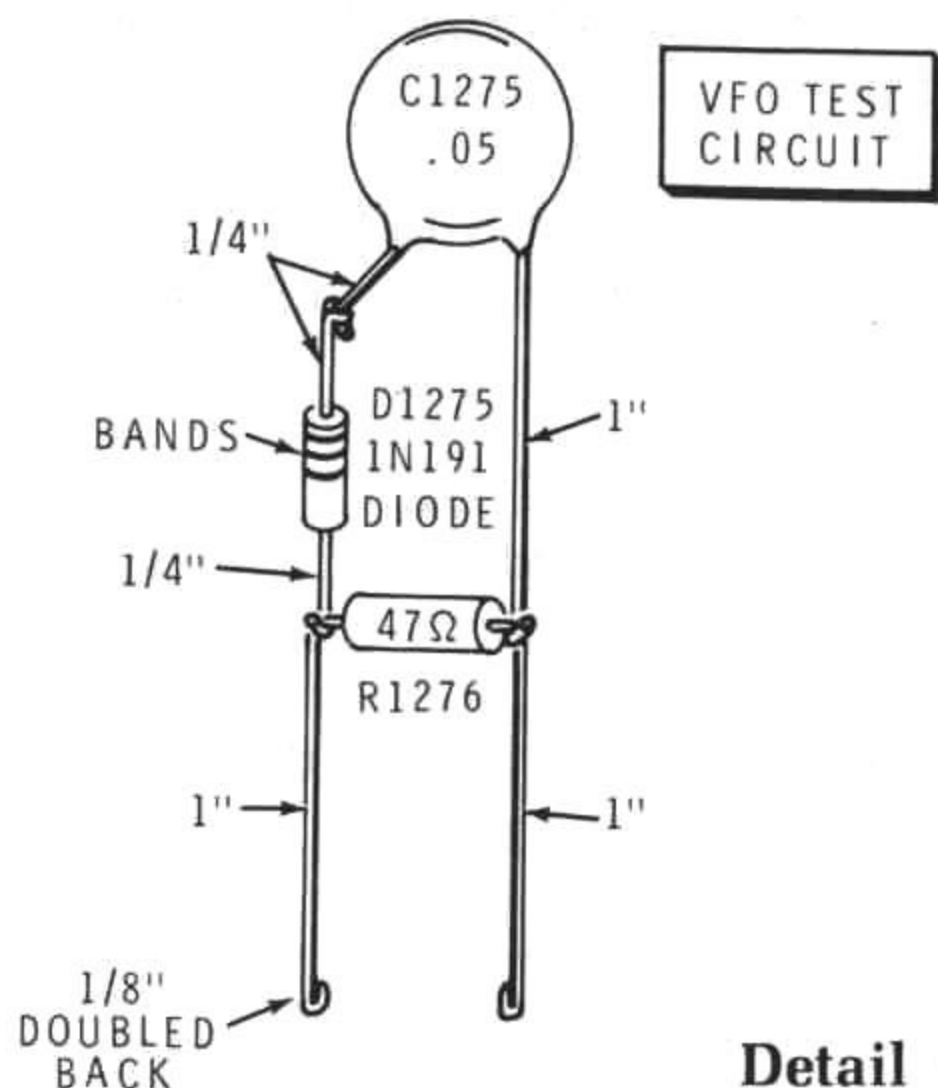
1. Be cautious when you test diode and transistor circuits. Although they have almost unlimited life when used properly, they are much more sensitive to excessive voltage or current than tubes.
2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short across components or voltage sources, it is very likely to cause damage to one or more transistors or diodes.

TROUBLESHOOTING CHART

The following chart lists the "Condition" and the "Possible Cause" of a number of malfunctions. If a particular part or parts are mentioned (transistor Q1, diode D1204, etc.) as a possible cause, check these parts to see if they are incorrectly wired or installed incorrectly. Also check to see if an improper part was installed at that location. It is also possible, on rare occasions, for a part to be faulty.

CONDITION	POSSIBLE CAUSE
No DC (rectified RF) output from VFO assembly. (See "Test Circuit Assembly and Use" on Page 71.)	<ol style="list-style-type: none"> 1. No 11-volt DC from Transceiver source. 2. No ground return from Transceiver source. 3. Internal problems. Refer to the "VFO Flow Chart" on Page 75. 4. Cable connections.
No output from the Remote VFO as seen on the Transceiver display.	<ol style="list-style-type: none"> 1. Cable connections. 2. Refer to Table A for a troubleshooting truth table. Consider $\leq .5$ VDC as a logic 0 and $\geq .5$ VDC as a logic 1.
No output from the Transceiver.	<ol style="list-style-type: none"> 1. Refer to Table A for a troubleshooting truth table. Consider $\leq .5$ VDC as a logic 0 and $\geq .5$ VDC as a logic 1. 2. D1251 or D1252. 3. Q1253, Q1254, or Q1255. 4. Control R1262 is fully clockwise. See "Crystal Level Adjust."
No output from the crystal oscillator.	<ol style="list-style-type: none"> 1. Refer to Table A for a troubleshooting truth table. Consider $\leq .5$ VDC as a logic 0 and $\geq .5$ VDC as a logic 1. 2. D1251 or D1252. 3. Q1253, Q1254, or Q1255. 4. Control R1262 is fully clockwise. See "Crystal Level Adjust."
Frequency instability.	<ol style="list-style-type: none"> 1. Recheck all mechanical connections. 2. Check cemented capacitors and coils on oscillator circuit board. 3. Shorten wires to variable coil L1201 and resolder them securely. 4. Resolder ground wires from tuning capacitor C1201 to circuit board solder lugs.





Detail 13-1A

TEST CIRCUIT ASSEMBLY AND USE

To assist you in isolating problems in the Remote VFO, you may easily determine whether your problem is in the VFO assembly, or in the cabling, switching, or other output circuits if you assemble and apply the simple test circuit as described in the following steps. NOTE: If you have an RF voltmeter, do not perform the following test circuit assembly steps; refer directly to the steps outlined under "Isolation Test — RF Voltmeter" below.

Refer to Pictorial 13-1 (Illustration Booklet, Page 10) and Detail 13-1A for the following steps.

Cut and form the VFO test circuit component leads in the following steps.

- () C1275: .05 μ F ceramic capacitor. Cut one lead to 1/4" and the other lead to 1". Bend a small hook in each lead.
- () R1276: Cut both leads of a 47 Ω (yellow-violet-black) resistor to 1". Bend 1/8" of the tip of each lead tightly back against the main part of the lead. Then bend both resistor leads 90 degrees to the resistor body as shown in the Detail.
- () D1275: Cut both leads of a 1N191 (brown-white-brown) diode (#56-26) to 1/4". Form a small hook in the end of each lead as shown.
- () Connect the short lead of ceramic capacitor C1275 to the **banded** end of diode D1275 as shown. Crimp the hooks together; then solder the connection.

- () Connect the long lead of capacitor C1275 to one lead of resistor R1276. Hook the capacitor lead close to the body of the resistor as shown; then solder the connection.
- () Hook the remaining lead of diode D1275 to the other end of resistor R1276 as shown. Solder the connection.
- () Prepare a 1-1/2" length of gray wire by removing 1/4" of insulation from each wire end. Double one end tightly back against the running length of the wire.
- () Remove the VFO socket from the VFO plug.
- () Push the doubled end of the 1-1/2" gray wire into hole 3 of the VFO plug.
- () Push the resistor-diode lead of the test circuit into hole 1 of the VFO plug. Then push the resistor-capacitor lead of the test circuit into hole 4.

NOTE: To perform the following test, you will need two lengths of wire to connect from the accessory socket on the Transceiver to the VFO assembly on the Remote unit. You will also need a high-impedance input voltmeter.

- () Remove the plug from the Transceiver accessory socket.
- () Connect a length of wire from Transceiver accessory socket pin 6 to the VFO plug connection at pin 4. This is the common (ground) connection.
- () Connect a length of wire from Transceiver accessory socket pin 7 to the end of the gray wire at VFO plug pin 3. This is the +11-volt source to the VFO assembly.
- () Connect the negative or common lead of the voltmeter to the connection at VFO plug pin 4.
- () Connect the positive (+) lead of the voltmeter to the junction of diode D1275 and capacitor C1275 as shown.
- () Turn the VFO dial pointer to midscale (2.5).

Allow the VFO to stabilize for 10 minutes with Transceiver power applied.

- () Turn the voltmeter to a low range and set the function switch to measure +DC volts.
- () Check for a small output reading on the voltmeter. NOTE: the level is immaterial at this time. However, you may wish to check that control R1232 in the VFO assembly is functioning properly. To do this, turn the control with a small screwdriver and check for a reading on the voltmeter, varying from (approximately) 0.2 volt to 2 volts.

NOTE: If you observed an output reading on the voltmeter, the VFO assembly is operating properly for the purposes of this check; problems in the Remote VFO are outside the VFO assembly.

ISOLATION TEST — RF VOLTMETER

Refer to Pictorial 13-2 for the following steps.

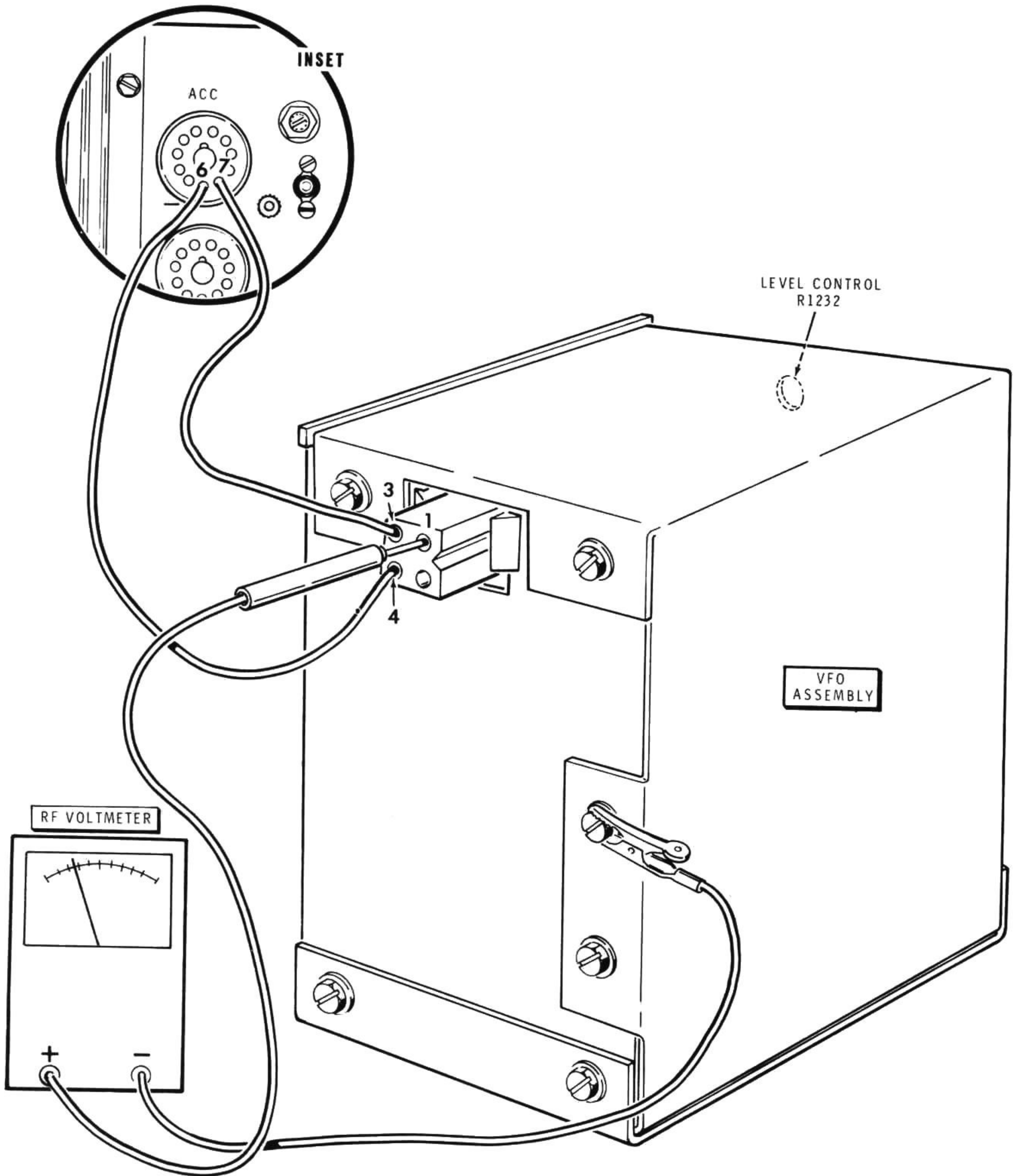
In addition to your voltmeter, you will need two lengths of wire that will connect from the Transceiver accessory socket to the VFO assembly on the Remote unit.

- () Remove the plug from the Transceiver accessory socket.

- () Remove the socket from the Remote VFO assembly.
- () Connect a length of wire from Transceiver accessory socket pin 6 to Remote VFO assembly plug pin 4.
- () Connect another length of wire from Transceiver accessory socket pin 7 to Remote VFO assembly plug pin 3.
- () Connect the common lead of the RF voltmeter to either chassis (ground).
- () Connect the positive (+) RF voltmeter probe to VFO assembly plug pin 1.
- () Read some small RF voltage. Turn Level control R1232 in the top of the VFO assembly and check for a varying output as seen on the voltmeter. This variation should be approximately 0.2 volt to 2 volts.

NOTE: If you observed an output reading on the RF voltmeter, the VFO assembly is operating properly for the purposes of this check; problems in the Remote VFO are outside the VFO assembly.

This completes the checkout procedure for proper RF output from the VFO assembly.



PICTORIAL 13-2

VOLTAGE CHARTS

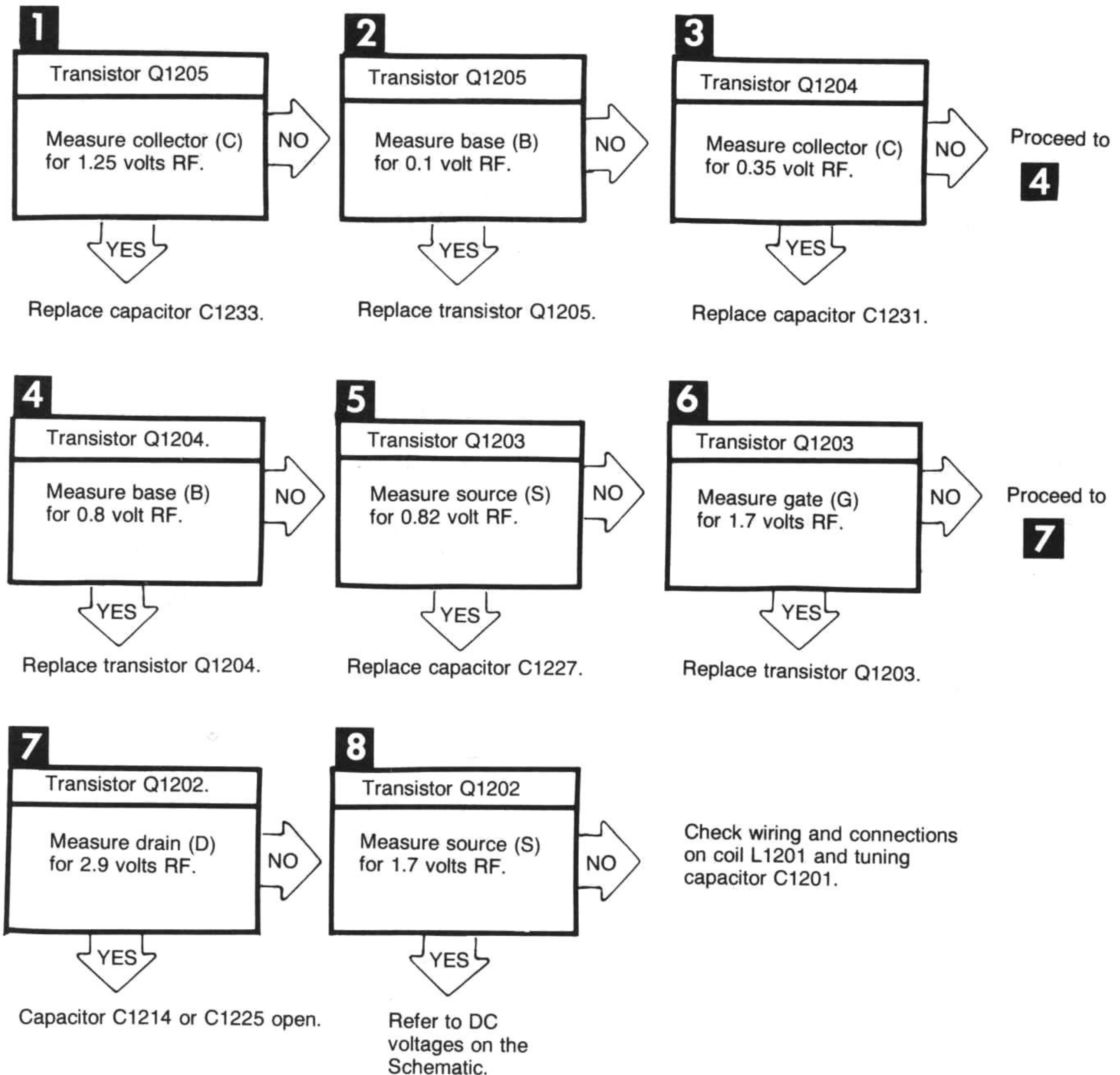
NOTE: The voltage readings indicated are shown with the **Remote** switches in the indicated positions. Readings are taken with a high impedance input voltmeter and are accurate to within $\pm 20\%$. All cables are properly connected to the Transceiver and power is applied.

TEST POINT (on XTAL OSC/SW circuit board)	DEPRESS REMOTE VFO SWITCH (see Figure 1, Illustration Booklet, Page 9.)	+DC VOLTS (TP to gnd)
A	T/R (SW1276D), XTAL ON (SW1275A), XTAL 1 (SW1275C)	0
A	T/R (SW1276D), XTAL ON (SW1275A), XTAL 2 (SW1275D)	9.2
B	T/R (SW1276D), XTAL ON (SW1275A), XTAL 1 (SW1275C)	9.2
B	T/R (SW1276D), XTAL ON (SW1275A), XTAL 2 (SW1275D)	0
C	XTAL ON (SW1275A)	10.2
D	T/R (SW1276D), Remote On (SW1275B)	6.9
E	RX (SW1276A), Remote On (SW1275B)	.8
F	T/R (SW1276D), Remote On (SW1275B)	.8
G	RX (SW1276A), Remote On (SW1275B)	.8
G	TX (SW1276B), Remote On (SW1275B)	.03
H	TX (SW1276B), Remote On (SW1275B)	.8
H	RX (SW1276A), Remote On (SW1275B)	.03
N	T/R (SW1276D), Remote On (SW1275B)	10.3

VFO Flow Chart

NOTE: In order to make the following voltage checks in the VFO chassis and circuit board assembly, you will need either an oscilloscope or an RF voltmeter. It will be necessary for you to first remove the circuit board and bracket assembly from the VFO chassis. Then, hook up the test circuit and install it in the VFO 4-pin plug as outlined on Page 71 and as shown in Pictorial 13-1 (Illustration Booklet, Page 10).

VFO FLOW CHART





SPECIFICATIONS

VFO Frequency Range	5.0 to 5.5 MHz.
Modes of Operation	Remote VFO only. Main VFO only. Remote Transmit/Main Receive. Main Transmit/Remote Receive. Crystal, 2 frequencies.
Stability	Less than 100 Hz drift per 30 minutes after 30 minute warmup.
Dial Backlash	Less than 50 Hz.
Power Requirement (Source SB-104A Transceiver)	11.0 volts DC at 50 mA and 13.6 volts DC at 460 mA.
Dimensions (overall)	13-7/8" long × 9-7/8" wide × 7-1/8" high. (35.2 cm. × 25.1 cm. × 18.1 cm.)
Net Weight	6-1/2 lbs. (2.95 kg.).

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

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram while you read this "Circuit Description." The component numbers on the Schematic are arranged in the following groups to help you locate specific parts on the Schematic, chassis, and circuit boards:

- 1201-1249 Parts inside the VFO assembly.
- 1251-1274 Parts on the XTAL OSC/SW circuit board.
- 1275-1299 Parts on the chassis.

VARIABLE FREQUENCY OSCILLATOR (VFO)

The VFO circuit consists of the oscillator circuit board, the buffer circuit board, a tuning capacitor, and a variable inductor.

Oscillator Circuit Board

Field-effect transistor Q1202 is used in a type of Hartley oscillator circuit which is controlled by tuning capacitor C1201 and a portion of coil L1201. Temperature-compensating capacitors C1202 through C1207 help hold the oscillator frequency stable during temperature changes. The remaining part of coil L1201 provides feedback to maintain oscillation. Variable coil L1201 also adjusts the frequency range of the Remote VFO so its dial reading corresponds to the digital display on the Transceiver.

Tuning capacitor C1201 is directly coupled to the dial pointer and through a 36:1 dual vernier drive system to the tuning knob.

A 13.6-volt shift signal is present at the LSB connection on the circuit board whenever the Transceiver is in the LSB mode. This voltage causes diode D1201 to act as a switch that either adds or removes capacitors C1209 and C1211 from the circuit. These capacitors shift the VFO frequency so the transmitter carrier frequency remains the same when you switch sidebands.

Zener diode ZD1201 is a 7.5-volt source regulator for the drain of Q1202 while diode D1204 reduces the level of harmonics in the VFO.

The output of the oscillator circuit is coupled through C1214 to the input of the buffer stage.

Buffer Circuit Board

The signal from the oscillator circuit is coupled through capacitor C1225 to the base of buffer transistor Q1203. Q1203 isolates the oscillator from the stages which follow and also acts as an impedance-matching device for the next stage.

Signals from Q1203 are coupled through C1227 to the base of voltage amplifier Q1204. Temperature-compensating diode D1202 and control R1232 set the gain of this stage.

Amplified signals from Q1203 then pass through C1231 to another voltage amplifier, Q1205, which is temperature compensated by D1203.

RF choke RFC1202 and capacitor C1232 prevent any RF from modulating the supply voltage.

The signal at the output of the buffer circuit board is coupled to a network of solid state switches and switching circuits which route the signal back to the Transceiver.

XTAL OSC/SW CIRCUIT BOARD AND SWITCHES

Power is applied to the Remote VFO, through the inter-connecting cables, anytime the Transceiver power is on. Therefore, if the Remote-On switch is depressed, the pilot lamps may be illuminated and one of the indicator lights (according to which switch circuit is activated) will be lit.

XTAL Oscillator

Transistor Q1253 and the associated circuitry forms a colpitts oscillator for crystal-controlled operation. Operating frequency is determined by the crystals at Y1251 or Y1252, which are selected by grounding either connection A or B, respectively. C1254 and C1255 are netting capacitors so you can bring your crystals on-frequency.

Emitter-follower transistor Q1254 forms a buffer stage to prevent the following stages from loading the oscillator.

A low-pass filter formed by L1251, L1252, and C1259 reduces the harmonic content of the oscillator.

When the crystal oscillator is activated, by applying 11 volts to connection C, transistor Q1255 becomes saturated and allows the oscillator signal to pass through to another low-pass filter formed by L1253, L1254, and C1267.

The signal then passes through an interconnect cable to the Transceiver VFO input jack for use throughout the Transceiver.

Control R1263 allows you to adjust the output of the crystal oscillator to the proper level.

VFO Switching

The VFO switching circuit, which is actuated by applying 11 volts to connection N, determines which VFO (in the Transceiver or in the Remote VFO) is in control of the transmitted or received signal.

Transistors Q1251 and Q1252 provide electronic switching for common-base RF switches Q1256 and Q1257. When a positive voltage is applied to either Q1256 or Q1257, the transistor is driven into saturation. This allows the RF signal at its collector to pass through to the low-pass filter formed by L1253, L1254, and C1267. The signal then passes through an interconnect cable to the Transceiver VFO input jack.

This circuit is designed so that only one of the RF switches may be actuated at a given time. This prevents the unwanted VFO signal from controlling the Transceiver.

Switches

Because the switching circuit is quite complicated, due to many interconnections, only the function of each switch is given below. Truth Table A will help you understand the operation of the switches from an electronic standpoint. Consider a logic 1 as any voltage greater than .7 volts DC and a logic 0 as any voltage less than .7 volts DC.

SW1275A provides the switching voltage for the crystal oscillator. This switch must be depressed before the crystal oscillator will operate. Voltage is removed from dial lights PL1275, PL1276, and PL1277 in this mode.

SW1275B provides the switching voltage for the RF switches and their control transistors. This switch must be depressed before either the main (Transceiver) or the remote VFOs will operate.

SW1275C provides a ground to circuit board connection A. This allows diode D1251 to turn on and select crystal Y1251. This switch also supplies voltage to the "XTAL 1" indicator light, I1279.

SW1275D provides a ground to circuit board connection B. This allows diode D1252 to turn on and select crystal Y1252. This switch also supplies voltage to the "XTAL 2" indicator light, I1281.

SW1276A causes the Remote VFO to control the Transceiver in the receive mode and causes the main VFO to control the Transceiver in the transmit mode. This switch also supplies voltage to the "R/REM T/MAIN" indicator light, I1278.

SW1276B causes the Remote VFO to control the Transceiver in the transmit mode and causes the main VFO to control the Transceiver in the receive mode. This switch also supplies voltage to the "R/MAIN T/REM" indicator light, I1277.

SW1276C causes the Transceiver to transmit and receive on the main VFO. This switch also supplies voltage to the "MAIN" indicator light, I1275. Voltage is removed from dial lights PL1275, PL1276, and PL1277 in this mode.

SW1276D causes the Transceiver to transmit and receive on the Remote VFO. This switch also supplies voltage to the "Remote" indicator light, I1276.

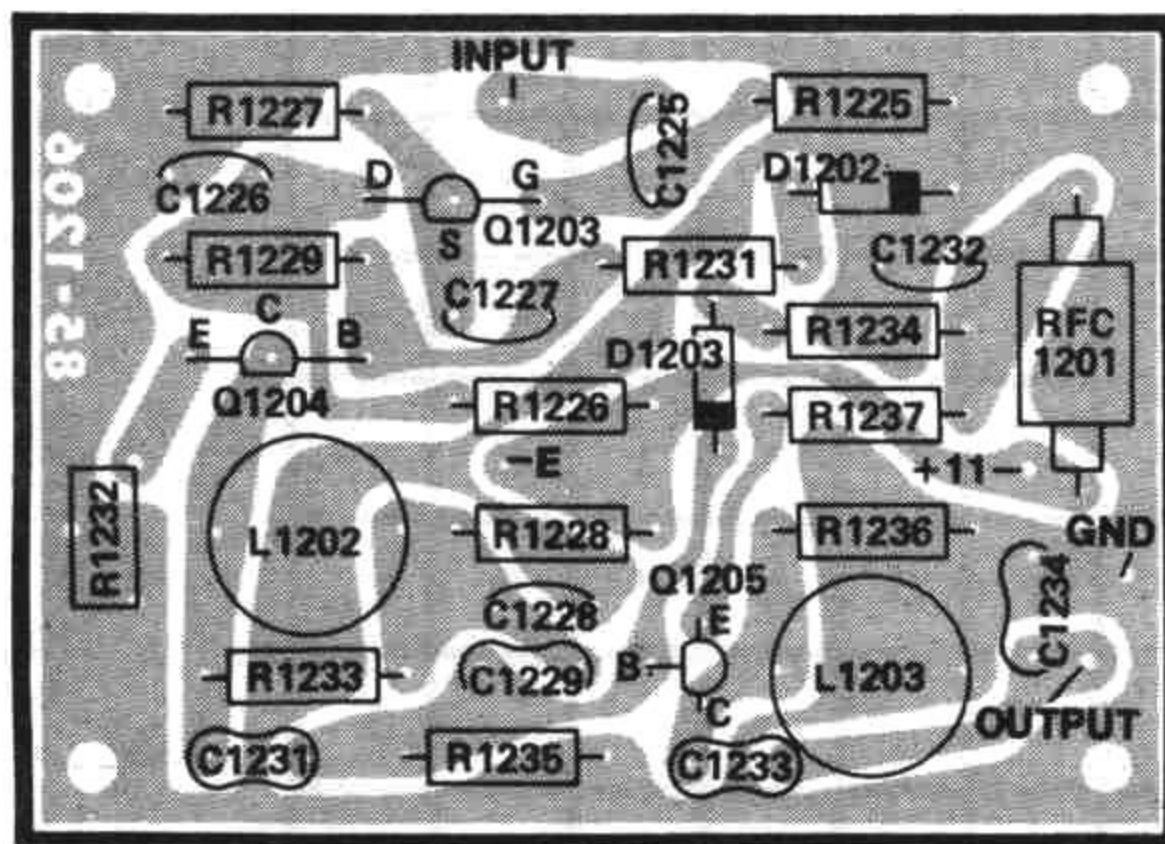
TABLE A

SWITCH SELECTED	MODE	CIRCUIT BOARD CONNECTION								
		A	B	C	D	E	F	G	H	N
SW1276A	RX	—	—	0	0	1	0	1	0	1
	TX	—	—	0	1	0	1	0	1	1
SW1276B	RX	—	—	0	0	1	0	0	1	1
	TX	—	—	0	1	0	1	1	0	1
SW1276C	RX	—	—	0	0	1	0	0	1	1
	TX	—	—	0	0	1	0	0	1	1
SW1276D	RX	—	—	0	1	0	1	1	0	1
	TX	—	—	0	1	0	1	1	0	1
SW1275A and SW1275C	RX	0	1	1	—	—	—	—	—	0
	TX	0	1	1	—	—	—	—	—	0
SW1275A and SW1275D	RX	1	0	1	—	—	—	—	—	0
	TX	1	0	1	—	—	—	—	—	0

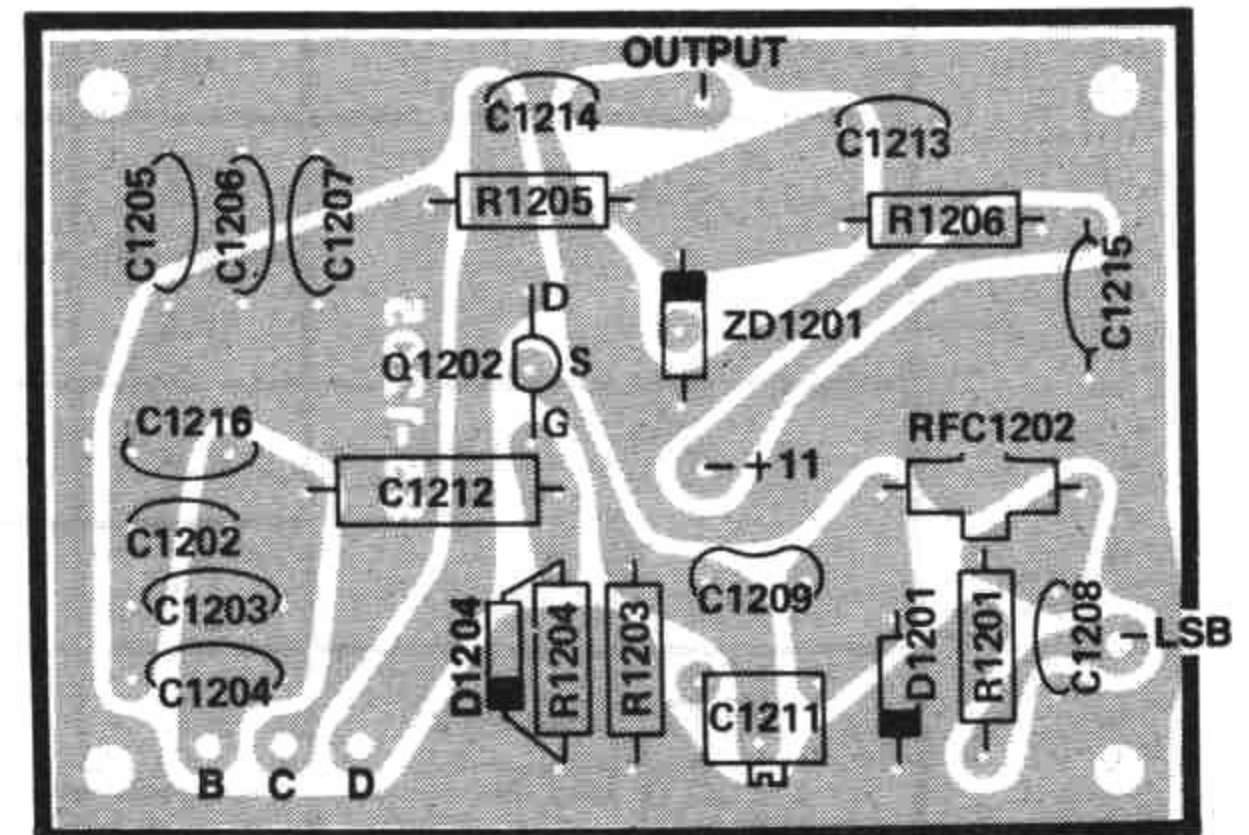
CIRCUIT BOARD X-RAY VIEWS

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

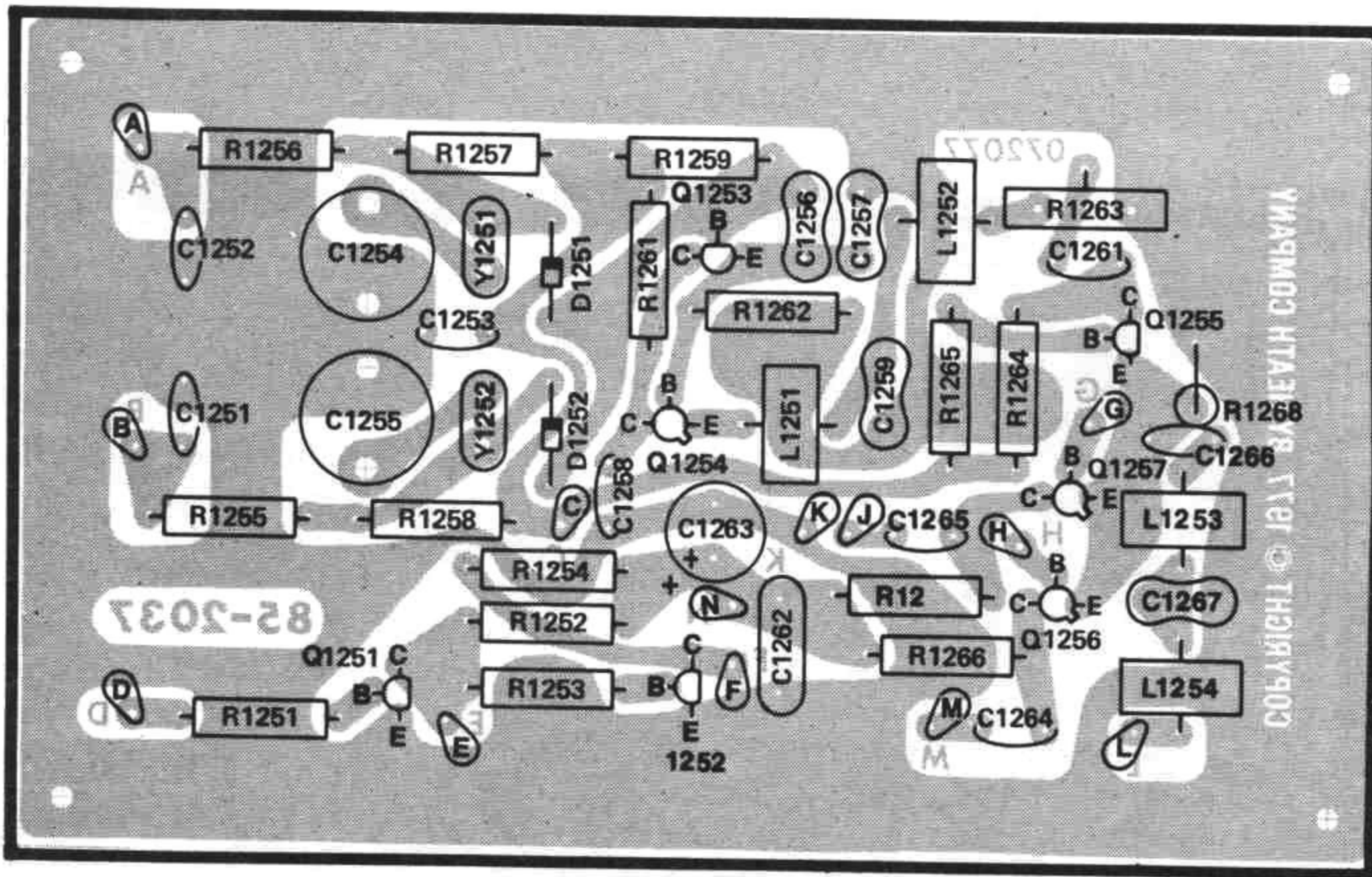
- A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View" or "Chassis Photograph."
- B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.
- C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



BUFFER CIRCUIT BOARD
(Shown from component side)

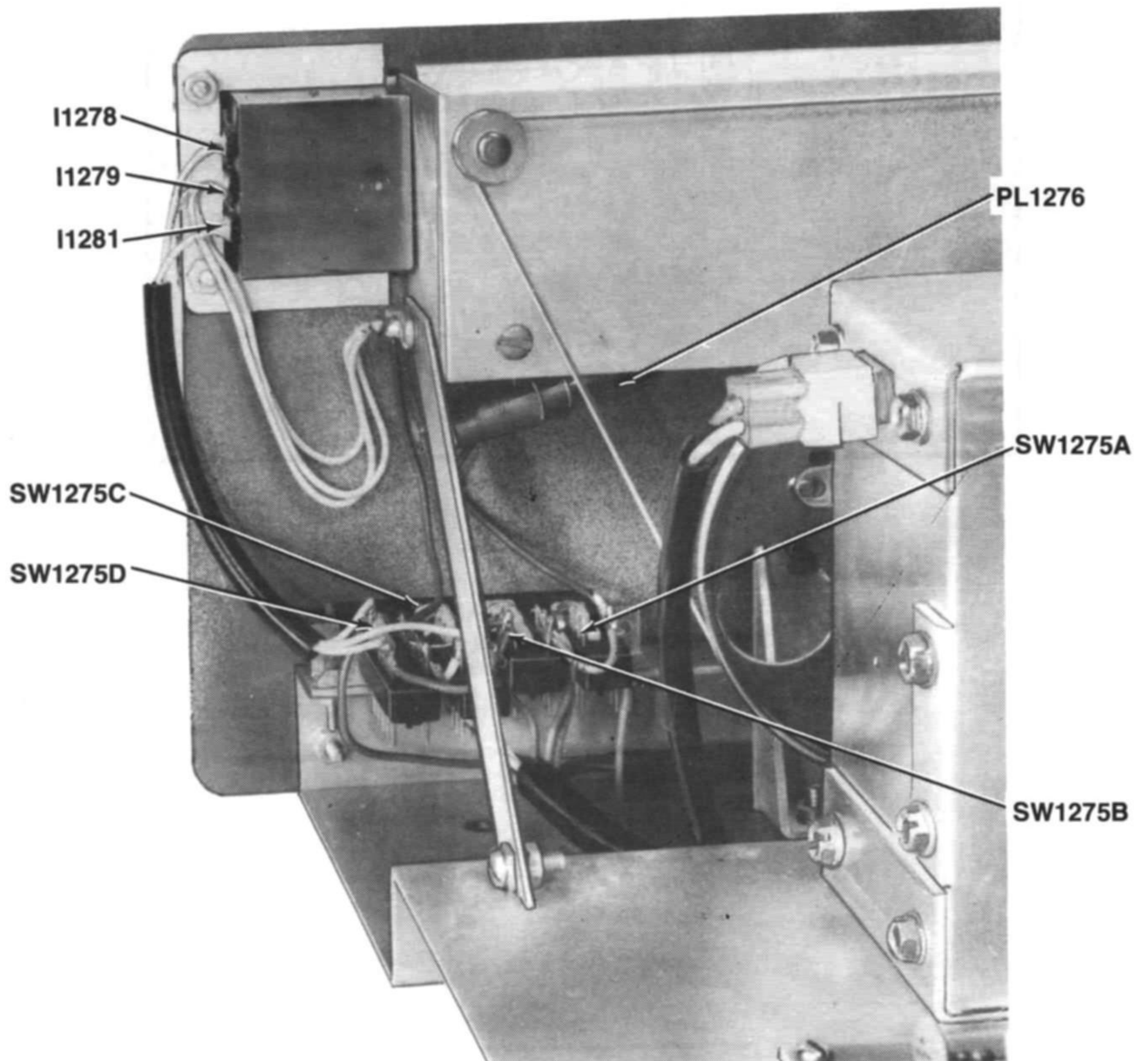


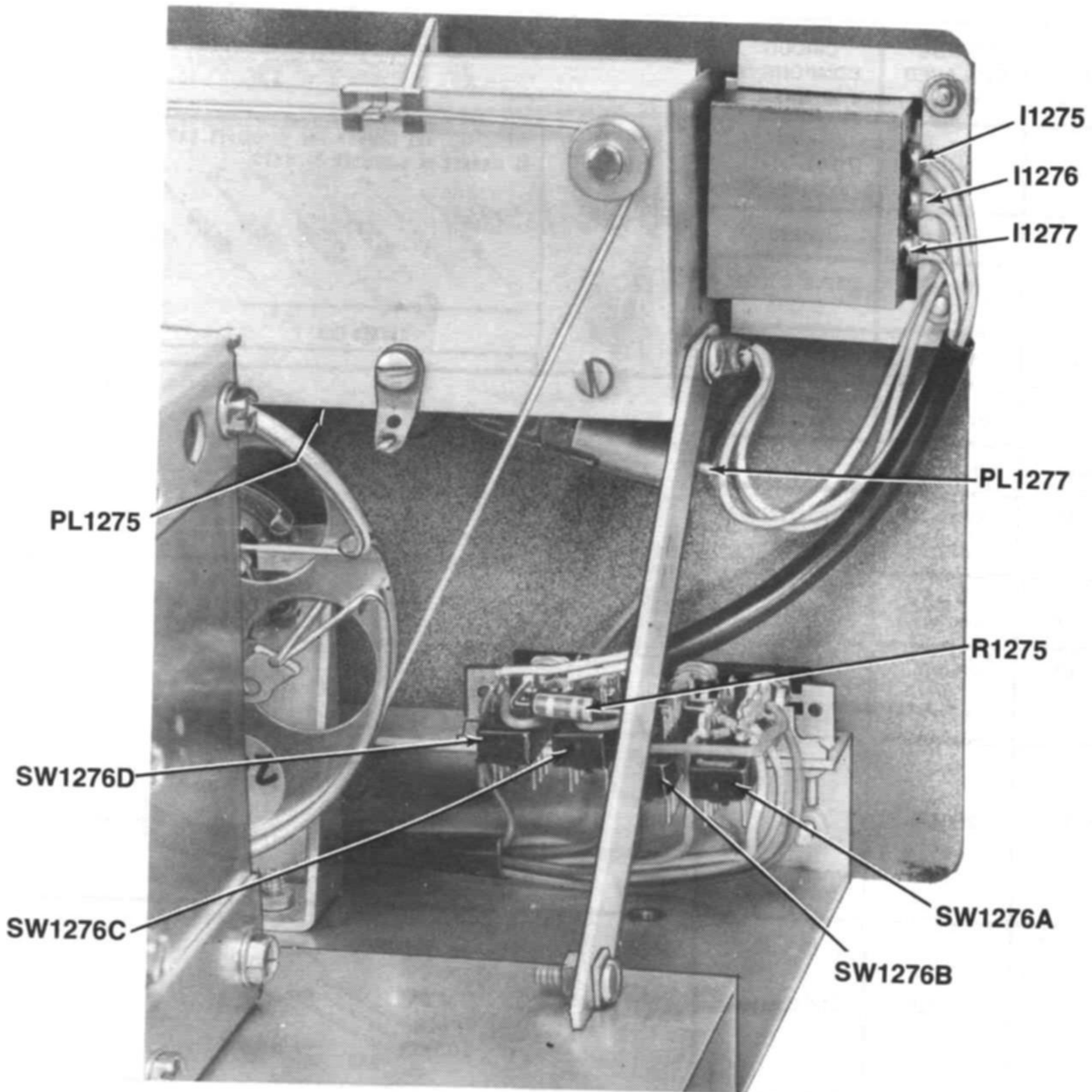
OSCILLATOR CIRCUIT BOARD
(Shown from component side)



SWITCH CIRCUIT BOARD
(Shown from component side)

CHASSIS PHOTOGRAPHS





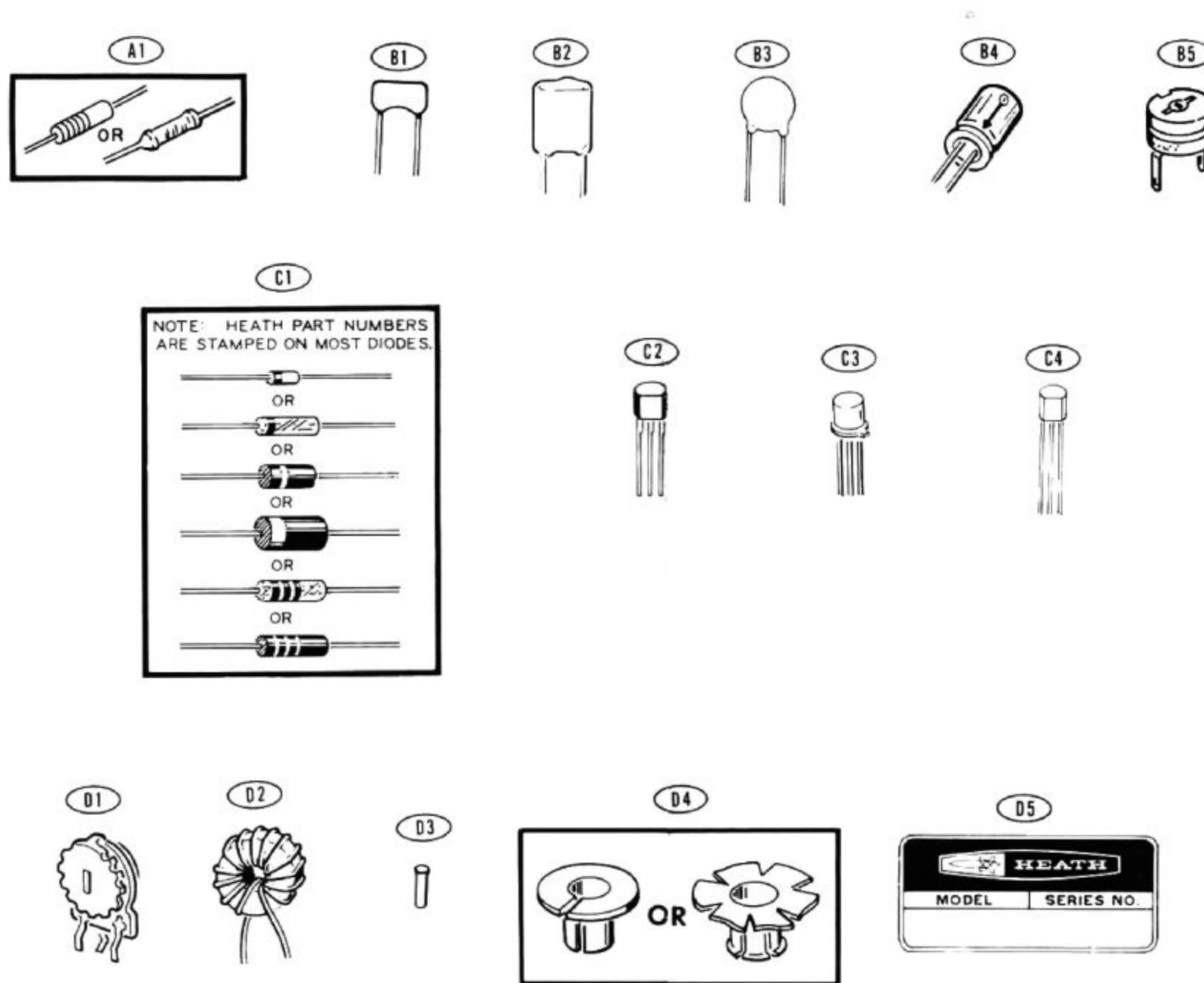
IDENTIFICATION CHART

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMPONENT NUMBER	IDENTIFICATION
56-24	1N458	D1201, D1251, D1252	<p>IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.</p> <p>BANDED END</p>
56-26	1N191	D1275	
56-56	1N4149	D1202, D1203, D1204	
56-97	VR7.5	ZD1201	
417-134	MPS6520	Q1255	<p>EMITTER BASE COLLECTOR FLAT</p>
417-234	2N3638A	Q1205	
417-864	MPSA05	Q1251, Q1252	
417-154	2N2369	Q1254	<p>COLLECTOR BASE EMITTER FLAT</p>
417-205	2N3866	Q1256, Q1257	
417-118	2N3393	Q1204	<p>EMITTER COLLECTOR BASE FLAT OR EMITTER COLLECTOR BASE FLAT</p>
417-169	MPF105	Q1202, Q1203	<p>DRAIN SOURCE GATE FLAT</p>
417-244	2N5089	Q1253	<p>EMITTER BASE COLLECTOR FLAT OR COLLECTOR BASE EMITTER FLAT</p>

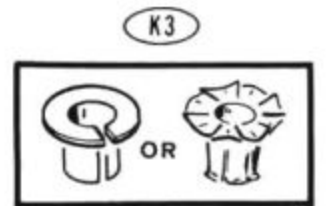
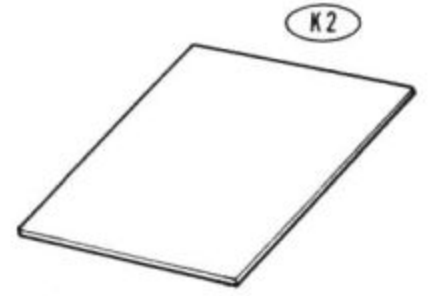
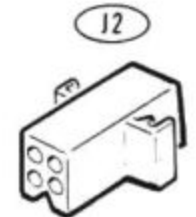
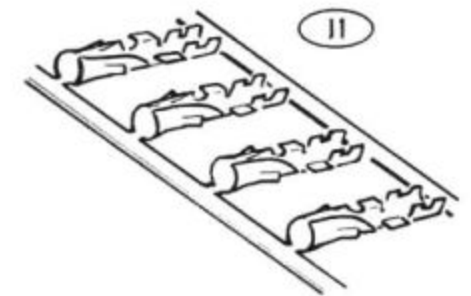
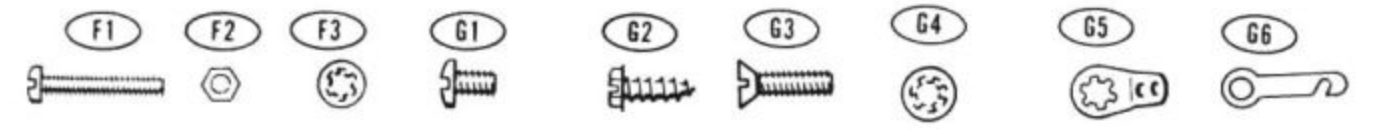
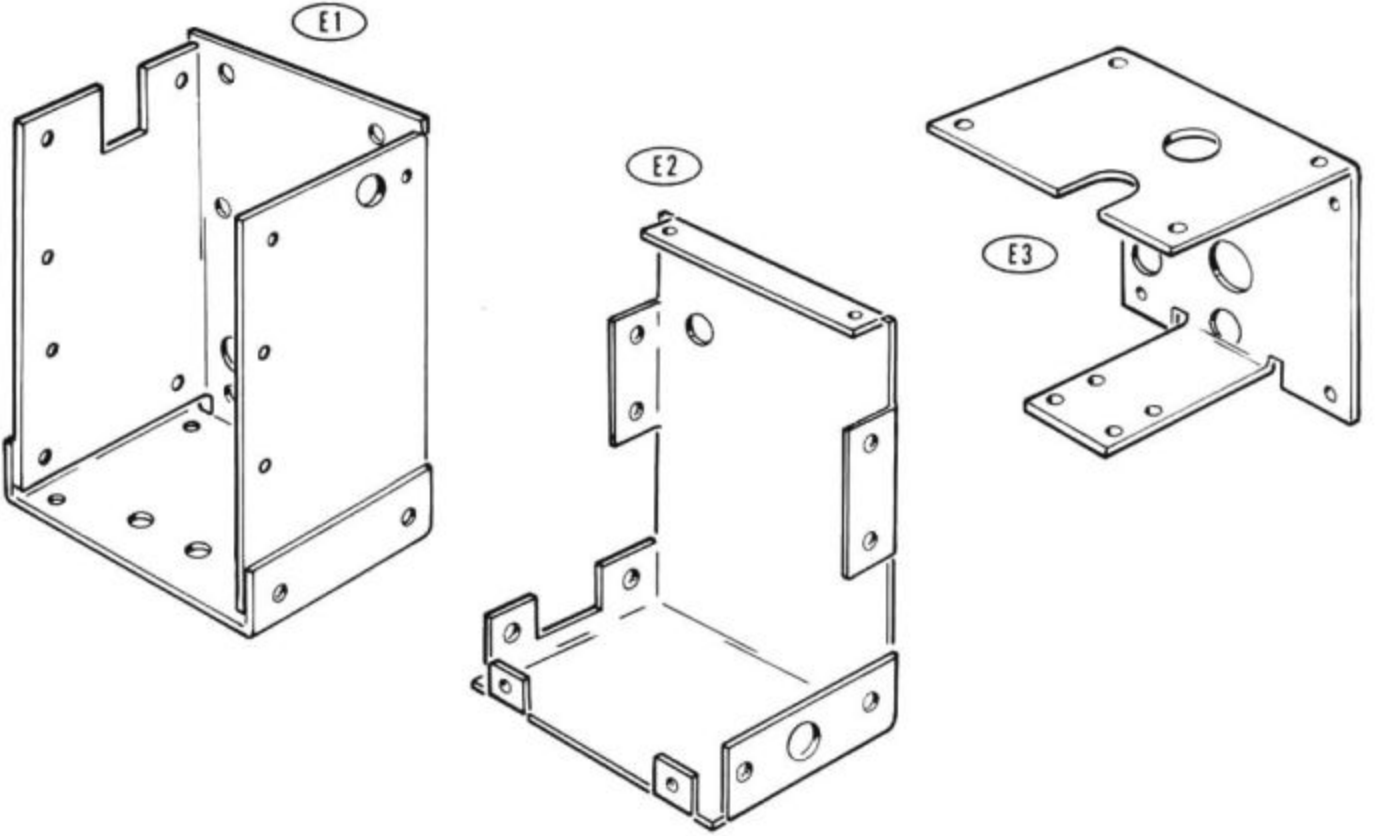
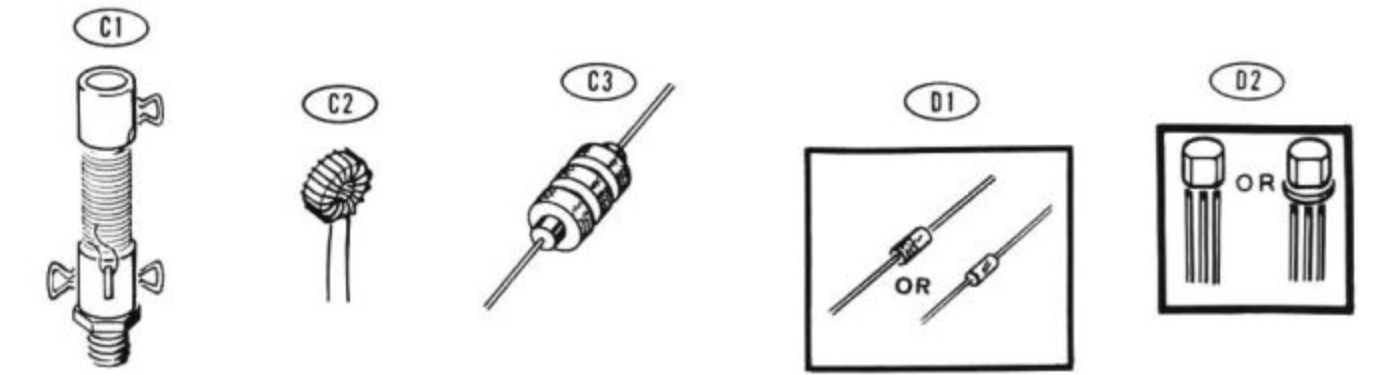
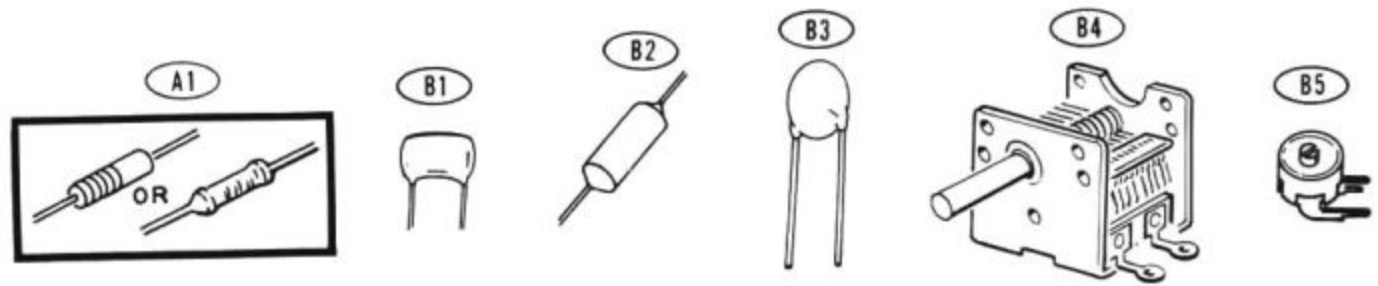
ILLUSTRATION BOOKLET

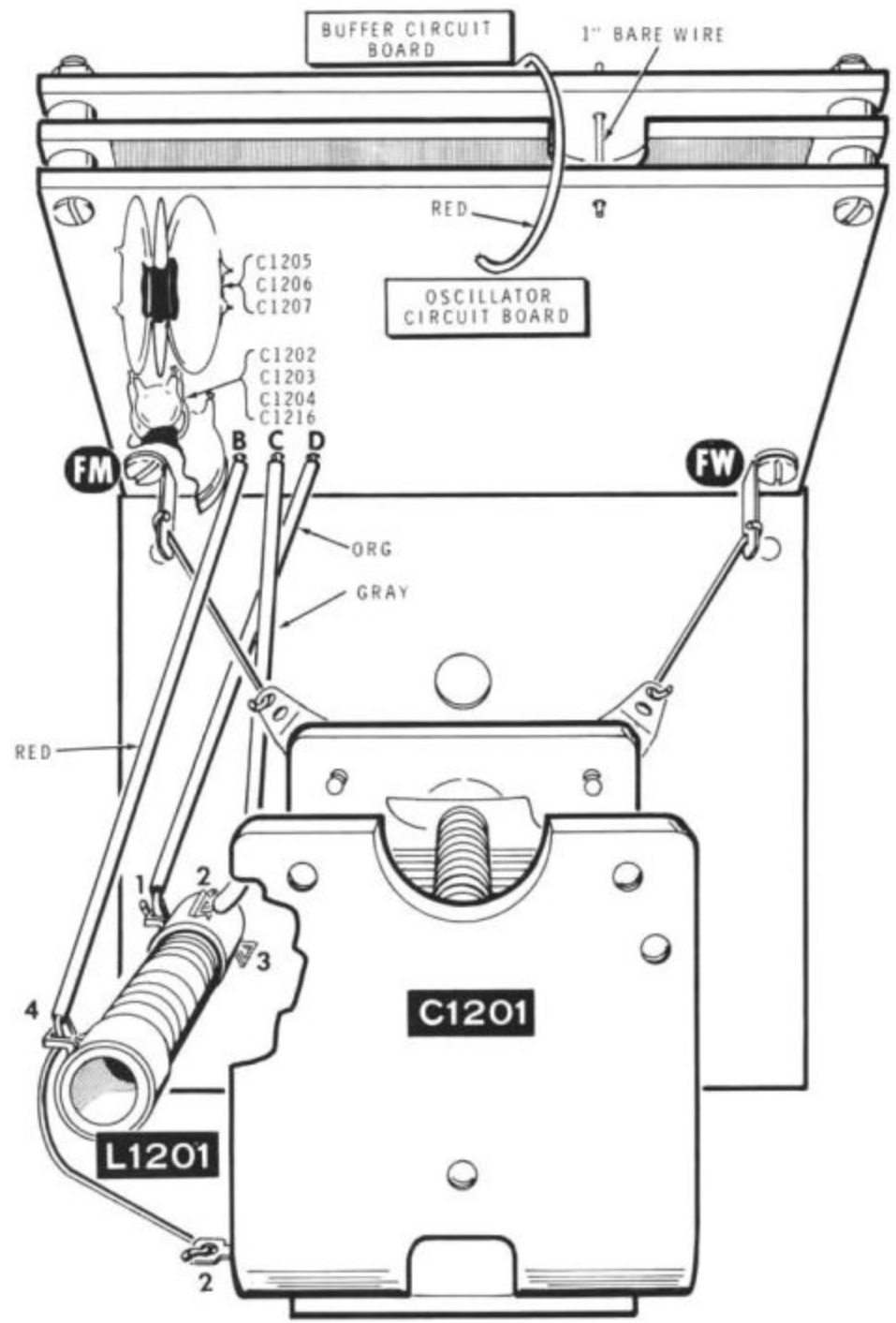
Part of 595-2055-02

XTAL OSC/SW CIRCUIT BOARD PARTS PICTORIAL

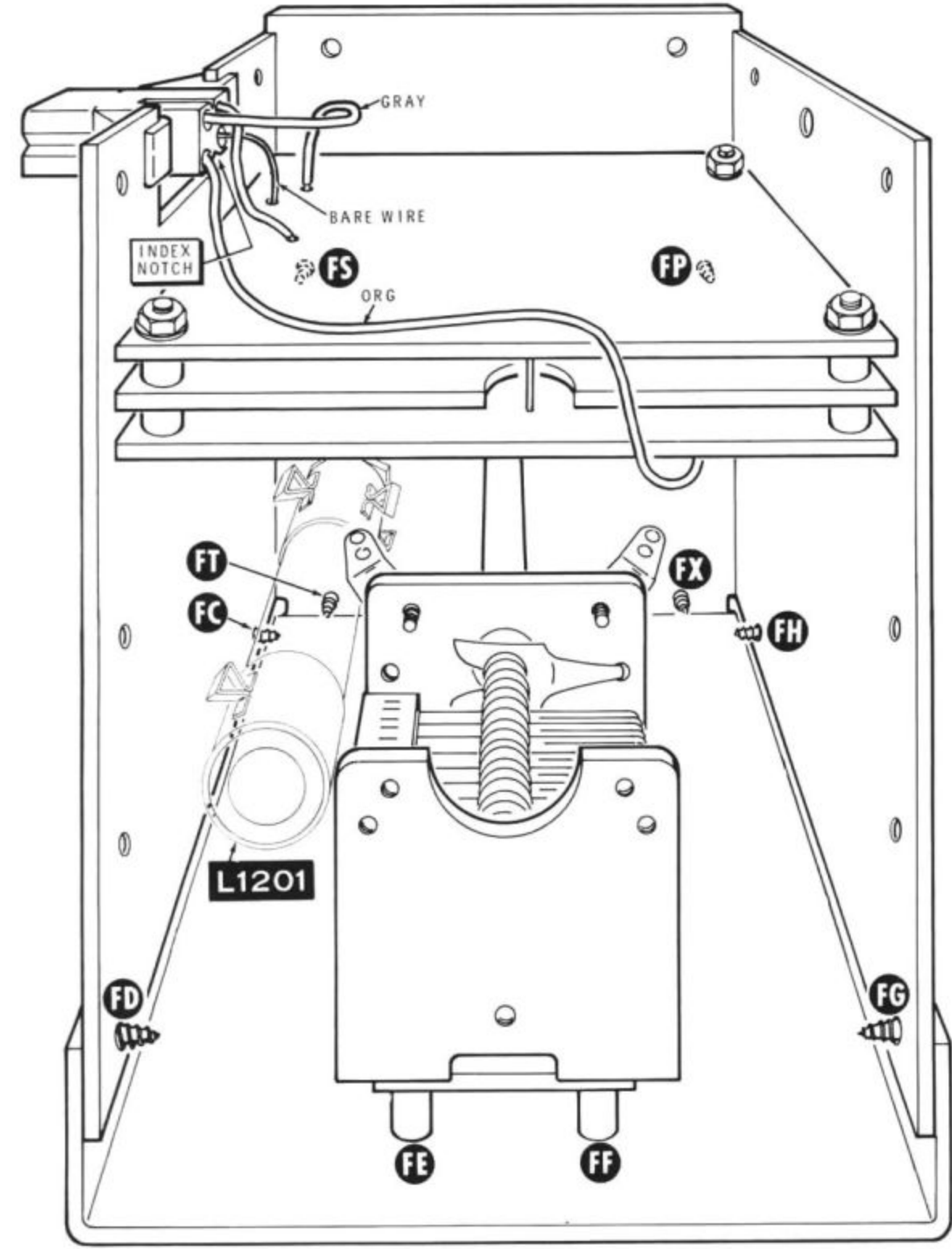


VFO PARTS PICTORIAL



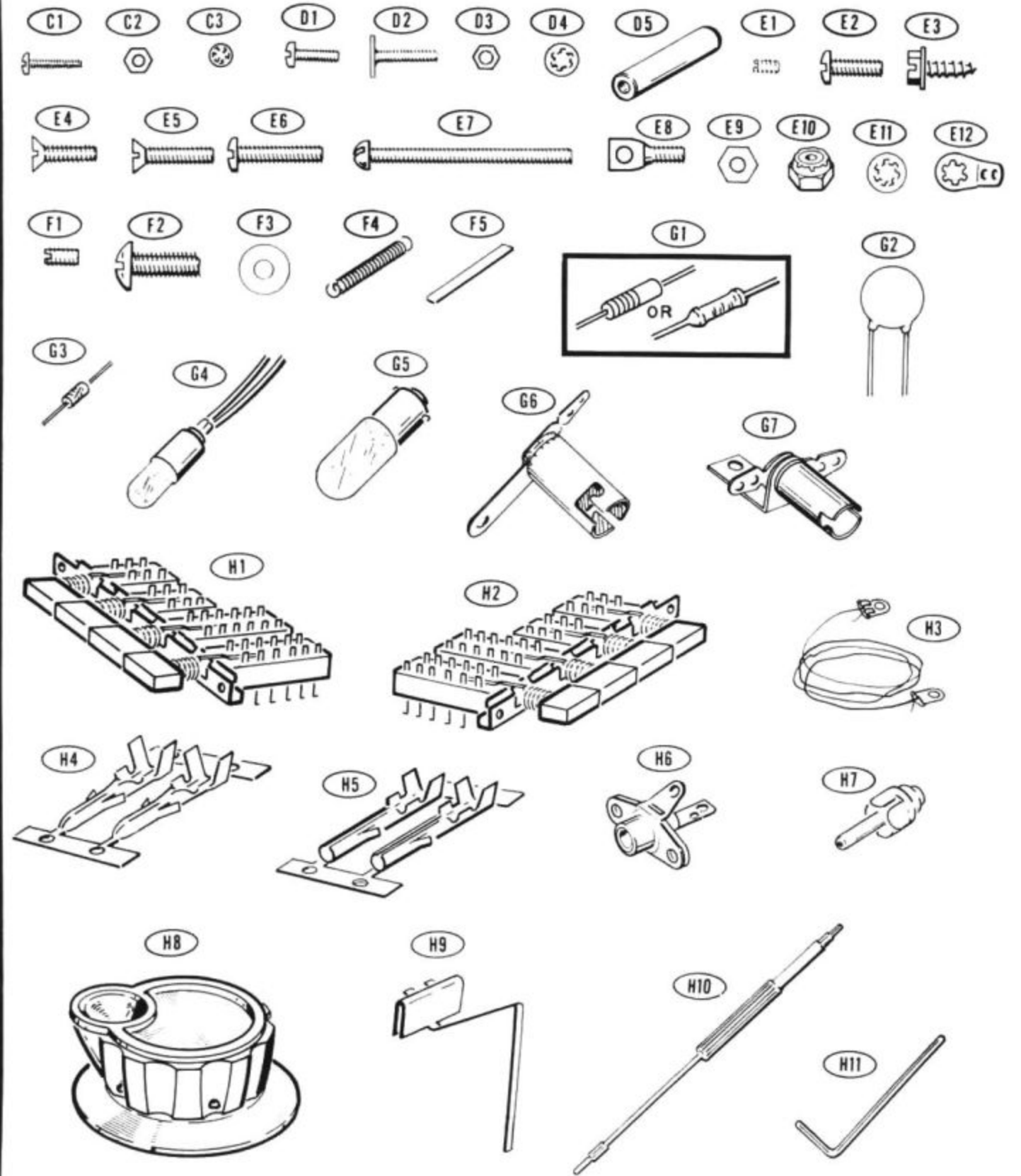
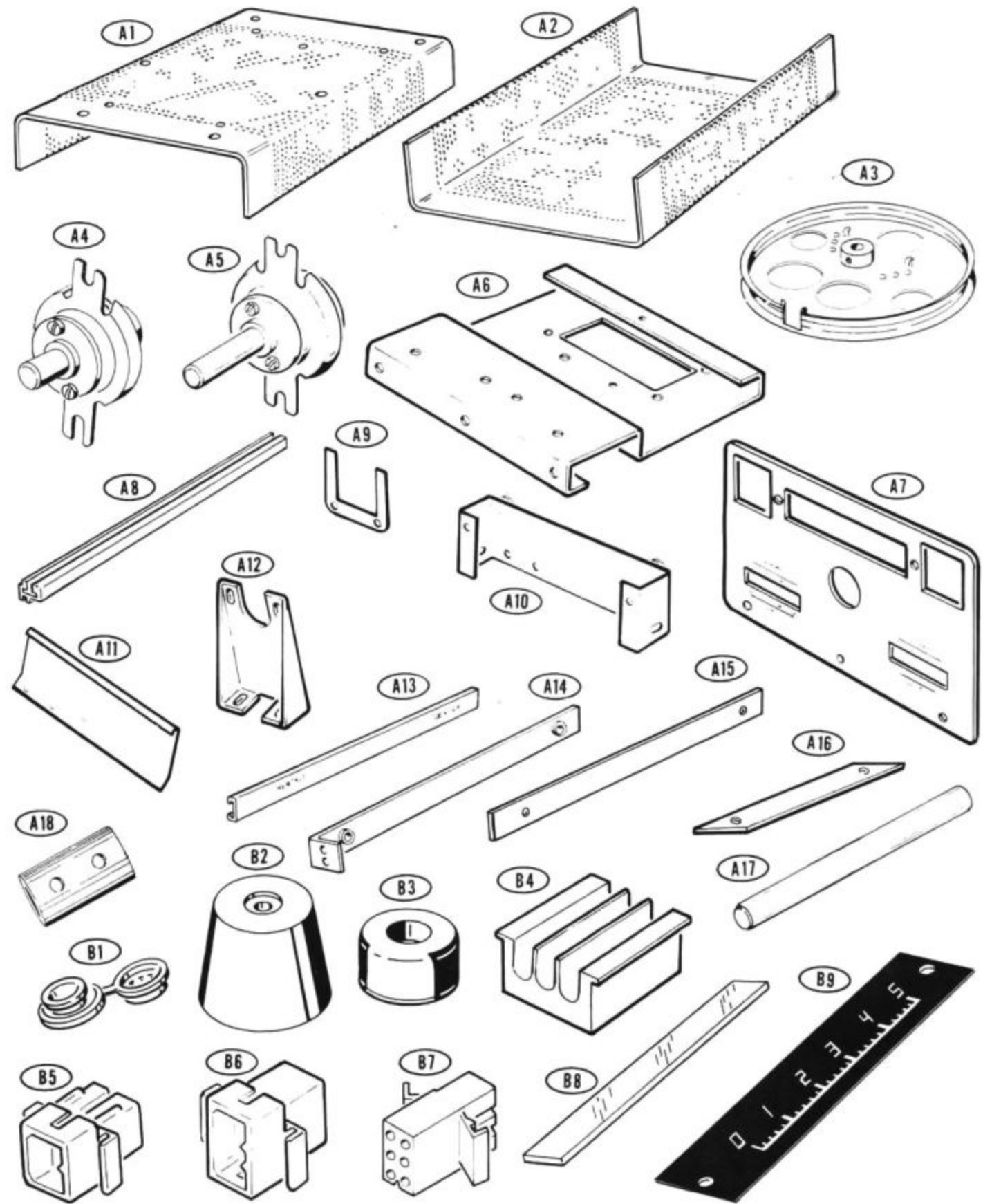


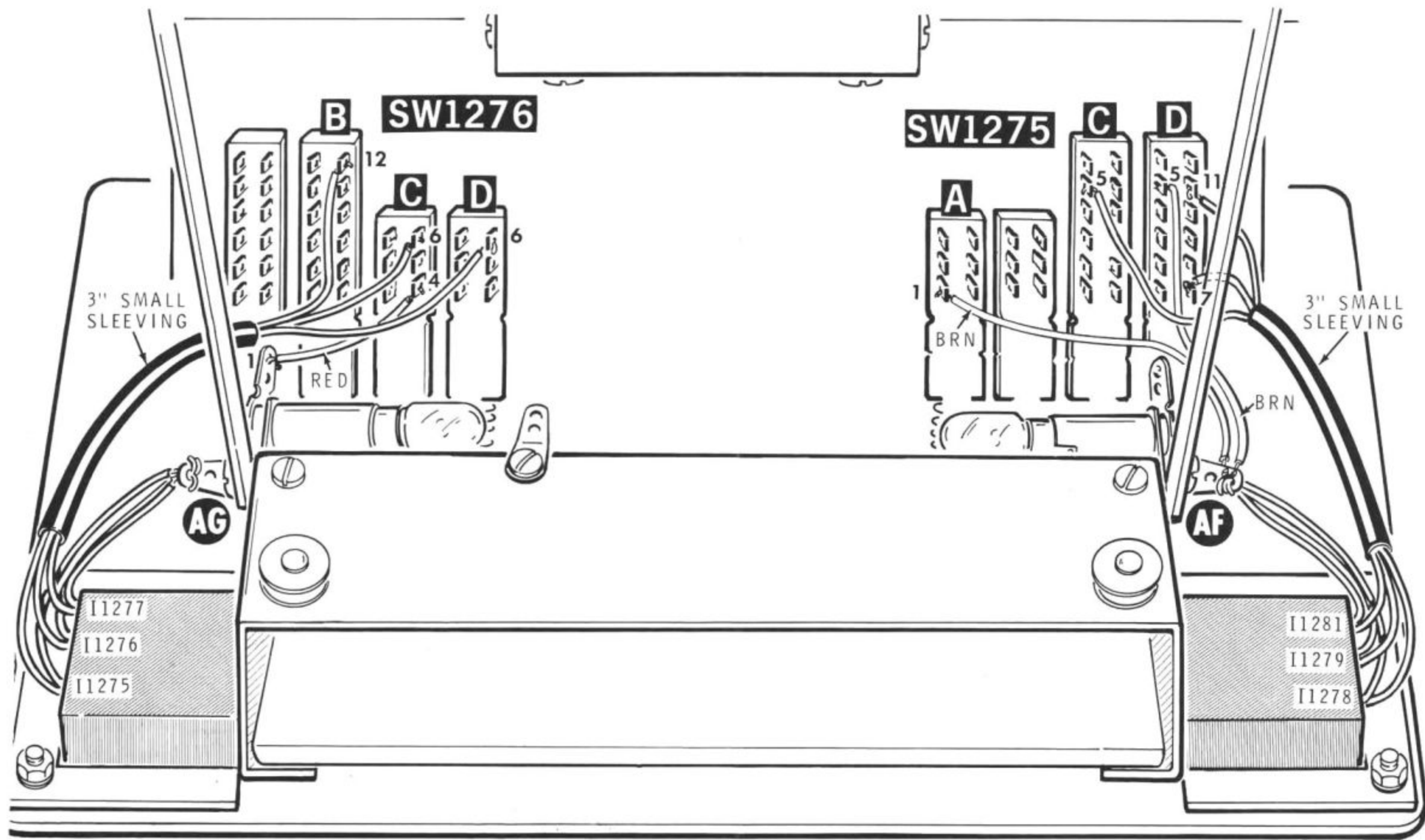
PICTORIAL 4-2



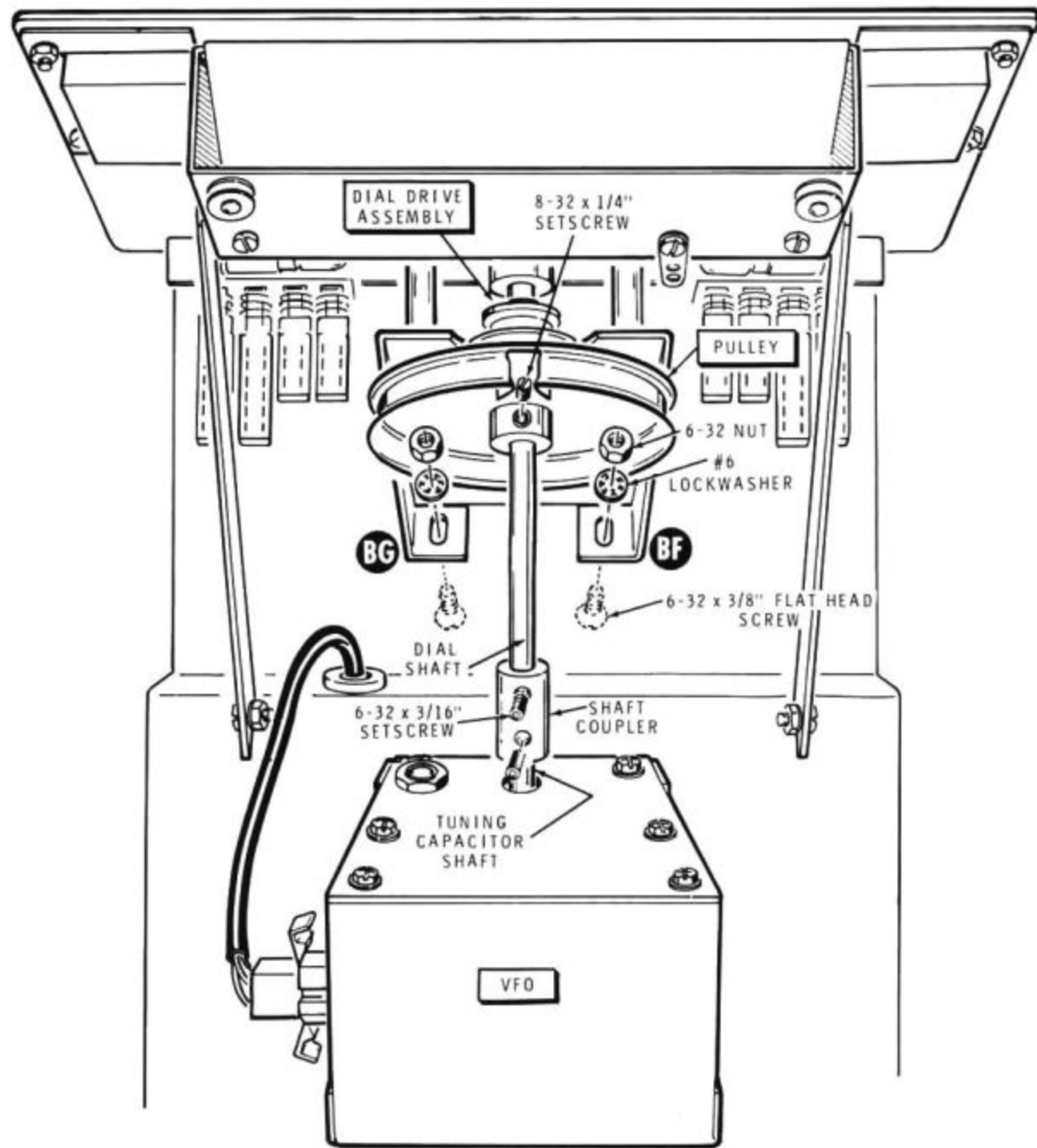
PICTORIAL 4-3

CHASSIS PARTS PICTORIAL

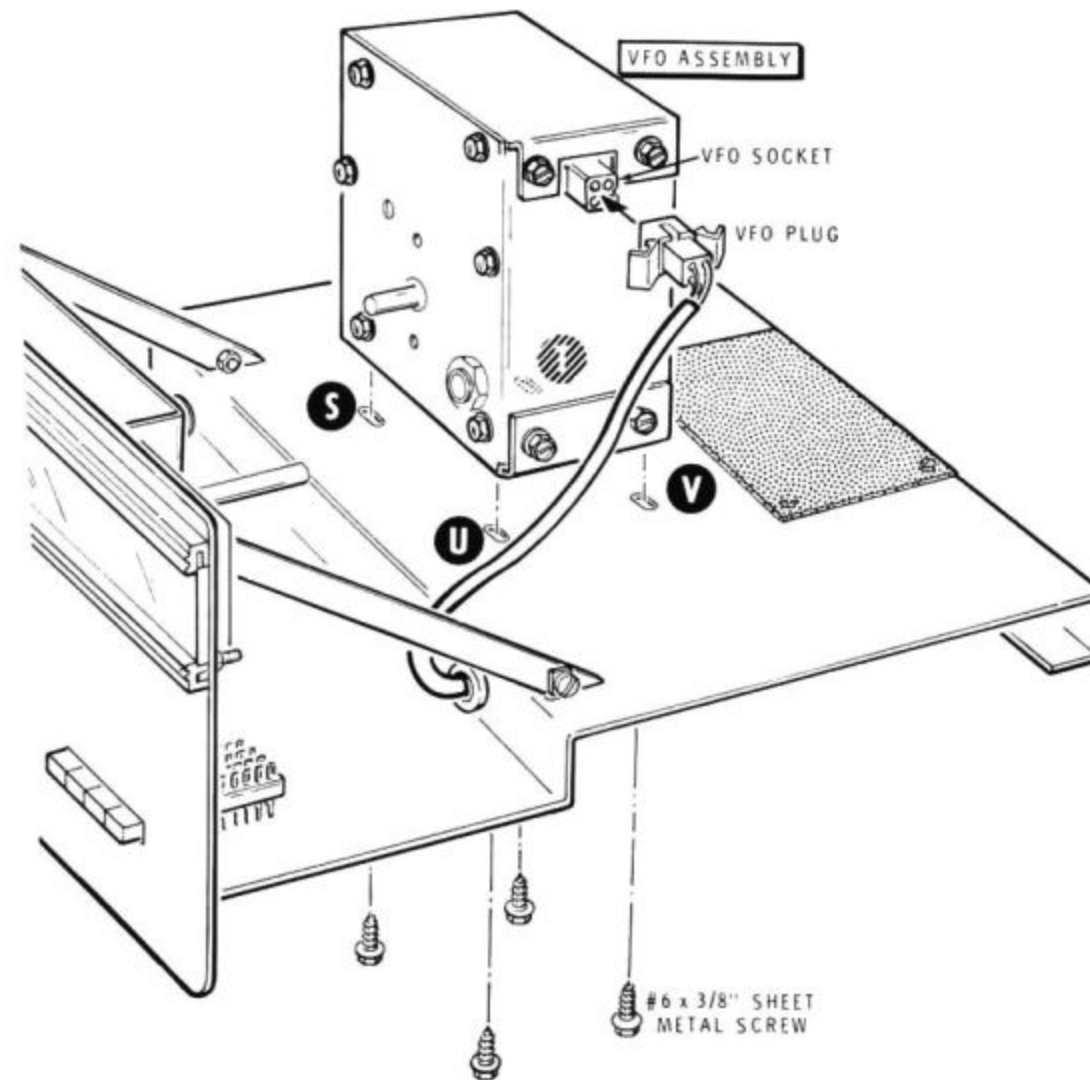




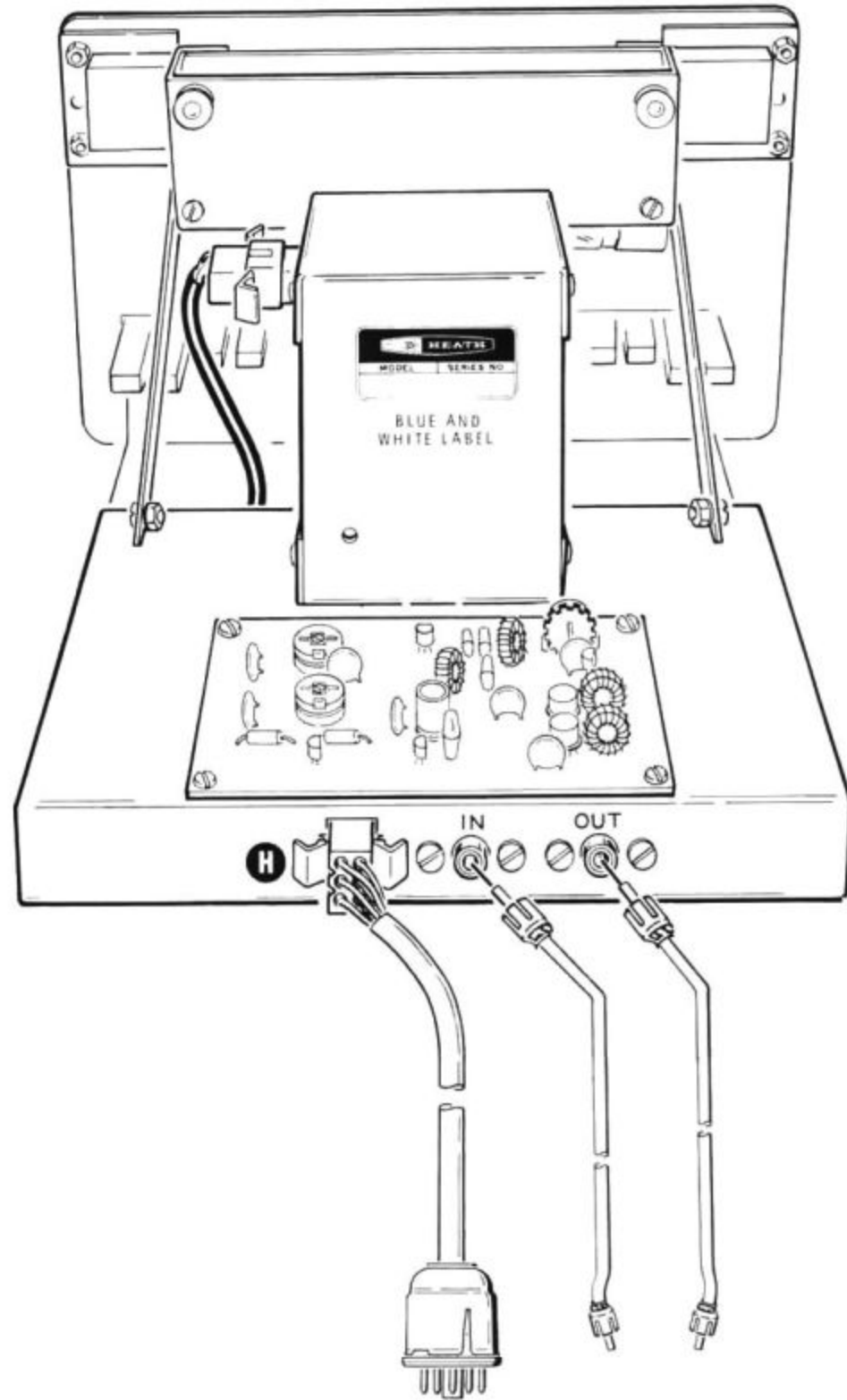
PICTORIAL 9-5



PICTORIAL 10-1



Detail 10-1B



PICTORIAL 11-2

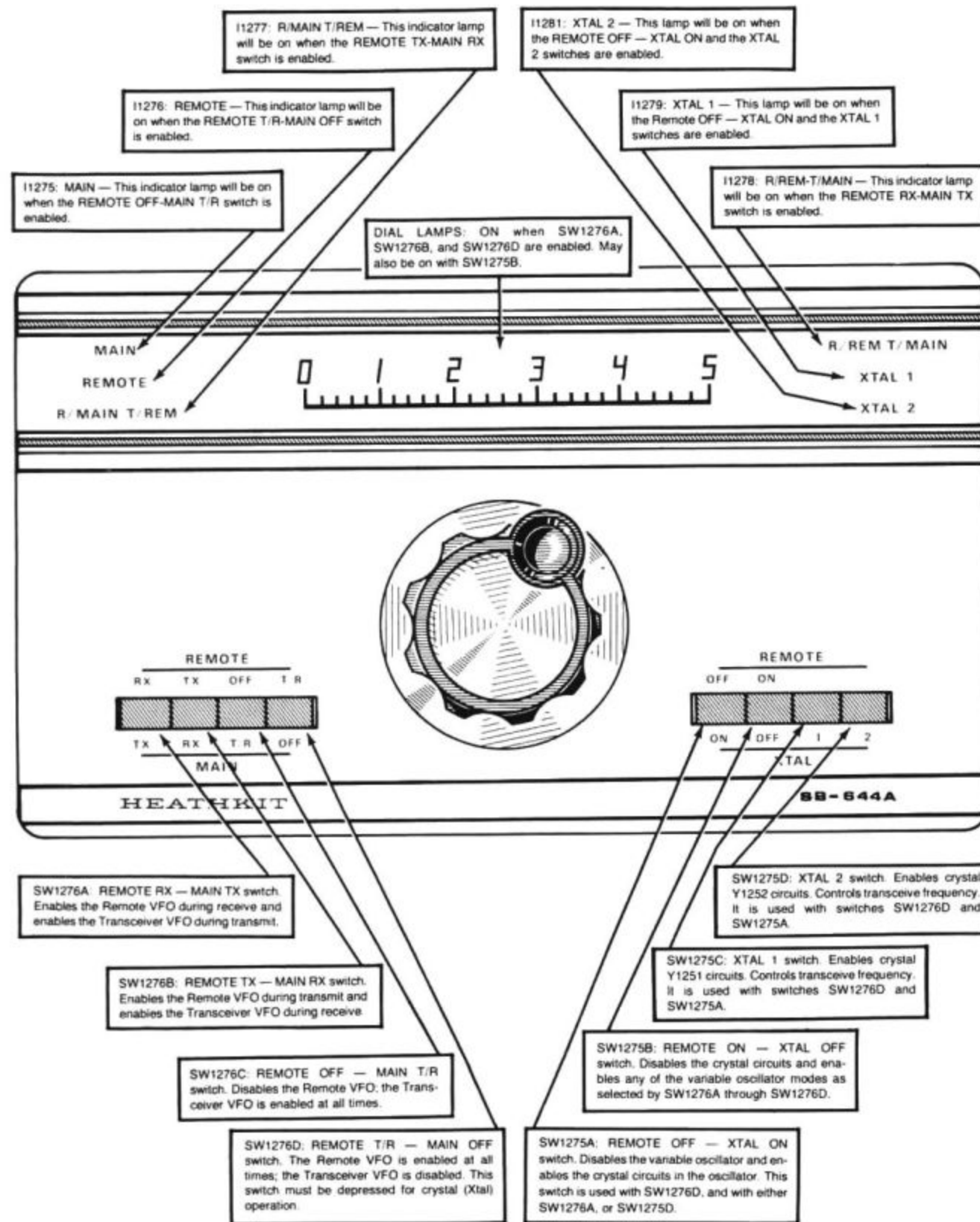


Figure 1

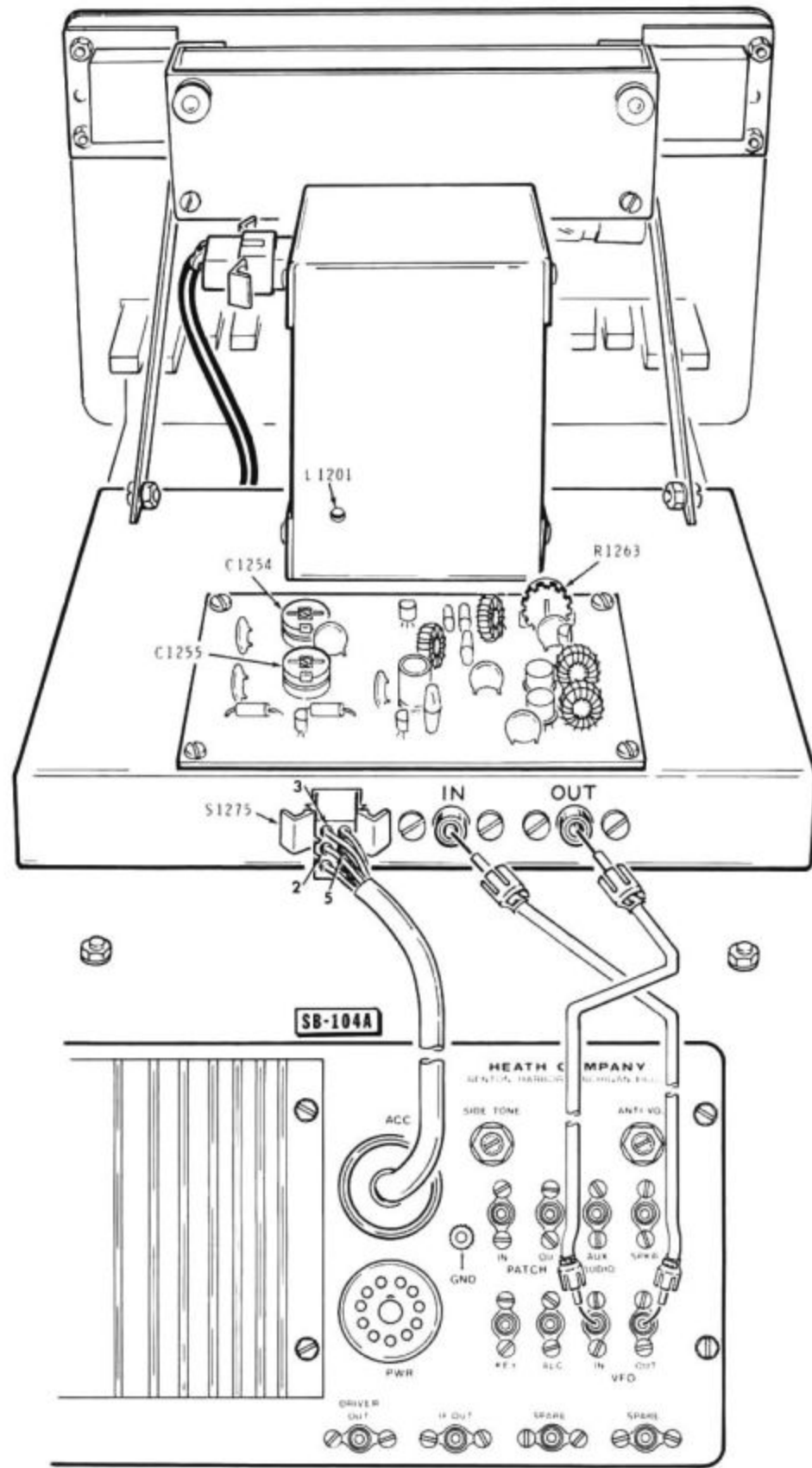
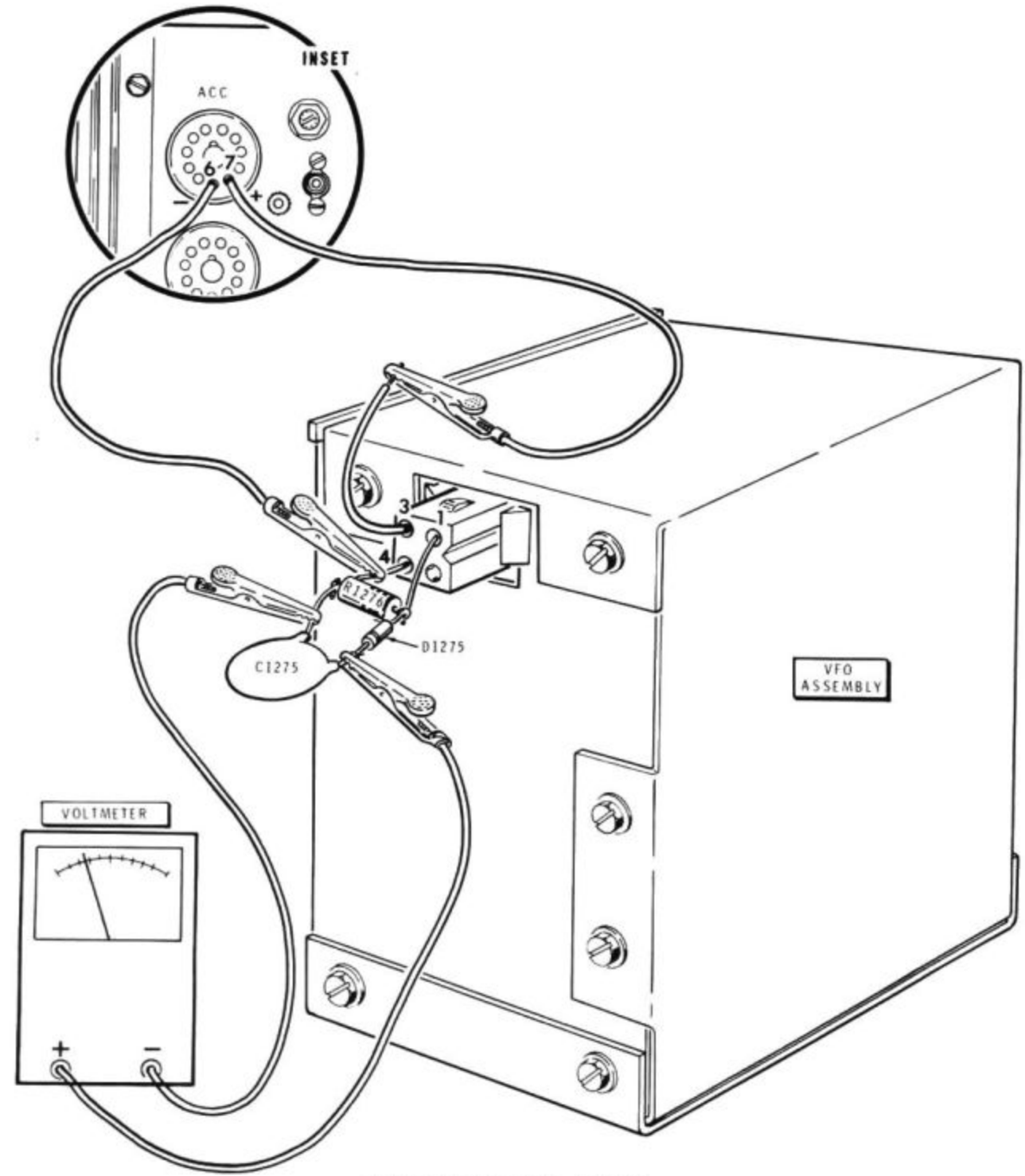


Figure 2



PICTORIAL 13-1

CUSTOMER SERVICE

REPLACEMENT PARTS

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

ORDERING FROM THE FACTORY

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

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

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

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

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

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

TECHNICAL CONSULTATION

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

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

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

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

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

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

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

REPAIR SERVICE

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

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

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

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

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

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

Heath Company
Service Department
Benton Harbor, Michigan 49022



HEATH COMPANY • BENTON HARBOR, MICHIGAN
THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.