HEATHKIT® MANUAL

for the

AUTO-TUNE ANTENNA TUNER

Model SA-2500

595-3027-1

HEATH COMPANY • BENTON HARBOR, MICHIGAN

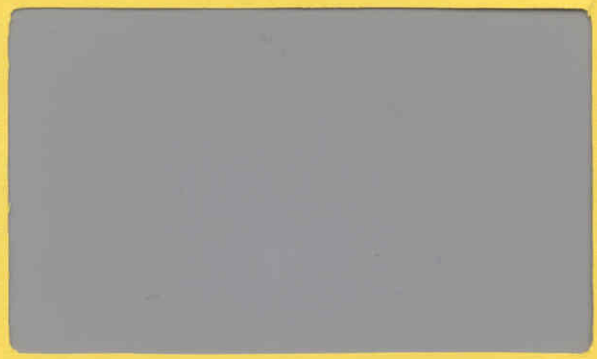
HEATH COMPANY PHONE DIRECTORY

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
8:00 A.M. to 12 P.M. and 1:00 P.M. to 4:30 P.M., EST, Weekdays Only

R/C, Audio, and Electronic Organs	(616) 982-3310
Amateur Radio	(616) 982-3296
Test Equipment, Weather Instruments and Home Clocks	(616) 982-3315
Television	(616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive, Appliances and General Products	(616) 982-3496
Computers — Hardware	(616) 982-3309
Computers — Software:	
Operating Systems, Languages, Utilities	(616) 982-3860
Application Programs	(616) 982-3884
Heath Craft Wood Works	(616) 982-3423



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 componen, 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

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Model SA-2500

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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

TABLE OF CONTENTS

INTRODUCTION

Your Heathkit Model SA-2500 Auto-Tune Antenna Tuner will automatically tune for a preset standing wave ratio (SWR), if that can be attained, to provide a good match between your receiving and transmitting equipment and practically any antenna you may wish to use for your HF operation. If you prefer, you can use the three front panel mounted lever switches to manually adjust your Antenna Tuner for the lowest possible SWR that can be obtained.

The Tuner is designed to operate on the 160- through 10-meter amateur bands, and will effectively tune and match balanced or unbalanced feed lines, and single-wire and ladder lines at the full legal power limit. With its continuously-variable inductor, you are assured precise antenna-matching all the way from 1.8 to 30 MHz, including the MARS frequencies, and all the newly-allocated bands.

Main circuit board mounted controls allow you to preset the roller inductor for up to 18 different positions in the AUTO mode (a low and a high for each of the nine bands, as indicated on the front panel, for example). The display on the front panel conveniently shows the number of active turns in use for each operating frequency.

The silver-plated straps and roller contact assembly minimizes RF losses at high frequencies. The large feed-through insulators withstand high-voltage RF when you use a single wire or a balanced feed line.

The dual wattmeter feature enables you to read both forward and reflected average power, in two ranges, up to the full legal power limit. An auto-range circuit automatically switches to the appropriate wattmeter range. The transition point, which is adjustable, is approximately at the 200-watt level.

The wattmeter section of your Auto-Tune Antenna Tuner installs directly into the transmission line to measure the power on all frequencies between 1.8 and 30 MHz. It measures 200/2000 watts in the forward direction and up to 50/500 watts reflected. Dual meters indicate the forward and reflected power separately for precise measurements. A factory aligned and calibrated sensor head insures high accuracy. SWR indications on the reflected meter provide direct readings from 1:1 to 3:1.

With a single switch, you can select a dummy load, or any of three permanently-connected antennas, including a long-wire antenna. You no longer need to connect and disconnect feed lines to load your transmitter into the dummy load.

With its factory-calibrated RF sensor, easy-to-read dual wattmeters, and with all its front panel controls, your new Auto-Tune Antenna Tuner will soon become an integral, indispensable component of your system.

UNPACKING

DO NOT UNPACK ANY PART OF YOUR KIT UNTIL A STEP DIRECTS YOU TO DO SO.

Locate the "Pack Index Sheet" that is packed inside the main shipping carton for your Antenna Tuner. Note that the shipping carton is divided into three smaller sections. These sections make up Packs 1 and 2 and the Final Pack, and may be made up of several bags, envelopes, small boxes, and loose parts. Do not unpack any of these parts until a step specifically directs you to do so.

When you check parts against a "Parts List," return any part or group of parts packaged in a bag or other container, with a part number on it, to its container after you identify it. Leave these parts there until you actually use them in a step. This will help prevent you from mixing up the parts, and help you identify the parts when you need them.

Some parts, however, are in a bag or envelope that is not marked with an actual part number, but with a packaging number that begins with the number "173-." These numbers are used for packaging purposes only and do not appear in the Manual "Parts Lists." Open each bag or envelope that is marked with only a "173-" packaging number to identify the parts it contains.

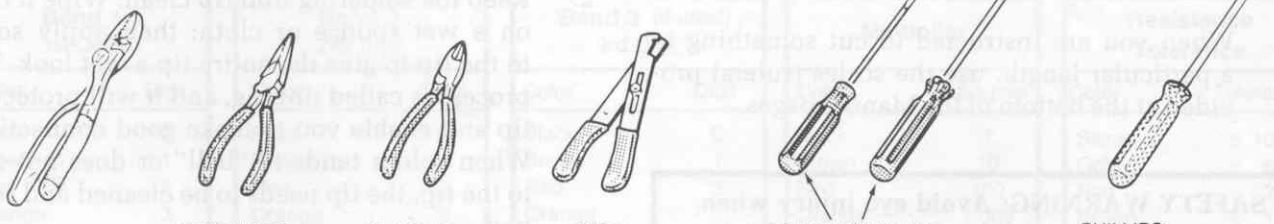
NOTE: Never use a "173-" packaging number if you must order a replacement part. Use only the part numbers listed in the Manual Parts List for this purpose.

Save all of the packaging material until you account for all of the parts.

ASSEMBLY NOTES

TOOLS

You will need these tools to assemble your kit.



PLIERS

LONG-NOSE PLIERS

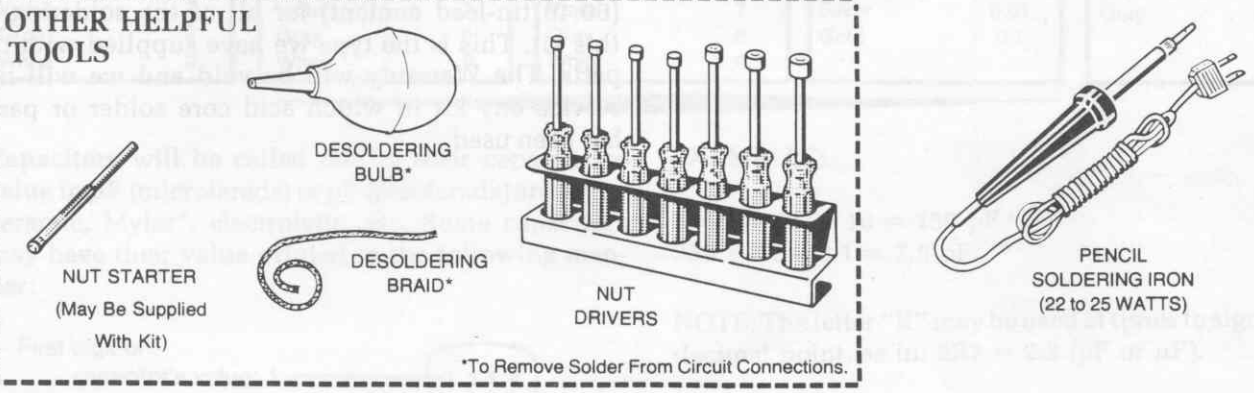
DIAGONAL CUTTERS

WIRE STRIPPERS

1/8" & 1/4"-BLADE SCREWDRIVERS

PHILLIPS SCREWDRIVER

OTHER HELPFUL TOOLS



DESOLDERING BULB*

NUT STARTER (May Be Supplied With Kit)

DESOLDERING BRAID*

NUT DRIVERS

PENCIL SOLDERING IRON (22 to 25 WATTS)

*To Remove Solder From Circuit Connections.

ASSEMBLY

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

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

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

4. Position all parts as shown in the Pictorials.

5. 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.

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

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

SOLDERING

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

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

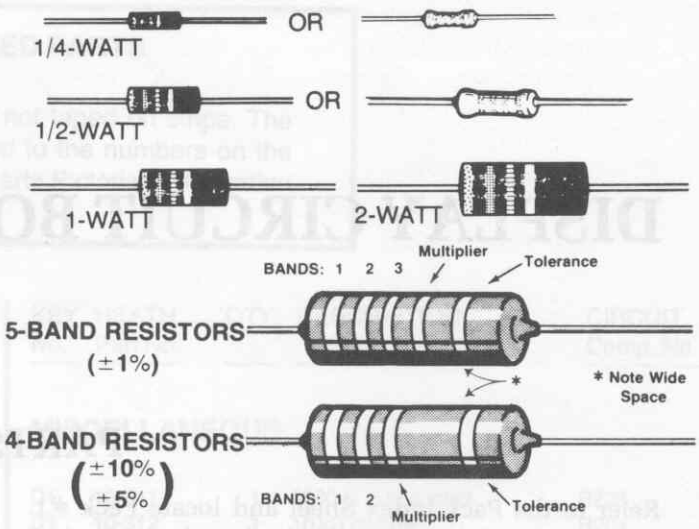
1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.

2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

NOTE: Always use rosin core, radio-type solder (60:40 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.

PARTS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). They are usually identified by a color code and four or five color bands, where each color represents a number. These colors (except for the last band, which indicates a resistor's "tolerance") will be given in the steps in their proper order. Therefore, the following color code is given for information only. NOTE: Occasionally, a "precision" or "power" resistor may have the value stamped on it.



Band 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

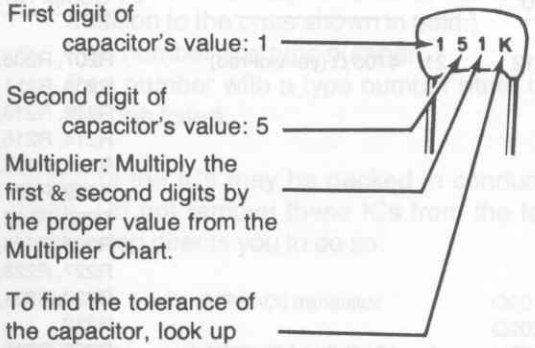
Band 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Band 3 (if used) 3rd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	± 10%
Gold	± 5%
Red	± 2%
Brown	± 1%
Green	± .5%
Blue	± .25%
Violet	± .1%
Gray	± .05%

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 × 10 = 150 pF

759 = 75 ×0.1 = 7.5 pF

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

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

*DuPont Registered Trademark

DISPLAY CIRCUIT BOARD

PARTS LIST

Refer to the Pack Index Sheet and locate Pack #1. Then unpack these parts and check each part against the following list. Do not remove components that are supplied on a tape from the tape until you use them in a step. Return any part that is packed in an individual envelope, with the part number on it, back to the envelope after you identify it until that part is called for in a step. Do not throw away any packing material until you account for all of the parts.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Part Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

TAPED COMPONENTS

NOTE: These parts are taped on a strip which was checked before shipment. Since these parts are taped in the order of assembly, you may not wish to check these parts against the following list.

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed. A 5% tolerance is indicated by a fourth color band of gold. 1% is indicated by a brown fifth color band.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-101-12	1	100 Ω (brn-blk-brn)	R201
6-151-12	1	150 Ω (brn-grn-brn)	R238
6-471-12	1	470 Ω (yel-viol-brn)	R202
6-152-12	1	1500 Ω (brn-grn-red)	R237
6-472-12	21	4700 Ω (yel-viol-red)	R207, R208, R209, R211, R212, R213, R214, R216, R217, R218, R219, R221, R222, R223, R225, R226, R227, R228, R229, R231, R232
6-103-12	4	10 kΩ (brn-blk-org)	R205, R215, R224, R235
6-473-12	1	47 kΩ (yel-viol-org)	R236
6-104-12	1	100 kΩ (brn-blk-yel)	R234
6-1133-12	1	113 kΩ, 1% (brn-brn-org-org)	R239

NON-TAPED PARTS

The following parts are not taped on strips. The key numbers correspond to the numbers on the "Display Circuit Board Parts Pictorial" (Illustration Booklet, Page 1).

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS				
A1	3-20-5	1	5 Ω, 5-watt, 10% wire-wound	R203
A1	3-16-5	1	175 Ω, 5-watt, 10% wire-wound	R206
CAPACITORS				
B1	21-75	1	100 pF ceramic (100K)	C206
B1	21-176	1	.01 μF ceramic	C202
B2	25-255	1	.22 μF tantalum	C203
B3	25-859	2	.47 μF electrolytic	C204, C205
B3	25-917	1	10 μF electrolytic	C201
TRANSISTORS-INTEGRATED CIRCUITS (ICs)				

NOTES:

1. Integrated circuits may be marked for identification in any of the following four ways:
   a. Part number.
   b. Type number. (On integrated circuits, this refers only to the numbers shown in **bold** print; the letters may be different or missing. Also, your ICs may have other numbers in addition to the ones shown in bold.)
   c. Part number and type number.
   d. Part number with a type number other than the one listed.
2. Some of the ICs may be packed in conductive foam. Do not remove these ICs from the foam until a step directs you to do so.

C1	417-864	3	MPSA05 transistor	Q201, Q202, Q203
C2	442-54	1	**7805** IC	U205
C3	442-724	1	**7107** IC	U204
C3	443-967	3	**7406** IC	U201, U202, U203

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
MISCELLANEOUS				
D1	10-311	1	5000 Ω (5 k) control	R233
D1	10-312	1	10 kΩ control	R204
	85-2975-1	1	Display circuit board	
D2	411-836	1	Display tube	V201
D3	412-601	6	#2174 lamp	PL201, PL202, PL203, PL204, PL205, PL206
D4	434-298	3	14-pin IC socket	
D4	434-253	1	40-pin IC socket	
D5	475-10	1	Ferrite bead	FB201
PARTS FROM THE FINAL PACK				
	340-8	2′4″	Bare wire	
	343-2	1′	Shielded cable	
	344-2	3′6″	Large black wire	
	344-3	2′4″	Large red wire	
	344-160	6′	White-blue wire	
	344-215	4′6″	Large blue wire	
	344-219	3′	Large white wire	
	346-46	4″	Heat-shrinkable sleeving	
	347-55	2′3″	8-wire flat cable	
E1	74-34	1	Double-stick tape (1/2″ × 4″)*	
E2	390-147	1	"Danger" label*	
E3	390-2457	1	Reference preset label*	
E4	390-2491	1	Decorative label*	
	489-1		Sandpaper	
E5		1	Blue and white label*	
	597-260	1	Parts Order Form*	
		2	Taped Component Chart	
		1	Assembly Manual (See Page 1 for the part number.)	
			Solder	

* These items may be packed inside the front cover of the Manual. Set these parts aside until they are called for during the assembly of the chassis.

STEP-BY-STEP ASSEMBLY

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

NOTES:

1. Many circuit board drawings, such as the one shown in Pictorial 1-1, are divided into two or more sections. These sections show you which area of the circuit board you are working in for a specific series of steps.

2. Refer to the "Taped Component Chart." Note that it is divided into numbered sections that match each section on the circuit board.

3. In each series of steps, you will install parts in a top- to-bottom, left-to-right sequence. Occasionally, you may be directed to install a particular component in an area out of sequence. Each of these components is identified in the step and on the Pictorial with a special callout.

4. Check off each step as you perform it. You may also wish to place a check mark near each component on the Pictorial as you install it.

5. In general, solder instructions are given only at the end of a series of similar steps. You may solder more often, if you desire.

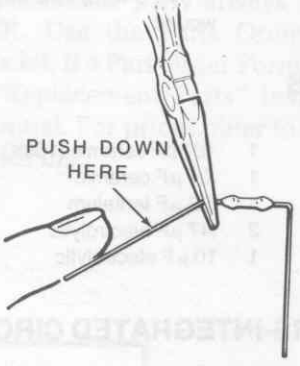
In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

Note that the circuit board has foil on both sides, but only one side has the component outlines shown on it. This side of the circuit board is referred to as the "component side."

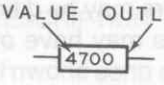
( ) **Position the circuit board as shown in the Pictorial with the component side up. Always install components on the component side of the circuit board, and solder the leads to the foil on the other side unless a step specifically directs you otherwise.**

NOTE: In the following steps, the location of each component is marked with its value and not its "Circuit Component Number" which is called out in the step. Before you install each component, be sure its value matches the value on the circuit board screen.

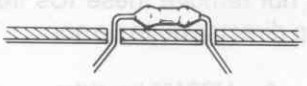
( ) **R227: Hold a 4700 Ω (yel-viol-red) resistor as shown and bend the leads straight down with long-nose pliers to fit the hole spacing on the circuit board.**



( ) **Start the leads into the holes at the resistor's location at the top of Section 1 of the circuit board. The end with color bands may be positioned either way. NOTE: Resistors are identified on the circuit board by the following outline.**

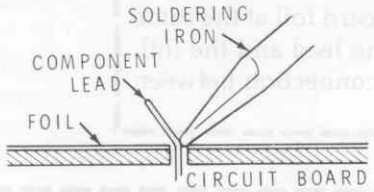


( ) **Press the resistor against the circuit board. Then bend the leads outward slighty to hold it in place.**

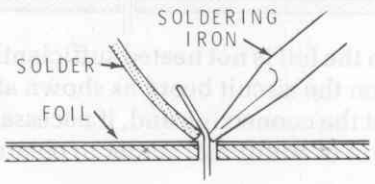


( ) Solder the resistor leads to the circuit board as follows:

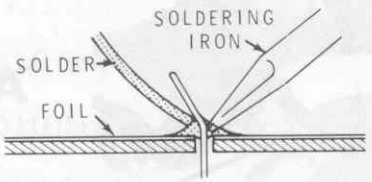
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.



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 12. After you have checked the solder connections, proceed with the assembly on this page. Use the same soldering procedure for each connection.

Start at the top of Section 1 and install the following components. The sequence of the steps matches the locations of the components on the circuit board. NOTE: Make sure you installed resistor R227 in an earlier step.

To make the assembly easier, you may wish to precut all the parts from a section and, as you do, prebend the leads, and lay the parts on your work surface in the order of assembly. Then you can hold the circuit board while you install the parts in sequence without interruption.

Install eight 4700 Ω (yel-viol-red) resistors at the following locations (in Section 1):

( ) R226.

( ) R225.

( ) R218.

( ) R217.

( ) R216.

( ) R209.

( ) R208.

( ) R207.

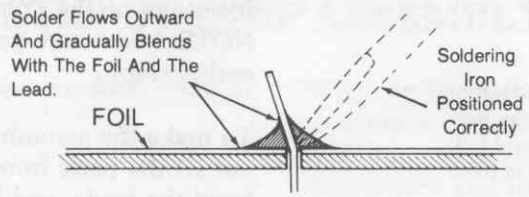
( ) Solder the leads to the foil and cut off the excess lead lengths.

Install the following resistors in Section 2 of the circuit board.

( ) R202: 470 Ω (yel-viol-brn).

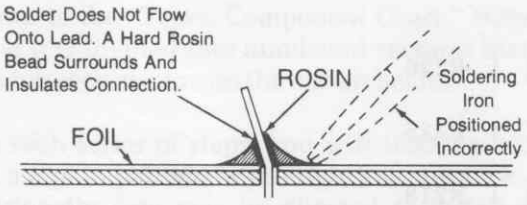
( ) R201: 100 Ω (brn-blk-brn).

A GOOD SOLDER CONNECTION

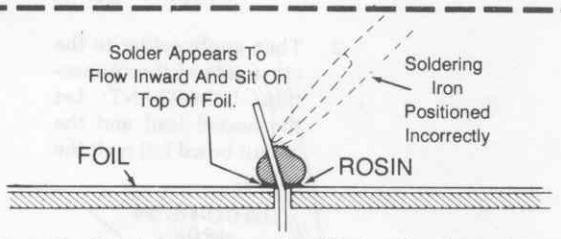


When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS



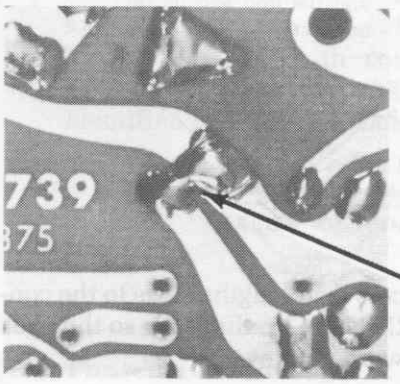
When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



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

SOLDER BRIDGES

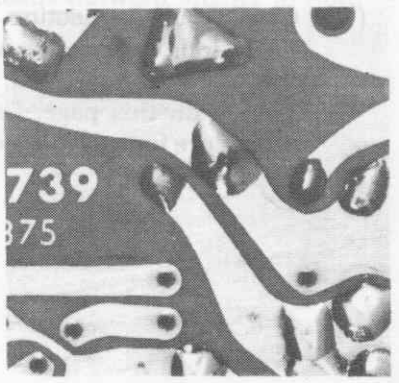
A solder bridge between two adjacent foils is shown in photograph **A**. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other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



A

SOLDER BRIDGE

B



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.

Install twelve 4700 Ω (yel-viol-red) resistors at the following locations (in Section 2):

( ) R232.

( ) R228.

( ) R229.

( ) R231.

( ) R223.

( ) R219.

( ) R221.

( ) R222.

( ) R214.

( ) R211.

( ) R212.

( ) R213.

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

Install the following resistors in Section 3 of the circuit board.

( ) R224: 10 kΩ (brn-blk-org).

( ) R215: 10 kΩ (brn-blk-org).

( ) R205: 10 kΩ (brn-blk-org).

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

Install the following resistors in Section 4 of the circuit board.

NOTE: Install the following resistors vertically as shown below. Be sure each resistor is still vertical to the circuit board before you solder the leads to the foil.

( ) R236: 47 kΩ (yel-viol-org).

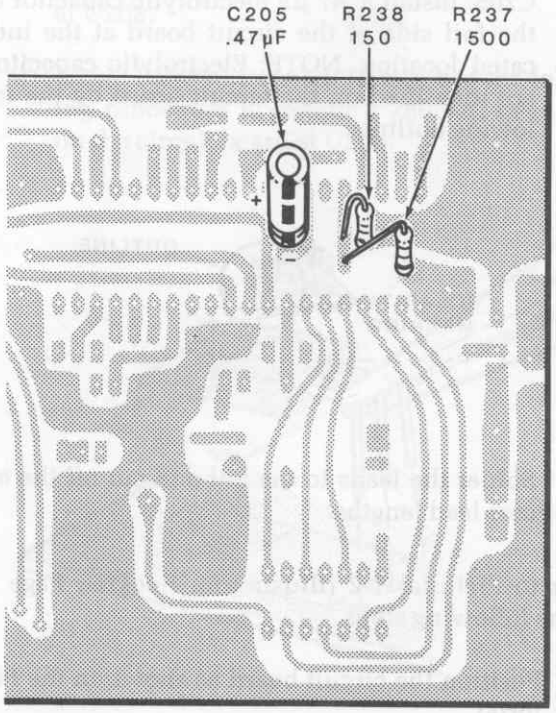
( ) R234: 100 kΩ (brn-blk-yel).

( ) R235: 10 kΩ (brn-blk-org).

( ) R239: 113 kΩ, 1% (brn-brn-org-org).

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

( ) Turn the circuit board over so the component side is down as shown in Detail 1-1A.



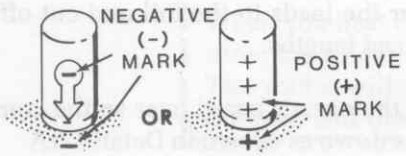
Detail 1-1A

NOTE: Install the following components on the foil side of the circuit board and solder them on the component side. Be sure to install these components at the correct locations; their outlines are printed on the component side.

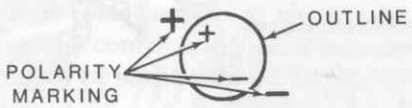
( ) R237: 1500 Ω (brn-grn-red). Be sure to mount this resistor vertically.

( ) R238: 150 Ω (brn-grn-brn). Be sure to mount this resistor vertically.

NOTE: In some of the following steps, you will install electrolytic capacitors. Before you install an electrolytic capacitor, look at it and identify the leads. One lead will have a positive (+) mark **or** a negative (−) mark near it. Be sure to install the positive lead in the positive-marked hole, or the negative lead in the negative-marked hole.



( ) C205: Install a .47 µF electrolytic capacitor on the foil side of the circuit board at the indicated location. NOTE: Electrolytic capacitors are identified on the circuit board by the following outline:



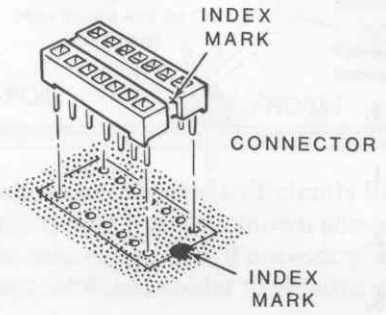
( ) Solder the leads to the foil and cut off the excess lead lengths.

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

( ) Position the circuit board as shown in the Pictorial.

NOTES:

1. In some of the following steps, you will install IC sockets. To install an IC socket, make sure the pins are straight. Then start the pins into the circuit board holes. The index mark on the circuit board must still be visible after you install the socket. Bend over a pin at two opposite corners to hold the socket in place. Then solder two pins to the foil, check to make sure the socket is still tight against the circuit board, and solder the remaining pins to the foil.



2. It is very easy to form a solder bridge between foils when you install an IC socket. After you install each socket, carefully inspect the foil for solder bridges and remove any that you find as described on the next page. If you suspect that you have a solder bridge, but are not positive, you can check your foil pattern against the one shown in the "Circuit Board X-Ray Views" (Illustration Booklet, Pages 50 and 51).

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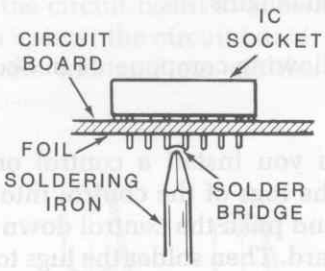
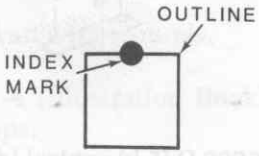
To remove a solder bridge, hold the circuit board component-side-up as shown and hold your soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip.

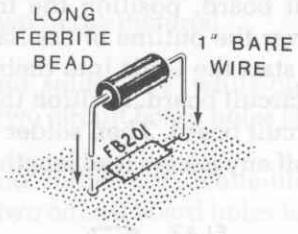


( ) Install a 14-pin IC socket on the circuit board at U201. NOTE: IC sockets are identified on the circuit board by the following outline.



( ) Install a 14-pin IC socket on the circuit board at U202.

( ) FB201: Cut a 1″ of bare wire. Then refer to Detail 1- 2A and use the 1″ bare wire to install a ferrite bead on the circuit board at FB201.



Detail 1-2A

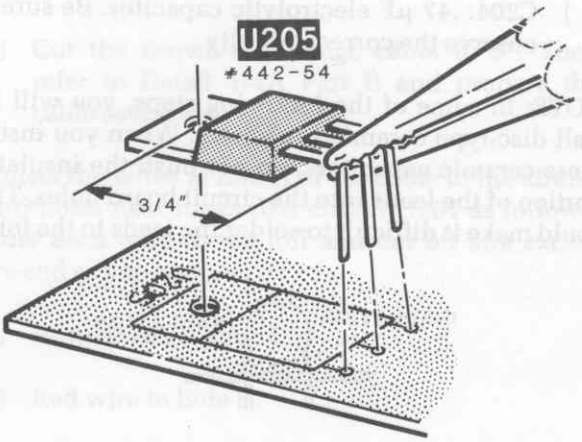
NOTE: When a step directs you to prepare a stranded wire, first cut the wire to the indicated length and remove 1/4″ of insulation from each end. Tightly twist together the fine strands at each end of the wire. Then melt a small amount of solder on these ends to hold the strands together.

( ) Prepare a 1-1/8″ white-blue wire. Then install the wire at "J" on the circuit board at the indicated location. Solder the wire ends to the foil and cut off any excess lengths. NOTE: Jumper wires are indicated on the circuit board by the following outline.

( ) Install a 40-pin IC socket on the circuit board at U204.

( ) Install a 14-pin IC socket on the circuit board at U203.

( ) U205: Refer to Detail 1-2B and use the following procedure to mount a 7805 IC (#442-54) on the circuit board at U205.



Detail 1-2B

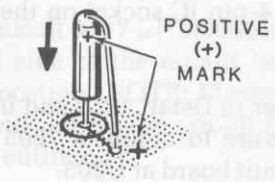
1. Use long-nose pliers to bend the leads of the IC at a point 3/4″ from the center of the hole in the mounting tab.

2. Start the leads of the IC into the circuit board holes at U205. Make sure the hole in the mounting tab lines up with the hole in the circuit board. Then solder the leads to the foil and cut off any excess lead lengths.

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

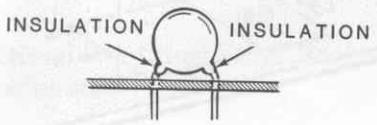
Install the following components in Section 1 of the circuit board.

( ) C203: Look at the .22 µF tantalum capacitor and determine which end is the positive end (which may be indicated by a + mark or a colored end). Then install the capacitor vertically on the circuit board as shown below. Be sure the positive and negative leads go into their correct circuit board holes.

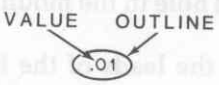


( ) C204: .47 µF electrolytic capacitor. Be sure to observe the correct polarity.

NOTE: In some of the following steps, you will install disc-type ceramic capacitors. When you install these 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.



Install ceramic capacitors in Section 1 of the circuit board as follows. NOTE: Ceramic capacitors are identified on the circuit board by the following outline.



( ) C202: .01 µF ceramic.

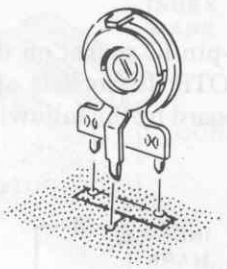
( ) C206: 100 pF ceramic (100K).

( ) C201: 10 µF electrolytic.

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

Install the following components in Section 2 of the circuit board.

NOTE: When you install a control on the circuit board, start the lugs of the control into their circuit board holes and push the control down tight against the circuit board. Then solder the lugs to the foil.

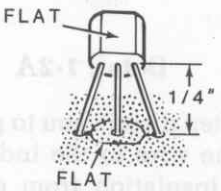


( ) R233: 5000 Ω (5 k) control (#10-311).

( ) R204: 10 kΩ control (#10-312).

Install the following components in section 3 of the circuit board.

NOTE: When you install the following transistors in the circuit board, position the transistor so the flat side is over the outline of the flat on the circuit board. Then start the leads into their corresponding holes in the circuit board. Position the transistor 1/4" above the circuit board. Then solder the leads to the foil and cut off any excess lead lengths.

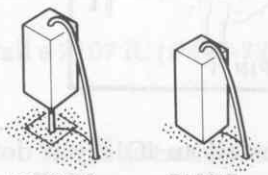


( ) Q203: MPSA05 transistor (#417-864).

( ) Q202: MPSA05 transistor (#417-864).

( ) Q201: MPSA05 transistor (#417-864).

NOTE: Mount the next two wire-wound resistors vertically on the circuit board as shown. Push each resistor down against the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.



( ) R206: 175 Ω, 5-watt wire-wound.

( ) R203: 5 Ω, 5-watt wire-wound.

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

( ) Prepare the following white-blue wires:

4″

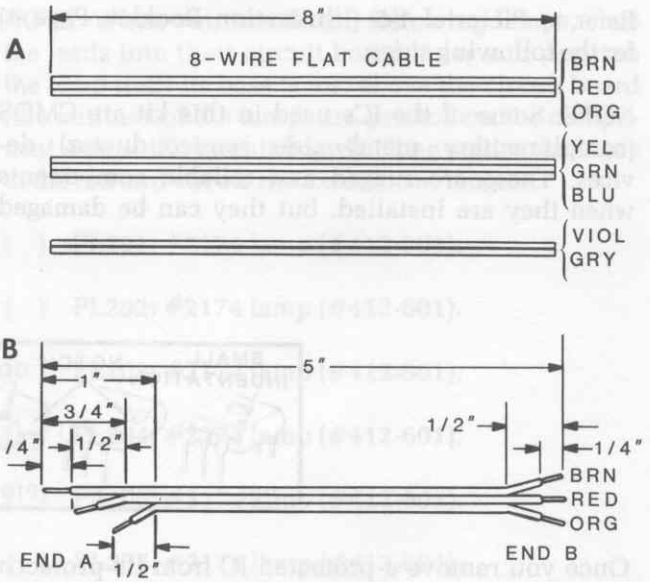
7″

NOTE: When you connect the prepared wires to the circuit board, in the next two steps, be sure to route each wire as shown in the Pictorial.

( ) Connect and solder a 4″ white-blue wire between the two circuit board holes labeled G.

( ) Connect and solder a 7″ white-blue wire between the two circuit board holes labeled C.

( ) Cut an 8″ length of 8-wire flat cable. Then refer to Detail 1-4A Part A and separate the 8″ cable into two 3-wire cables and a 2-wire cable as shown. Use the brown-red-orange 3-wire cable in the next step. Set the remaining cables aside for use later.



Detail 1-4A

( ) Cut the brown-red-orange cable to 5″. Then refer to Detail 1-4A Part B and prepare the cable as shown.

Connect the wires at End A of the cable to the circuit board holes near integrated circuit U201 as follows. Solder each wire to the foil and cut off any excess wire end as you connect it.

( ) Brown wire to hole J.

( ) Red wire to hole K.

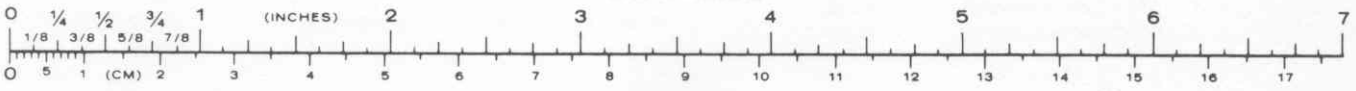
( ) Orange wire to hole L.

Connect the wires at End B of the cable to the circuit board holes near integrated circuit U204 as follows. Solder each wire to the foil and cut off any excess wire end as you connect it.

( ) Brown wire to hole J.

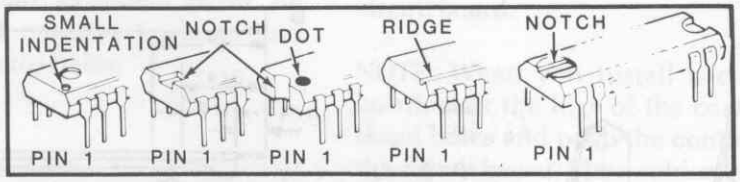
( ) Red wire to hole K.

( ) Orange wire to hole L.



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

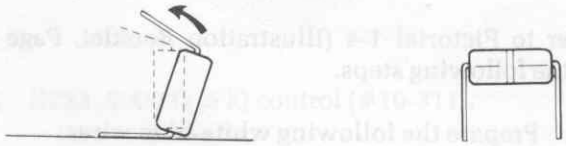
NOTE: Some of the ICs used in this kit are CMOS (complimentary metal-oxide semiconductor) devices. These are rugged and reliable components when they are installed, but they can be damaged by static electricity during installation. The other ICs are of a type that is not susceptible to static electricity. Nevertheless, you should treat these ICs as if they were CMOS types, since it will avoid all possible confusion between ICs and provide protection in all cases. Use the procedure shown in Detail 1-5A whenever you are directed to install ICs.



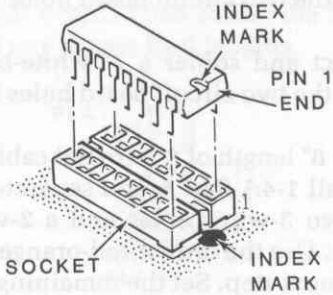
Once you remove a protected IC from its protective foam packing, DO NOT lay the IC down or let go of it until it is installed in its socket. When you bend the leads of a protected IC, hold the IC in one hand and place your other hand on your work surface before you touch the IC to your work surface.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

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

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



Position the pin 1 end of the IC over the index mark on the circuit board. Then start the IC pins into the socket. Make sure that all of the pins are started into the socket. Then push the IC firmly into the socket. NOTE: An IC pin can become bent under the IC and it will appear as though it is correctly installed in the socket.



Detail 1-5A

( ) Position the circuit board as shown in the Pictorial.

Install integrated circuits in the sockets on the circuit board as follows. NOTE: Be careful not to damage the components that are mounted on the foil side of the circuit board when you install the ICs.

( ) U201: Install a 7406 IC (#443-967) at U201.

( ) U202: Install a 7406 IC (#443-967) at U202.

( ) U203: Install a 7406 IC (#443-967) at U203.

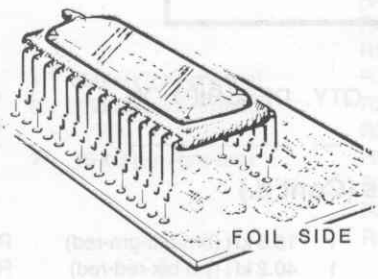
( ) U204: Install a 7107 IC (#442-724) at U204.

Refer to Pictorial 1-6 (Illustration Booklet, Page 4) for the following steps.

( ) Position the circuit board with the foil side up as shown in the Pictorial (note the location of the large hole).

NOTE: The following components are printed on the component side of the circuit board but are to be mounted on the foil side.

( ) V201: Install the display tube in the circuit board at V201. Be sure to position the end with the nipple as shown in the Pictorial. Make sure all of its pins are through the circuit board; then solder them to the foils. NOTE: The display tube will fit correctly in the circuit board in only one direction.



NOTE: When you install the following lamps, start the leads into their circuit board holes and position the lamp until its base is just above the circuit board (the outlines of the lamps are printed on the component side of the circuit board). Then solder the leads to the foil and cut off the excess lead lengths.

( ) PL201: #2174 lamp (#412-601).

( ) PL202: #2174 lamp (#412-601).

( ) PL203: #2174 lamp (#412-601).

( ) PL204: #2174 lamp (#412-601).

( ) PL206: #2174 lamp (#412-601).

( ) PL205: #2174 lamp (#412-601).

CIRCUIT BOARD CHECKOUT

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

( ) Unsoldered connections.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

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

( ) Transistors for the proper installation.

( ) Integrated circuits for the proper installation.

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

This completes the assembly of the display circuit board. Set the circuit board aside until it is called for during the assembly of the chassis. NOTE: Be sure to set the circuit board in a safe place so the display tube and lamps will not become damaged.

Proceed to "Main Circuit Board."

MAIN CIRCUIT BOARD

PARTS LIST

Refer to the Pack Index Sheet and locate Pack #2. Then unpack these parts and check them against the following list. Do not remove components that are supplied on a tape from the tape until you use them in a step. Return any part that is packed in an individual envelope, with the part number printed on it, back to the envelope after you identify it. Keep that part in the envelope until it is called for in a step. Do not throw away any packing material until you account for all the parts.

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

TAPED COMPONENTS

NOTE: These parts are taped on a strip which was checked before shipment. Since these parts are taped in the order of assembly, you may not wish to check these parts against the following list.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS			
1/4-Watt, 1%			
NOTE: The following resistors have five color bands. The last band, which is brown, is set apart from the other bands and will not be called out. These resistors have a temperature coefficient (TC) of 100 parts per million per °C (100 PPM/°C) unless otherwise stated.			
6-4320-12	1	432 Ω (yel-org-red-blk)	R453
6-9090-12	1	909 Ω (wht-blk-wht-blk)	R415
Resistors (Cont'd.)			
6-1652-12	1	16.5 kΩ (brn-blu-grn-red)	R312
6-4022-12	1	40.2 kΩ (yel-blk-red-red)	R311
6-1005-12	3	10 MΩ (brn-blk-blk-grn)	R303, R395, R408
1/4-Watt, 5%			
NOTE: The following resistors have four color bands. The last band, which is gold, will not be called out.			
6-279-12	1	2.7 Ω (red-viol-gld)	R454
6-100-12	3	10 Ω (brn-blk-blk)	R407, R438, R508

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HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (Cont'd.)			
6-220-12	2	22 Ω (red-red-blk)	R434, R507
6-560-12	1	56 Ω (grn-blu-blk)	R383
6-151-12	4	150 Ω (brn-grn-brn)	R377, R425, R427, R502
6-221-12	1	220 Ω (red-red-brn)	R452
6-471-12	2	470 Ω (yel-viol-brn)	R468, R473
6-511-12	1	510 Ω (grn-brn-brn)	R322
6-561-12	22	560 Ω (grn-blu-brn)	R313, R338 R387, R388, R401, R406, R421, R432, R439, R441, R444, R445, R457, R463, R464, R467, R489, R491, R492, R494, R495, R506
6-681-12	2	680 Ω (blu-gry-brn)	R334, R382
6-751-12	1	750 Ω (viol-grn-brn)	R328
6-102-12	10	1000 Ω (brn-blk-red)	R333, R347, R351, R352, R402, R409, R431, R448, R505, R512
6-152-12	10	1500 Ω (brn-grn-red)	R337, R354, R386, R393, R404, R416, R419, R455, R458, R488
6-222-12	3	2200 Ω (red-red-red)	R422, R449, R497
6-272-12	3	2700 Ω (red-viol-red)	R321, R403, R462
6-432-12	1	4300 Ω (yel-org-red)	R451
6-472-12	11	4700 Ω (yel-viol-red)	R426, R442, R446, R465, R472, R476, R484, R485, R493, R501, R509
6-682-12	1	6800 Ω (blu-gry-red)	R376
6-752-12	3	7500 Ω (viol-grn-red)	R319, R327, R331
6-153-12	7	15 kΩ (brn-grn-org)	R314, R317, R353, R355, R399, R405, R412
6-223-12	8	22 kΩ (red-red-org)	R304, R305, R307, R308, R324, R329, R339, R342
6-473-12	5	47 kΩ (yel-viol-org)	R301, R396, R423, R471, R498
6-563-12	1	56 kΩ (grn-blu-org)	R350
6-104-12	16	100 kΩ (brn-blk-yel)	R306, R336, R356, R357, R378, R394, R397, R398, R413, R414, R443, R447, R475, R477, R496, R511
6-124-12	1	120 kΩ (brn-red-yel)	R332
6-224-12	4	220 kΩ (red-red-yel)	R323, R346, R435, R346
6-334-12	1	330 kΩ (org-org-yel)	R343
6-684-12	3	680 kΩ (blu-gry-yel)	R345, R479, R481
6-105-12	1	1 MΩ (brn-blk-grn)	R325
6-125-12	2	1.2 MΩ (brn-red-grn)	R315, R316
6-225-12	3	2.2 MΩ (red-red-grn)	R348, R436, R514
CAPACITORS			
21-761	2	.01 μF (103) glass ceramic	C336, C341
CHOKES			
45-604	2	100 μH (brn-blk-brn-silv)	L301, L302
DIODES			
56-89	2	GD510	D334, D335
56-94	1	12.8-volt zener	D333
56-97	1	1N3017B	D304
57-27	4	1N2071	D329, D331, D332, D346

NON-TAPED PARTS

The following parts are not taped on strips. The key numbers correspond to the numbers on the "Main Circuit Board Parts Pictorial" (Illustration Booklet, Page 5).

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS				
1/4-Watt, 5%				
NOTE: The following resistors have four color bands. The last band, which is gold, will not be called out.				
A1	6-103-12	31	10 kΩ (brn-blk-org)	R309, R310, R341, R344, R349, R384, R385, R389, R391, R392, R411, R417, R418, R424, R428, R429, R433, R437, R459, R461, R469, R474, R478, R482, R483, R486, R487, R499, R503, R504, R515
CAPACITORS				
Ceramic				
B1	21-13	1	500 pF	C307
B1	21-140	4	.001 µF	C306, C346, C352, C353
Capacitors (Cont'd.)				
B1	21-176	34	.01 µF	C301, C302, C303, C304, C305, C308, C309, C311, C312, C314, C315, C316, C317, C318, C321, C322, C324, C326, C327, C328, C329, C335, C344, C351, C355, C356, C357, C362, C363, C364, C365, C366, C367, C368
B2	21-192	13	.1 µF (104)	C323, C338, C339, C343, C348, C349, C354, C358, C359, C361, C369, C371, C372
Electrolytic				
C1	25-922	1	.68 µF	C325
C1	25-924	1	2.2 µF	C347
C1	25-879	1	4.7 µF	C360
C1	25-917	1	10 µF vertical	C319
C2	25-864	3	10 µF horizontal	C313, C370, C373
C1	25-915	5	47 µF	C333, C334, C337, C342, C345
C1	25-887	1	220 µF	C332
C3	25-910	1	3300 µF	C331

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
DIODES				
D1	56-56	52	1N4149	D301, D302, D303, D305, D306, D307, D308, D309, D311, D312, D313, D314, D315, D316, D317, D318, D319, D321, D322, D323, D324, D325, D326, D327, D328, D336, D337, D338, D339, D342, D343, D344, D347, D348, D349, D352, D353, D354, D355, D356, D357, D358, D361, D362, D363, D364, D365, D366, D367, D369, D371, D372
SCRs - TRANSISTORS - INTEGRATED CIRCUITS (ICs)				

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

1. Part number.
2. Type number. (On integrated circuits, use only those number and letters in **BOLD** print. Disregard any other number or letters.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

E1	57-624	4	2N5061 SCR	D341, D345, D351, D368

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
SCRs - Transistors - Integrated Circuits (ICs) (Cont'd.)				
E2	417-222	1	2N5308 transistor	Q309
E2	417-801	1	MPSA20 transistor	Q305
E3	417-818	7	MJE181 transistor	Q312, Q321, Q322, Q331, Q332, Q338, Q339
E3	417-819	1	MJE171 transistor	Q304
E2	417-864	26	MPSA05 transistor	Q301, Q302, Q303, Q306, Q307, Q311, Q313, Q314, Q315, Q316, Q317, Q318, Q319, Q325, Q326, Q327, Q328, Q329, Q335, Q336, Q337, Q342, Q343, Q344, Q345, Q347
E2	417-865	1	MPSA55 transistor	Q308
E4	417-918	6	2N6387 transistor	Q323, Q324, Q333, Q334, Q341, Q346
E5	442-53	3	555 IC	U306, U312, U313
E5	442-602	3	LM**324** IC	U302, U314, U317
E2	442-627	1	78L05 IC	U311
E2	442-665	2	79L05 IC	U308, U309
E2	442-687	1	78L10 IC	U316
E5	442-707	1	LF353 IC	U303

NOTE: The following ICs are packed in a special foam material to protect them from possible damage due to static electricity. Do not remove these ICs from their protective foam material until you are instructed to do so.

E5	443-1164	1	RC**4200** IC	U304
E5	442-99	2	CD**4016** IC	U301, U305
E5	443-607	2	MC1**4013** IC	U307, U315

CONTROLS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
F1	10-936	16	1000 Ω (1k)	R360, R361, R362, R363, R364, R365, R366, R367, R368, R369, R370, R371, R372, R373, R374, R375
F1	10-311	5	5000 Ω (5k)	R335, R358, R359, R379, R381
F1	10-312	1	10 kΩ	R326
F1	10-390	1	20 kΩ	R318
F1	10-222	1	50 kΩ	R302

MISCELLANEOUS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
G1	54-992	1	Power transformer	T301
	85-2976-1	1	Main circuit board	
	134-1373	1	Wiring harness	
G2	412-640	1	LST5053 LED (light emitting diode)	D359
G3	432-866	3	Spring connector	
G4	432-1080	1	Small 3-hole socket shell	
G5	434-230	5	8-pin IC socket	
G5	434-298	7	14-pin IC socket	
G6	475-10	17	Ferrite bead	FB301, FB302, FB303, FB304, FB305, FB306, FB307, FB308, FB309, FB311, FB312, FB313, FB314, FB315, FB316, FB317, FB318

STEP-BY-STEP ASSEMBLY

Refer to Pictorial 2-1 (Illustration Booklet, Page 6) for the following steps.

( ) Locate the "Taped Component Chart" for Pack #2 and follow the instructions on the top of the Chart for Pack #1 before you continue with the following steps.

NOTE: In the following steps, the location of each component is marked with its value and not its "Circuit Component Number" which is called out in the step. Before you install each component, be sure its value matches the value on the circuit board screen.

( ) Position the main circuit board as shown in the Pictorial.

Install the following components in Section 1 of the circuit board.

( ) R416: 1500 Ω (brn-grn-red).

( ) R451: 4300 Ω (yel-org-red).

( ) R452: 220 Ω (red-red-brn).

( ) R449: 2200 Ω (red-red-red).

( ) R453: 432 Ω, 1% (yel-org-red-blk). Mount this resistor vertically as shown on the circuit board.

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

Install the following components in Section 2 of the circuit board.

NOTES:

1. In some of the following steps, you will install diodes. Whenever you install a diode, always match the banded end of the diode with the band mark on the circuit board. The circuit will not work properly if a diode is installed backwards.

2. The banded end of each diode is positioned toward the colored tape.

3. You will be directed to mount some of the diodes vertically. In all cases, these diodes must be mounted so the body of the diode is over the circle part of the outline on the circuit board and the **banded end up.**

IMPORTANT: The "Circuit Component Number" for several of the following components is preceded by an asterisk (*). These components are not on the "Taped Component Chart," but on their own strips. **Be sure you locate each of these components in their separate envelopes.**

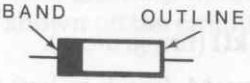
( ) *D307: 1N4149 diode (#56-56). Mount this diode vertically as shown.

NOTE: Unless specified otherwise, the following resistors have a tolerance of 5% (gold fourth color band).

( ) R351: 1000 Ω (brn-blk-red). Mount this resistor vertically as shown on the circuit board.

( ) R352: 1000 Ω (brn-blk-red). Mount this resistor vertically as shown on the circuit board.

( ) *D347: 1N4149 diode (#56-56). NOTE: Diodes that are to be mounted horizontally are identified on the circuit board by the following outline:



( ) *D366: 1N4149 diode (#56-56).

( ) *R486: 10 kΩ (brn-blk-org).

( ) *R487: 10 kΩ (brn-blk-org).

( ) *D365: 1N4149 diode (#56-56).

( ) *D348: 1N4149 diode (#56-56).

( ) R415: 909 Ω, 1% (wht-blk-wht-blk). Mount this resistor vertically as shown on the circuit board.

( ) R471: 47 kΩ (yel-viol-org).

( ) *R417: 10 kΩ (brn-blk-org).

( ) *R418: 10 kΩ (brn-blk-org).

( ) R465: 4700 Ω (yel-viol-red).

( ) R463: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) *D355: 1N4149 diode (#56-56).

( ) *D358: 1N4149 diode (#56-56).

( ) *R459: 10 kΩ (brn-blk-org).

( ) *R461: 10 kΩ (brn-blk-org).

( ) R454: 2.7 Ω (red-viol-gold). Mount this resistor vertically as shown on the circuit board.

( ) R455: 1500 Ω (brn-grn-red).

( ) *D357: 1N4149 diode (#56-56).

( ) *D356: 1N4149 diode (#56-56).

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

Install the following components in Section 3 of the circuit board.

( ) R354: 1500 Ω (brn-grn-red). Mount this resistor vertically as shown on the circuit board.

( ) R353: 15 kΩ (brn-grn-org).

( ) R355: 15 kΩ (brn-grn-org). Mount this resistor vertically as shown on the circuit board.

( ) R356: 100 kΩ (brn-blk-yel). Mount this resistor vertically as shown on the circuit board.

( ) R357: 100 kΩ (brn-blk-yel). Mount this resistor vertically as shown on the circuit board.

( ) R489: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R421: 560 Ω (grn-blu-brn).

( ) R488: 1500 Ω (brn-grn-red).

( ) R419: 1500 Ω (brn-grn-red).

( ) R464: 560 Ω (grn-blu-brn).

( ) R457: 560 Ω (grn-blu-brn).

( ) R458: 1500 Ω (brn-grn-red).

( ) R467: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R462: 2700 Ω (red-viol-red).

( ) *R474: 10 kΩ (brn-blk-org).

( ) R473: 470 Ω (yel-viol-brn).

( ) R468: 470 Ω (yel-viol-brn).

( ) *R469: 10 kΩ (brn-blk-org).

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

Install the following components in Section 4 of the circuit board.

( ) R495: 560 Ω (grn-blu-brn).

( ) R494: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R493: 4700 Ω (yel-viol-red).

( ) R509: 4700 Ω (yel-viol-red).

( ) R491: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R492: 560 Ω (grn-blu-brn).

( ) R444: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R445: 560 Ω (grn-blu-brn).

( ) R442: 4700 Ω (yel-viol-red).

( ) R446: 4700 Ω (yel-viol-red).

( ) R439: 560 Ω (grn-blu-brn).

( ) R441: 560 Ω grn-blu-brn).

( ) R472: 4700 Ω (yel-viol-red).

( ) R476: 4700 Ω (yel-viol-red).

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

Install the following components in Section 5 of the circuit board.

( ) R511: 100 kΩ (brn-blk-yel).

( ) *D372: 1N4149 diode (#56-56). Mount this diode vertically as described earlier.

( ) R512: 1000 Ω (brn-blk-red). Mount this resistor vertically as shown on the circuit board.

( ) R496: 100 kΩ (brn-blk-yel).

( ) *D371: 1N4149 diode (#56-56). Mount this diode vertically.

( ) *D362: 1N4149 diode (#56-56).

( ) R447: 100 kΩ (brn-blk-yel).

( ) *D354: 1N4149 diode (#56-56).

( ) *D361: 1N4149 diode (#56-56).

( ) R443: 100 kΩ (brn-blk-yel).

( ) *D353: 1N4149 diode (#56-56).

( ) R448: 1000 Ω (brn-blk-red). Mount this resistor vertically as shown on the circuit board.

( ) R427: 150 Ω (brn-grn-brn).

( ) R477: 100 kΩ (brn-blk-yel).

( ) *R478: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) *D363: 1N4149 diode (#56-56).

( ) *D364: 1N4149 diode (#56-56).

( ) R475: 100 kΩ (brn-blk-yel).

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

Install the following components in Section 6 of the circuit board.

( ) R350: 56 kΩ (grn-blu-org).

( ) *D308: 1N4149 diode (#56-56).

( ) R347: 1000 Ω (brn-blk-red).

( ) *R344: 10 kΩ (brn-blk-org).

( ) R346: 220 kΩ (red-red-yel).

( ) R422: 2200 Ω (red-red-red).

( ) R423: 47 kΩ (yel-viol-org).

( ) *R424: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) R426: 4700 Ω (yel-viol-red). Mount this resistor vertically as shown on the circuit board.

( ) R501: 4700 Ω (yel-viol-red). Mount this resistor vertically as shown on the circuit board.

( ) *R499: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) R425: 150 Ω (brn-grn-brn). Mount this resistor vertically as shown on the circuit board.

( ) R498: 47 kΩ (yel-viol-org). Mount this resistor vertically as shown on the circut board.

( ) R497: 2200 Ω (red-red-red).

( ) R502: 150 Ω (brn-grn-brn).

( ) *R503: 10 kΩ (brn-blk-org).

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

Install the following components in Section 7 of the circuit board.

( ) R343: 330 kΩ (org-org-yel).

( ) R338: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R342: 22 kΩ (red-red-org).

( ) *R341: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) R345: 680 kΩ (blu-gry-yel).

( ) R337: 1500 Ω (brn-grn-red). Mount this resistor vertically as shown on the circuit board.

( ) R348: 2.2 MΩ (red-red-grn).

( ) *R349: 10 kΩ (brn-blk-org).

( ) *R429: 10 kΩ (brn-blk-org).

( ) *R428: 10 kΩ (brn-blk-org).

( ) R431: 1000 Ω (brn-blk-red). Mount this resistor vertically as shown on the circuit board.

( ) R432: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) *D349: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R434: 22 Ω (red-red-blk). Mount this resistor vertically as shown on the circuit board.

( ) R505: 1000 Ω (brn-blk-red).

( ) R507: 22 Ω (red-red-blk). Mount this resistor vertically as shown on the circuit board.

( ) *D367: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R506: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) *R504: 10 kΩ (brn-blk-org).

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

Install the following components in Section 8 of the circuit board.

( ) D329: 1N2071 diode (#57-27).

( ) R336: 100 kΩ (brn-blk-yel).

( ) *D306: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R339: 22 kΩ (red-red-org).

( ) *D305: 1N4149 diode (#56-56).

( ) *D301: 1N4149 diode (#56-56).

( ) R513: 220 kΩ (red-red-yel).

( ) *R433: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) R514: 2.2 MΩ (red-red-grn). Mount this resistor vertically as shown on the circuit board.

( ) *R437: 10 kΩ (brn-blk-org).

( ) *D352: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R438: 10 Ω (brn-blk-blk). Mount this resistor vertically as shown on the circuit board.

( ) *R515: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) *D369: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R508: 10 Ω (brn-blk-blk). Mount this resistor vertically as shown on the circuit board.

( ) L302: 100 μH choke (#45-604, brn-blk-brn-silv).

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

Install the following components in Section 9 of the circuit board.

( ) D331: 1N2071 diode (#57-27).

( ) D332: 1N2071 diode (#57-27).

( ) R303: 10 MΩ, 1% (brn-blk-blk-grn). Mount this resistor vertically as shown on the circuit board.

( ) R301: 47 kΩ (yel-viol-org). Mount this resistor vertically as shown on the circuit board.

( ) R305: 22 kΩ (red-red-org).

( ) R304: 22 kΩ (red-red-org).

( ) R306: 100 kΩ (brn-blk-yel).

( ) *D302: 1N4149 diode (#56-56).

( ) R479: 680 kΩ (blu-gry-yel).

( ) R435: 220 kΩ (red-red-yel).

( ) R484: 4700 Ω (yel-viol-red).

( ) R436: 2.2 MΩ (red-red-grn). Mount this resistor vertically as shown on the circuit board.

( ) R481: 680 kΩ (blu-gry-yel).

( ) R485: 4700 Ω (yel-viol-red).

( ) *R482: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) R332: 120 kΩ (brn-red-yel).

( ) *D303: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R331: 7500 Ω (viol-grn-red). Mount this resistor vertically as shown on the circuit board.

( ) R328: 750 Ω (viol-grn-brn). Mount this resistor vertically as shown on the circuit board.

( ) R327: 7500 Ω (viol-grn-red). Mount this resistor vertically as shown on the circuit board.

( ) R323: 220 kΩ (red-red-yel). Mount this resistor vertically as shown on the circuit board.

( ) R322: 510 Ω (grn-brn-brn).

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

Install the following components in Section 10 of the circuit board.

( ) R308: 22 kΩ (red-red-org).

( ) R311: 40.2 kΩ, 1% (yel-blk-red-red). Mount this resistor vertically as shown on the circuit board.

( ) *R483: 10 kΩ (brn-blk-org).

( ) R307: 22 kΩ (red-red-org). Mount this resistor vertically as shown on the circuit board.

( ) *R310: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) *R309: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) R321: 2700 Ω (red-viol-red).

( ) R333: 1000 Ω (brn-blk-red). Mount this resistor vertically as shown on the circuit board.

( ) R334: 680 Ω (blu-gry-brn). Mount this resistor vertically as shown on the circuit board.

( ) D304: 1N3017B zener diode (#56-97). Mount this diode vertically as shown on the circuit board.

( ) R319: 7500 Ω (viol-grn-red).

( ) R317: 15 kΩ (brn-grn-org). Mount this resistor vertically as shown on the circuit board.

( ) L301: 100 μH choke (#45-604, brn-blk-brn-silv). Mount this choke vertically as shown on the circuit board.

( ) R315: 1.2 MΩ (brn-red-grn). Mount this resistor vertically as shown on the circuit board.

( ) R314: 15 kΩ (brn-grn-org).

( ) R316: 1.2 MΩ (brn-red-grn).

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

Install the following components in Section 11 of the circuit board.

( ) R376: 6800 Ω (blu-gry-red). Mount this resistor vertically as shown on the circuit board.

( ) R312: 16.5 kΩ, 1% (brn-blu-grn-red). Mount this resistor vertically as shown on the circuit board.

( ) R393: 1500 Ω (brn-grn-red).

( ) R313: 560 Ω (grn-blue-brn).

( ) *R411: 10 kΩ (brn-blk-org).

( ) R409: 1000 Ω (brn-blk-red).

( ) *D344: 1N4149 diode (#56-56).

( ) R403: 2700 Ω (red-viol-red).

( ) R412: 15 kΩ (brn-grn-org).

( ) R413: 100 kΩ (brn-blk-yel). Mount this resistor vertically as shown on the circuit board.

( ) R414: 100 kΩ (brn-blk-yel). Mount this resistor vertically as shown on the circuit board.

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

Install the following components in Section 12 of the circuit board.

( ) D334: GD510 diode (#56-89). Mount this diode vertically as shown on the circuit board.

NOTE: The following glass capacitors can be installed either way in the circuit board.

( ) C336: .01 μF (103) glass ceramic capacitor.

( ) C341: .01 μF (103) glass ceramic capacitor.

( ) D335: GD510 diode (#56-89). Mount this diode vertically as shown on the circuit board.

( ) R378: 100 kΩ (brn-blk-yel). Mount this resistor vertically as shown on the circuit board.

( ) D333: 12.8 V zener diode (#56-94).

( ) R377: 150 Ω (brn-grn-brn). Mount this resistor vertically as shown on the circuit board.

( ) *R389: 10 kΩ (brn-blk-org).

( ) *R392: 10 kΩ (brn-blk-org).

( ) *D338: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R395: 10 MΩ, 1% (brn-blk-blk-grn). Mount this resistor vertically as shown on the circuit board.

( ) R394: 100 kΩ (brn-blk-yel).

( ) *D339: 1N4149 diode (#56-56).

( ) R396: 47 kΩ (yel-viol-org). Mount this resistor vertically as shown on the circuit board.

( ) R397: 100 kΩ (brn-blk-yel). Mount this resistor vertically as shown on the circuit board.

( ) R398: 100 kΩ (brn-blk-yel). Mount this resistor vertically as shown on the circuit board.

( ) R399: 15 kΩ (brn grn-org).

( ) *D343: 1N4149 diode (#56-56).

( ) R404: 1500 Ω (brn-grn-red).

( ) D346: 1N2071 diode (#57-27).

( ) R405: 15 kΩ (brn-grn-org).

( ) R406: 560 Ω (grn-blu-brn).

( ) R407: 10 Ω (brn-blk-blk).

( ) R408: 10 MΩ, 1% (brn-blk-blk-grn).

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

Install the following components in Section 13 of the circuit board.

( ) *D336: 1N4149 diode (#56-56).

( ) *D337: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R382: 680 Ω (blu-gry-brn).

( ) R383: 56 Ω (grn-blu-blk).

( ) *R391: 10 kΩ (brn-blk-org).

( ) *R384: 10 kΩ (brn-blk-org).

( ) *R385: 10 kΩ (brn-blk-org). Mount this resistor vertically as shown on the circuit board.

( ) R387: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R388: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R386: 1500 Ω (brn-grn-red). Mount this resistor vertically as shown on the circuit board.

( ) *D342: 1N4149 diode (#56-56). Mount this diode vertically as shown on the circuit board.

( ) R401: 560 Ω (grn-blu-brn). Mount this resistor vertically as shown on the circuit board.

( ) R402: 1000 Ω (brn-blk-red).

( ) R325: 1 MΩ (brn-blk-grn).

( ) R324: 22 kΩ (red-red-org). Mount this resistor vertically as shown on the circuit board.

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

Install the following components in Section 14 of the circuit board.

NOTE: Install eight 1N4149 diodes (#56-56) at the following locations:

( ) *D311.

( ) *D316.

( ) *D309.

( ) *D317.

( ) *D313.

( ) *D314.

( ) *D312.

( ) *D315.

( ) R329: 22 kΩ (red-red-org). Mount this resistor vertically as shown on the circuit board.

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

Install five 1N4149 diodes (#56-56) in Section 15 of the circuit board at the following locations:

( ) *D319.

( ) *D322.

( ) *D321.

( ) *D324.

( ) *D323.

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

Install five 1N4149 diodes (#56-56) in Section 16 of the circuit board at the following locations:

( ) *D318.

( ) *D327.

( ) *D328.

( ) *D325.

( ) *D326.

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

NOTE: The following parts are not taped on strips.

Refer to Pictorial 2-2 (Illustration Booklet, Page 7) for the following steps.

( ) Position the main circuit board as shown in the Pictorial.

NOTES:

1. When you install IC sockets in some of the following steps, be sure to match the index mark on the socket with the index mark on the circuit board (like you did when you installed IC sockets on the display circuit board). Since some of the resistors on the circuit board are higher than the IC sockets, we recommend that you bend over one pin at two opposite corners to hold the socket tight against the circuit board while you solder the pins to the foil. When you bend the two pins over, be sure they do not touch foils to which they are not normally connected.

2. When a step directs you to install a ferrite bead, use a 1" bare wire (like you did when you installed it on the display circuit board).

Install the following IC sockets and ferrite beads in Section 1 of the circuit board.

( ) 14-pin IC socket at U305.

( ) FB311: Ferrite bead at FB311.

( ) 14-pin IC socket at U314.

( ) FB318: Ferrite bead at FB318.

( ) FB309: Ferrite bead at FB309.

( ) FB316: Ferrite bead at FB316.

( ) 14-pin IC socket at U317.

Install the following IC sockets and ferrite beads in Section 2 of the circuit board.

( ) FB305: Ferrite bead at FB305.

( ) 8-pin IC socket at U306.

( ) FB312: Ferrite bead at FB312.

( ) FB313: Ferrite bead at FB313.

( ) FB317: Ferrite bead at FB317.

Install the following IC sockets and ferrite beads in Section 3 of the circuit board.

( ) FB304: Ferrite bead at FB304.

( ) 14-pin IC socket at U307.

( ) FB314: Ferrite bead at FB314.

( ) FB315: Ferrite bead at FB315.

Install the following IC sockets and ferrite beads in Section 4 of the circuit board.

( ) FB302: Ferrite bead at FB302.

( ) 14-pin IC socket at U302.

( ) 14-pin IC socket at U315.

( ) 8-pin IC socket at U303.

Install the following IC sockets and ferrite beads in Section 5 of the circuit board.

( ) FB301: Ferrite bead at FB301.

( ) FB303: Ferrite bead at FB303.

( ) 14-pin IC socket at U301.

( ) 8-pin IC socket at U304.

Install the following IC sockets and ferrite beads in Section 6 of the circuit board.

( ) FB307: Ferrite bead at FB307.

( ) FB308: Ferrite bead at FB308.

( ) 8-pin IC socket at U312.

( ) 8-pin IC socket at U313.

( ) FB306: Ferrite bead at FB306.

Refer to Pictorial 2-3 (Illustration Booklet, Page 8) for the following steps.

( ) U316: Install a 78L10 integrated circuit (#442-687) in Section 1 of the circuit board at U316. Be sure to install the IC so its flat side matches the flat of the outline on the circuit board (like you did when you installed transistors on the display circuit board). Position the IC 1/4" above the circuit board, solder the leads to the foil, and cut off any excess lead lengths.

Install nine MPSA05 transistors (#417-864) in Section 2 of the circuit board at the following locations. Solder the leads to the foil and cut off any excess lead lengths as you install each transistor.

( ) Q303.

( ) Q337.

( ) Q336.

( ) Q315.

( ) Q314.

( ) Q328.

( ) Q329.

( ) Q327.

( ) Q326.

Similarly, install seven MPSA05 transistors (#417-864) in Section 3 of the circuit board at the following locations:

( ) Q347.

( ) Q325.

( ) Q316.

( ) Q335.

( ) Q317.

( ) Q343.

( ) Q342.

Install transistors and SCRs in Section 4 of the circuit board as follows. NOTE: Use the same method to install SCRs as you use for transistors.

( ) Q318: MPSA05 transistor (#417-864).

( ) Q319: MPSA05 transistor (#417-864).

( ) D351: 2N5061 SCR (#57-624).

( ) Q345: MPSA05 transistor (#417-864).

( ) Q344: MPSA05 transistor (#417-864).

( ) D368: 2N5061 SCR (#57-624).

Install the following transistors in Section 5 of the circuit board.

( ) Q301: MPSA05 transistor (#417-864).

( ) Q313: MPSA05 transistor (#417-864).

Install the following transistors in Section 6 of the circuit board.

( ) Q305: MPSA20 transistor (#417-801).

( ) Q308: MPSA55 transistor (#417-**865**).

( ) Q309: 2N5308 transistor (#417-222).

( ) Q302: MPSA05 transistor (#417-864).

Install the following transistors, ICs, and SCRs in Section 7 of the circuit board.

( ) U311: **78L**05 IC (#442-627).

( ) U308: **79L**05 IC (#442-665).

( ) U309: **79L**05 IC (#442-665).

( ) D341: 2N5061 SCR (#57-624).

( ) Q306: MPSA05 transistor (#417-864).

( ) Q307: MPSA05 transistor (#417-864).

( ) D345: 2N5061 SCR (#57-624).

( ) Q311: MPSA05 transistor (#417-864).

NOTE: No components will be installed in Section 8 of the circuit board at this time.

Refer to Pictorial 2-4 (Illustration Booklet, Page 9) for the following steps.

Install the following ceramic capacitors in Section 1 of the circuit board.

( ) C362: .01 µF.

( ) C317: .01 µF.

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

Install the following ceramic capacitors in Section 2 of the circuit board.

( ) C318: .01 µF.

( ) C355: .01 µF.

( ) C363: .01 µF.

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

Install the following ceramic capacitors in Section 3 of the circuit board.

( ) C316: .01 µF.

( ) C321: .01 µF.

( ) C322: .01 µF.

( ) C324: .01 µF.

( ) C323: .1 µF (104).

( ) C314: .01 µF.

( ) C356: .01 µF.

( ) C368: .01 µF.

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

Install the following ceramic capacitors in Section 4 of the circuit board.

( ) C315: .01 µF.

( ) C369: .1 µF (104).

( ) C371: .1 µF (104).

( ) C357: .01 µF.

( ) C361: .1 µF (104).

( ) C372: .1 µF (104).

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

Install the following ceramic capacitors in Section 5 of the circuit board.

( ) C328: .01 μF.

( ) C329: .01 μF.

( ) C304: .01 μF.

( ) C364: .01 μF.

( ) C359: .1 μF (104).

( ) C358: .1 μF (104).

( ) C365: .01 μF.

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

Install the following ceramic capacitors in Section 6 of the circuit board.

( ) C326: .01 μF.

( ) C327: .01 μF.

( ) C305: .01 μF.

( ) C366: .01 μF.

( ) C303: .01 μF.

( ) C367: .01 μF.

( ) C312: .01 μF.

( ) C309: .01 μF.

( ) C311: .01 μF.

( ) C307: 500 pF.

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

Install the following ceramic capacitors in Section 7 of the circuit board.

( ) C335: .01 μF.

( ) C301: .01 μF.

( ) C302: .01 μF.

( ) C306: .001 μF (1000 pF).

( ) C308: .01 μF.

( ) C354: .1 μF (104).

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

Install the following ceramic capacitors in Section 8 of the circuit board.

( ) C339: .1 μF (104).

( ) C338: .1 μF (104).

( ) C344: .01 μF.

( ) C343: .1 μF (104).

( ) C346: .001 μF (1000 pF).

( ) C352: .001 μF (1000 pF).

( ) C353: .001 μF (1000 pF).

( ) C348: .1 μF (104).

( ) C349: .1 μF (104).

( ) C351: .01 μF.

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

NOTE: No capacitors will be installed in Section 9 of the circuit board.

Refer to Pictorial 2-5 (Illustration Booklet, Page 10) for the following steps.

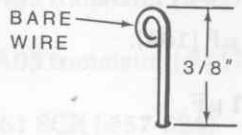
Install a test point, three electrolytic capacitors, and an LED (light-emitting diode) in Section 1 of the circuit board as follows:

( ) TP302: Use the following procedure to install a test point on the circuit board at TP302:

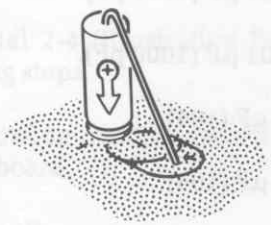
1. Cut a 1" bare wire. Then form a small loop in one end of the wire as shown.

2. Push the free end of the wire into the circuit board hole until the top (looped end) of the wire is 3/8" above the circuit board. Then solder the wire to the foil and cut off any excess wire end.

3. Position the looped end of the wire so it is perpendicular to the circuit board.



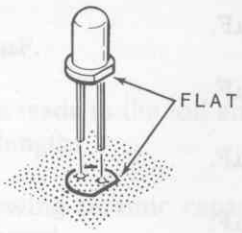
( ) C373: 10 µF electrolytic capacitor. NOTE: Install this capacitor vertically as shown below.



( ) D359: Use the following procedure to install an LED (#412-640) in the circuit board at D359:

1. Start the leads of the LED into the circuit board holes so the flat on the LED matches the flat of the outline on the circuit board.

2. Push the LED down tight against the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.



( ) C360: 4.7 µF electrolytic.

( ) C370: 10 µF electrolytic capacitor. NOTE: Install this capacitor vertically (like you did when you installed the last capacitor on this circuit board).

Install the following electrolytic capacitors in Section 2 of the circuit board. NOTE: Always observe the correct polarity when you install electrolytic capacitors (like you did when you installed them in the display circuit board).

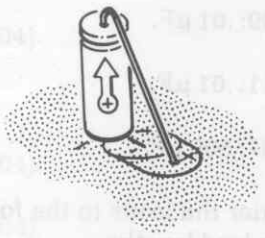
( ) C319: 10 µF. Be sure to use the 10 µF electrolytic capacitor that has both leads extending from the same end.

( ) C332: 220 µF.

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

Install electrolytic capacitors in Section 3 of the circuit board as follows:

( ) C313: 10 µF. NOTE: Install this capacitor vertically as shown below.



( ) C325: .68 µF.

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

( ) TP301: Install a test point in Section 4 of the circuit board at TP301. Use the same procedure you used earlier.

Install the following electrolytic capacitors in Section 5 of the circuit board.

( ) C334: 47 µF.

( ) C333: 47 µF.

( ) C347: 2.2 µF.

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

Install the following electrolytic capacitors and test points in Section 6 of the circuit board.

( ) C337: 47 µF electrolytic.

( ) TP304: Test point.

( ) TP303: Test point.

( ) C342: 47 µF electrolytic.

( ) C345: 47 µF electrolytic.

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

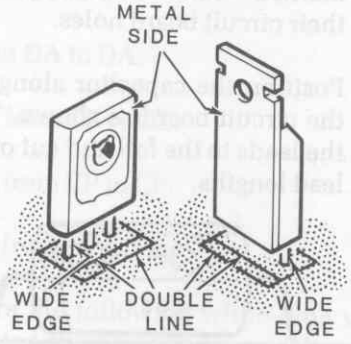
NOTE: No electrolytic capacitors will be installed in Section 7 of the circuit board.

Refer to Pictorial 2-6 (Illustration Booklet, Page 11) for the following steps.

NOTE: Solder the leads and lugs of the following components to the foil as you install them. Cut off any excess lead or lug lengths.

( ) R335: Install a 5000 Ω (5 k) control (#10-311) in Section 1 of the circuit board at R335. Use the same procedure you used when you installed the controls in the display circuit board.

NOTE: When you install the following types of transistors, first match the metal side of the transistor with the double line on the circuit board. Start the transistor leads into their corresponding circuit board holes and push the transistor down until the wider part of the leads touch the circuit board. Then solder the leads to the foil and cut off any excess lead lengths.



Install six MJE181 transistors (#417-818) in Section 2 of the circuit board at the following locations:

( ) Q339.

( ) Q338.

( ) Q322.

( ) Q321.

( ) Q332.

( ) Q331.

Install six 2N6387 transistors (#417-918) in Section 3 of the circuit board at the following locations:

( ) Q346.

( ) Q341.

( ) Q324.

( ) Q323.

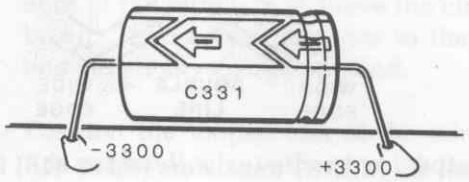
( ) Q334.

( ) Q333.

( ) C331: Use the following procedure to install a 3300 µF electrolytic capacitor on the circuit board:

1. Match the positive (+) mark on the capacitor with the circuit board hole marked "+3300" or match the negative (-) mark on the capacitor with the hole marked "-3300". Then start the leads into their circuit board holes.

2. Position the capacitor along the side of the circuit board as shown. Then solder the leads to the foil and cut off the excess lead lengths.

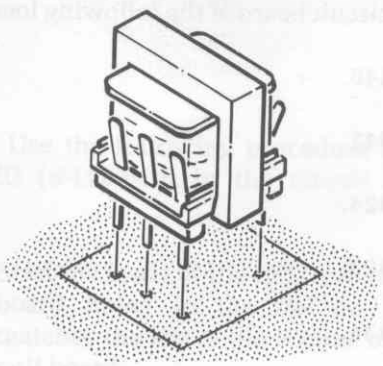


Install the following controls in Section 5 of the circuit board.

( ) R302: 50 kΩ (#10-222).

( ) R318: 20 kΩ (#10-390).

( ) T301: Install a power transformer (#54-992) in Section 6 of the circuit board at T301 as shown below. First match the transformer lugs with the circuit board holes. Start the lugs into the holes and push the transformer down tight against the circuit board. Then solder the lugs to the foil and cut off any excess lug lengths.



Install the following controls and transistors in Section 7 of the circuit board.

( ) R381: 5000 Ω (5 k) control (#10-311).

( ) Q304: MJE171 transistor (#417-819).

( ) R379: 5000 Ω (5 k) control (#10-311).

( ) Q312: MJE181 transistor (#417-818).

Install the following controls in Section 8 of the circuit board.

( ) R359: 5000 Ω (5 k) (#10-311).

( ) R358: 5000 Ω (5 k) (#10-311).

( ) R361: 1000 Ω (1 k) (#10-936).

( ) R360: 1000 Ω (1 k) (#10-936).

( ) R326: 10 kΩ (#10-312).

Install five 1000 Ω (1 k) controls (#10-936) in Section 9 of the circuit board at the following locations:

( ) R367.

( ) R364.

( ) R365.

( ) R362.

( ) R363.

Install five 1000 Ω (1 k) controls (#10-936) in Section 10 of the circuit board at the following locations:

( ) R366.

( ) R369.

( ) R368.

( ) R371.

( ) R370.

Install four 1000 Ω (1 k) controls (#10-936) in Section 11 of the circuit board at the following locations:

( ) R374.

( ) R375.

( ) R372.

( ) R373.

Refer to Pictorial 2-7 (Illustration Booklet, Page 12) for the following steps.

Install integrated circuits (ICs) in the sockets on the circuit board as follows. NOTE: Be sure to install them correctly as you were instructed when you assembled the display circuit board.

( ) U305: CD4016 IC (#442-99) at U305.

( ) U314: LM324 IC (#442-602) at U314.

( ) U317: LM324 IC (#442-602) at U317.

( ) U306: 555 IC (#442-53) at U306.

( ) U307: MC14013 IC (#443-607) at U307.

( ) U302: LM324 IC (#442-602) at U302.

( ) U315: MC14013 IC (#443-607) at U315.

( ) U301: CD4016 IC (#442-99) at U301.

( ) U304: RC4200 IC (#443-1164) at U304.

( ) U303: LF353 IC (#442-707) at U303.

( ) U312: 555 IC (#442-53) at U312.

( ) U313: 555 IC (#442-53) at U313.

Refer to Pictorial 2-8 (Illustration Booklet, Page 13) for the following steps.

( ) Prepare the following white-blue wires. They are listed in the order in which you will use them.

5-1/2″

5″

7″

3-3/4″

2-3/4″

4-1/2″

Connect the prepared white-blue wires between the circuit board holes as follows. Be sure to route each wire as shown on the Pictorial. Solder the wire ends to the foil as you connect each wire and cut off any excess wire ends.

( ) 5-1/2″ from DB to DB.

( ) 5″ from CY to CY.

( ) 7″ from DA to DA.

( ) 3-3/4″ from CZ to CZ.

( ) 2-3/4″ from CP to CP.

( ) 4-1/2″ from CR to CR.

( ) Prepare the following white-blue wires. They are listed in the order in which you will use them.

4-1/2″

4″

5″

2-3/4″

5-1/2″

5″

Connect the prepared white-blue wires between the circuit board holes as follows. Be sure to route each wire as shown on the Pictorial. Solder the wire ends to the foil as you connect each wire and cut off any excess wire ends.

( ) 4-1/2″ from CS to CS.

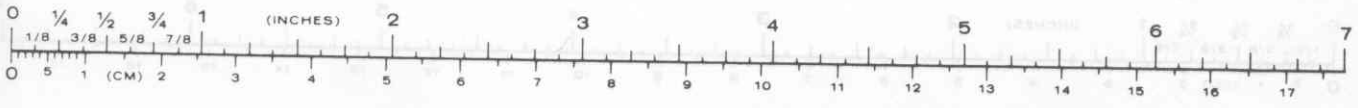
( ) 4″ from CT to CT.

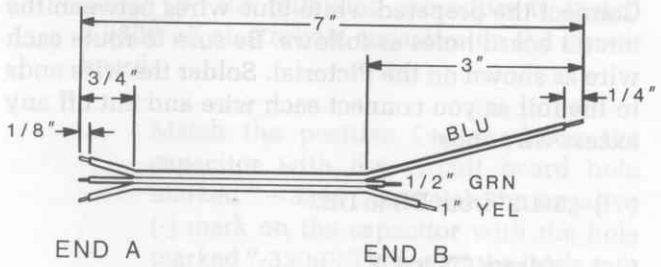
( ) 5″ from CU to CU.

( ) 2-3/4″ from CX to CX.

( ) 5-1/2″ from CN to CN.

( ) 5″ from CL to CL.





Detail 2-8A

( ) Locate the 8" blue-green-yellow flat cable that you set aside during the assembly of the display circuit board. Then refer to Detail 2-8A and use the following procedure to prepare the cable:

1. Cut the 3-wire cable to 7".

2. Prepare each end of the cable as shown.

( ) Refer to Detail 2-8B Part A and install a spring connector on each wire at End A of the prepared cable.

Position a small 3-hole socket shell so the slotted side is up as shown in Detail 2-8B Part B. Then push the following spring connectors on one end of the prepared cable into the holes of the socket shell until they lock into place.

( ) Blue wire into hole 1.

( ) Green wire into hole 2.

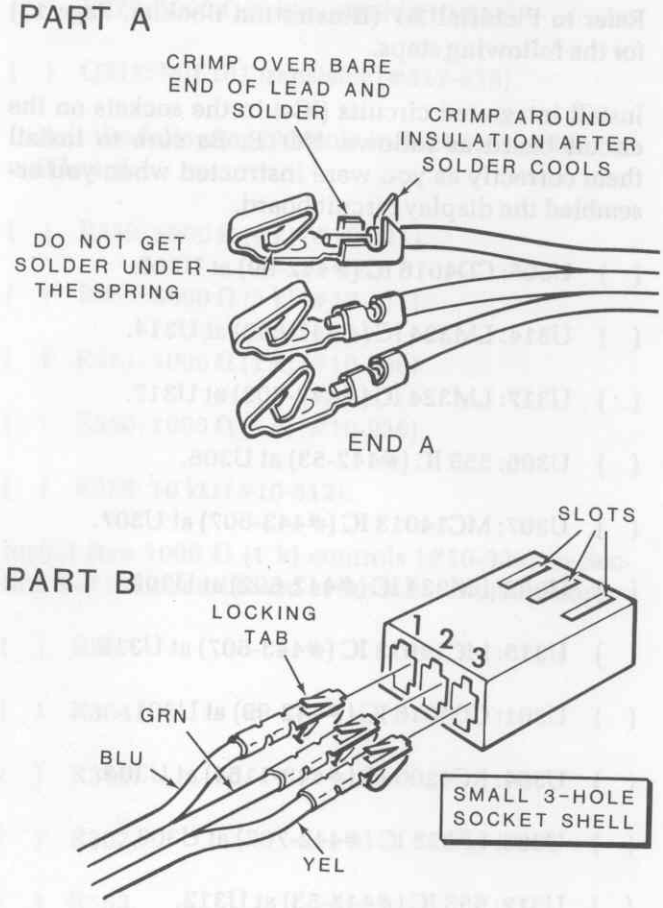
( ) Yellow wire into hole 3.

Connect the wires at the free end of the prepared cable to the circuit board holes as follows. Solder each wire to the foil and cut off any excess wire end as you connect it.

( ) Yellow wire to hole S.

( ) Green wire to hole R.

( ) Blue wire to hole P.

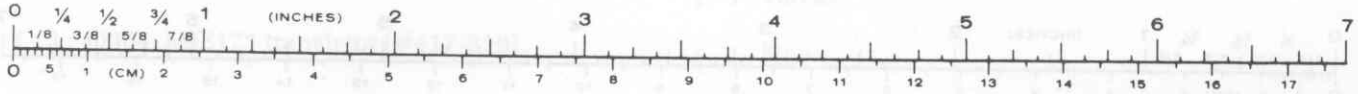


Detail 2-8B

( ) Unfold the wire harness (#134-1373) as shown in Pictorial 2-9 (Illustration Booklet, Page 14). Refer to the wire colors at some of the breakouts (where a group of wires come from the harness) to make sure you have the harness positioned properly.

Refer to Pictorial 2-10 (Illustration Booklet, Page 15) for the following steps.

( ) Position breakouts #2 through #7 along the bottom edge of the circuit board as shown in the Pictorial.



Connect the wires coming from harness breakout #2 to the circuit board holes as follows. Solder each wire to the foil and cut off any excess wire end as you connect it.

( ) White-yellow wire to hole BT.

( ) Blue wire to hole AN.

( ) White-orange wire to hole BR.

( ) White-green wire to hole BU.

( ) White-violet wire to hole G.

( ) Violet wire to hole T.

Connect and solder the following wires coming from harness breakout #3 to the circuit board holes.

( ) Black wire to hole BA.

( ) White-black wire to hole BC.

( ) White-brown wire to hole AZ.

( ) Brown wire to hole BB.

( ) White-yellow wire to hole AX.

( ) Violet wire to hole DF.

( ) White-orange wire to hole AY.

( ) White-blue wire to hole AU.

( ) Blue wire to hole BF.

( ) Orange wire to hole DH.

( ) White-violet wire to hole BG.

( ) White-green wire to hole BH.

( ) Either red wire to hole H.

( ) Remaining red wire to hole J.

Connect and solder the following wires coming from harness breakout #4 to the circuit board holes.

( ) White-green wire to hole BX.

( ) White wire to hole BD.

( ) Blue wire to hole BY.

( ) White-black wire to hole BZ.

( ) White-gray wire to hole BN.

( ) Green wire to hole BK.

( ) White-orange wire to hole BJ.

( ) White-red wire to hole CA.

( ) White-brown wire to hole BP.

( ) Yellow wire to hole BL.

( ) Orange wire to hole BS.

( ) Brown wire to hole CB.

( ) White-blue wire to hole CD.

( ) Violet wire to hole CC.

( ) Red wire to hole DC.

Connect and solder the following wires coming from harness breakout #5 to the circuit board holes.

( ) Orange wire to hole DG.

( ) Violet wire to hole DE.

( ) Black wire to hole DJ.

( ) White wire to hole BE.

( ) Either white-violet wire to hole E.

( ) Remaining white-violet wire to hole U.

( ) Blue wire to hole C.

( ) Green wire to hole A.

( ) Gray wire to hole B.

( ) White-orange wire to hole D.

Connect and solder the following wires coming from harness breakout #6 to the circuit board holes.

( ) Yellow wire to hole Z.

( ) Violet wire to hole AP.

( ) White-violet wire to hole AT.

( ) White-red wire to hole CE.

( ) Either gray wire to hole AR.

( ) Remaining gray wire to hole AS.

( ) Small red wire to hole DD.

( ) White wire to hole LO.

( ) White-brown wire to hole HI.

( ) Small orange wire to hole Y.

( ) Green wire to hole X.

( ) Blue wire to hole F.

( ) Large red wire to hole K.

( ) Either large orange wire to hole L.

( ) Remaining large orange wire to hole N.

Connect and solder the following wires coming from harness breakout #7 to the circuit board holes.

( ) Yellow wire to hole AK.

( ) Green wire to hole AL.

( ) Both white-red wires to holes AC.

( ) Both white-brown wires to holes AB.

( ) Both white-blue wires to holes AG.

( ) Both white-violet wires to holes AH.

( ) Both white-green wires to holes AF.

( ) Both white-orange wires to holes AD.

( ) Both white-black wires to holes AA.

( ) Both white-gray wires to holes AJ.

( ) Both white-yellow wires to holes AE.

CIRCUIT BOARD CHECKOUT

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

( ) Unsoldered connections.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

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

( ) Diodes for the proper type and installation.

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

( ) LED for the correct installation.

( ) Transistors for the proper type and installation.

( ) Integrated circuits for the proper type and installation.

This completes the assembly of the main circuit board. Set the circuit board aside until it is called for during the assembly of the chassis. Proceed to "Chassis."

CHASSIS

PARTS LIST

Unpack all remaining parts from the large shipping carton. Check all parts against the following list and the "Chassis Parts Pictorial" (Illustration Booklet, Pages 16 through 19). Make a check (√) after each part as you identify it. If any part is packaged in an individual envelope with a part number on it, place it back in the envelope after you identify it until it is called for in a step.

ELECTRONIC PARTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-750-12	1	75 Ω (viol-grn-blk) 1/4-watt, 5% resistor	R2
A1	6-561-12	2	560 Ω (grn-blu-brn) 1/4-watt, 5% resistor	R4, R5
A2	10-1203	1	100 Ω control	R3
A2	10-14	1	250 kΩ control	R1
A3	12-68	1	1500 Ω/200 kΩ control	R6/R7
A4	21-140	2	.001 µF ceramic capacitor	C3, C4
A5	21-145	5	.001 µF feedthrough capacitor	C5, C6, C7, C8, C9
A4	21-72	3	.005 µF ceramic capacitor	C11, C12, C13
A4	21-176	3	.01 µF ceramic capacitor	C14, C15, C16
A6	40-1952	1	1 µH coil	L2
A7	40-2030	1	Roller inductor	L1
A8	54-1015	1	Power transformer	T1
A9	56-67	1	1N4740A zener diode	D1

Electronic Parts (Cont'd.)

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A10	61-52	3	3-lug toggle switch	SW8, SW9, SW11
A11	61-53	1	6-lug toggle switch	SW6
A12	63-1402	1	Rotary switch	SW7
A13	64-927	1	Pushbutton switch assembly	SW1, SW2, SW3, SW4
A14	69-103	1	Relay	K1
A15	100-1836	1	Sensor Assembly*	
A16	150-74	2	Optical coupler	U2, U3
A17	401-163	1	Speaker	SP1
A18	407-757	1	FWD meter	M1
A19	407-758	1	REF meter	M2
A20	420-636	3	Motor	A1, A2, A3
A21	421-33	1	1/4-ampere slow-blow fuse	F1
A22	423-2	1	Fuseholder	
A23	442-674	1	7812 IC	U1
A24	475-10	5	Ferrite bead	FB1, FB2, FB3, FB4, FB5

* See separate "Sensor Assembly (#100-1836)"

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

HARDWARE

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

#2 Hardware

B1	250-1172	10	2-56 × 1/4″ screw
B2	252-51	10	2-56 nut
B3	254-26	10	#2 lockwasher

#4 Hardware

C1	250-156	4	4-40 × 1/8″ setscrew
C2	250-213	4	4-40 × 5/16″ screw
C3	250-1448	2	4-40 × 3/8″ flat head screw
C4	250-478	4	4-40 × 1-3/4″ flat head screw
C5	252-15	4	Small 4-40 nut
C6	252-2	8	Large 4-40 nut
C7	254-9	10	#4 lockwasher
C8	259-9	2	#4 solder lug

#6 Hardware

D1	250-1282	1	6-32 × 1/8″ setscrew
D2	250-230	6	6-32 × 3/16″ setscrew
D3	250-1325	38	6-32 × 1/4″ screw
D4	250-1307	4	#6 × 1/4″ sheet metal screw
D5	250-1264	2	6-32 × 3/8″ hex head screw
D6	250-1280	22	6-32 × 3/8″ pan head screw
D7	250-1423	4	6-32 × 3/8″ flat head screw
D8	250-475	4	#6 × 3/8″ hex head sheet metal screw
D9	250-1331	4	6-32 × 5/8″ pan head screw
D10	250-1305	1	#6 × 5/8″ self-tapping screw
D11	250-134	1	6-32 × 3/4″ brass screw
D12	250-168	2	6-32 × 1-3/8″ screw
D13	252-3	29	6-32 nut
D14	253-127	2	#6 steel flat washer
D15	253-714	30	#6 brass flat washer
D16	254-1	31	#6 lockwasher
D17	259-1	3	#6 solder lug

#8 Hardware

E1	250-585	16	8-32 × 1/2″ screw
E2	250-329	17	8-32 × 5/8″ screw
E3	252-4	1	8-32 nut
E4	252-180	1	8-32 wing nut
E5	253-9	10	#8 steel flat washer
E6	253-715	48	#8 fiber flat washer
E7	254-2	8	#8 lockwasher
E8	259-2	2	#8 solder lug

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

#10 Hardware

F1	252-163	1	10-32 wing nut
F2	252-199	26	10-32 brass nut
F3	253-19	2	#10 steel flat washer
F4	253-716	16	#10 fiber flat washer
F5	259-26	3	#10 solder lug

Other Hardware

G1	250-1235	2	1/4-32 × 1/4″ setscrew
G2	252-39	2	1/4-32 nut
G3	252-701	12	Brass control nut
G4	253-10	5	Control flat washer
G5	253-36	1	Brass spring washer
G6	254-5	3	Control lockwasher
G7	258-704	2	Dished spring
G8	258-705	2	Forked spring
G9	258-734	3	Contactor spring
G10	259-10	3	Control solder lug
G11	455-11	1	Split bushing
G12	455-26	2	Shaft bushing
G13	455-642	1	Shaft collar
G14	455-667	3	Decoder disk collar

SPACERS

H1	255-59	2	Tapered spacer
H2	255-719	50	Large 17/64″ spacer
H3	255-720	4	Large 3/16″ spacer
H4	255-721	100	Small 17/64″ spacer
H5	255-722	4	Small 3/16″ spacer
H6	255-728	8	8-32 × 8-5/16″ spacer
H7	255-812	1	1/2″ hex spacer
H8	255-813	1	9/16″ hex spacer
H9	255-814	2	11/16″ hex spacer

SHAFTS - COUPLERS

J1	266-896	4	10-32 × 9-7/8″ threaded brass rod
J2	266-1047	1	Tension rod
J3	453-278	2	9-7/8″ hex shaft
J4	453-343	1	16″ shaft
J5	456-1	3	Flexible shaft coupler
J6	456-7	1	Shaft coupler

METAL PARTS

K1	90-1305-1	1	Cabinet top
K2	200-1436-1	1	Main chassis
K3	203-2154-1	1	Front panel
K4	203-2155-2	1	Rear panel
K5	204-1856	1	Speaker mounting bracket
K6	204-2207	6	Capacitor mounting bracket
K7	204-2355	2	Angle bracket

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

Metal Parts (Cont'd.)

K8	204-2509	4	Meter bracket
K9	204-2688	1	Control mounting bracket
K10	204-2691	1	Switch mounting bracket
K11	205-1679	2	Capacitor front plate
K12	205-1680	2	Capacitor rear plate
K13	205-1681	50	Stator plate
K14	205-1682	52	Rotor plate
K15	205-1915	1	Top shield
K16	206-1453	1	Center shield
K17	206-1454	1	Input shield
K18	212-56	1	5-1/2" strap
K19	212-57	1	4-1/4" strap
K20	212-59	2	4-19/32" strap
K21	212-60	1	6" strap
K22	258-742	2	Grounding spring

CONNECTORS

L1	432-66	4	Push-on connector
L2	432-70	1	9-hole plug shell
L3	432-71	1	9-hole socket shell
L4	432-72	14	Male connector pin
L5	432-73	14	Female connector pin
L6	432-196	1	2-hole socket shell
L7	432-720	1	3-hole plug shell
L8	432-723	1	Large 3-hole socket shell
L9	432-907	1	2-hole plug shell

INSULATORS

N1	71-2	3	Small ceramic feedthrough insulator (disassembled)
N2	71-11	1	Large ceramic feedthrough insulator (disassembled)
N3	73-43	1	3/8" grommet
N4	73-147	1	3" foam tape
N5	75-109	2	Small insulator paper (3-3/8" × 5-3/8")
N6	75-754	1	Strain relief
	75-836	1	Large insulator paper (5" × 13")
N7	266-894	9	Ceramic insulator plate (1 extra included)

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

MISCELLANEOUS

	89-54	1	Line cord
P1	205-1741	2	Inductor end plate
P2	261-9	4	Round foot
P3	266-898	2	Steel ball
P4	266-1048	1	Roller contact
P5	266-1213	1	Switch detent
P6	266-1216	2	Decoder disk
P7	351-9	1	Glue
P8	352-14	1	Grease
P9	354-5	8	Cable tie
P10	431-41	1	2-lug terminal strip
P11	431-42	1	5-lug terminal strip
P12	446-735	1	Window
P13	451-615	1	Worm gear
P14	451-618	1	Spur gear
P15	462-1130	1	Small round knob
P16	462-1178	3	Large round knob
P17	462-1170	5	Pushbutton knob
P18	462-1171	1	Lever knob
P19	485-29	2	Button plug
P20	490-5	1	Nut starter
P21	490-14	1	Large allen wrench
P22	490-23	1	Small allen wrench
P23	490-168	1	Open-end wrench

Sensor Assembly (#100-1836)

INPORTANT: The Sensor Assembly contains the following parts. This Assembly has been factory tested and aligned. **Do NOT attempt to adjust any components in the Sensor Assembly;** to do so may void the Warranty. Replacing components inside the Assembly may also cause it to require realignment at the factory.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS, 1/4-WATT, 5%			
6-470-12	2	47 Ω (yel-viol-blk)	R101, R102
6-332-12	1	3300 Ω (org-org-red)	R103
6-223-12	1	22 kΩ (red-red-org)	X101
6-104-12	1	100 kΩ (brn-blk-yel)	X102
CONTROLS			
10-312	1	10 kΩ	R104
10-390	1	20 kΩ	R107
10-941	2	100 kΩ	R105, R106
CAPACITORS — COIL			
20-103	2	150 pF mica capacitor	C101, C102
20-172	2	.001 μF mica capacitor	C103, C104
31-8	1	1-8 pF trimmer capacitor	C105
40-1970	1	29.5 μH toroid coil	L101
HARDWARE			
250-480	2	4-40 × 15/16″ screw	
252-15	2	4-40 nut	

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Hardware (Cont'd.)			
254-9	2	#4 lockwasher	
253-43	2	#5 flat washer	
250-324	2	6-32 × 3/16″ screw	
253-1	1	#6 fiber flat washer	
254-1	6	#6 lockwasher	
255-705	2	Spacer	
257-12	1	Eyelet	
259-6	2	#6 solder lug	
MISCELLANEOUS			
56-20	2	1N295A diode	D101, D102
63-1400	1	Rotary switch	SW101
85-2038-1	1	Printed circuit board	
204-9	2	Angle bracket	
212-61	3	Switch bus	
214-230-1	1	Sensor housing	
340-3	4-1/2″	16-gauge bare wire	
340-8	5″	22-gauge bare wire	
346-21	1″	Sleeving	
347-39	3′	5-conductor cable	
436-55	4	Coaxial jack	J1, J2, J6, J7
475-10	2	Ferrite bead	

STEP-BY-STEP ASSEMBLY

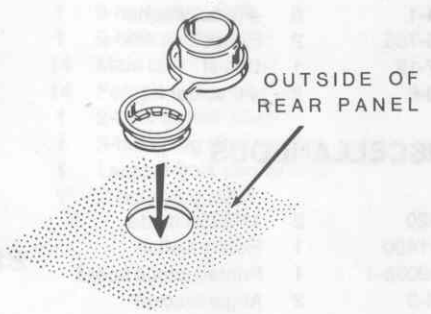
REAR PANEL ASSEMBLY

Refer to Pictorial 3-1 (Illustration Booklet Page 20) for the following steps.

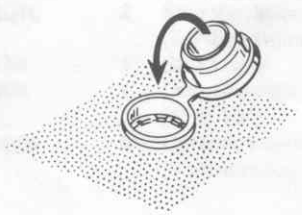
( ) Position the rear panel as shown in the Pictorial.

( ) Carefully peel the backing paper from the "danger" label. Then press the label onto the outside of the rear panel in the area shown. Do not cover any holes or printing on the rear panel.

( ) Refer to Detail 3-1A and install a 3/8" grommet in hole A from outside the rear panel as shown.



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 3-1A

( ) Locate the sensor assembly and position it as shown in Detail 3-1B. CAUTION: DO NOT ATTEMPT TO ADJUST OR IN ANY WAY TAMPER WITH THE SENSOR COMPONENTS, EXCEPT AS DIRECTED IN THE FOLLOWING STEPS. This unit has been factory calibrated; any attempt to readjust its controls may void the Warranty.

( ) Locate the three packets containing the small ceramic feedthrough insulators (#71-2) and other parts. Open one of these packets and remove all of its contents. Use these parts in the following steps.

Refer again to Detail 3-1B while you perform the next four steps.

( ) 1. Place a nut on one end of a feedthrough stud. Turn the nut until 1/8" of the thread is beyond the nut. Push this end of the stud through the hole in the end of the strap coming from switch SW101 lug 12. Turn another nut onto the end of the stud to secure the strap; then grasp the inner nut with pliers as you use the wrench provided to tighten the outer nut.

( ) 2. Place a flat washer onto the end of the stud, followed by a male ceramic element and a fiber washer as shown.

( ) 3. In exactly the same way, install a feedthrough stud on the end of the strap coming from switch SW101 lug 6. Place a flat washer, a male ceramic element, and a fiber washer on the stud.

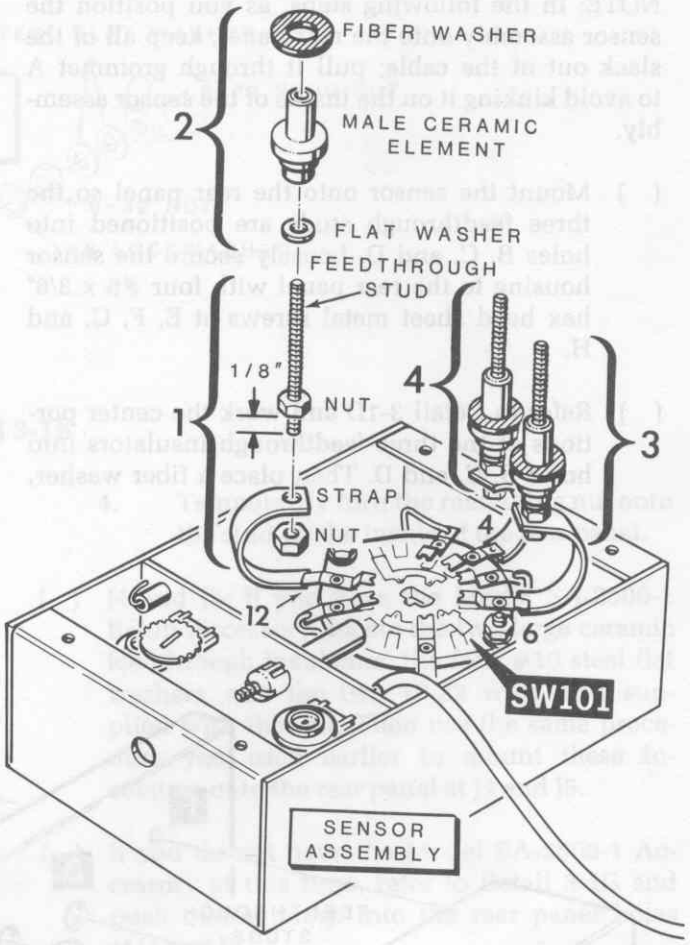
( ) 4. In exactly the same way, install the remaining feedthrough stud on the end of the strap coming from switch SW101 lug 4. Place a flat washer, a male ceramic element, and a fiber washer on the stud.

( ) Refer to Detail 3-1C and position the stud at lug 6 straight up, near the lower corner of the sensor assembly as shown. You will have to bend the strap slightly to do this. Position the stud at lug 12 straight up, directly across the switch, 2″ from the stud at lug 6.

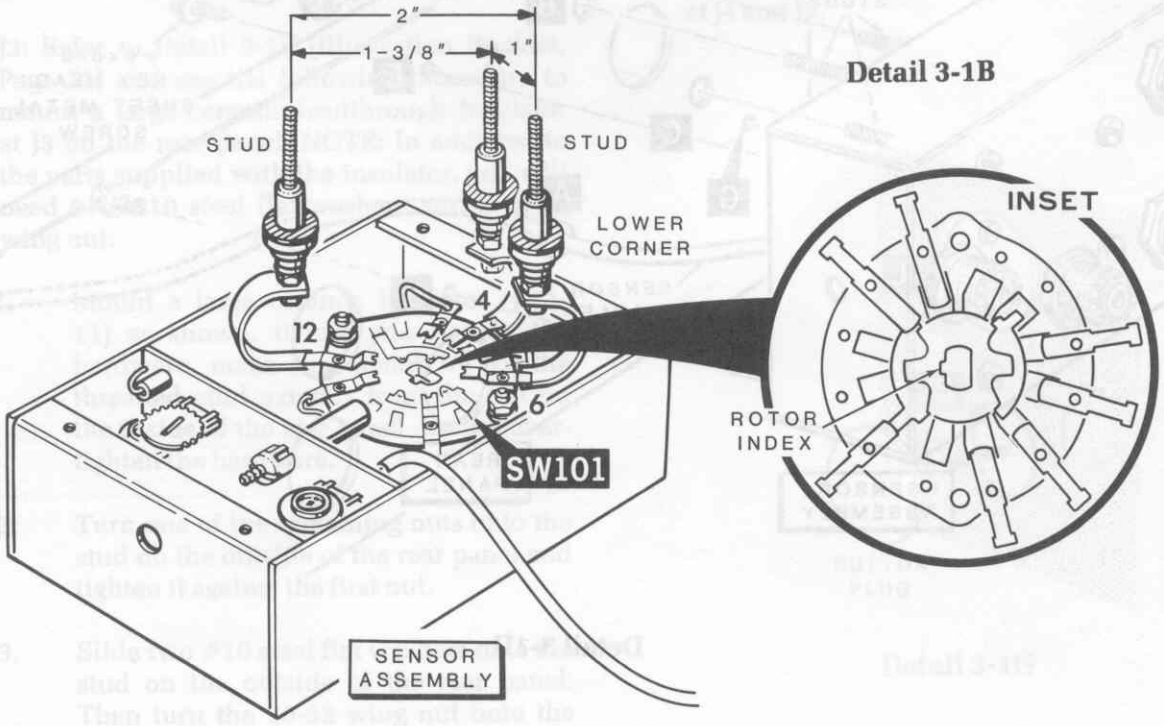
( ) Refer again to Detail 3-1C and position the stud at lug 4 straight up, so it is 1-3/8″ from the stud at lug 12 and 1″ from the stud at lug 6.

( ) Before you mount the sensor to the rear panel, refer to the inset drawing on Detail 3-1C and make certain the rotor index is at the "bypass" setting **exactly** as shown. Then, do not move the rotor from this position during any later steps.

( ) Place the sensor assembly close to the outside of the rear panel. Then push the end of the sensor cable through grommet A and pull the cable through to take up all of the slack.



Detail 3-1B



Detail 3-1C

NOTE: In the following steps, as you position the sensor assembly onto the rear panel, keep all of the slack out of the cable; pull it through grommet A to avoid kinking it on the inside of the sensor assembly.

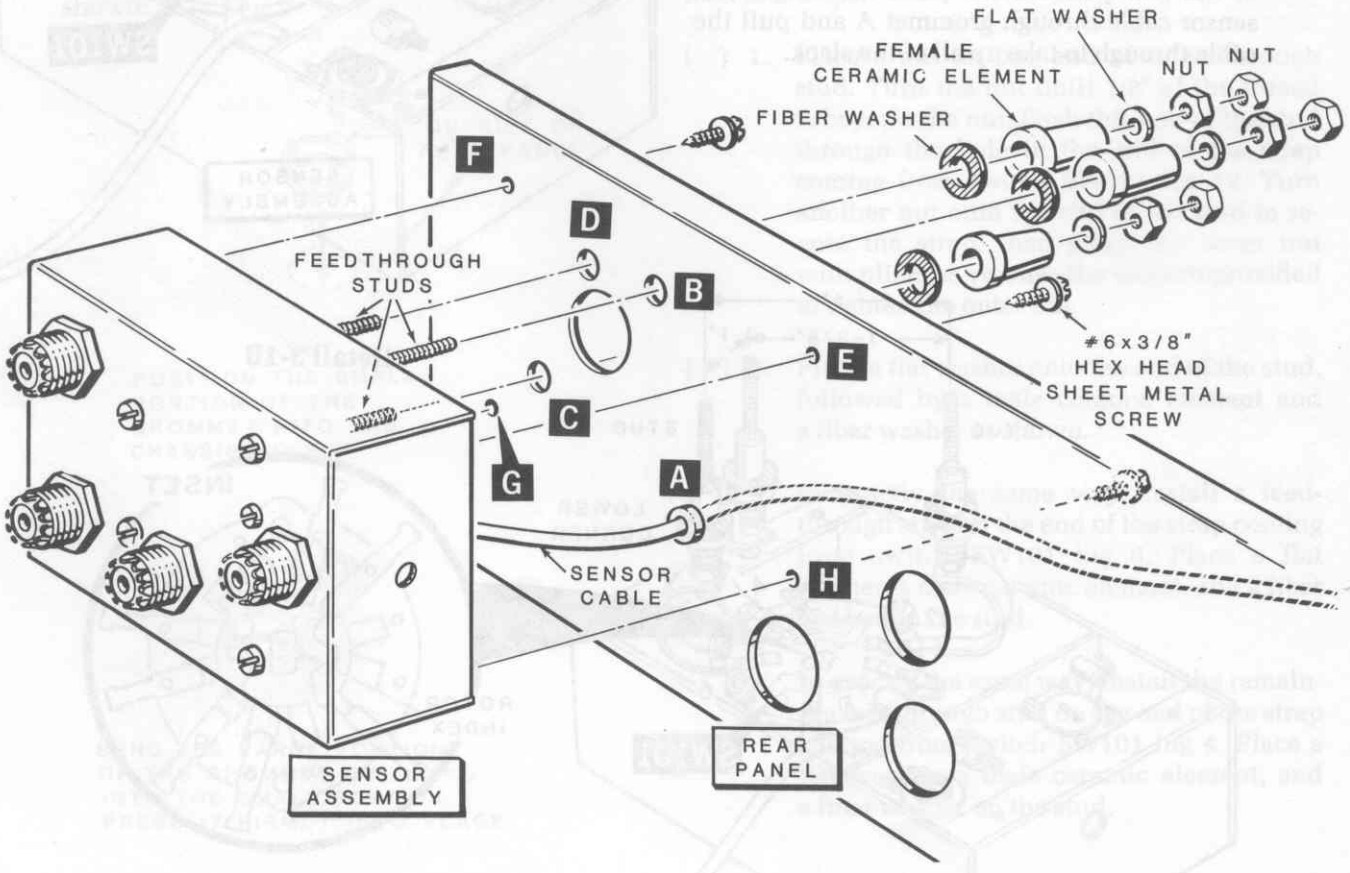
( ) Mount the sensor onto the rear panel so the three feedthrough studs are positioned into holes B, C, and D. Loosely secure the sensor housing to the rear panel with four #6 x 3/8" hex head sheet metal screws at E, F, G, and H.

( ) Refer to Detail 3-1D and work the center portions of the three feedthrough insulators into holes B, C, and D. Then place a fiber washer, a female ceramic element, a flat washer, and a nut onto each feedthrough stud. Tighten each nut finger tight.

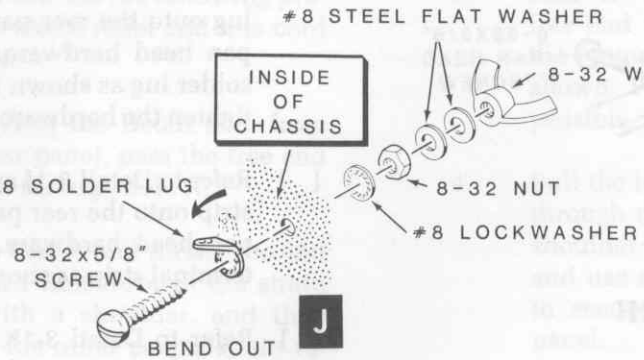
( ) Tighten the mounting screws at E, F, G, and H.

NOTE: In the following step, do not overtighten the feedthrough nut and break the insulator.

( ) Turn the nut on each feedthrough insulator at B, C, and D until it is just snug. Then turn the remaining nuts onto the ends of the feedthrough studs so they will not become misplaced.



Detail 3-1D



Detail 3-1E

NOTE: In the following steps, only the screw size is given. For example, if a step calls for "8-32 × 5/8" hardware," it means you should use an 8-32 × 5/8" screw, one or more #8 lockwashers, and an 8-32 nut. The Pictorial or Detail referred to in the step shows the proper number and use of the lockwashers.

( ) Form a #8 solder lug as shown in Detail 3-1E. Then mount the solder lug at J on the rear panel as shown in the Detail. Use 8-32 × 5/8" hardware, two #8 steel flat washers, and an 8-32 wing nut. Position the solder lug as shown in the Pictorial.

( ) J3: Refer to Detail 3-1F (Illustration Booklet, Page 21) and use the following procedure to mount a large ceramic feedthrough insulator at J3 on the rear panel. NOTE: In addition to the parts supplied with the insulator, you will need two #10 steel flat washers and a 10-32 wing nut.

1. Mount a large ceramic insulator (#71-11) as shown. Before you tighten the hardware, make sure about 1/4" of the threaded stud extends from the nut on the inside of the rear panel. Do **not** overtighten the hardware.

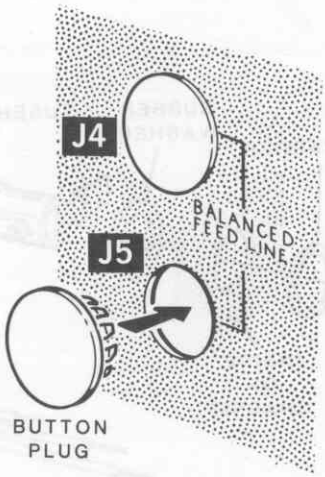
2. Turn one of the remaining nuts onto the stud on the outside of the rear panel and tighten it against the first nut.

3. Slide two #10 steel flat washers onto the stud on the outside of the rear panel. Then turn the 10-32 wing nut onto the stud and tighten it against the flat washers.

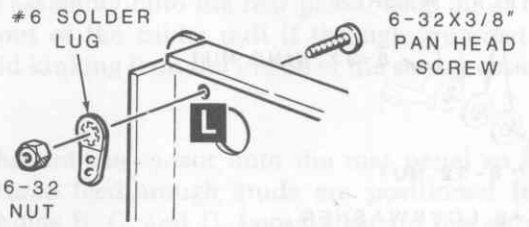
4. Temporarily turn the remaining nut onto the stud on the inside of the rear panel.

( ) J4 and J5: If you have the Model SA-2500-1 Balun Accessory, locate the two large ceramic feedthrough insulators, the four #10 steel flat washers, and the two 10-32 wing nuts supplied with that kit. Then use the same procedure you used earlier to mount these insulators onto the rear panel at J4 and J5.

( ) If you do not have the Model SA-2500-1 Accessory at this time, refer to Detail 3-1G and push button plugs into the rear panel holes at J4 and J5.



Detail 3-1G



Detail 3-1H

( ) Refer to Detail 3-1H and mount a #6 solder lug onto the rear panel at L. Use 6-32 × 3/8" pan head hardware. Be sure to position the solder lug as shown in the Pictorial before you tighten the hardware.

( ) Refer to Detail 3-1J and mount a 2-lug terminal strip onto the rear panel at K. Use 6-32 × 3/8" pan head hardware. Be sure to position the terminal strip as shown in the Pictorial.

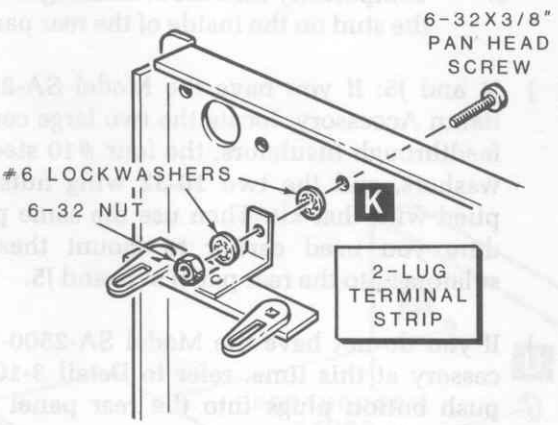
( ) Refer to Detail 3-1K and mount a fuseholder onto the rear panel at F1. Use the hardware supplied with the fuseholder. Be sure to position the fuseholder as shown in the Pictorial. Temporarily install the fuseholder cap, if this has not already been done.

( ) Refer to Detail 3-1L and use the following procedure to prepare the free end of the line cord:

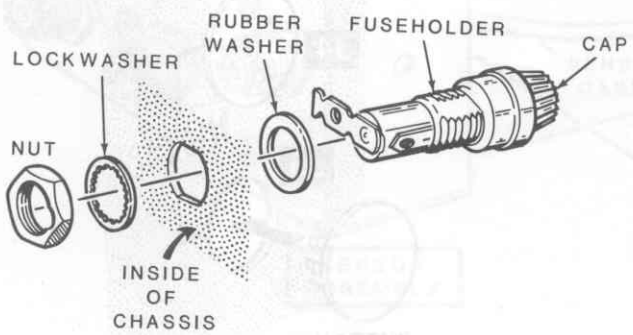
1. Carefully remove 3-1/2" of outer insulation from the line cord.

2. Cut the free end of the black line cord lead to 3" and the free end of the white line cord lead to 2".

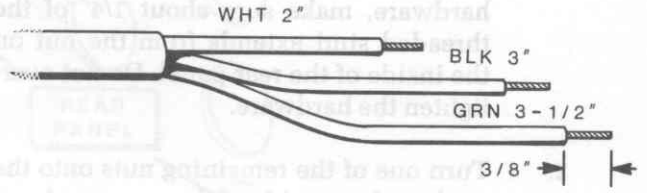
3. Remove 3/8" of insulation from the end of each line cord lead and prepare the ends.



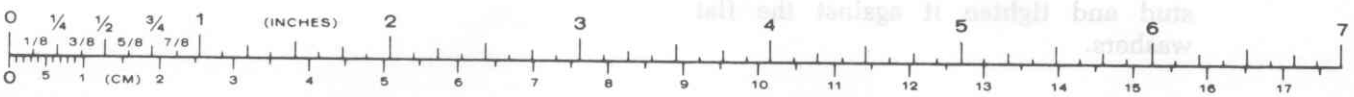
Detail 3-1J



Detail 3-1K



Detail 3-1L



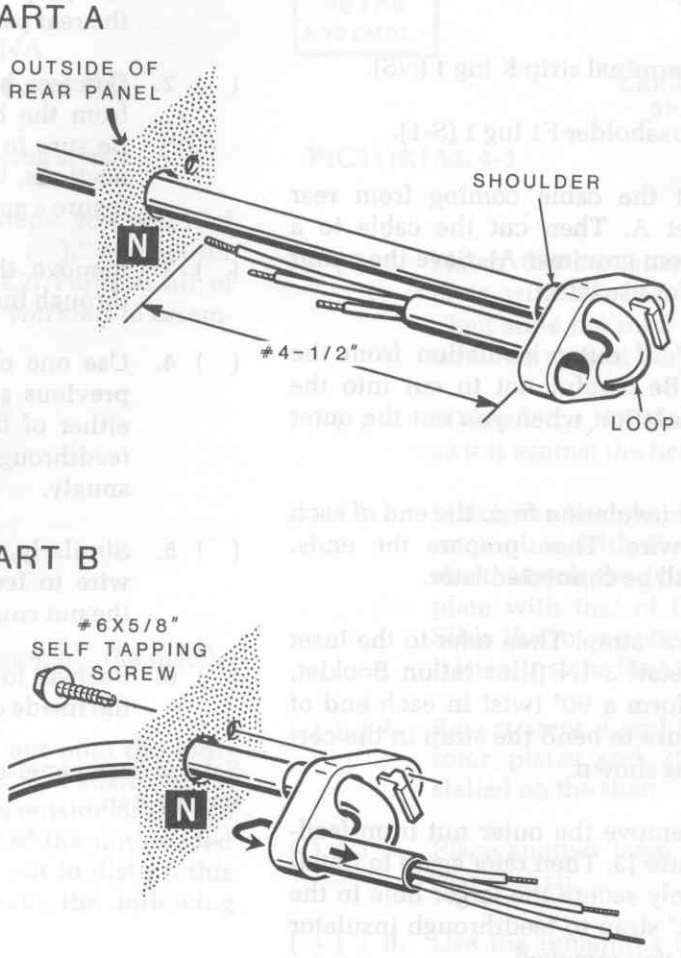
( ) Refer to Detail 3-1M and use the following procedure to secure the strain relief and line cord to the rear panel at N:

1. Refer to Part A of the Detail and, from outside the rear panel, pass the free end of the line cord through hole N.

2. Refer again to Part A and thread the end of the line cord first through the strain relief hole with a shoulder, and then back through the other center strain relief hole as shown. Pull the end of the line cord through until 4-1/2″ of the end of the line cord is exposed from the back of the strain relief hole with the shoulder to remove the excess slack.

3. Refer to Part B of the Detail and pass the free end of the line cord back through the remaining strain relief hole as shown. Pull the end through as far as possible.

4. Pull the longer end of the line cord back through rear panel hole N, position the shoulder of the strain relief into hole N, and use a #6 × 5/8″ self-tapping screw to secure the strain relief to the rear panel.



Detail 3-1M

NOTES:

1. Refer to the inset drawing on the Pictorial when you are directed to make a mechanically secure connection.

2. In the following steps, (NS) means not to solder the connection because you will add other wires later. "S-" with a number, such as (S-2), means to solder the connection. The number following the "S-" tells you how many wires should be at the connection. This helps you check your work for errors as you assemble the kit.

Connect the line cord leads as follows. Be sure to make mechanically secure connections.

( ) Green lead to solder lug L (S-1). Do not shorten this wire.

( ) White lead to terminal strip K lug 1 (NS).

( ) Black lead to fuseholder F1 lug 1 (S-1).

( ) Straighten out the cable coming from rear panel grommet A. Then cut the cable to a length of 6" (from grommet A). Save the cutoff piece of cable for use later.

( ) Remove 1-1/2" of outer insulation from the sensor cable. Be careful not to cut into the inner wire insulation when you cut the outer insulation.

( ) Remove 3/8" of insulation from the end of each sensor cable wire. Then prepare the ends. These wires will be connected later.

( ) Locate the 5-1/2" strap. Then refer to the inset drawing on Detail 3-1N (Illustration Booklet, Page 21) and form a 90° twist in each end of the strap. Be sure to bend the strap in the correct direction as shown.

( ) Temporarily remove the outer nut from feedthrough insulator J3. Then refer again to Detail 3-1N and loosely secure the larger hole in the prepared 5-1/2" strap to feedthrough insulator J3 with the nut you removed.

( ) Temporarily remove the outer nut from feedthrough insulator D. Then refer again to Detail 3-1N and loosely secure the free end of the 5-1/2" strap to feedthrough insulator D with the nut you removed.

( ) Form the 5-1/2" strap as shown in the Pictorial. Then tighten the outer nuts on feedthrough insulators J3 and D.

NOTE: Perform the next six steps **only** if you have the Model SA-2500-1 Balun Accessory. If you do not have the Accessory, set the rear panel assembly aside until it is called for in a step, skip the next six steps, and proceed directly to "Transmitter and Antenna Matching Capacitors (C1 and C2)."

( ) 1. Refer to the steps in the Accessory Manual and prepare and mount the balun coil onto the rear panel at T1.

( ) 2. Connect **both** of the taped wires coming from the balun coil to solder lug J (S-2). Be sure to make mechanically secure connections. Use sufficient solder and heat to insure a good solder connection.

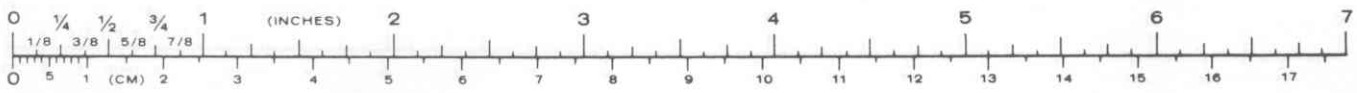
( ) 3. Remove the outer nuts from large feedthrough insulators J4 and J5.

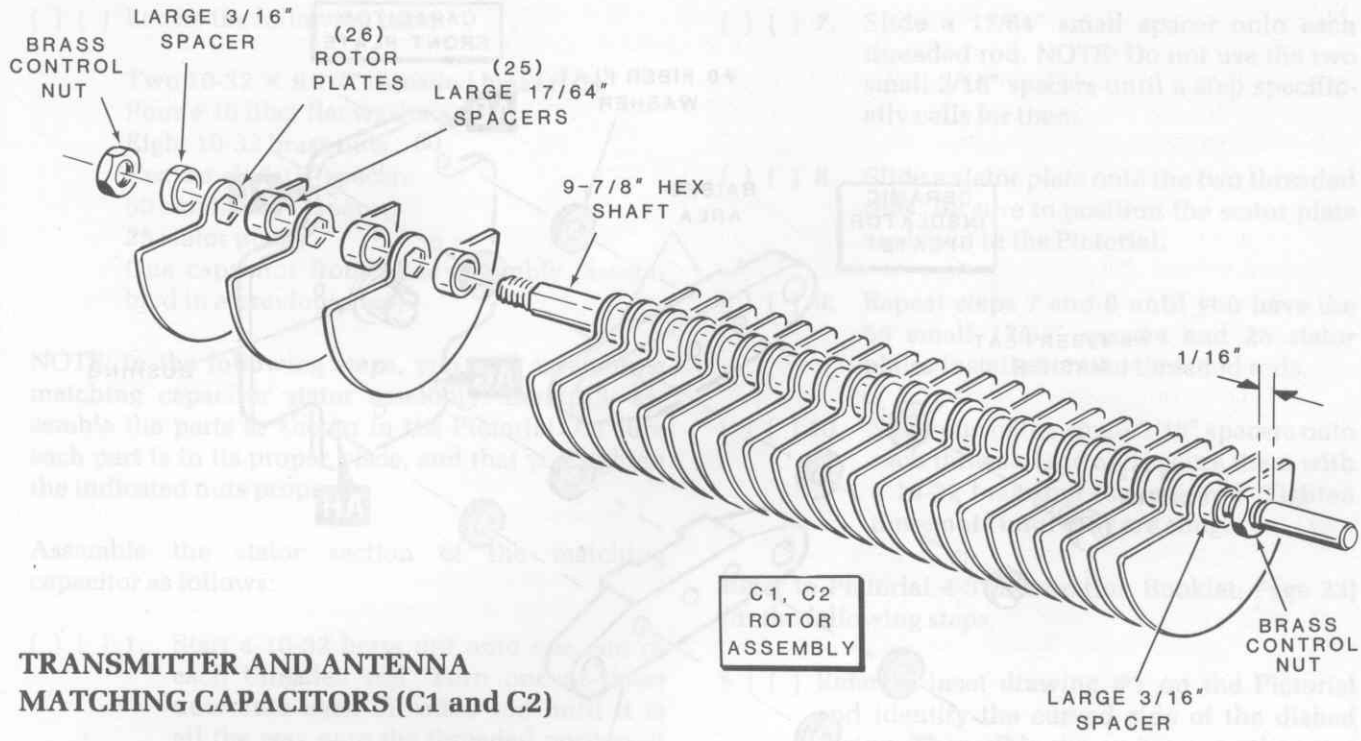
( ) 4. Use one of the nuts you removed in the previous step to secure the solder lug on either of the untaped balun coil wires to feedthrough insulator J4. Tighten the nut snugly.

( ) 5. Similarly, secure the remaining balun coil wire to feedthrough insulator J5. Tighten the nut snugly.

( ) 6. Push all four balun coil wires down against the inside of the rear panel.

Set the rear panel assembly aside until it is called for in a step.





PICTORIAL 4-1

TRANSMITTER AND ANTENNA MATCHING CAPACITORS (C1 and C2)

Refer to Pictorial 4-1 for the following steps.

NOTE: In most of the following steps, you will find double check-off spaces — "( ) ( )," one set for capacitor C1 and the other for C2. Perform **all** of the steps for one capacitor before you start to assemble the other.

( ) ( ) Locate the following parts:

Two brass control nuts
One 9-7/8" hex shaft
Two large 3/16" spacers
25 large 17/64" spacers
26 rotor plates

Use the following procedure to assemble the matching capacitor rotor assembly:

( ) ( ) 1. Turn a brass control nut onto the indicated end of the 9-7/8" hex shaft. Adjust this control nut so the outside of the nut is 1/16" from the end of the unthreaded part of the shaft. Try not to disturb this nut when you perform the following steps.

( ) ( ) 2. Slide a large 3/16" spacer all the way onto the shaft so it is against the control nut.

( ) ( ) 3. Match the hex shaped hole in a rotor plate with the hex shape on the shaft. Then slide the rotor plate onto the shaft until it is against the 3/16" spacer.

( ) ( ) 4. Slide a large 17/64" spacer onto the shaft so it is against the first rotor plate.

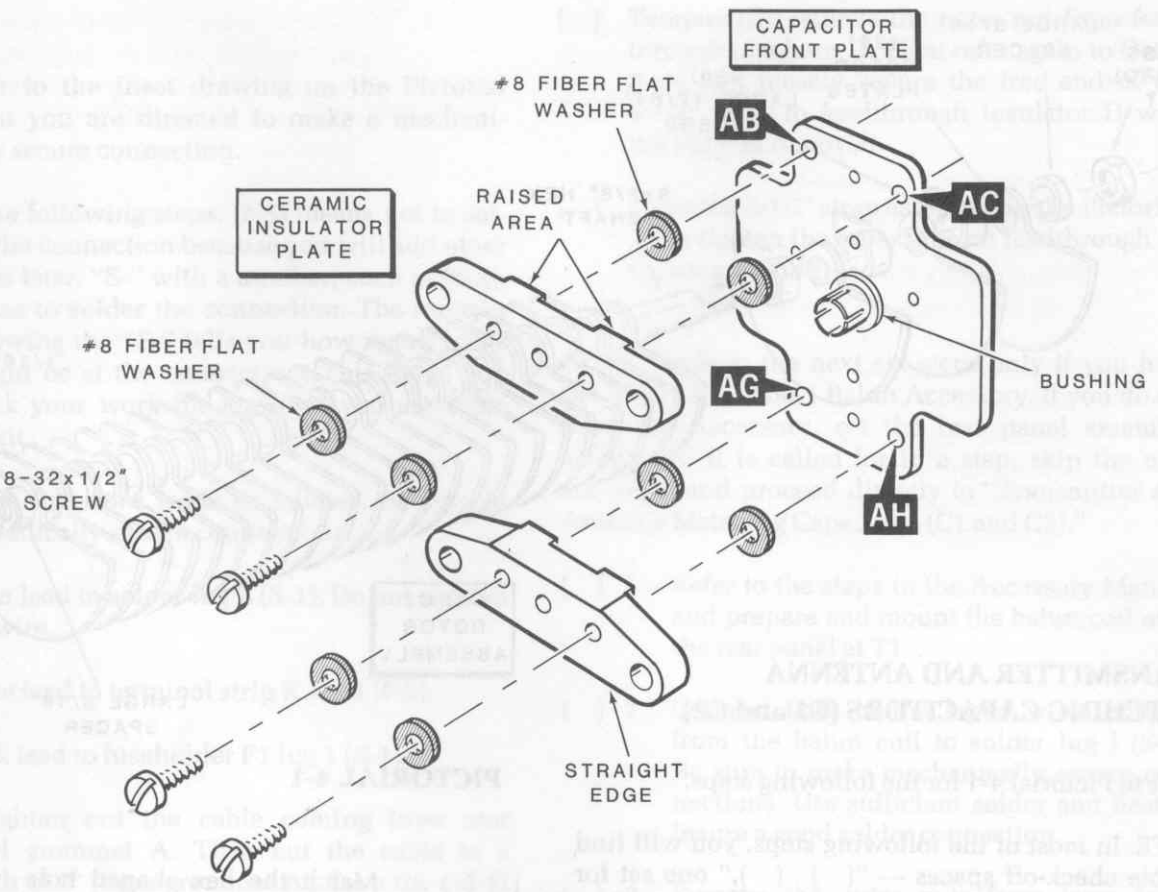
( ) ( ) 5. Match the hex shaped hole in a second rotor plate with the hex shape on the shaft. Match the position of the second plate with that of the first rotor plate. Slide the rotor plate onto the shaft until it is against the first 17/64" spacer.

( ) ( ) 6. Repeat steps 4 and 5 until you have 26 rotor plates and 25 large spacers installed on the shaft.

( ) ( ) 7. Place another large 3/16" spacer on the rear of shaft.

( ) ( ) 8. Use the remaining brass control nut to secure the rotor plates and the spacers on the shaft.

Set the rotor assembly aside temporarily.



Detail 4-2A

Refer to Pictorial 4-2 (Illustration Booklet, Page 22) for the following steps.

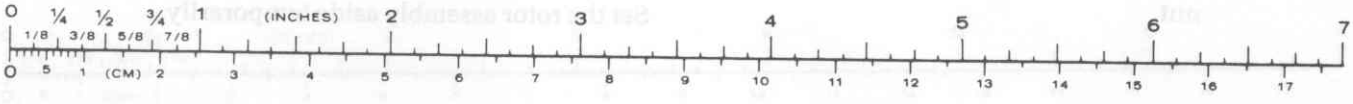
NOTES:

1. The ceramic insulator plates have two raised areas on one side. When you are instructed to mount these plates to a capacitor plate, as in the next step, be sure you position the side with the raised area toward the capacitor plate. Also be sure you orient each insulator plate so its straight edge is positioned as shown in the Detail.

2. When you tighten the 8-32 × 1/2″ screws to secure the capacitor insulator plate to a capacitor plate, do **not** overtighten the screws as you may break the ceramic insulator plate.

( ) ( ) Refer to Detail 4-2A and mount a ceramic insulator plate to a capacitor **front** plate at AB and AC. Use an 8-32 × 1/2″ screw and two #8 fiber flat washers at each of the two holes. Make sure you install the insulator plate on the same side as the bushing, as shown. Also, hold this side of the front plate against a flat surface when you tighten the screws. This will make sure the top edge of the ceramic insulator plate is flush with the top edge of the capacitor front plate.

( ) ( ) Similarly, mount another ceramic insulator plate to the capacitor front plate at AG and AH.



( ) ( ) Locate the following parts:

Two 10-32 × 9-7/8″ threaded brass rods
Four #10 fiber flat washers
Eight 10-32 brass nuts
Two small 3/16″ spacers
50 small 17/64″ spacers
25 stator plates
One capacitor front plate assembly (assembled in a previous step)

NOTE: In the following steps, you will assemble a matching capacitor stator assembly. Carefully assemble the parts as shown in the Pictorial. Be sure each part is in its proper place, and that you tighten the indicated nuts properly.

Assemble the stator section of the matching capacitor as follows:

( ) ( ) 1. Start a 10-32 brass nut onto one end of each threaded rod. Turn one of these nuts onto each threaded rod until it is all the way onto the threaded portion of the rod. Back this nut off until **two threads** are exposed.

( ) ( ) 2. Start a second 10-32 brass nut onto each threaded rod. Position the nut 3/16″ from the first nut as shown. NOTE: This nut may be adjusted later.

( ) ( ) 3. Slide a #10 fiber flat washer onto the end of each threaded rod.

( ) ( ) 4. Position the capacitor front plate assembly as shown (note the position of the ceramic insulator plates and the three indicated holes). Then insert the ends of the threaded rods (that have the nuts) through holes AA and AD in the indicated ceramic insulator plate.

( ) ( ) 5. Slide a #10 fiber flat washer onto the end of each threaded rod.

( ) ( ) 6. Start a 10-32 brass nut onto the end of each threaded rod. Turn these nuts onto the rods until they are snug against the ceramic insulators and fiber flat washers. Do **not** overtighten the nuts and break the insulator.

( ) ( ) 7. Slide a 17/64″ small spacer onto each threaded rod. NOTE: Do not use the two small 3/16″ spacers until a step specifically calls for them.

( ) ( ) 8. Slide a stator plate onto the two threaded rods. Be sure to position the stator plate as shown in the Pictorial.

( ) ( ) 9. Repeat steps 7 and 8 until you have the 50 small 17/64″ spacers and 25 stator plates installed on the threaded rods.

( ) ( ) 10. Slide one of the small 3/16″ spacers onto each threaded rod and secure them with a 10-32 brass nut on each rod. Tighten these nuts until they are snug.

Refer to Pictorial 4-3 (Illustration Booklet, Page 23) for the following steps.

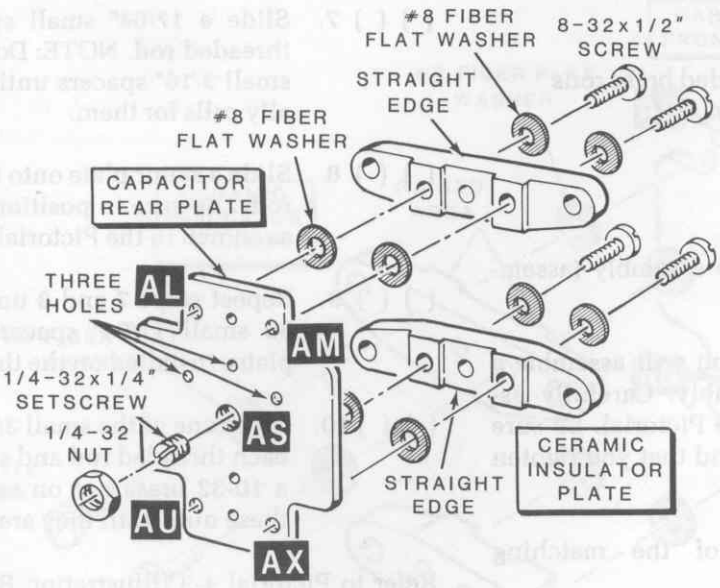
( ) ( ) Refer to inset drawing #1 on the Pictorial and identify the curved side of the dished spring. Then slide the spring onto the rotor shaft so the curved side is toward the rotor plates.

( ) Refer to Detail 4-3A and open the grease pod by cutting across one corner and into the pod just enough to make a small opening. Use diagonal cutters or scissors.

( ) ( ) Squeeze out an amount of grease equal to a medium-sized pea; then use a toothpick and apply the grease to the rotor shaft at the three locations shown in the Pictorial.

( ) ( ) Position the rotor and stator assemblies as shown in the Pictorial. Then push the rotor shaft through the bushing in the capacitor front plate as far as it will go.

Detail 4-3A



Detail 4-3B

( ) ( ) Refer to Detail 4-3B and mount a ceramic insulator plate to a capacitor **rear** plate at AL and AM. Use an 8-32 ×1/2" screw and two #8 fiber flat washers at each of the two holes. Hold this side of the rear plate against a flat surface when you tighten the screws. This will make the top edge of the ceramic insulator plate flush with the top edge of the capacitor rear plate.

( ) ( ) Similarly, mount another ceramic insulator plate to the capacitor rear plate at AU and AX. Use and 8-32 × 1/2" screw and two #8 fiber flat washers at each of the two holes.

( ) ( ) Refer again to Detail 4-3B and start a 1/4-32 × 1/4" setscrew into a 1/4-32 nut. Then install the setscrew in hole AS. Turn the screw in until the unslotted end is flush with the other side of the plate. Do **not** tighten the nut yet.

( ) ( ) Position the capacitor assembly as shown in the Pictorial.

( ) ( ) Turn a second 10-32 brass nut onto each of the two threaded rods of the capacitor assembly. Turn each of these nuts until there is **1/16"** space between the inner and outer nuts as shown in the Pictorial.

IMPORTANT: The rear plate assemblies will be mounted differently on capacitors C1 and C2. Mark each capacitor rear plate assembly for identification in one of the next two steps.

( ) To mark the rear plate assembly for **capacitor C1** (only): Study Detail 4-3B carefully and note the location of the three small holes, just above the larger center hole. Turn the assembly topside down so these three holes are **below** the larger center hole. On the **upper** ceramic isulator plate, write "C1 — TOP." Then, in a following step, when you are instructed to mount the end plate assembly, make **sure** this lettering is positioned upward.

( ) To mark the rear plate assembly for **capacitor C2** (only): Make certain the assembly is positioned **exactly** as shown in Detail 4-3B with the three holes positioned **above** the larger center hole. On the upper ceramic insulator plate, write "C2 — TOP." Be sure this lettering is positioned upward when the assembly is mounted onto the capacitor main assembly in another step.

( ) ( ) Slide a #10 fiber flat washer onto the end of each threaded rod.

( ) ( ) Apply a small amount of grease in the recessed area in the end of the setscrew installed in hole AS of the rear capacitor plate. Then place a steel ball in the recessed area of the rotor shaft.

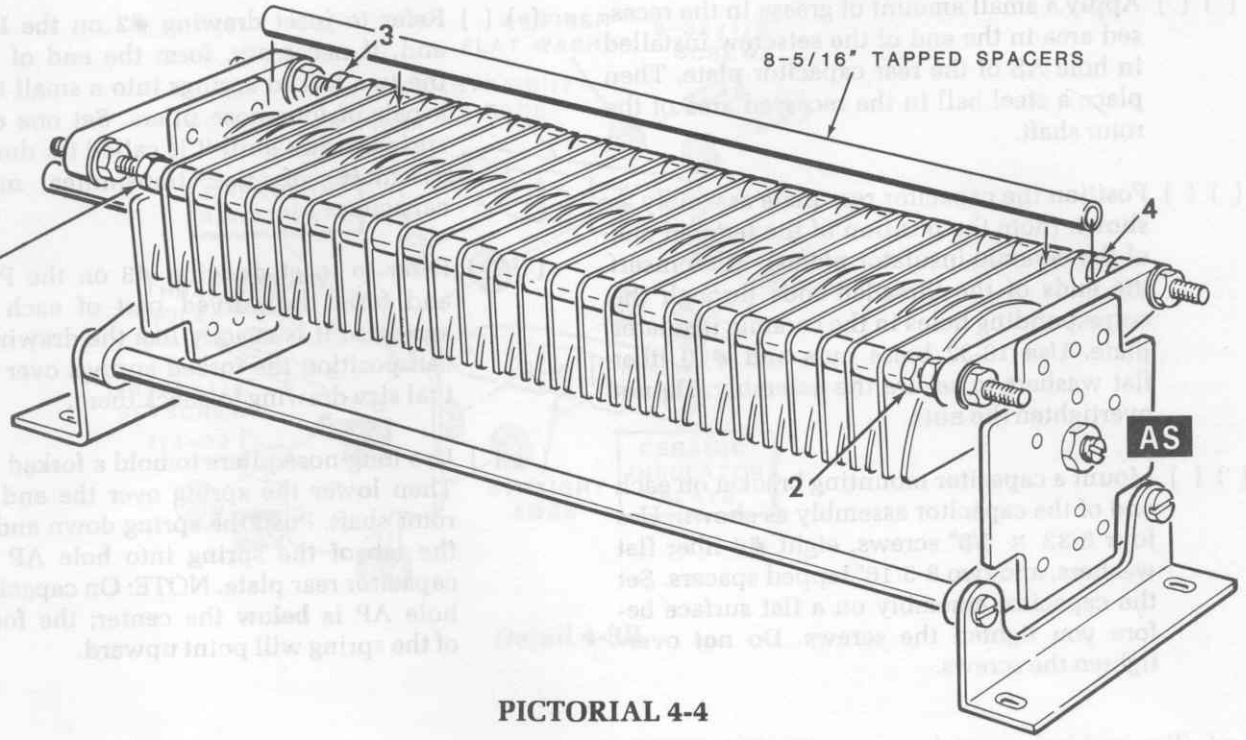
( ) ( ) Position the capacitor rear plate assembly as shown (note the position of the lettered end of the ceramic insulator plates). Then insert the ends of the threaded rods through the corresponding holes in the ceramic insulator plate. Use 10-32 brass nuts and #10 fiber flat washers to secure the assembly. Do **not** overtighten the nuts.

( ) ( ) Mount a capacitor mounting bracket on each end of the capacitor assembly as shown. Use four 8-32 × 5/8″ screws, eight #8 fiber flat washers, and two 8-5/16″ tapped spacers. Set the capacitor assembly on a flat surface before you tighten the screws. Do **not** overtighten the screws.

( ) ( ) Refer to inset drawing #2 on the Pictorial and, if necessary, form the end of each of the two forked springs into a small tab. Use a pair of long-nose pliers. Set one of these springs aside until it is called for during the assembly of the transmitter matching capacitor.

( ) ( ) Refer to inset drawing #3 on the Pictorial and form the curved part of each forked spring so it is exactly like the drawing. You can position the forked springs over the actual size drawing to check them.

( ) ( ) Use long-nose pliers to hold a forked spring. Then lower the spring over the end of the rotor shaft. Push the spring down and insert the tab of the spring into hole AP in the capacitor rear plate. NOTE: On capacitor C1, hole AP is **below** the center; the fork end of the spring will point upward.



PICTORIAL 4-4

Refer to Pictorial 4-4 for the following steps.

( ) ( ) Position the capacitor assembly as shown in the Pictorial.

( ) ( ) Tighten the setscrew in hole AS of the capacitor rear plate only until you feel some resistance. Then turn the capacitor shaft back and forth with one hand. You should be able to turn the shaft without noticing too much resistance. However, it should not continue turning after you let go of the shaft.

( ) ( ) Turn the capacitor shaft so the plates are fully meshed (closed).

NOTE: In the following steps, first locate an unused 8-5/16" tapped spacer. Then use the spacer to check the top (inside) spacing of the top ceramic insulators as shown in Pictorial 4-4. Do this at **both** upper corners, close to each threaded brass rod.

( ) ( ) Turn nuts 1, 2, 3 and 4 (as necessary) to position each plate in the stator halfway between two corresponding rotor plates. Carefully inspect the capacitor assembly from one side, then the other side, to make sure each stator plate is positioned properly. Then tighten the four nuts.

This completes the assembly of the matching capacitor. Set the capacitor aside until it is called for in a step. If you have not assembled both capacitors, return to "Transmitter and Antenna Matching Capacitors (C1 and C2)" on Page 55 and complete the steps for the other capacitor. When you complete both capacitors, proceed to the following section.

ROLLER INDUCTOR (L1)

Refer to Pictorial 5-1 (Illustration Booklet, Page 24) for the following steps.

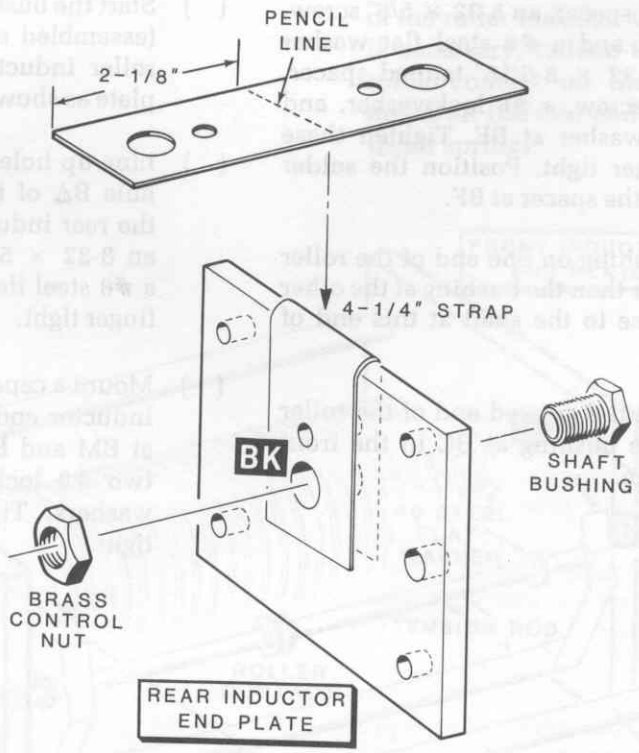
( ) Peel the paper from both sides of the two inductor end plates.

( ) Refer to Detail 5-1A and make a pencil line across the center of the 4-1/4" strap. NOTE: The pencil line will help you bend the strap in the middle when you mount it later.

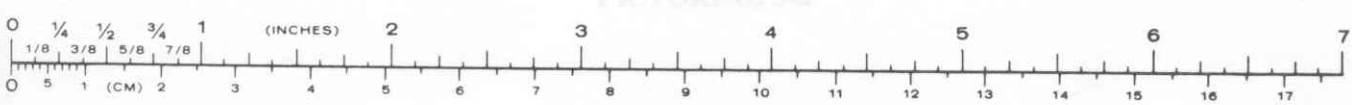
( ) Position one of the inductor end plates as shown in Detail 5-1A (note the positions of the seven holes in the plate).

( ) Bend the 4-1/4" strap over the indicated edge of the inductor end plate. Secure the strap to the plate at hole BK with a shaft bushing and a brass control nut. Be sure the small holes in the strap line up with the corresponding hole in the inductor end plate before you tighten the hardware.

NOTE: The inductor end plate you just prepared will be referred to as the **rear** inductor end plate. Set the rear inductor end plate aside temporarily.



Detail 5-1A



( ) Position the remaining inductor end plate as shown in Detail 5-1B (Illustration Booklet, Page 25). Note the positions of the seven holes in the plate.

( ) Refer to the inset drawing on Detail 5-1B and cut a control solder lug at the indicated location. Then mount the control solder lug at hole BC with a shaft bushing and a brass control nut. Position the solder lug as shown before you tighten the nut.

( ) Mount an 8-32 × 8-5/16″ tapped spacer to the inductor end plate at BA. Use an 8-32 × 5/8″ screw, a #8 lockwasher, and a #8 steel flat washer. Tighten the screw only finger tight.

( ) Mount a capacitor mounting bracket to the inductor end plate at BE and BF. Use an 8-32 × 8-5/16″ tapped spacer, an 8-32 × 5/8″ screw, a #8 solder lug, and a #8 steel flat washer at BE. Use an 8-32 × 8-5/16″ tapped spacer, an 8-32 × 5/8″ screw, a #8 lockwasher, and a #8 steel flat washer at BF. Tighten these screws only finger tight. Position the solder lug at BE toward the spacer at BF.

( ) Note that the bushing on one end of the roller inductor is longer than the bushing at the other end. Apply grease to the shaft at this end of the inductor.

( ) Slide the shaft at the greased end of the roller inductor into the bushing at BC in the front inductor end plate.

( ) Start a 4-40 × 1/8″ setscrew into a shaft collar. Then slide the collar onto the rear shaft of the roller inductor. Do not tighten the setscrew in the collar at this time.

( ) Refer to the inset drawing on the Pictorial and identify the curved side of the brass spring washer. Then slide the spring washer onto the rear shaft of the roller inductor with the curved side of the spring washer toward the inductor.

( ) Apply grease to the rear shaft end of the roller inductor.

( ) Slide two contactor springs onto the spacer mounted at BF. Be sure to position these springs as shown in the Pictorial.

( ) Start the bushing in the rear inductor end plate (assembled earlier) onto the rear shaft of the roller inductor. Be sure to position the end plate as shown in the Pictorial.

( ) Line up hole BG with the spacer coming from hole BA of the front end plate. Then mount the rear inductor end plate to the spacer. Use an 8-32 × 5/8″ screw, a #8 lockwasher, and a #8 steel flat washer. Tighten the screw only finger tight.

( ) Mount a capacitor mounting bracket to the rear inductor end plate and the remaining spacers at BM and BN. Use two 8-32 × 5/8″ screws, two #8 lockwashers, and two #8 steel flat washers. Tighten these screws only finger tight.

Refer to Pictorial 5-2 for the following steps.

( ) Slide the roller contact onto the tension rod. Then slide a #6 steel flat washer onto each end of the tension rod.

( ) Start one end of the prepared tension rod into hole BD in the front inductor end plate.

( ) Start the free end of the tension rod into hole BL in the rear inductor end plate. Be sure the groove in the roller contact rests on one of the wire turns of the inductor.

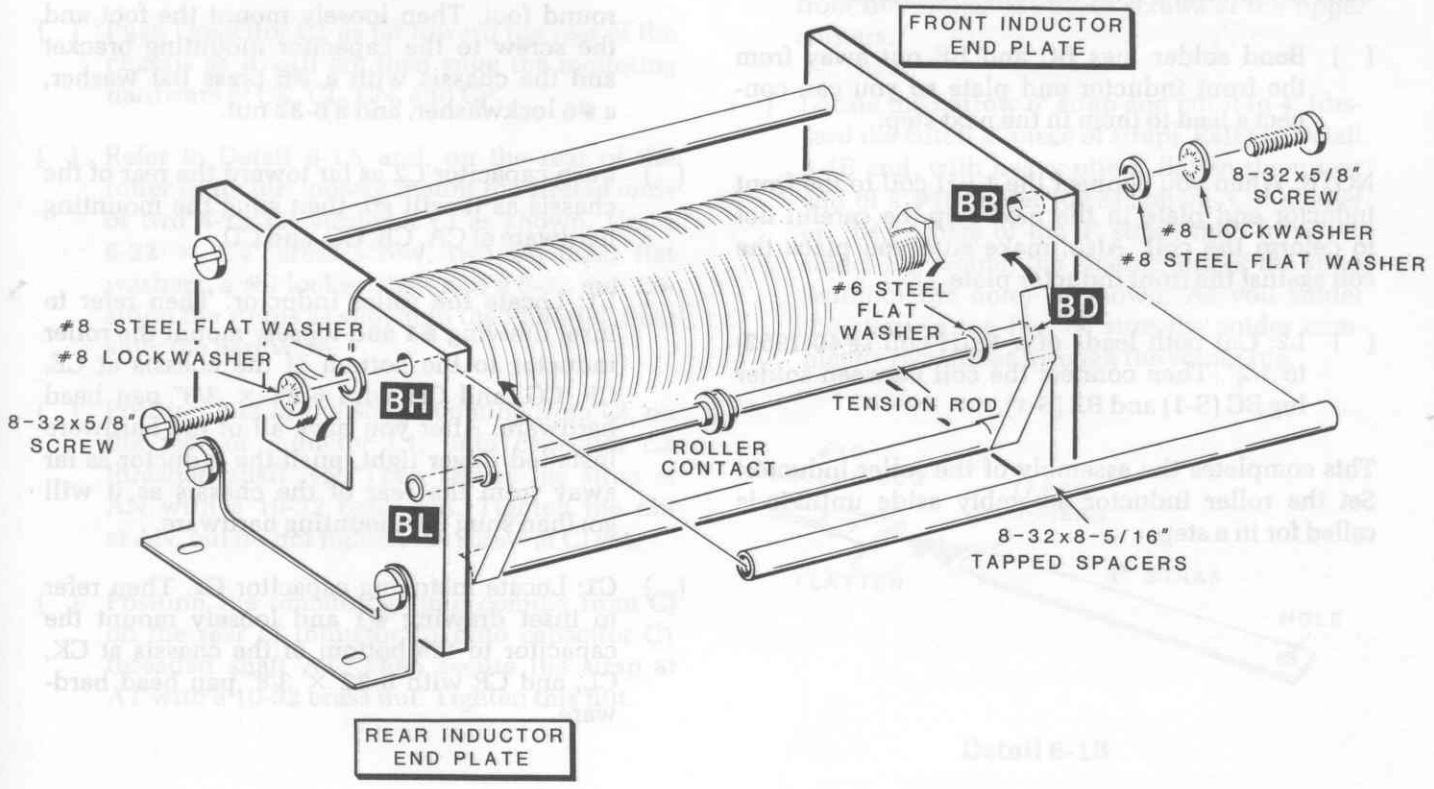
( ) Position the two contactor springs toward the ends of the tension rod. Be sure the #6 steel flat washers on the tension rod are on the sides of the contactor springs **away** from the end plates.

( ) Push an 8-32 × 8-5/16″ tapped spacer between the front and rear inductor end plates. Be sure the contactor springs are **inside** the spacer as shown. Then mount the spacer at BB and BH. Use two 8-32 × 5/8″ screws, two #8 lockwashers, and two #8 steel flat washers. Tighten the screws only finger tight.

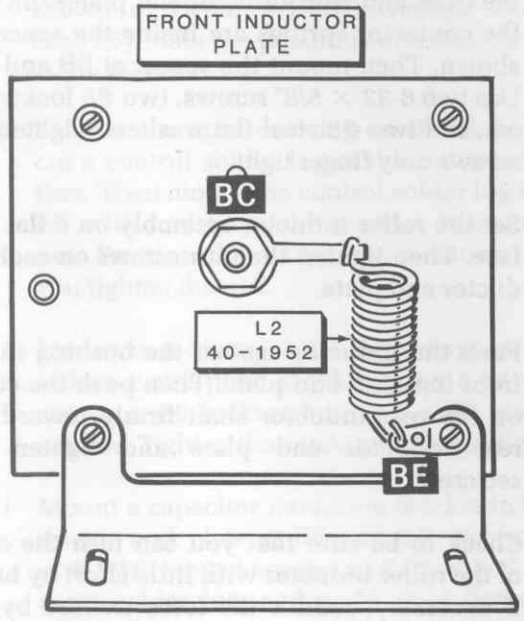
( ) Set the roller inductor assembly on a flat surface. Then tighten the four screws on each inductor end plate.

( ) Push the inductor against the bushing in the front inductor end plate. Then push the collar on the rear inductor shaft firmly toward the rear inductor end plate and tighten the setscrew.

( ) Check to be sure that you can turn the shaft of the roller inductor with little effort by hand. If necessary, reduce the force exerted by the roller contact on the inductor by pushing down on the free end of each of the two contactor springs.



PICTORIAL 5-2



PICTORIAL 5-3

Refer to Pictorial 5-3 for the following steps.

( ) Bend solder lugs BC and BE out away from the front inductor end plate so you can connect a lead to them in the next step.

NOTE: When you connect the 1 μH coil to the front inductor end plate in the next step, be careful not to deform the coil. Also, make sure you place the coil against the front inductor plate.

( ) L2: Cut both leads of a 1 μH coil (#40-1952) to 1/2". Then connect the coil between solder lug BC (S-1) and BE (S-1).

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

MAIN CHASSIS

Refer to Pictorial 6-1 (Illustration Booklet, Page 26) for the following steps.

( ) Position the chassis as shown in the Pictorial.

NOTE: Before you install each of the two matching capacitors and the roller inductor in the following steps, first make sure that no paint covers the chassis where these assemblies will be mounted. The mounting brackets for these assemblies require a good contact with the metal chassis. Use sandpaper (supplied) or a knife to remove any paint away from these areas.

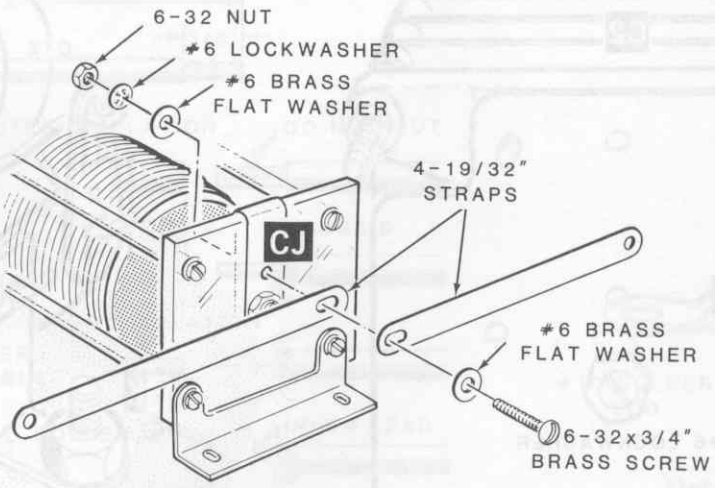
( ) C2: Locate matching capacitor **C2**. Then refer to inset drawing #1 on the Pictorial and loosely mount the capacitor to the bottom of the chassis at CA, CB, and CC with 6-32 × 3/8" pan head hardware. Be sure to use two #6 brass flat washers on each screw as shown.

( ) Refer to inset drawing #2 and, at CD, place a #6 brass flat washer onto a 6-32 × 5/8" pan head screw and push the screw firmly into a round foot. Then loosely mount the foot and the screw to the capacitor mounting bracket and the chassis with a #6 brass flat washer, a #6 lockwasher, and a 6-32 nut.

( ) Push capacitor C2 as far toward the rear of the chassis as it will go; then snug the mounting hardware at CA, CB, CC, and CD.

( ) L1: Locate the roller inductor. Then refer to inset drawing #1 and loosely mount the roller inductor to the bottom of the chassis at CE, CF, CG, and CH with 6-32 × 3/8" pan head hardware. After you have all of the hardware installed finger tight, push the inductor as far away from the rear of the chassis as it will go; then snug the mounting hardware.

( ) C1: Locate matching capacitor **C1**. Then refer to inset drawing #1 and loosely mount the capacitor to the bottom of the chassis at CK, CL, and CP with 6-32 × 3/8" pan head hardware.



Detail 6-1A

( ) Refer to inset drawing #2 and, at CN, place a #6 brass flat washer onto a 6-32 × 5/8" pan head screw and push the screw firmly into a round foot. Then loosely mount the foot and the screw to the capacitor mounting bracket and the chassis with a #6 brass flat washer, a #6 lockwasher, and a 6-32 nut.

( ) Push capacitor C1 as far toward the rear of the chassis as it will go; then snug the mounting hardware at CK, CL, CN, and CP.

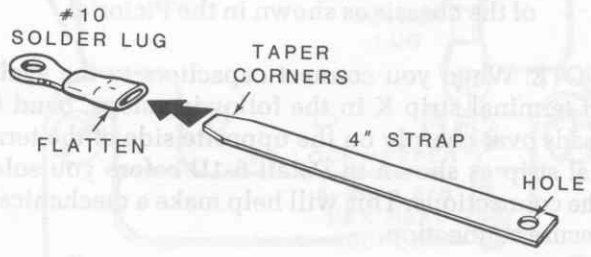
( ) Refer to Detail 6-1A and, on the rear of the roller inductor, loosely mount the **slotted** ends of two 4-19/32" straps at CJ as shown. Use a 6-32 × 3/4" brass screw, two #6 brass flat washers, a #6 lockwasher, and a 6-32 nut. Position the straps as shown in the Pictorial; then snug the hardware.

( ) Position one of the straps coming from CJ, on the rear of inductor L1, onto capacitor C2 threaded shaft AN. Then secure the strap at AN with a 10-32 brass nut. Tighten the nut at AN, but do not tighten the screw at CJ yet.

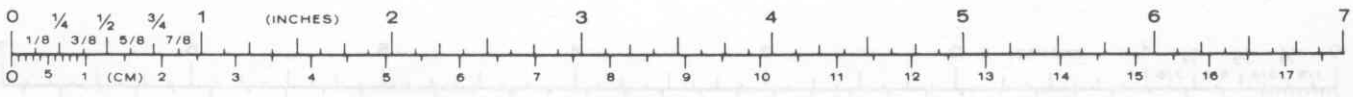
( ) Position the remaining strap coming from CJ on the rear of inductor L1 onto capacitor C1 threaded shaft AT. Then secure the strap at AT with a 10-32 brass nut. Tighten this nut.

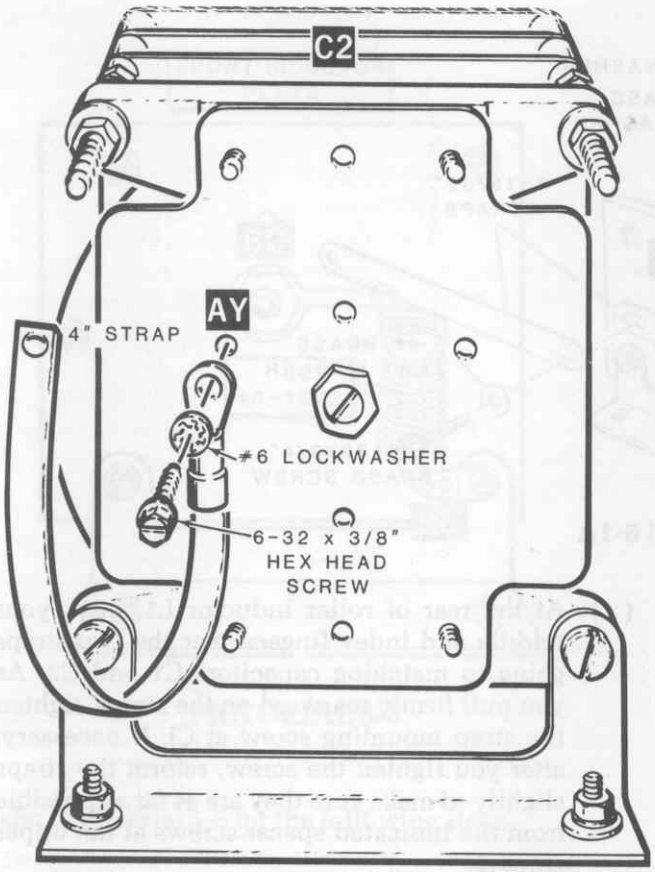
( ) At the rear of roller inductor L1, hook your middle and index fingers over the two straps going to matching capacitors C1 and C2. As you pull firmly rearward on the straps, tighten the strap mounting screw at CJ. If necessary, after you tighten the screw, reform the straps slightly to make sure they are as far as possible from the indicated spacer screws at the upper corners.

( ) Locate the narrow 6" strap and cut it to 4" (discard the cutoff 2" piece of strap). Refer to Detail 6-1B and, with heavy pliers, flatten the upper end of a #10 solder lug as shown. Cut a taper on the corners of the 4" strap; then form the solder lug around the tapered end of the strap (without the hole) as shown. As you solder the strap to the lug, be sure the solder completely penetrates **through** the solder lug.



Detail 6-1B



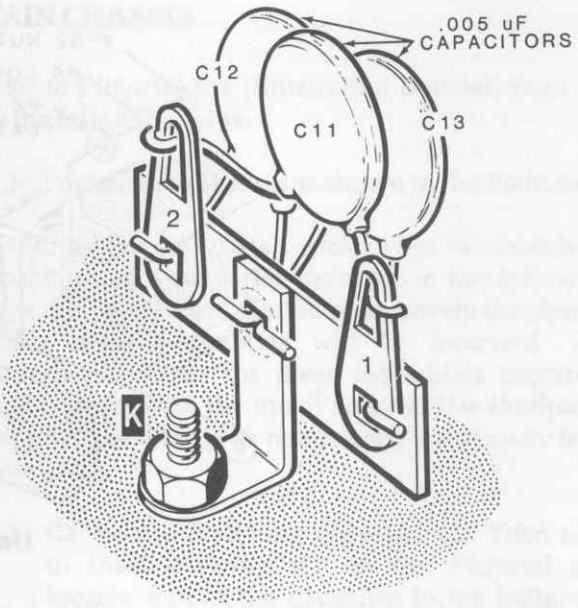


Detail 6-1C

( ) Refer to Detail 6-1C and secure the solder lug on the prepared strap to hole AY in the rear mounting plate of capacitor C2 with a 6-32 × 3/8″ hex head screw and a #6 lockwasher. Position the strap as shown in the Pictorial; then tighten the screw finger tight.

( ) Position the rear panel assembly near the rear of the chassis as shown in the Pictorial.

NOTE: When you connect capacitors to the eyelets of terminal strip K in the following steps, bend the leads over sharply on the opposite side of the terminal strip as shown in Detail 6-1D before you solder the connections. This will help make a mechanically secure connection.



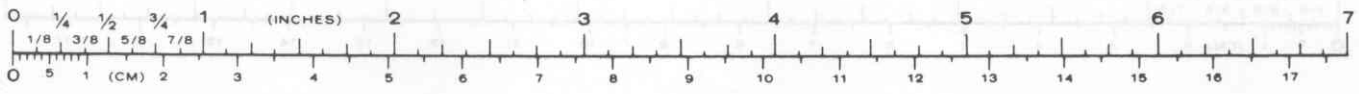
Detail 6-1D

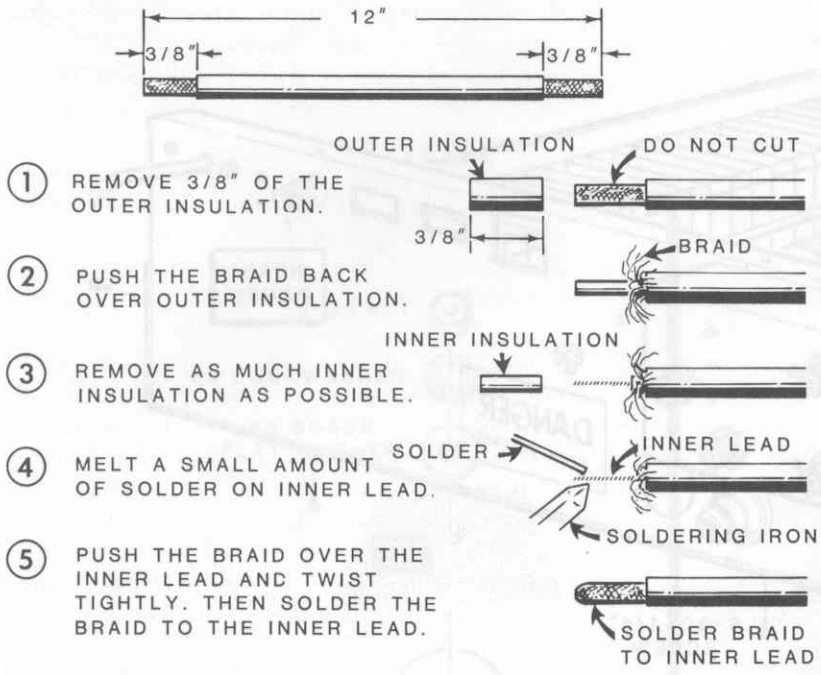
( ) C13: Cut both leads of a .005 μF ceramic capacitor to 3/8″. Then connect the capacitor between the **eyelet** of terminal strip K lug 1 (S-1) and the center eyelet (NS). Be careful not to burn the line cord wire that was previously connected to the terminal strip lug.

( ) C12: Cut both leads of a .005 μF ceramic capacitor to 3/8″. Then connect the capacitor between the **eyelet** of terminal strip K lug 2 (S-1) and the center eyelet (S-2).

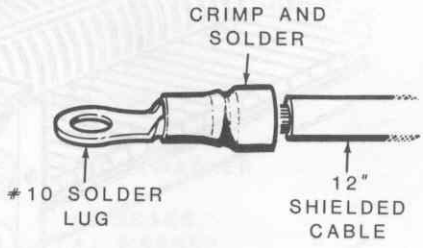
( ) C11: Cut both leads of a .005 μF ceramic capacitor to 5/8″. Then connect the capacitor between terminal strip K **lugs** 1 (NS) and 2 (NS).

( ) Temporarily remove the outer nut from the feedthrough insulator at C. Then secure the free end of the strap coming from AY on capacitor C2 to feedthrough insulator C with the nut you removed. Position the strap as shown in the Pictorial; then tighten the hardware on both ends of the strap.





Detail 6-1E



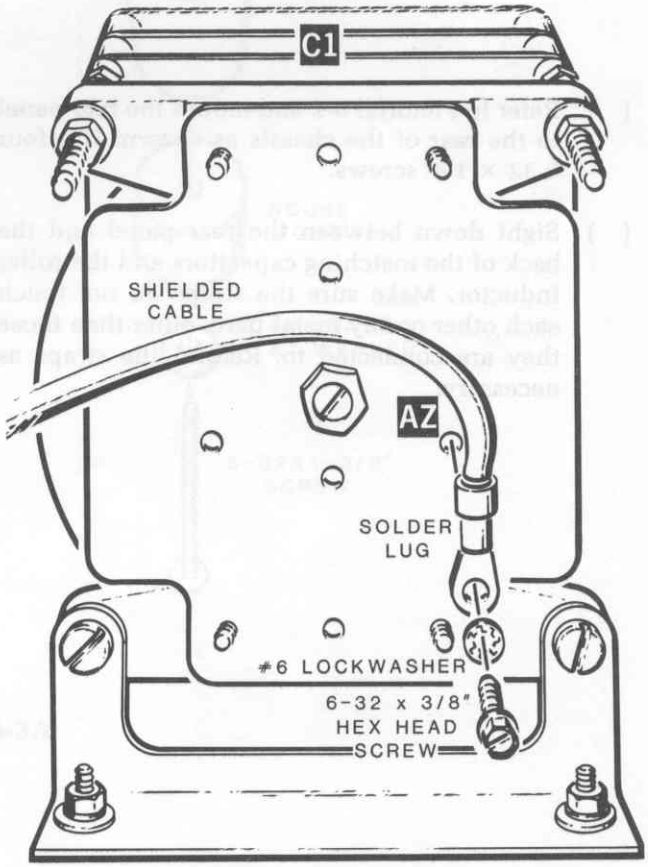
Detail 6-1F

( ) Refer to Detail 6-1E and prepare both ends of a 12" shielded cable as shown. NOTE: The object is to connect the inner lead to the braid of the cable at both ends.

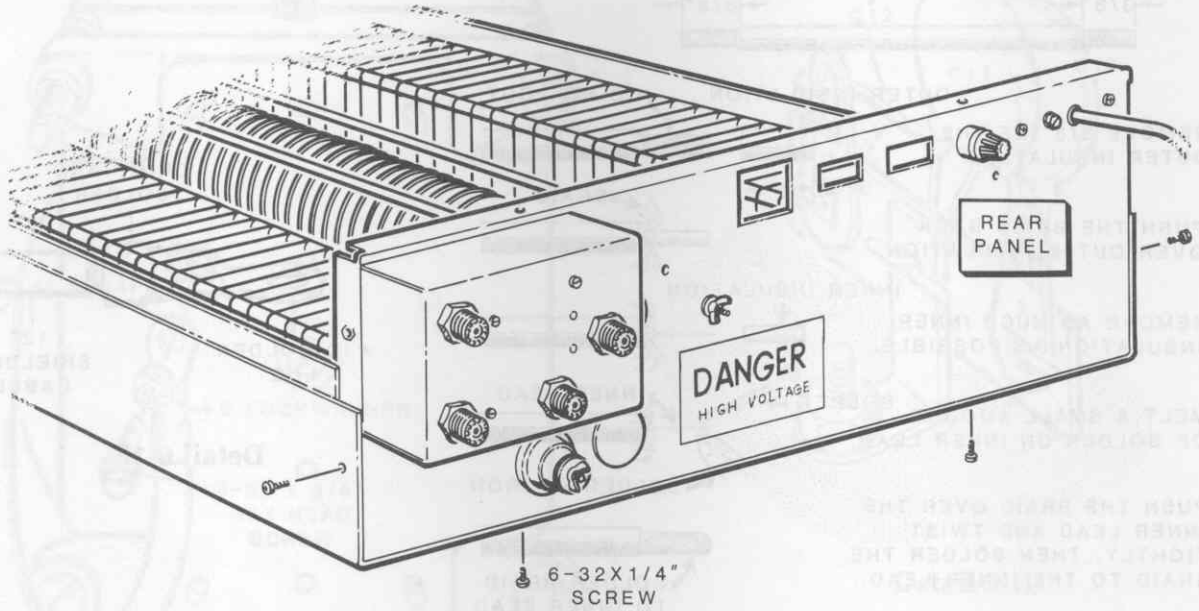
( ) Refer to Detail 6-1F and crimp and solder a #10 solder lug on each end of the prepared shielded cable. Be sure to use enough solder and heat to ensure a good solder connection.

( ) Refer to Detail 6-1G and secure the solder lug on one end of the prepared shielded cable to hole AZ in the rear mounting plate of capacitor C1 with a 6-32 × 3/8" hex head screw and a #6 lockwasher. Be sure to position the solder lug as shown in the Pictorial before you tighten the screw.

( ) Temporarily remove the outer nut from the feedthrough insulator at B. Then secure the free end of the shielded cable to feedthrough insulator B with the nut you removed. Position the solder lug as shown in the Pictorial before you tighten the nut.



Detail 6-1G



PICTORIAL 6-2

( ) Refer to Pictorial 6-2 and mount the rear panel to the rear of the chassis as shown. Use four 6-32 × 1/4" screws.

( ) Sight down between the rear panel and the back of the matching capacitors and the roller inductor. Make sure the straps do not touch each other or any metal parts other than those they are connected to. Reform the straps as necessary.

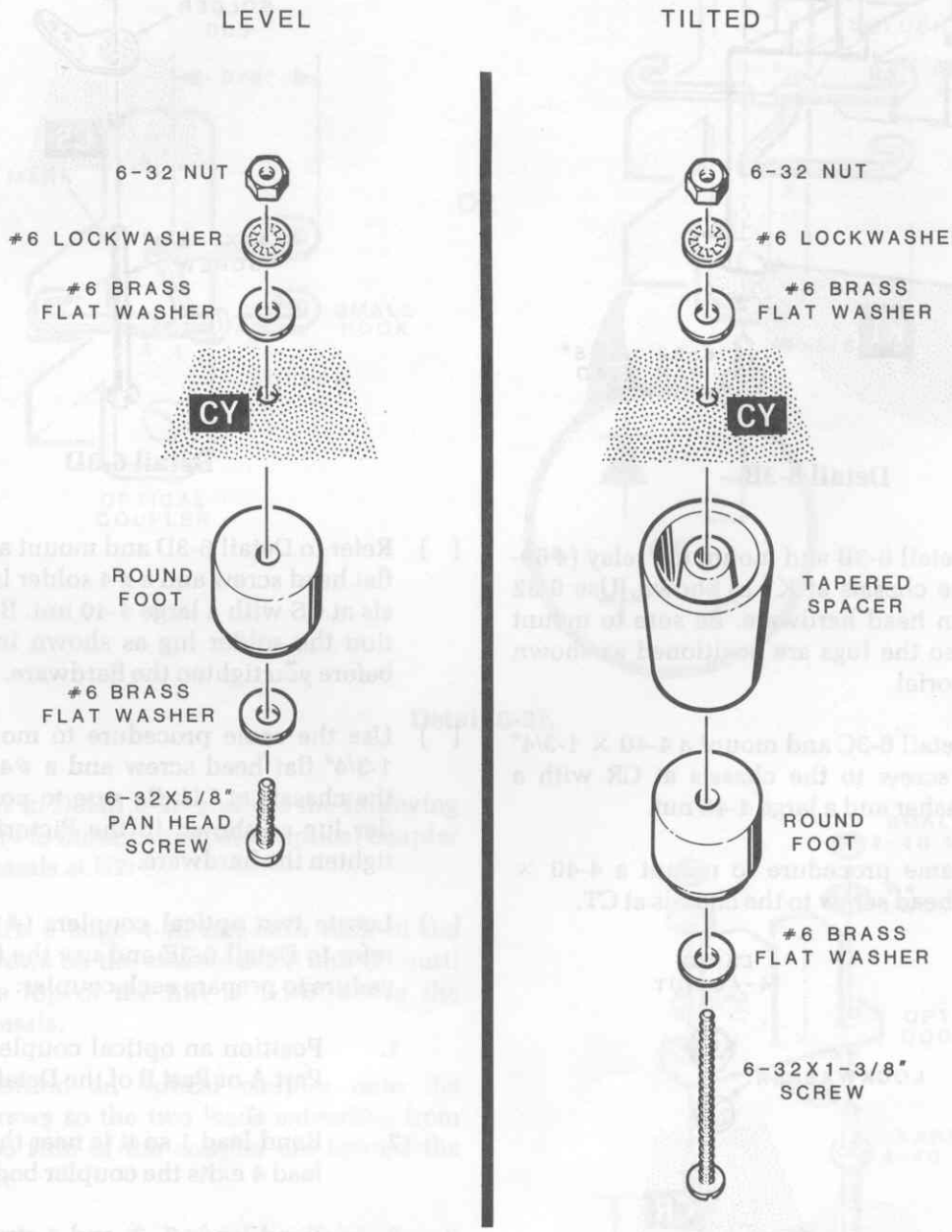
Refer to Pictorial 6-3 (Illustration Booklet, Page 27) for the following steps.

( ) Position the chassis as shown in the Pictorial.

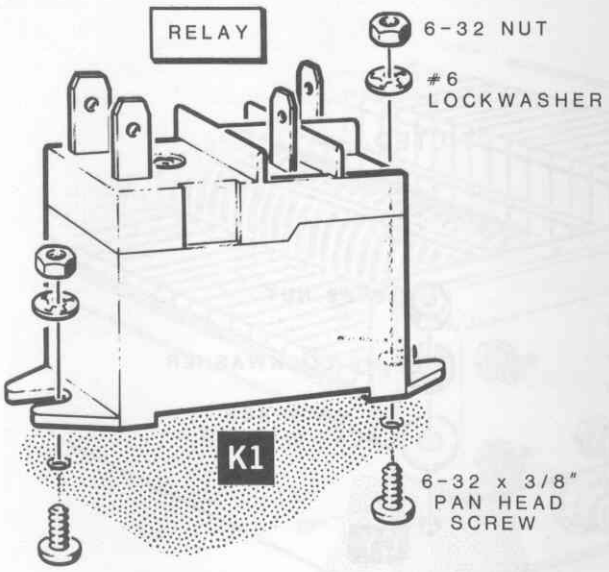
NOTE: Perform only one of the following two steps:

1. ( ) If you wish to have your Antenna Tuner sit level, refer to Detail 6-3A and install only round feet at CY and CZ on the bottom of the chassis. Use 6-32 × 5/8" pan head hardware.

2. ( ) If you wish to have the front of the chassis tilted upward, mount round feet and tapered spacers at CY and CZ on the bottom of the chassis. Use 6-32 × 1-3/8" hardware.


LEVEL
6-32 NUT
#6 LOCKWASHER
#6 BRASS FLAT WASHER
CY
ROUND FOOT
#6 BRASS FLAT WASHER
6-32X5/8" PAN HEAD SCREW
TILTED
6-32 NUT
#6 LOCKWASHER
#6 BRASS FLAT WASHER
CY
TAPERED SPACER
ROUND FOOT
#6 BRASS FLAT WASHER
6-32X1-3/8" SCREW

Detail 6-3A

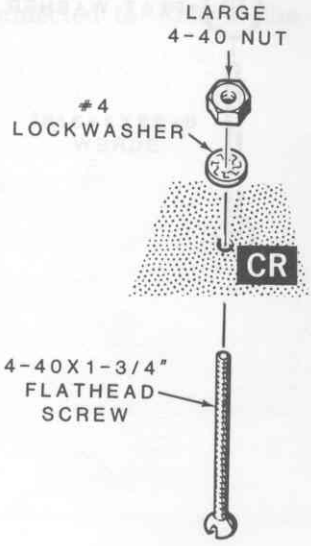


Detail 6-3B

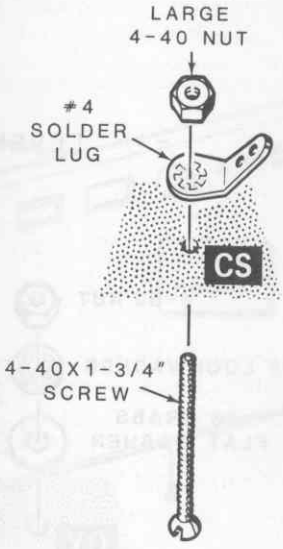
( ) Refer to Detail 6-3B and mount the relay (#69-103) to the chassis at K1 as shown. Use 6-32 × 3/8" pan head hardware. Be sure to mount the relay so the lugs are positioned as shown in the Pictorial.

( ) Refer to Detail 6-3C and mount a 4-40 × 1-3/4" flat head screw to the chassis at CR with a #4 lockwasher and a large 4-40 nut.

( ) Use the same procedure to mount a 4-40 × 1-3/4" flat head screw to the chassis at CT.



Detail 6-3C



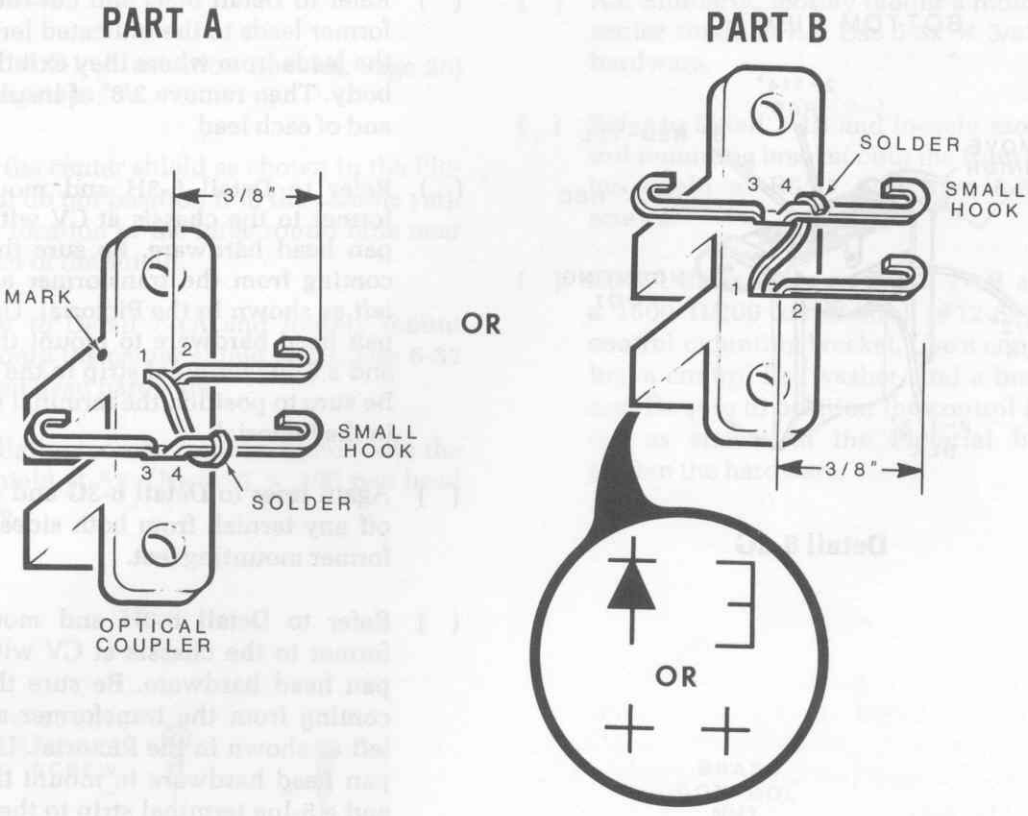
Detail 6-3D

( ) Refer to Detail 6-3D and mount a 4-40 × 1-3/4" flat head screw and a #4 solder lug to the chassis at CS with a large 4-40 nut. Be sure to position the solder lug as shown in the Pictorial before you tighten the hardware.

( ) Use the same procedure to mount a 4-40 × 1-3/4" flat head screw and a #4 solder lug to the chassis at CU. Be sure to position the solder lug as shown in the Pictorial before you tighten the hardware.

( ) Locate two optical couplers (#150-74). Then refer to Detail 6-3E and use the following procedure to prepare each coupler:

1. Position an optical coupler as shown in Part A or Part B of the Detail.
2. Bend lead 1 so it is near the point where lead 4 exits the coupler body as shown.
3. Bend leads 2, 3, and 4 straight out from the sides of the coupler.
4. Solder lead 1 to lead 4. Then cut off any excess lead length from lead 1.
5. Cut the remaining three leads to 3/8" and form a small hook in the end of each of these leads. A wire will be connected to these leads later.



Detail 6-3E

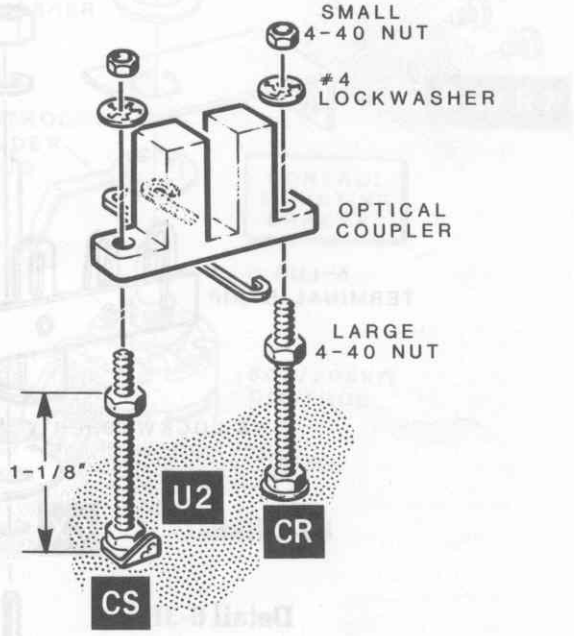
( ) U2: Refer to Detail 6-3F and use the following procedure to mount a prepared optical coupler to the chassis at U2:

1. Turn a large 4-40 nut onto each of the screws on the chassis at CR and CS until the top of the nut is 1-1/8" above the chassis.

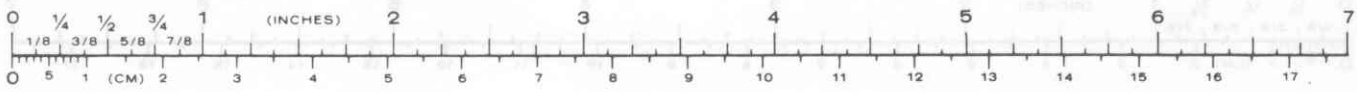
2. Position an optical coupler onto the screws so the two leads extending from one side of the coupler are toward the left.

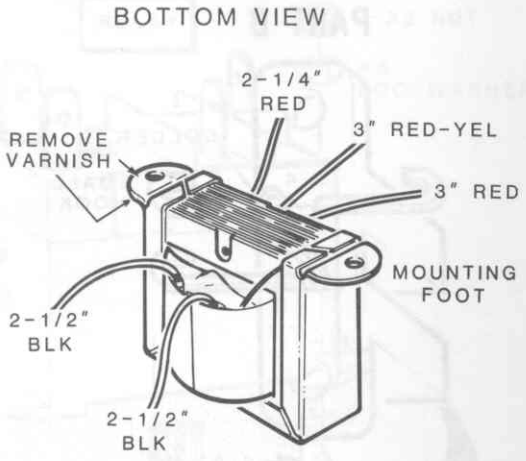
3. Use two #4 lockwashers and two **small** 4-40 nuts to secure the coupler to the screws.

( ) U3: Use the same procedure to mount an optical coupler to the chassis at U3 (on screws CT and CU). Be sure the two leads extending from one side of the coupler are toward the left.



Detail 6-3F





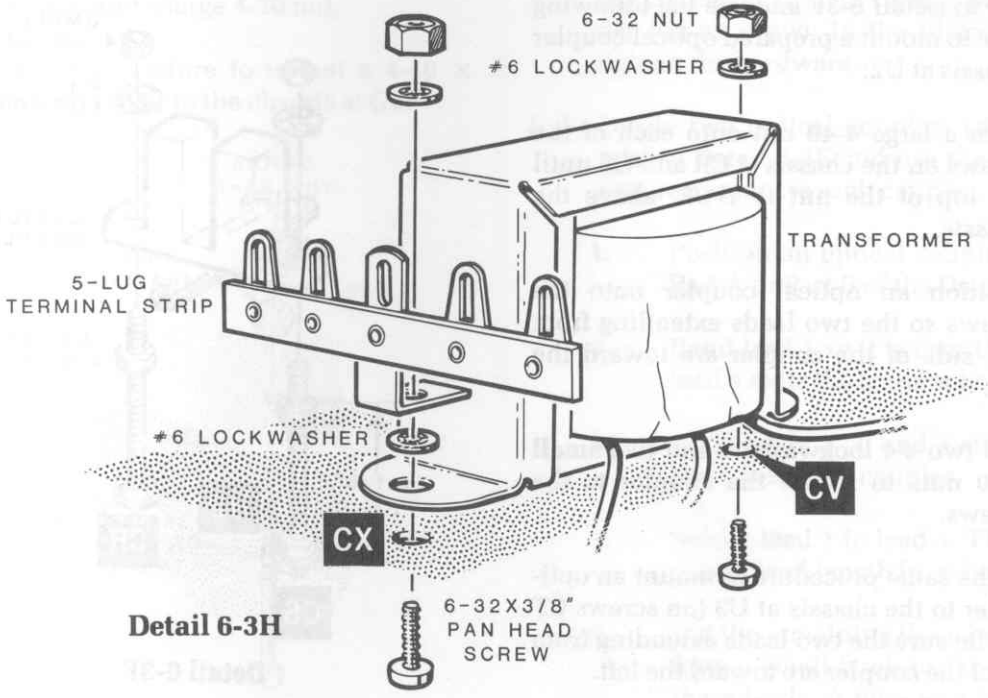
Detail 6-3G

( ) Refer to Detail 6-3G and cut the power transformer leads to the indicated lengths. Measure the leads from where they exit the transformer body. Then remove 3/8″ of insulation from the end of each lead.

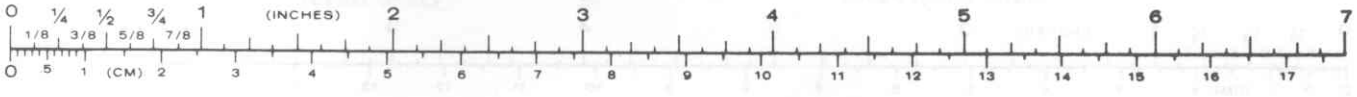
( ) Refer to Detail 6-3H and mount the transformer to the chassis at CV with 6-32 × 3/8″ pan head hardware. Be sure the black wires coming from the transformer are toward the left as shown in the Pictorial. Use 6-32 × 3/8″ pan head hardware to mount the transformer and a 5-lug terminal strip to the chassis at CX. Be sure to position the terminal strip as shown in the Pictorial.

( ) Again refer to Detail 6-3G and scrape or sand off any tarnish from both sides of both transformer mounting feet.

( ) Refer to Detail 6-3H and mount the transformer to the chassis at CV with 6-32 × 3/8″ pan head hardware. Be sure the black wires coming from the transformer are toward the left as shown in the Pictorial. Use 6-32 × 3/8″ pan head hardware to mount the transformer and a 5-lug terminal strip to the chassis at CX. Be sure to position the terminal strip as shown in the Pictorial.



Detail 6-3H



CENTER SHIELD

Refer to Pictorial 7-1 (Illustration Booklet, Page 28) for the following steps.

( ) Position the center shield as shown in the Pictorial (but do not position it in the chassis yet). Note the location of the large round hole near one corner of the shield.

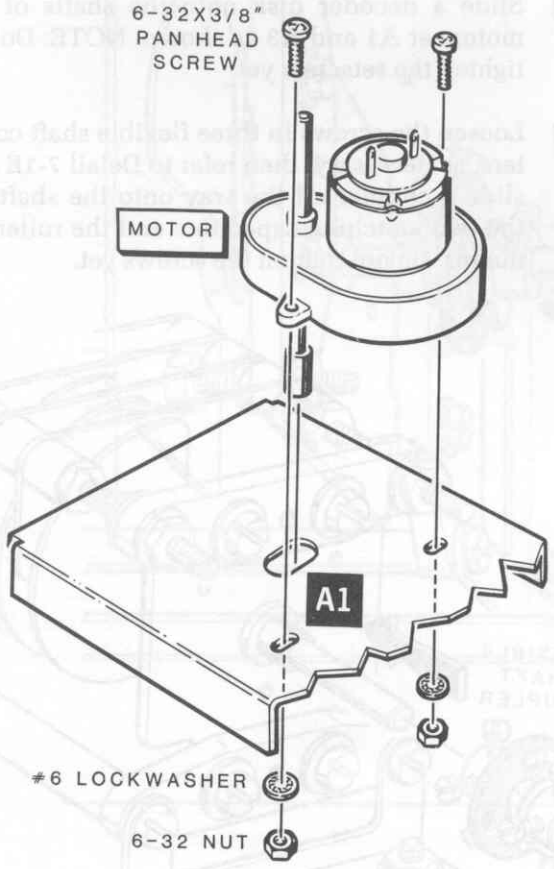
( ) A1: Refer to Detail 7-1A and loosely mount a motor onto the center shield at A1. Use 6-32 × 3/8″ pan head hardware.

( ) A2: Similarly, loosely mount a motor onto the center shield at A2. Use 6-32 × 3/8″ pan head hardware.

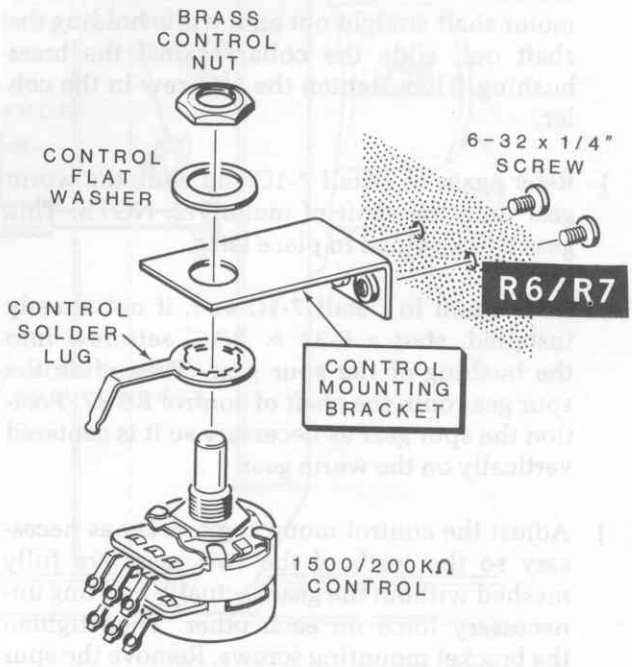
( ) A3: Similarly, loosely mount a motor onto the center shield at A3. Use 6-32 × 3/8″ pan head hardware.

( ) Refer to Detail 7-1B and loosely mount a control mounting bracket onto the front of the center shield at R6/R7 with two 6-32 × 1/4″ screws.

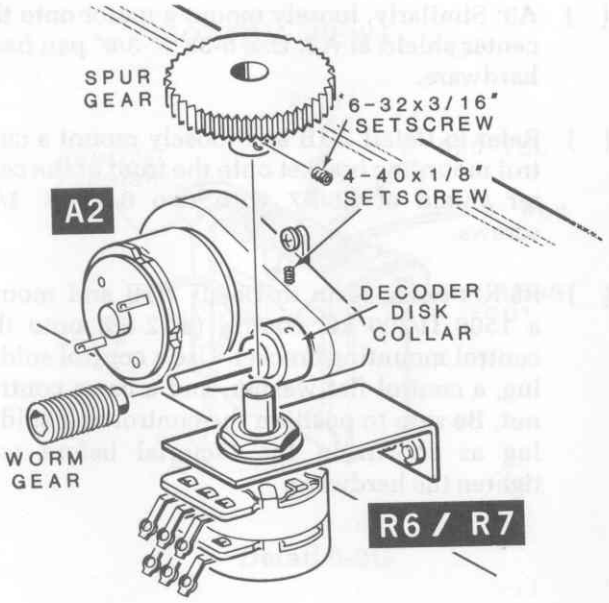
( ) R6/R7: Refer again to Detail 7-1B and mount a 1500 Ω/200 kΩ control (#12-68) onto the control mounting bracket. Use a control solder lug, a control flat washer, and a brass control nut. Be sure to position the control and solder lug as shown in the Pictorial before you tighten the hardware.



Detail 7-1A



Detail 7-1B



Detail 7-1C

( ) Refer to Detail 7-1C and start a 4-40 × 1/8″ setscrew into a decoder disk collar. Then slide the collar onto the shaft of motor A2. Pull the motor shaft straight out and, while holding the shaft out, slide the collar against the brass bushing. Then tighten the setscrew in the collar.

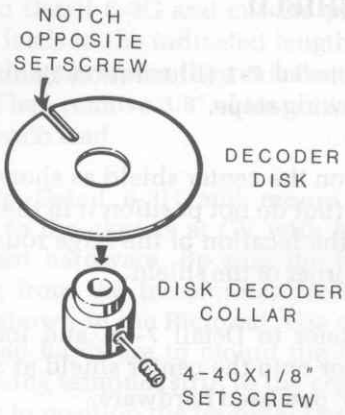
( ) Refer again to Detail 7-1C and slide the worm gear onto the shaft of motor A2. NOTE: This gear will be glued in place later.

( ) Refer again to Detail 7-1C and, if not already installed, start a 6-32 × 3/16″ setscrew into the bushing of the spur gear. Then slide the spur gear onto the shaft of control R6/R7. Position the spur gear as necessary so it is centered vertically on the worm gear.

( ) Adjust the control mounting bracket as necessary so the teeth of the two gears are fully meshed without the gears actually exerting unnecessary force on each other. Then tighten the bracket mounting screws. Remove the spur gear and set it aside until it is called for in a step.

( ) Refer to Detail 7-1D and use the following procedure to prepare two decoder disks:

1. Make sure the decoder disk is as flat as possible. Position the disk onto a disk decoder collar so the slot in the disk is opposite the side of the collar that has the setscrew hole. Then solder the two together. NOTE: This requires a lot of heat.

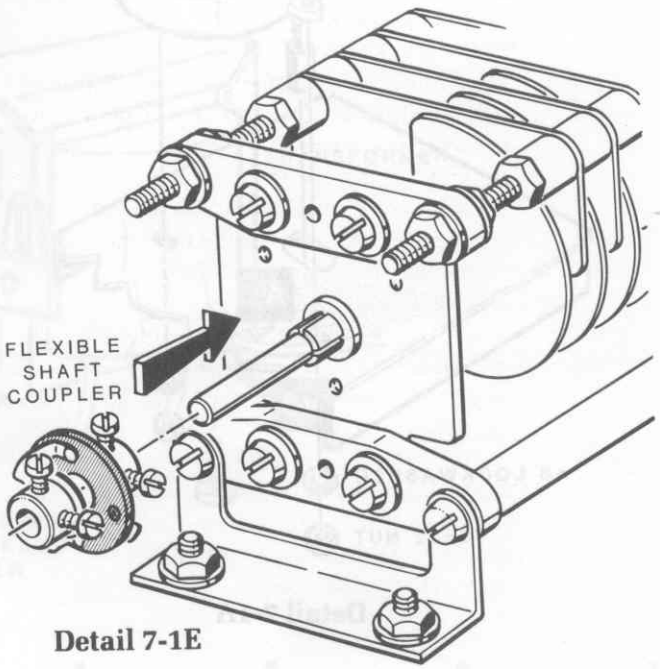


Detail 7-1D

2. After the decoder disk cools, start a 4-40 × 1/8″ setscrew into the disk decoder collar.

( ) Slide a decoder disk onto the shafts of the motors at A1 and A3 as shown. NOTE: Do not tighten the setscrew yet.

( ) Loosen the screws in three flexible shaft couplers, as necessary; then refer to Detail 7-1E and slide a coupler all the way onto the shafts of the two matching capacitors and the roller inductor. Do not tighten the screws yet.



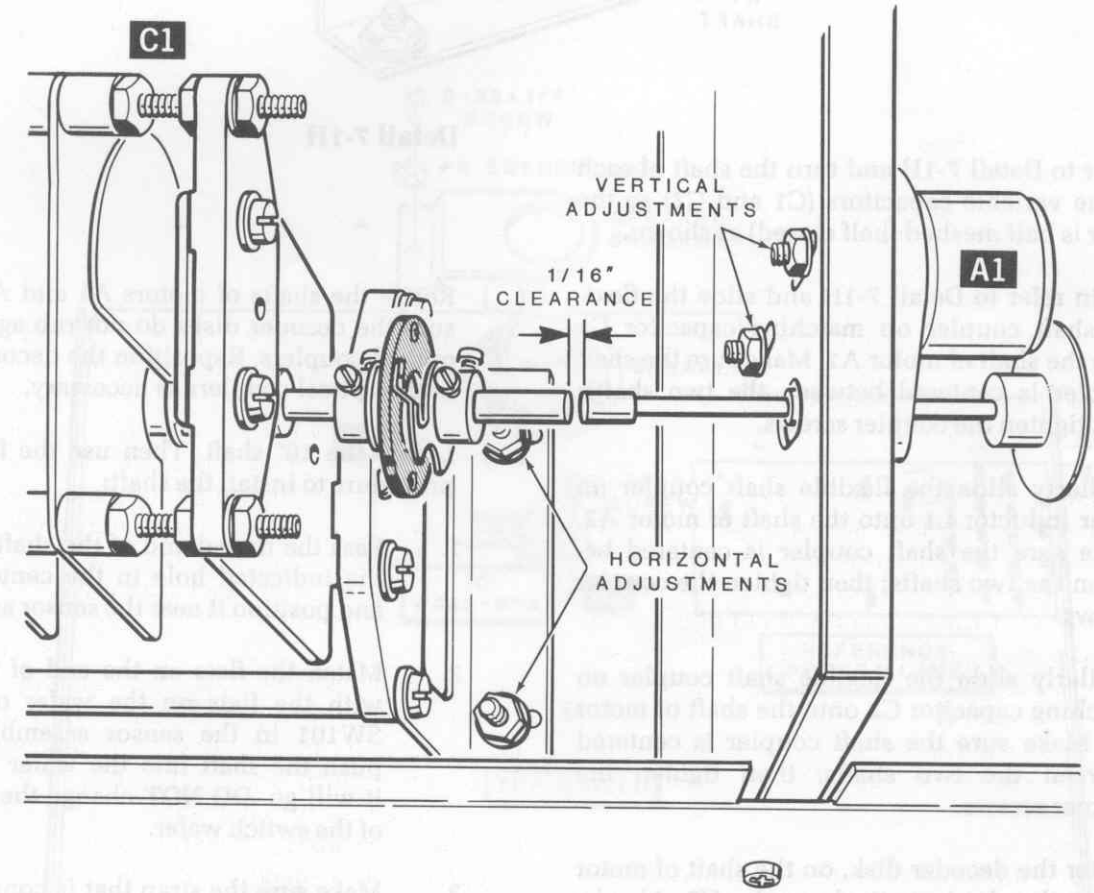
Detail 7-1E

( ) Refer to Detail 7-1F (Illustration Booklet, Page 29) and lower the center shield into the chassis as shown. Be sure the decoder disks are positioned in the slots in optical couplers U2 and U3 as shown in the Pictorial. Then mount the center shield to the chassis with four 6-32 × 1/4″ screws.

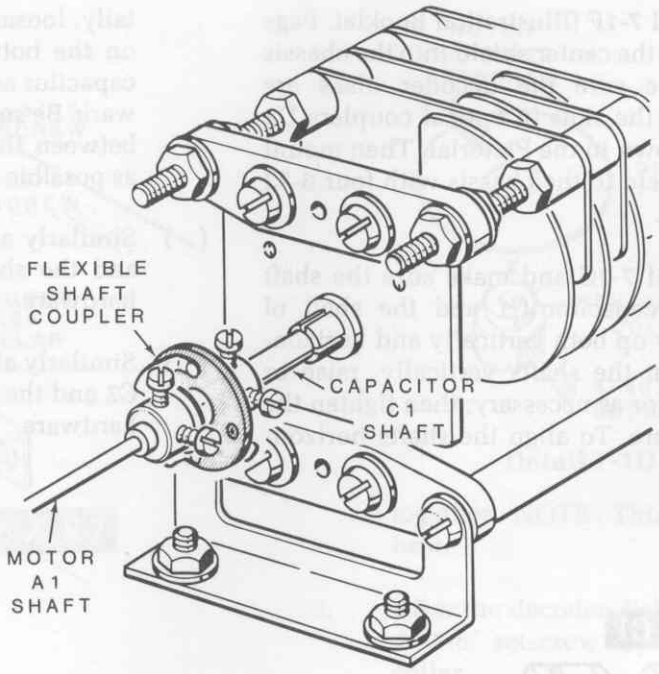
( ) Refer to Detail 7-1G and make sure the shaft of matching capacitor C1 and the shaft of motor A1 line up both vertically and horizontally. To align the shafts vertically, raise or lower the motor as necessary; then tighten the motor hardware. To align the shafts horizontally, loosen the capacitor mounting hardware on the bottom of the chassis, reposition the capacitor as necessary, and retighten the hardware. Be sure to keep at least 1/16″ of clearance between the shafts (push the capacitor as far as possible toward the rear of the chassis).

( ) Similarly align the shaft of roller inductor L1 and the shaft of motor A2. Then tighen the hardware.

( ) Similarly align the shaft of matching capacitor C2 and the shaft of motor A3. Then tighen the hardware.



Detail 7-1G



Detail 7-1H

( ) Refer to Detail 7-1H and turn the shaft of each of the variable capacitors (C1 and C2) so the rotor is half meshed (half closed) as shown.

( ) Again refer to Detail 7-1H and slide the flexible shaft coupler on matching capacitor C1 onto the shaft of motor A1. Make sure the shaft coupler is centered between the two shafts; then tighten the coupler screws.

( ) Similarly slide the flexible shaft coupler on roller inductor L1 onto the shaft of motor A2. Make sure the shaft coupler is centered between the two shafts; then tighten the coupler screws.

( ) Similarly slide the flexible shaft coupler on matching capacitor C2 onto the shaft of motor A3. Make sure the shaft coupler is centered between the two shafts; then tighten the coupler screws.

( ) Center the decoder disk, on the shaft of motor A1, in the slot in optical coupler U2. Also be sure the slot in the decoder disk is downward as shown. Then tighten the setscrew.

( ) Similarly center the decoder disk on the shaft of motor A3 in the slot in optical coupler U3. Then tighten the setscrew.

( ) Rotate the shafts of motors A1 and A3. Make sure the decoder disks do not rub against the optical couplers. Reposition the decoder disks or the optical couplers as necessary.

( ) Locate the 16″ shaft. Then use the following procedure to install the shaft:

1. Pass the flatted end of the shaft through the indicated hole in the center shield and position it near the sensor assembly.

2. Match the flats on the end of the shaft with the flats on the wafer of switch SW101 in the sensor assembly. Then push the shaft into the wafer as far as it will go. **DO NOT** change the position of the switch wafer.

3. Make sure the strap that is connected to the feedthrough insulator at D on the rear panel is not touching the 16″ shaft. Reform the strap as necessary.

NOTE: As you perform the remainder of the assembly steps, do not disturb the position of the 16″ shaft.

TOP SHIELD

Refer to Pictorial 8-1 for the following steps.

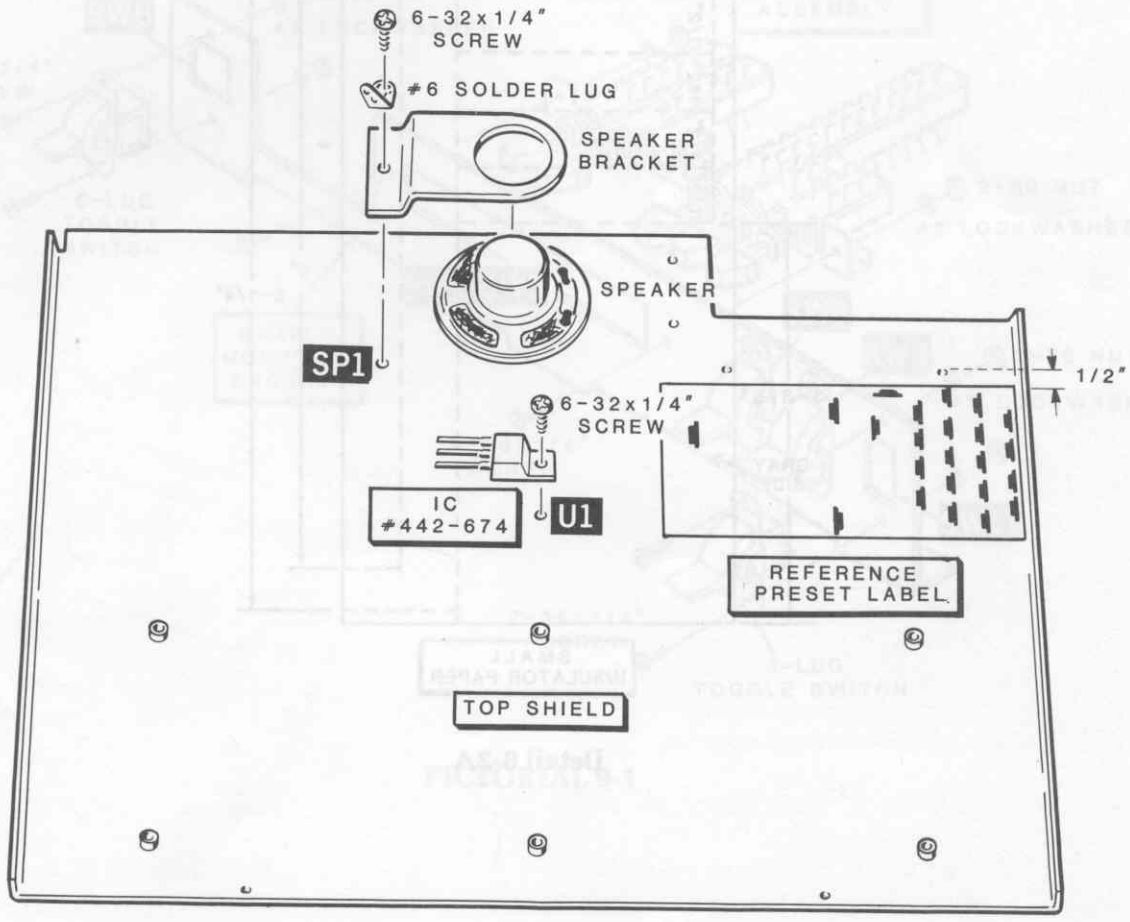
( ) Position the top shield as shown in the Pictorial.

( ) Locate the reference preset label and carefully peel the larger label from the backing paper. Then press the label onto the top shield in the area shown in the Pictorial. Be sure to position the label so its indicated long side is 1/2" from the center of the two adjacent holes in the shield. Save the smaller label for use later.

( ) U1: Mount the 7812 integrated circuit (#442-674) to the top shield at U1 with a 6-32 × 1/4" screw as shown. Be sure to position the IC as shown in the Pictorial before you tighten the screw.

CAUTION: When you handle the speaker in the next step, handle it carefully so you do not puncture its paper cone. This would damage the speaker.

( ) SP1: Mount the speaker and the speaker bracket to the top shield at SP1 as shown. Use a 6-32 × 1/4" screw and a #6 solder lug as shown. Be sure to position the speaker, solder lug, and bracket as shown in the Pictorial before you tighten the screw.



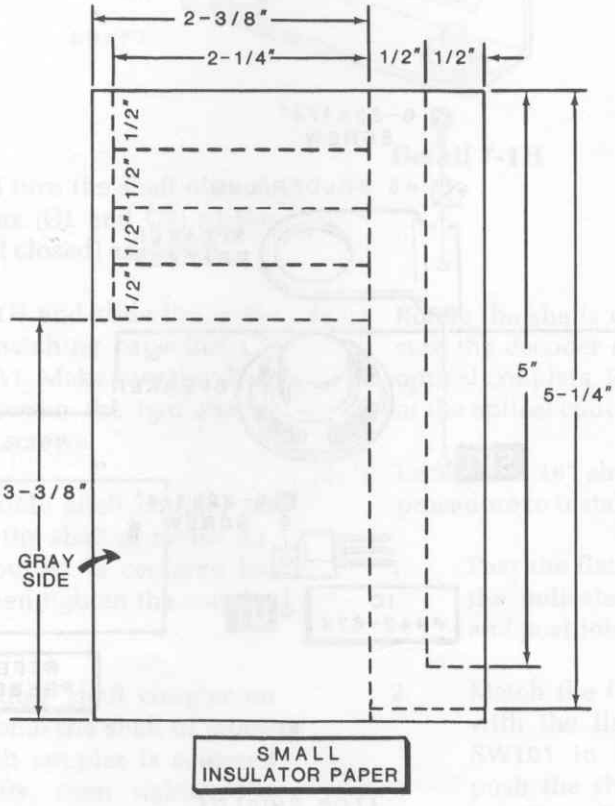
PICTORIAL 8-1

( ) Refer to Pictorial 8-2 (Illustration Booklet, Page 30) and mount the top shield to the rear panel with two 6-32 × 1/4″ screws. Use two 6-32 × 1/4″ screws and two grounding springs to secure the top shield to the center shield as shown. Be careful not to pinch any of the line cord wires between the rear panel and the top shield. Also be sure the free end of the sensor cable extends through the large rectangular opening in the top shield as shown.

( ) Locate one of the small insulator papers (3-3/8″ × 5-3/8″). Then refer to Detail 8-2A and cut seven insulators from the paper as shown. Use the 2-3/8″ × 3-3/8″ piece in the next step. Save the remaining insulators for use later.

( ) Remove the backing paper from the 2-3/8″ × 3-3/8″ insulator paper and press the insulator onto the top shield (under the 2-lug terminal strip) as shown.

Set the chassis assembly aside until it is called for.



Detail 8-2A

SWITCH SUBPANEL

Refer to Pictorial 9-1 for the following steps.

( ) Position the switch mounting bracket as shown in the Pictorial.

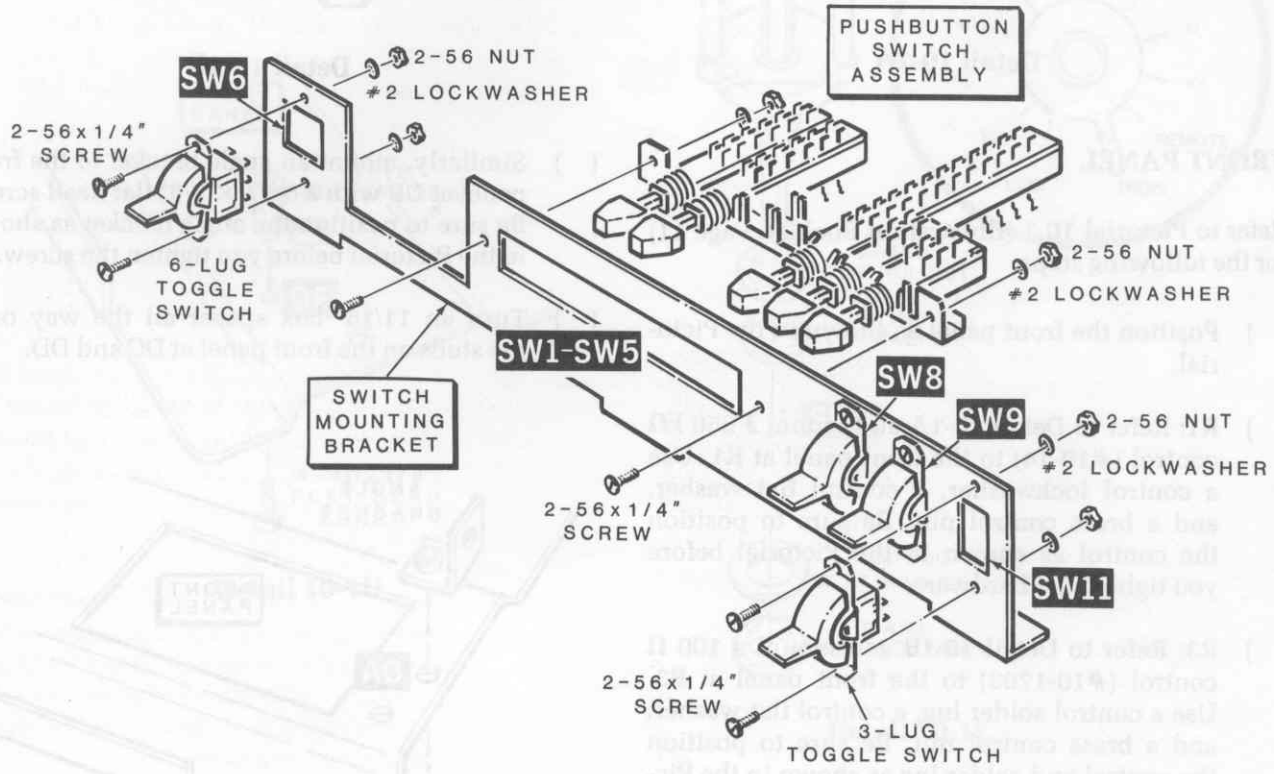
( ) SW6: Mount the 6-lug toggle switch to the mounting bracket at SW6. Use 2-56 × 1/4" hardware as shown. Do not use any hardware that may have been supplied with the switch.

( ) SW8, SW9, & SW11: Use the same method to mount 3-lug toggle switches to the mounting bracket at SW8, SW9, and SW11.

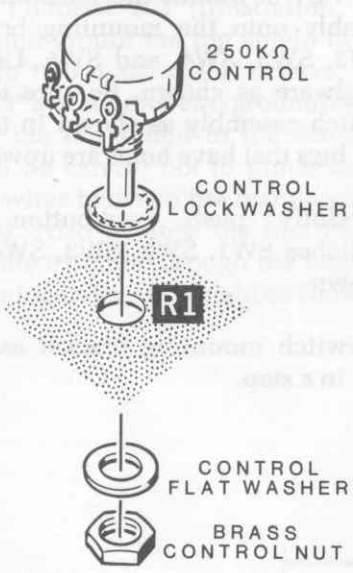
( ) SW1-SW5: Mount the pushbutton switch assembly onto the mounting bracket at SW1, SW2, SW3, SW4, and SW5. Use 2-56 × 1/4" hardware as shown. Be sure to position the switch assembly as shown in the Pictorial so the lugs that have holes are upward.

( ) Carefully push pushbutton knobs onto switches SW1, SW2, SW3, SW4, and SW5 as shown.

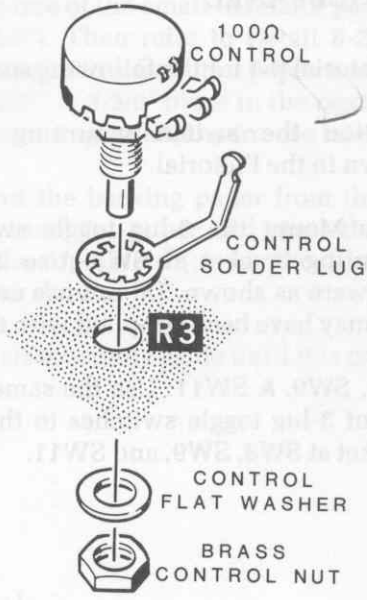
Set the switch mounting bracket aside until it is called for in a step.



PICTORIAL 9-1



Detail 10-1A



Detail 10-1B

FRONT PANEL

Refer to Pictorial 10-1 (Illustration Booklet, Page 31) for the following steps.

( ) Position the front panel as shown in the Pictorial.

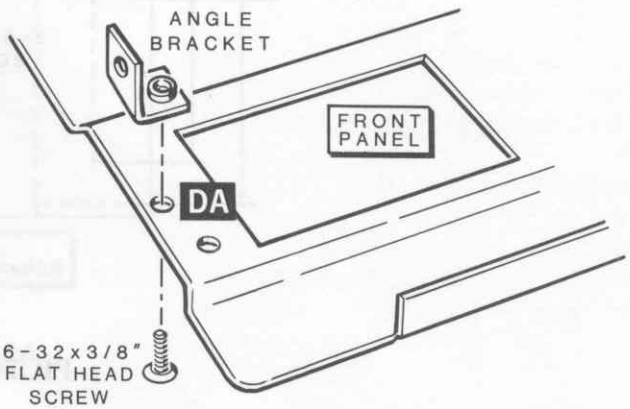
( ) R1: Refer to Detail 10-1A and mount a 250 kΩ control (#10-14) to the front panel at R1. Use a control lockwasher, a control flat washer, and a brass control nut. Be sure to position the control as shown in the Pictorial before you tighten the hardware.

( ) R3: Refer to Detail 10-1B and mount a 100 Ω control (#10-1203) to the front panel at R3. Use a control solder lug, a control flat washer, and a brass control nut. Be sure to position the control and solder lug as shown in the Pictorial before you tighten the hardware.

( ) Refer to Detail 10-1C and mount an angle bracket to the front panel at DA. Use a 6-32 × 3/8″ flat head screw. Be sure to position the angle bracket as shown in the Pictorial before you tighten the screw.

( ) Similarly, mount an angle bracket to the front panel at DB with a 6-32 × 3/8″ flat head screw. Be sure to position the angle bracket as shown in the Pictorial before you tighten the screw.

( ) Turn an 11/16″ hex spacer all the way onto the studs on the front panel at DC and DD.



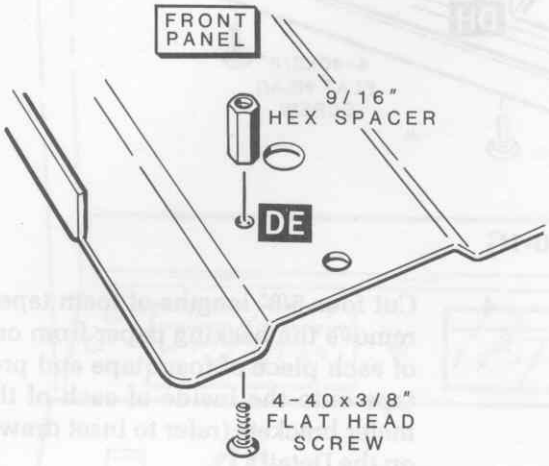
Detail 10-1C

( ) Refer to Detail 10-1D and use a 4-40 × 3/8" flat head screw to mount a 9/16" hex spacer to the front panel at DE.

( ) SW7: Refer to Detail 10-1E and use the following procedure to mount the rotary switch (#63-103) to the front panel at SW7:

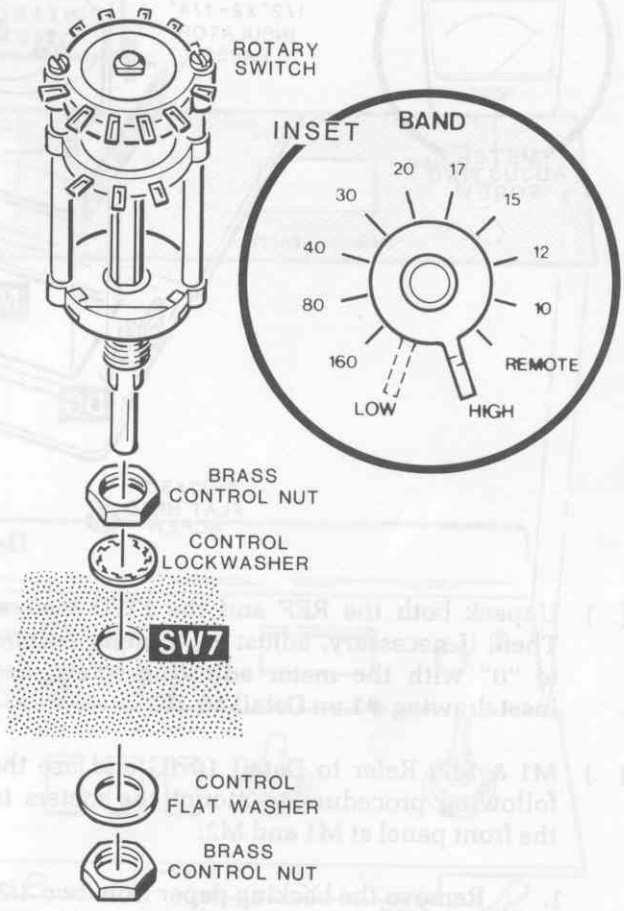
1. Turn a brass control nut all the way onto the bushing of the switch.

2. Mount the switch onto the front panel with a control lockwasher, a control flat washer, and a brass control nut. Be sure to position the switch as shown in the Pictorial before you tighten the hardware (note the locations of the three lugs on one of the switch wafers).

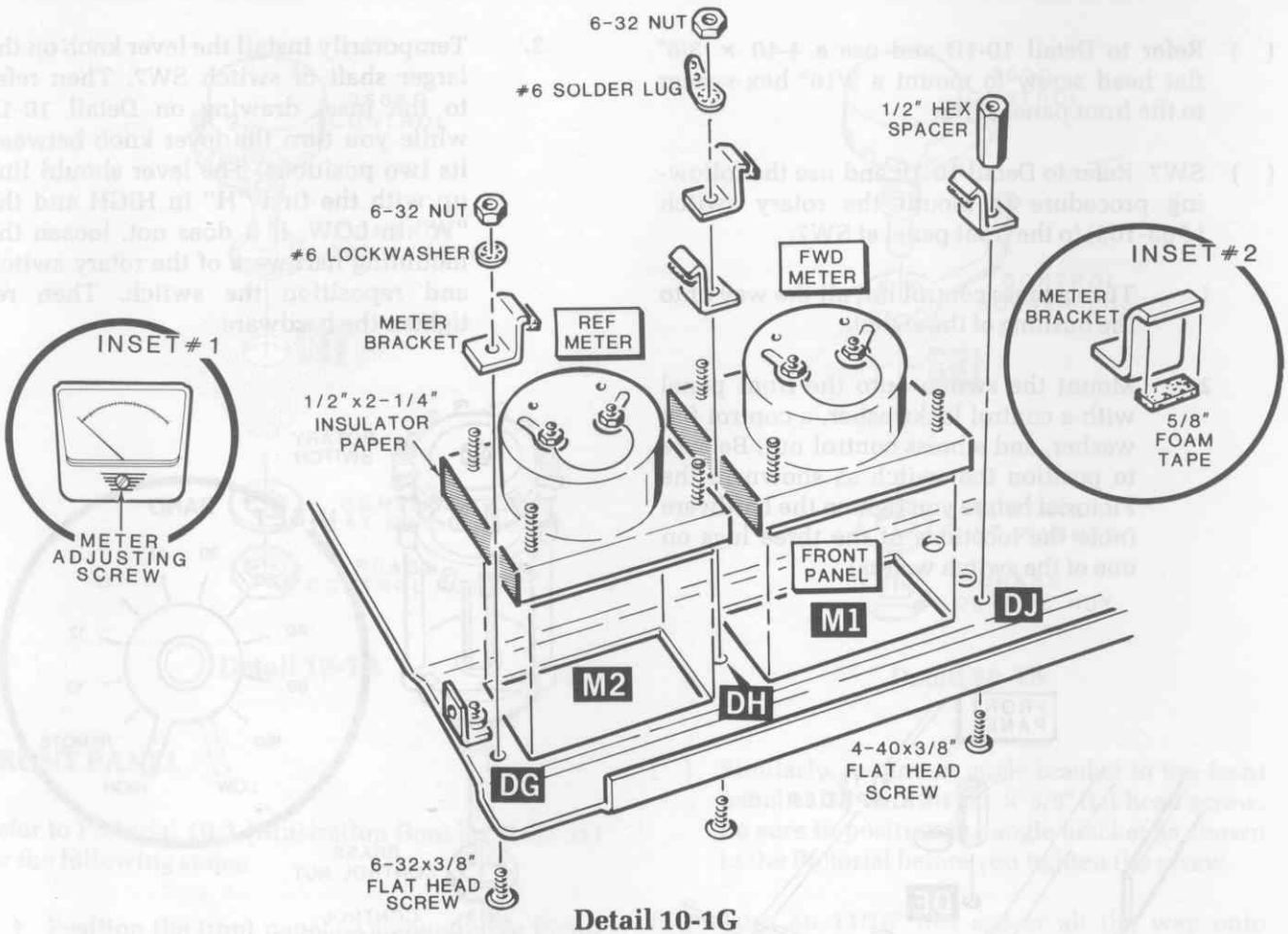


Detail 10-1D

3. Temporarily install the lever knob on the larger shaft of switch SW7. Then refer to the inset drawing on Detail 10-1E while you turn the lever knob between its two positions. The lever should line up with the first "H" in HIGH and the "W" in LOW. If it does not, loosen the mounting hardware of the rotary switch and reposition the switch. Then re-tighten the hardware.



Detail 10-1E



Detail 10-1G

( ) Unpack both the REF and the FWD meters. Then, if necessary, adjust each meter pointer to "0" with the meter adjusting screw. See inset drawing #1 on Detail 10-1G.

( ) M1 & M2: Refer to Detail 10-1G and use the following procedure to mount the meters to the front panel at M1 and M2:

1. Remove the backing paper from two 1/2" × 2-1/4" insulators and press the insulators onto the sides of REF meter M2 (#407-758) as shown.

2. Position the prepared meter in front panel cutout M2.

3. Press 1/2" × 2-1/4" insulators onto the sides of FWD meter M1 (#407-757). Then position the meter in front panel cutout M1.

4. Cut four 5/8" lengths of foam tape. Then remove the backing paper from one side of each piece of foam tape and press the tape onto the inside of each of the four meter brackets (refer to inset drawing #2 on the Detail).

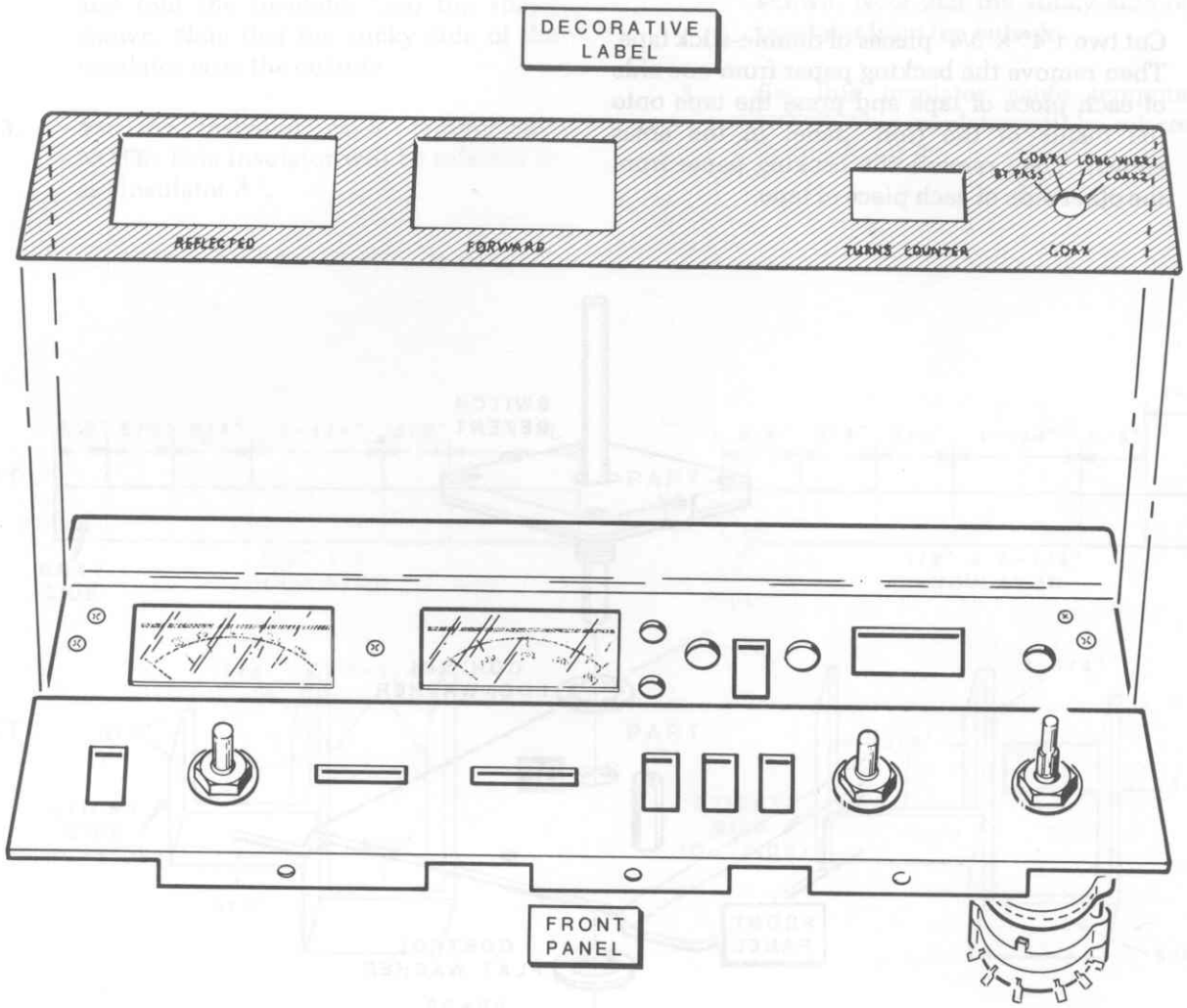
5. Use one of the prepared meter brackets and 6-32 × 3/8" flat head hardware to mount REF meter M2 to the front panel at DG. NOTE: Be careful not to let the meters fall out of their holes when you tighten the hardware.

6. Use two prepared meter brackets to mount meters M1 and M2 to the front panel at DH. Use 6-32 × 3/8" flat head hardware and a #6 solder lug. Be sure to position the solder lug as shown in the Pictorial before you tighten the hardware.

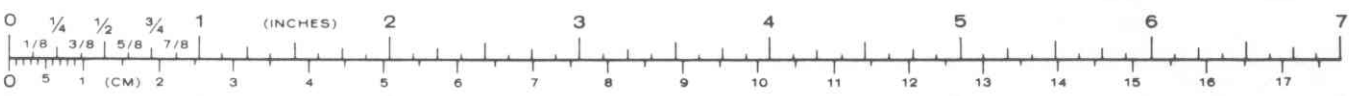
7. Use a prepared meter bracket, a 4-40 × 3/8″ flat head screw, and a 1/2″ hex spacer to mount meter M1 to the front panel at DJ.

NOTE: The hardware supplied with the meters will not be used.

( ) Carefully peel the backing paper from the decorative label. Then refer to Detail 10-1H and press the label onto the front of the front panel as shown. Be sure to line up the three windows and one round hole in the label with the corresponding cutouts and round hole in the panel before you press the label into place. Also, be sure one of the short label sides is flush with the corresponding front panel side.



Detail 10-1H



( ) Refer to Detail 10-1J and mount the switch detent to the front panel at DF. Use a control lockwasher, a control flat washer, and a brass control nut. Position the switch detent as shown in the Pictorial before you tighten the hardware (the exact positioning of the switch detent is not important).

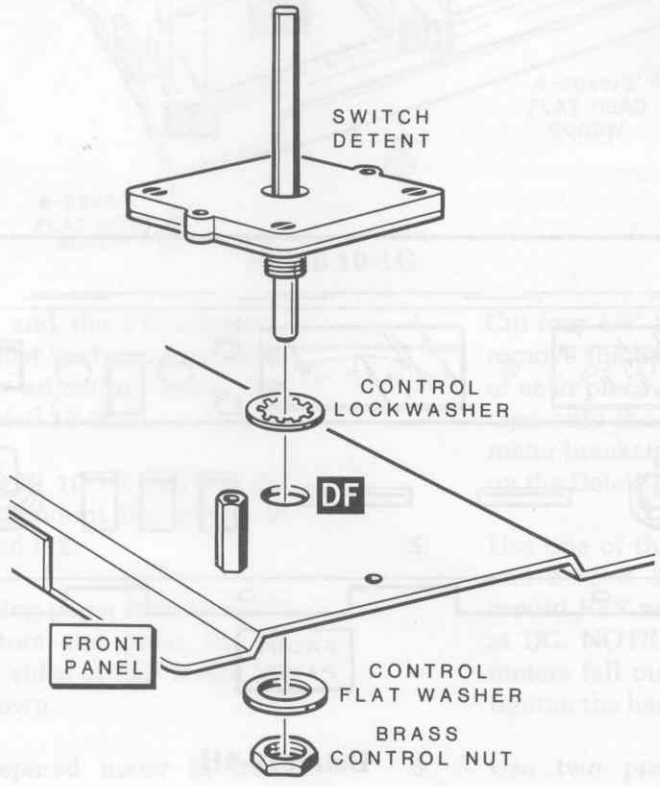
NOTE: Perform the next two steps only if you wish to have an amber-colored digital display. If you wish to have a blue display, skip the next two steps.

( ) Cut two 1/4" × 3/4" pieces of double-stick tape. Then remove the backing paper from one side of each piece of tape and press the tape onto the inside of the front panel in the areas shown. Then remove the backing paper from the other side of each piece of tape.

( ) Use the following procedure to install the window on the inside of the front panel:

1. Carefully peel away any backing paper or film that may be present on either side of the window.

2. Press the window into place against the double-stick tape on the front panel. Be sure to center the window on the opening in the panel.



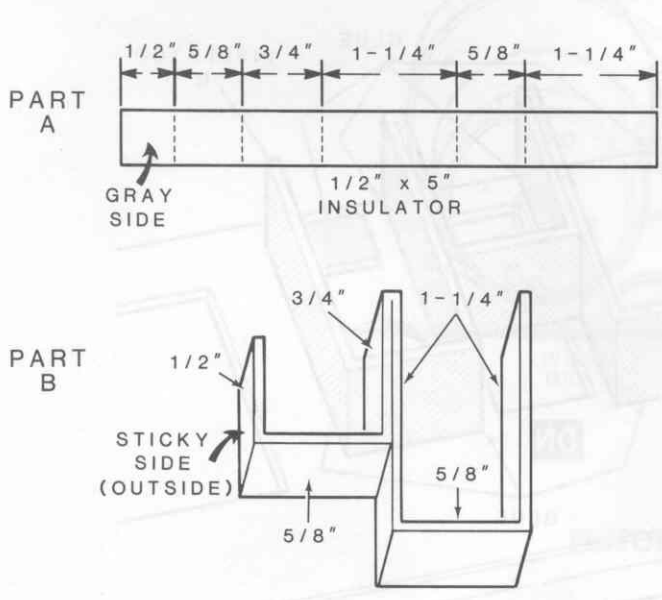
Detail 10-1J

( ) Locate the 1/2″ × 5″ insulator that you set aside earlier. Then refer to Detail 10-1K and use the following procedure to prepare the insulator:

1. Refer to Part A of the Detail and mark the gray side of the insulator in the indicated places.
2. Remove the backing paper from the insulator. Then refer to Part B of the Detail and fold the insulator into the shape shown. Note that the sticky side of the insulator is on the outside.
3. Set the insulator aside temporarily. NOTE: This insulator will be referred to as "insulator A".

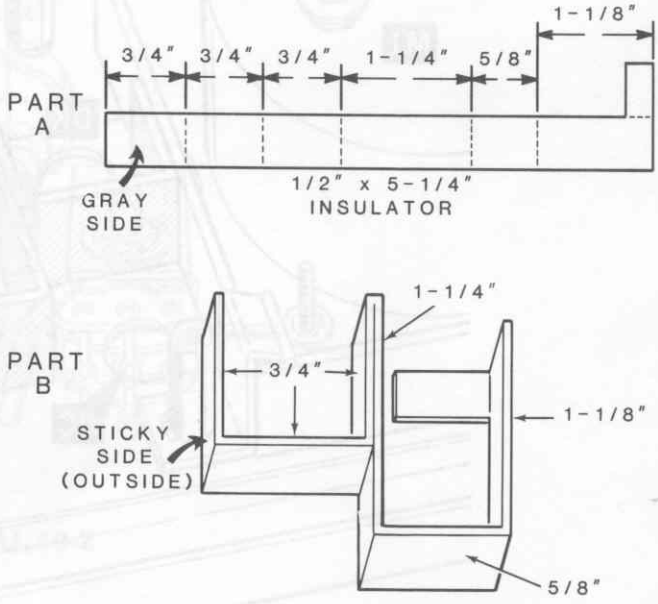
( ) Locate the 1/2″ × 5-1/4″ insulator that you set aside earlier. Then refer to Detail 10-1L and use the following procedure to prepare the insulator:

1. Refer to Part A of the Detail and mark the insulator in the indicated places.
2. Remove the backing paper from the insulator. Then refer to Part B of the Detail and fold the insulator into the shape shown. Note that the sticky side of the insulator is on the outside.
3. Set this insulator aside temporarily. NOTE: This insulator will be referred to as "insulator B".



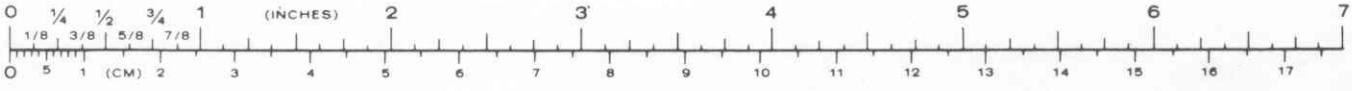
INSULATOR A

Detail 10-1K



INSULATOR B

Detail 10-1L

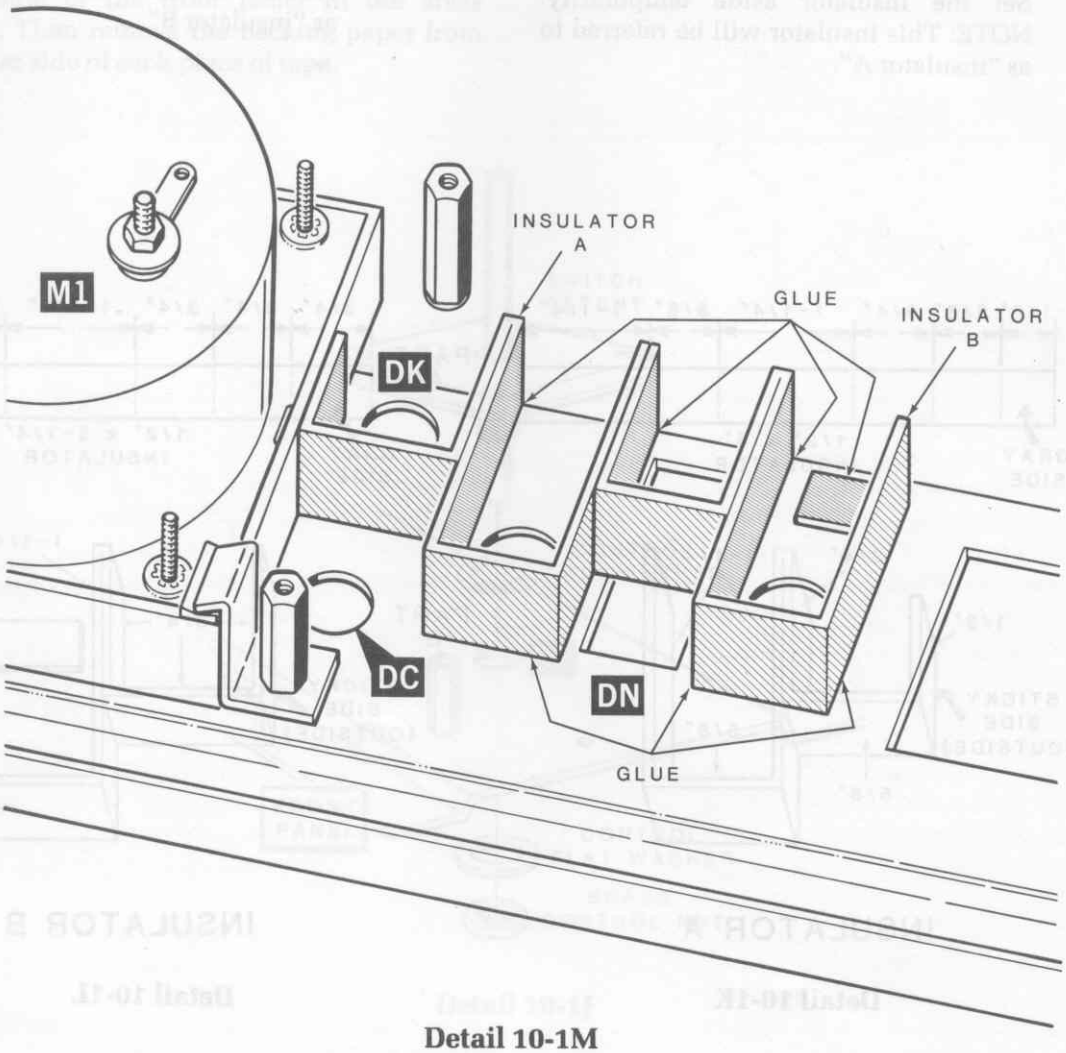


( ) Refer to Detail 10-1M and press the indicated side of insulator A onto the side of meter M1 in the area shown. Be sure the insulator is positioned between holes DK and DL in the front panel as shown in the Pictorial.

( ) Refer again to Detail 10-1M and press the indicated side of insulator B onto the free end of insulator A as shown. Then press the foot on the free end of the insulator onto the inside of the front panel. Be sure insulator B is centered above rectangular cutout DN.

NOTE: Read the next two steps and study Detail 10-1M and Pictorial 10-2 before you perform these steps. Be sure you know where to apply the epoxy before you mix it; epoxy solidifies very quickly.

( ) Refer to the instructions on the package of glue to mix the glue. Then use small amounts of the glue to secure the insulator paper to the front panel in the places indicated in the Pictorial.



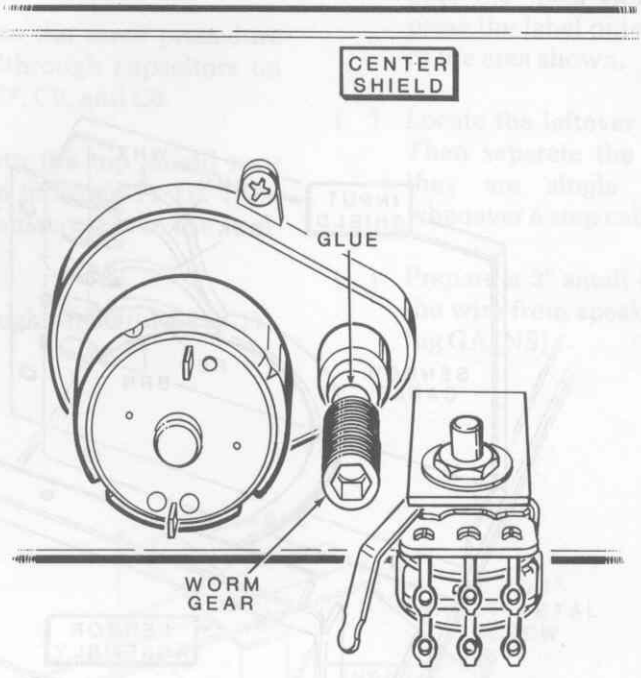
Detail 10-1M

( ) Before the remaining glue sets, refer to Pictorial 10-2 and use the following procedure to glue the worm gear on the chassis to its motor shaft:

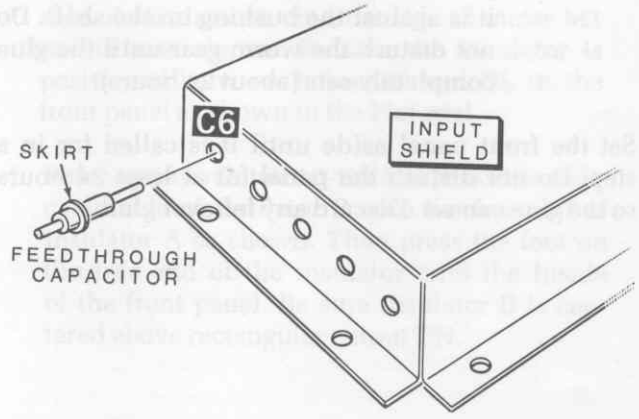
1. Pull the worm gear part way off of motor shaft A2 on the chassis center shield.

2. Apply glue to the exposed motor shaft directly next to the worm gear. Then push the gear back onto the shaft until it is against the bushing on the shaft. Do not disturb the worm gear until the glue completely sets (about 24 hours).

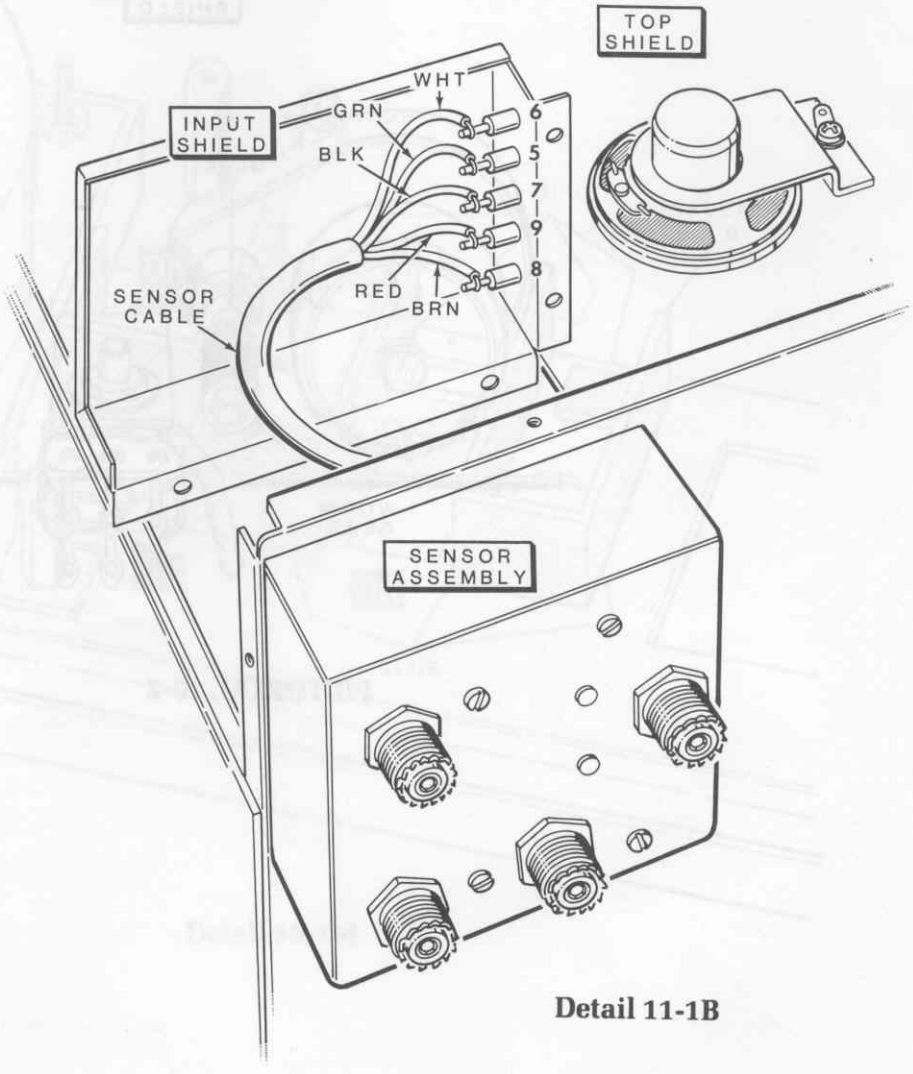
Set the front panel aside until it is called for in a step. Do not disturb the panel for at least 24 hours so the glue can set. Discard any leftover glue.



PICTORIAL 10-2



Detail 11-1A



Detail 11-1B

WIRING

Refer to Pictorial 11-1 (Illustration Booklet, Page 32) for the following steps.

( ) C6: Refer to Detail 11-1A and use the following procedure to install a .001 μF feedthrough capacitor on the input shield (#206-1454):

1. Use a pencil eraser to clean the outside surface around hole C6.

2. Insert the longest end of the capacitor into the hole and solder the entire skirt to the shield. Do not bridge solder across the insulator.

( ) C5, C7, C9, and C8: Use the same procedure to install .001 μF feedthrough capacitors on the input shield at C5, C7, C9, and C8.

Position the input shield onto the top shield near the sensor assembly as shown in Detail 11-1B. Then connect the free end of the sensor cable to the feedthrough capacitors as follows:

( ) Brown wire to feedthrough capacitor C8 (S-1).

( ) Red wire to feedthrough capacitor C9 (S-1).

( ) Black wire to feedthrough capacitor C7 (S-1).

( ) Green wire to feedthrough capacitor C5 (S-1).

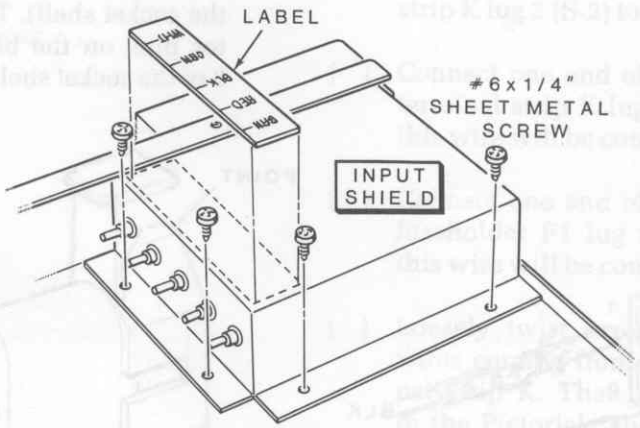
( ) White wire to feedthrough capacitor C6 (S-1).

( ) Position the input shield onto the top shield as shown in Detail 11-1C. Then use four #6 × 1/4" sheet metal screws to secure the input shield to the top shield.

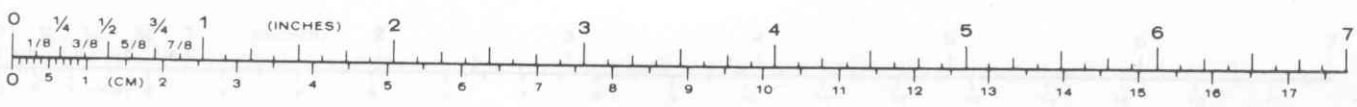
( ) Locate the remaining part of the reference preset label (#390-2457) that you set aside earlier. Then refer again to Detail 11-1C and carefully peel the label from the backing paper and press the label onto the top of the input shield in the area shown.

( ) Locate the leftover pieces of 8-wire flat cable. Then separate the wires from each other so they are single wires. Use these wires whenever a step calls for small wire.

( ) Prepare a 3" small brown wire. Then connect the wire from speaker SP1 lug 1 (S-1) to solder lug GA (NS).



Detail 11-1C



( ) Prepare the following wires:

4″ large black

26″ large red

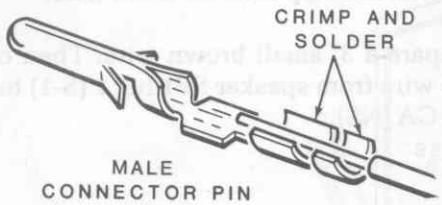
( ) Refer to Detail 11-1D Part A and install a male connector pin on one end of each of the prepared wires.

Position a large 2-hole socket shell as shown in Detail 11-1D Part B (note the location of the point on the socket shell). Then push the male connector pins on the wires into the socket shell until they lock into place as follows:

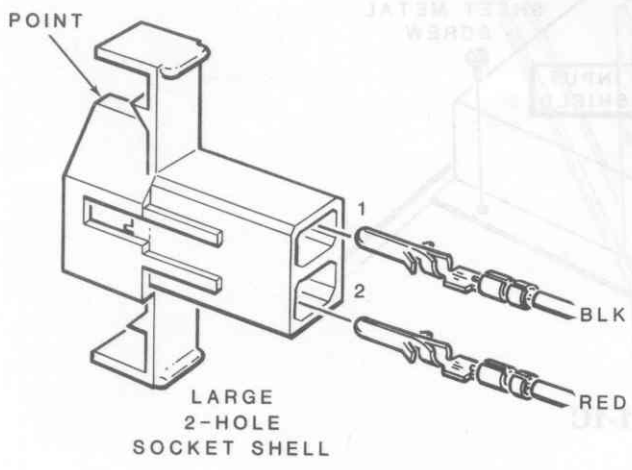
( ) Black wire into hole 1.

( ) Red wire into hole 2.

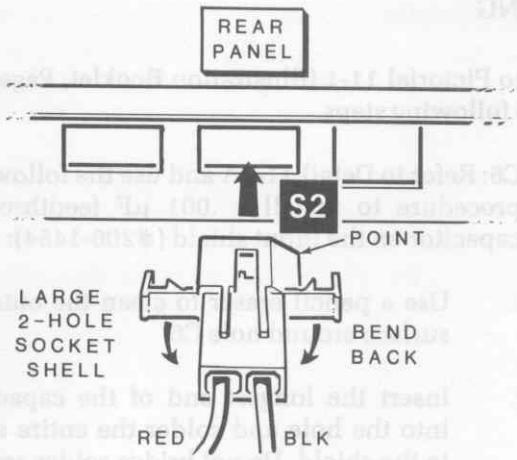
PART A



PART B



Detail 11-1D



Detail 11-1E

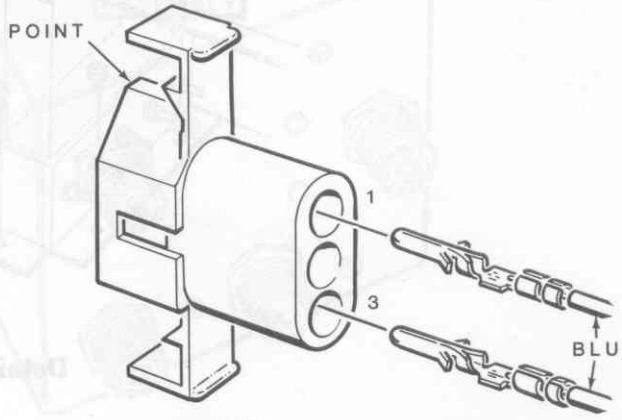
( ) S2: Bend back the ears on the socket shell as shown in Detail 11-1E. Then push the socket shell into the rear panel hole at S2 until it locks into place.

( ) Connect the free end of the black wire coming from socket S2 to solder lug GA (S-2).

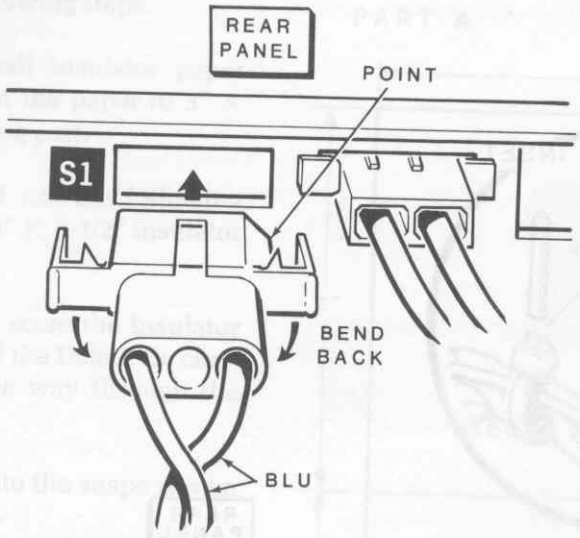
( ) Route the red wire coming from socket S2 as shown. It will be connected later.

( ) Prepare two 26″ large blue wires. Then install a male connector pin on one end of each wire.

( ) Position a 3-hole socket shell as shown in Detail 11-1F (note the location of the point on the socket shell). Then push the male connector pins on the blue wires into holes 1 and 3 of the socket shell until they lock into place.



Detail 11-1F



Detail 11-1G

( ) S1: Bend back the ears on the socket shell as shown in Detail 11-1G. Then push the socket shell into the rear panel hole at S1 until it locks into place.

( ) Loosely twist together the wires coming from socket S1 (approximately 1 turn per inch). Then route the twisted pair as shown in the Pictorial. The free ends of these wires will be connected later.

( ) Prepare the following wires:

30″ large white

24″ large black

2″ large black

NOTE: When you solder the wires to terminal strip K in the following steps, the solder instructions do not include the wires that were previously soldered in the **eyelets** of the terminal strip.

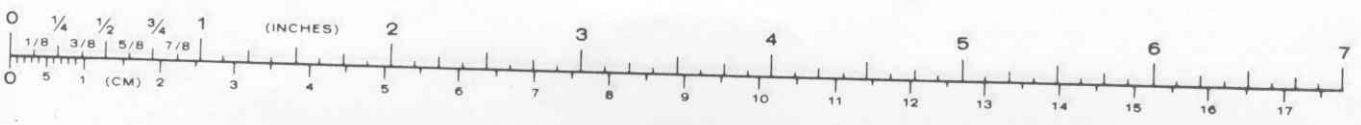
( ) Bend out lug 2 of fuseholder F1 enough so you can connect wires to it in some of the following steps.

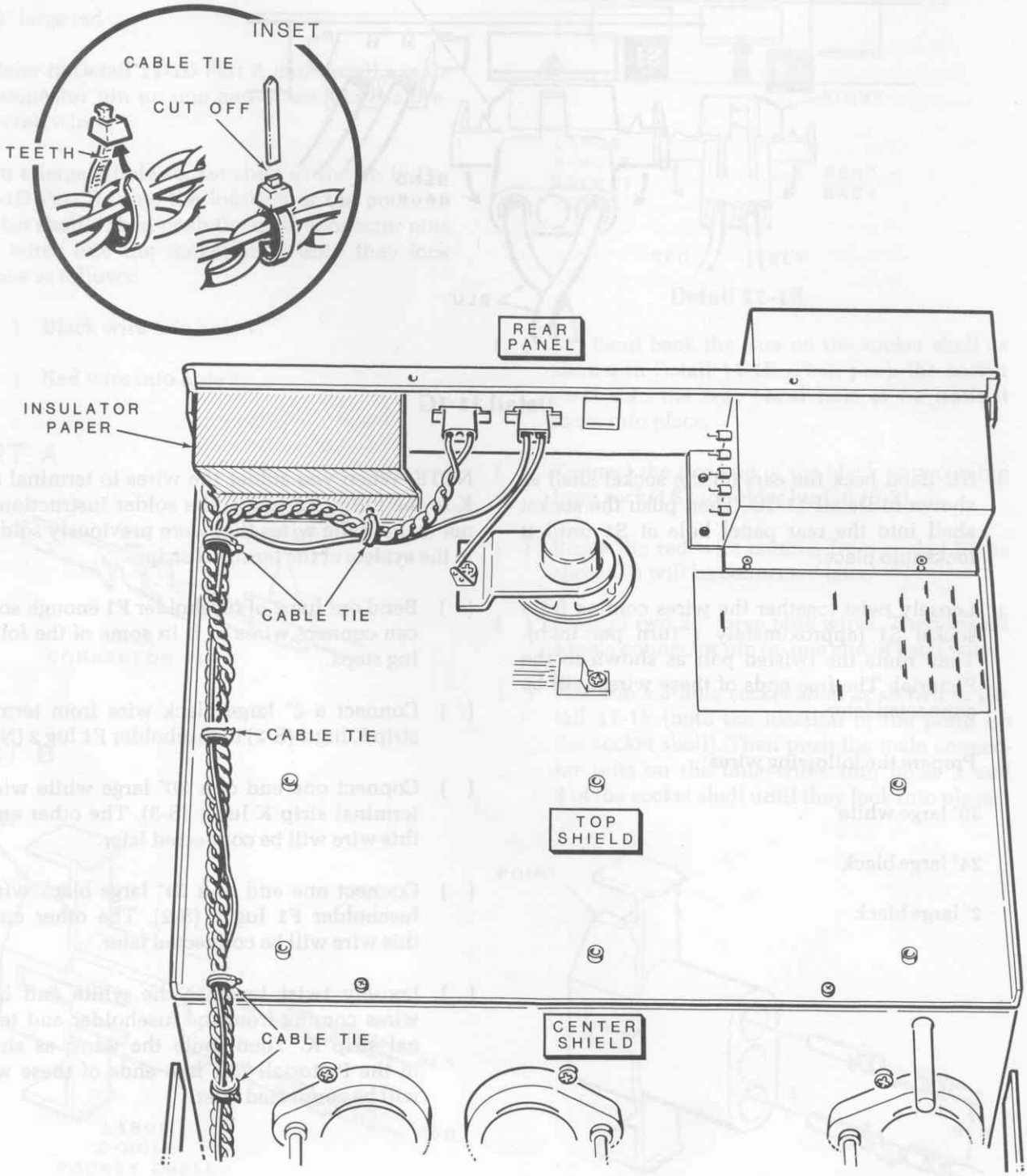
( ) Connect a 2″ large black wire from terminal strip K lug 2 (S-2) to fuseholder F1 lug 2 (NS).

( ) Connect one end of a 30″ large white wire to terminal strip K lug 1 (S-3). The other end of this wire will be connected later.

( ) Connect one end of a 24″ large black wire to fuseholder F1 lug 2 (S-2). The other end of this wire will be connected later.

( ) Loosely twist together the white and black wires coming from the fuseholder and terminal strip K. Then route the wires as shown in the Pictorial. The free ends of these wires will be connected later.





PICTORIAL 11-2

Refer to Pictorial 11-2 for the following steps.

( ) Locate the remaining small insulator paper (3-3/8″ × 5-3/8″). Then cut the paper to 3″ × 3-1/2″. Discard the remaining part.

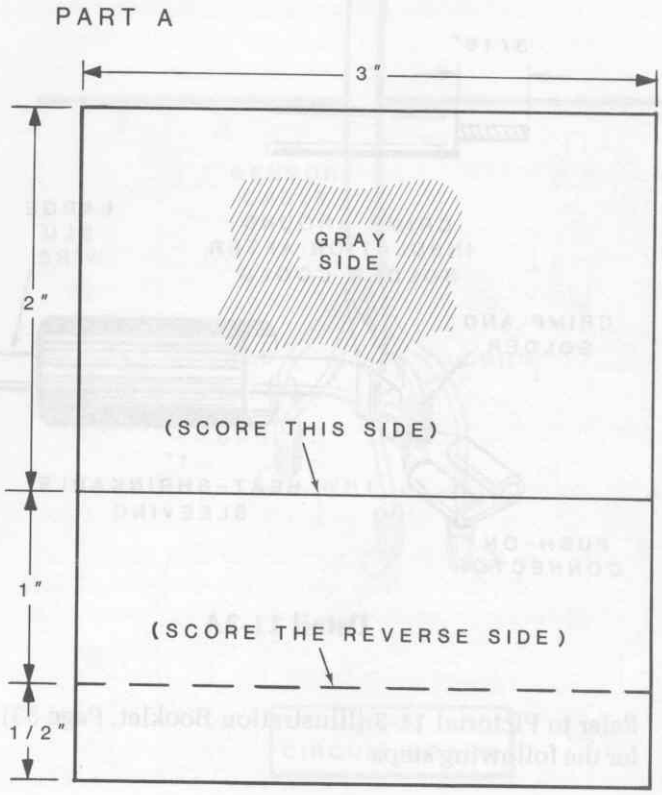
( ) Refer to Detail 11-2A and use the following procedure to prepare the 3″ × 3-1/2″ insulator paper:

1. Use a knife blade to score the insulator as shown in Part A of the Detail. Be careful not to cut all the way through the insulator.

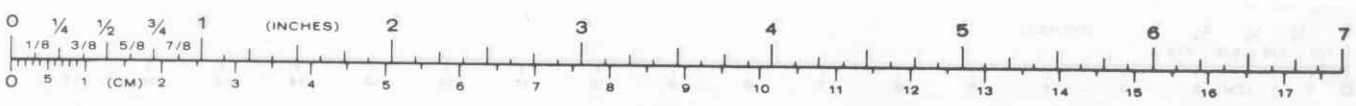
2. Bend the insulator into the shape shown in Part B of the Detail.

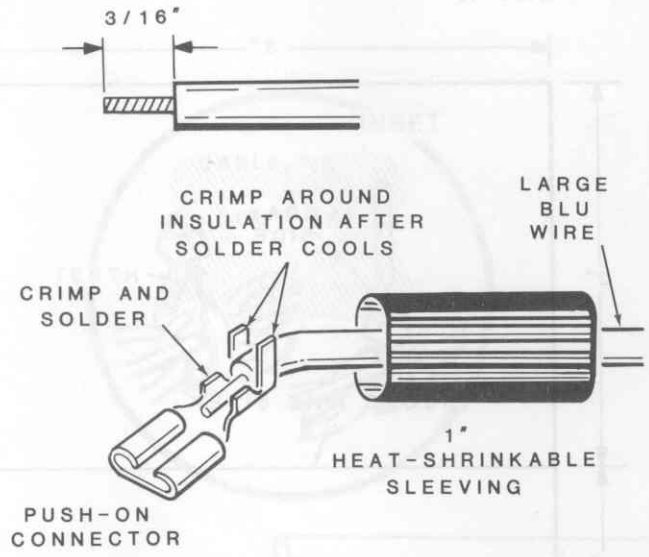
( ) Press the prepared insulator paper onto the top shield in the area shown in the Pictorial. Be sure the insulator paper is under the edge of the rear panel as shown.

( ) Refer to the inset drawing on the Pictorial and install five cable ties on the indicated wires coming from the rear panel. Position each cable tie in the approximate area shown in the Pictorial.



Detail 11-2A





Detail 11-3A

Refer to Pictorial 11-3 (Illustration Booklet, Page 33) for the following steps.

( ) Cut two 1″ lengths of heat-shrinkable sleeving. Use these lengths of sleeving in the next step.

( ) Refer to Detail 11-3A and use the following procedure to install a push-on connector on the free end of each of the two large blue wires (coming from the rear panel):

1. Slide a 1″ length of heat-shrinkable sleeving onto each of the large blue wires.
2. Crimp and solder a push-on connector onto the end of each wire.
3. When each connection cools, slide the sleeving down onto the connector so the end of the sleeving is flush with the end of the connector.
4. Use the heat from a match, lighter, or candle to shrink the sleeving against the connector and wire. Be sure to keep the heat moving so you do not burn the sleeving.

( ) Route the large blue wires around motor A1 as shown in the Pictorial. Then push the connectors on the blue wires onto relay K1 lugs 3 and 5.

( ) Route the large white wire coming from the rear panel as shown in the Pictorial. Then connect the free end of the wire to terminal strip CX lug 2 (NS).

( ) Prepare a 12″ large black wire. Then connect one end of the wire to terminal strip CX lug 1 (NS). Route the wire as shown in the Pictorial and loosely twist it around the white wire that you connected in the previous step. The free end of this wire will be connected later.

Connect the free ends of the wires coming from power transformer T1 to terminal strip CX as follows:

( ) Either black wire to lug 1 (S-2).

( ) Remaining black wire to lug 2 (S-2).

( ) Red-yellow wire to lug 3 (S-1).

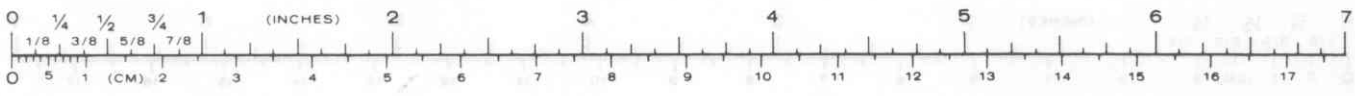
( ) Either red wire to lug 4 (NS).

( ) Remaining red wire to lug 5 (NS).

( ) R4: Cut both leads of a 560 Ω (grn-blu-brn) resistor to 5/8″. Then connect the resistor from optical coupler U2 lug 3 (S-1) to solder lug CS (S-1).

( ) C14: Cut both leads of a .01 μF ceramic capacitor to 5/8″. Then connect the capacitor between motor A1 lugs 1 (NS) and 2 (NS).

( ) C15: Cut both leads of a .01 μF ceramic capacitor to 5/8″. Then connect the capacitor between motor A2 lugs 1 (NS) and 2 (NS).



( ) R5: Cut both leads of a 560 Ω (grn-blu-brn) resistor to 5/8". Then connect the resistor from optical coupler U3 lug 3 (S-1) to solder lug CU (S-1).

( ) C16: Cut both leads of a .01 μF ceramic capacitor to 5/8". Then connect the capacitor between motor A3 lugs 1 (NS) and 2 (NS).

Refer to Pictorial 11-4 (Illustration Booklet, Page 34) for the following steps.

( ) Locate the cutoff sensor cable that you set aside earlier. Then cut an 11" length of the cable. Discard the remainder.

( ) Remove 1-1/2" of outer insulation from each end of the 11" cable. Be careful not to cut into the inner wire insulation when you cut the outer insulation.

( ) Remove 3/8" from each wire at each end of the 11" cable and prepare the ends.

( ) Position the main circuit board as shown in the Pictorial.

( ) Refer to Detail 11-4A and slide a ferrite bead onto the white cable wire. Then connect and solder the wire to main circuit board hole WHT and cut off any excess wire end.

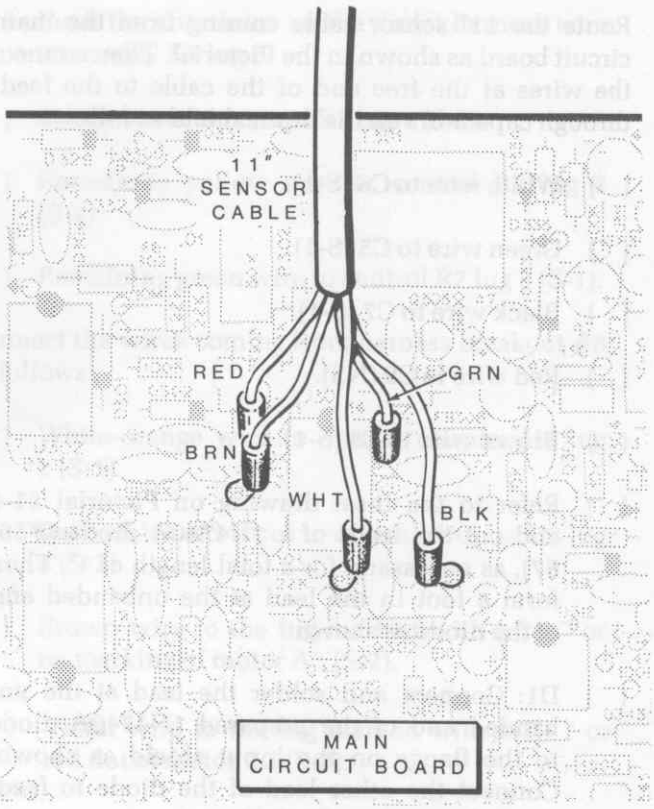
Slide a ferrite bead onto each of the remaining wires at the same end of the cable and connect them to the main circuit board holes as follows. Solder each wire to the foil and cut off any excess wire end as you connect it.

( ) Black wire to hole BLK.

( ) Green wire to hole GRN.

( ) Brown wire to hole BRN.

( ) Red wire to hole RED.



Detail 11-4A

( ) Locate the large insulator paper (5" × 13"). Then refer to Detail 11-4B (Illustration Booklet, Page 35) and position it onto the top shield in the area shown. NOTE: When you have the insulator paper properly positioned, it will fit correctly on the six studs.

( ) Again refer to Detail 11-4B and mount the main circuit board onto the top shield as shown. Use six 6-32 × 1/4" screws. Be careful not to pinch any wires between the circuit board and the top shield or between the screws and the circuit board.

( ) Be sure the slots in the small 3-hole socket shell, coming from the main circuit board, are facing upward (away from the top shield). Then push the socket onto integrated circuit U1.

Route the 11″ sensor cable coming from the main circuit board as shown in the Pictorial. Then connect the wires at the free end of the cable to the feed-through capacitors on the input shield as follows:

( ) White wire to C6 (S-1).

( ) Green wire to C5 (S-1).

( ) Black wire to C7 (S-1).

( ) Red wire to C9 (NS).

( ) Brown wire to C8 (S-1).

( ) Refer to the inset drawing on Pictorial 11-4 and cut the leads of a 1N4740A diode (#56-67), as necessary, for a total length of 1″. Then form a foot in the lead at the unbanded end of the diode as shown.

( ) D1: Connect and solder the lead at the unbanded end of the prepared 1N4740A diode to the flange on the input shield as shown. Connect the other lead of the diode to feed-through capacitor C9 (S-2).

( ) Locate the wires coming from harness breakout #1 (this is the end of the harness that extends from the left side of the main circuit board). Then refer to Detail 11-4C (Illustration Booklet, Page 35) Part A and crimp and solder a female connector pin onto the end of each wire coming from breakout #1 **except the yellow wire.**

Position a 9-hole plug shell as shown in Detail 11-4C Part B (note the location of the "V" side of the plug shell). Then push the female connector pins on the harness wires into the plug shell until they lock into place as follows. NOTE: Be sure to insert the pins into the correct holes; they are very difficult to remove once they are installed.

( ) White-black wire into hole 1.

( ) White-brown wire into hole 2.

( ) White-red wire into hole 3.

( ) White-orange wire into hole 4.

( ) White-yellow wire into hole 5.

( ) White-green wire into hole 6.

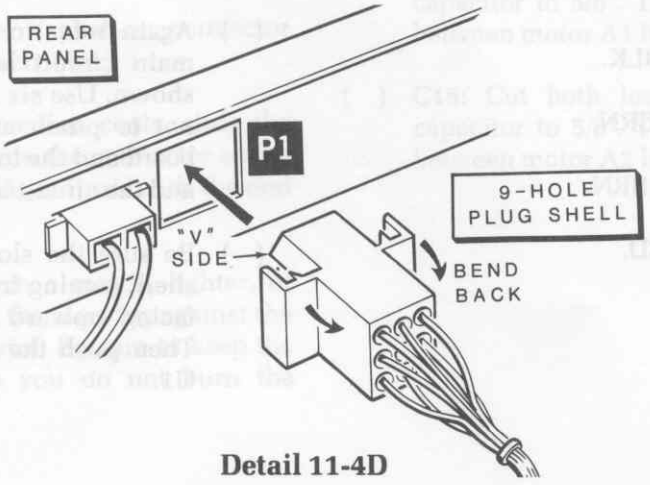
( ) White-blue wire into hole 7.

( ) White-violet wire into hole 8.

( ) White-gray wire into hole 9.

( ) P1: Bend back the ears on the 9-hole plug shell as shown in Detail 11-4D. Then push the plug shell into the rear panel hole at P1 until it locks into place.

( ) Connect the free end of the yellow wire coming from harness breakout #1 to speaker SP1 lug 1 (S-1).



Detail 11-4D

Refer to Pictorial 11-5 (Illustration Booklet, Page 36) for the following steps.

( ) Route harness breakouts #8 through 11 across the front of the chassis as shown in the Pictorial.

Connect the wires coming from harness breakout #10 as follows:

( ) White-brown wire to optical coupler U2 lug 2 (S-1).

( ) White-red wire to optical coupler U2 lug 4 (S-1).

NOTE: If you find the holes in the motor lugs are not large enough to connect harness wires to them, in some of the following steps, wrap the wire around the lug near the capacitor lead.

( ) Long yellow wire to the lug marked with a "+" or red dot of motor A1 (S-2).

( ) Long green wire to the lug marked with a "−" or no marking of motor A1 (S-2).

( ) Blue wire to the lug marked with a "+" or red dot of motor A2 (S-2).

( ) White-green wire to the lug marked with a "−" or no marking of motor A2 (S-2).

( ) Slide a 1" length of heat-shrinkable sleeving onto the gray wire. Then crimp and solder a push-on connector onto the end of the wire and shrink the sleeving onto the connector and wire. Use the same procedure you used earlier with the large blue wires.

( ) Similarly, install sleeving and a push-on connector on the free end of the violet wire.

( ) Push the connector on the gray harness wire onto relay K1 lug 1.

( ) Push the connector on the violet harness wire onto relay K1 lug 6.

( ) Orange wire to control R7 lug 1 (S-1).

( ) Remaining yellow wire to control R7 lug 2 (S-1).

( ) Remaining green wire to control R7 lug 3 (S-1).

Connect the wires coming from harness breakout #8 as follows:

( ) White-orange wire to optical coupler U3 lug 2 (S-1).

( ) **Both** white-red wires to optical coupler U3 lug 4 (S-2).

( ) Brown wire to the lug marked with a "−" or no marking of motor A3 (S-2).

( ) Violet wire to the lug marked with a "+" or red dot of motor A3 (S-2).

Connect some of the wires coming from harness breakout #11 as follows:

( ) White-green wire to control R6 lug 3 (S-1).

( ) White-yellow wire to control R6 lug 2 (S-1).

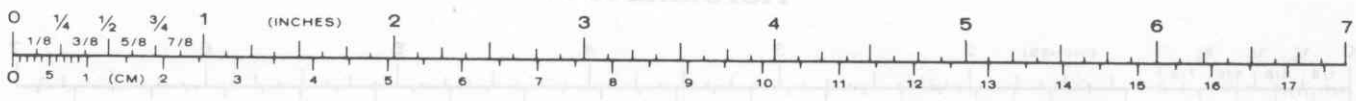
( ) White-orange wire to control R6 lug 1 (S-1).

( ) **Both** black wires to the control solder lug (S-2).

( ) Either large orange wire to terminal strip CX lug 4 (S-2).

( ) Remaining large orange wire to terminal strip CX lug 5 (S-2).

NOTE: The remaining wires coming from harness breakout #11 will be connected later.



Refer to Pictorial 11-6 for the following steps.

( ) Position the switch subpanel as shown in the Pictorial.

( ) Cut three 1" lengths of bare wire. Use these bare wires in the following steps.

( ) Connect a 1" bare wire between switch SW2 lugs 1 (S-1) and 12 (S-1).

( ) Connect a 1" bare wire from switch SW2 lug 4 (S-1) to switch SW1 lug 9 (S-1).

( ) Connect a 1" bare wire from switch SW3 lug 3 (NS) to switch SW4 lug 4 (NS).

( ) Prepare the following wires. The wires are listed in the order in which you will use them.

7" small red

5" small brown

4-1/2" small yellow

8" small orange

4" small red

2-1/2" small brown

( ) Connect one end of a 7" small red wire to switch SW2 lug 11 (S-1). The other wire end will be connected later.

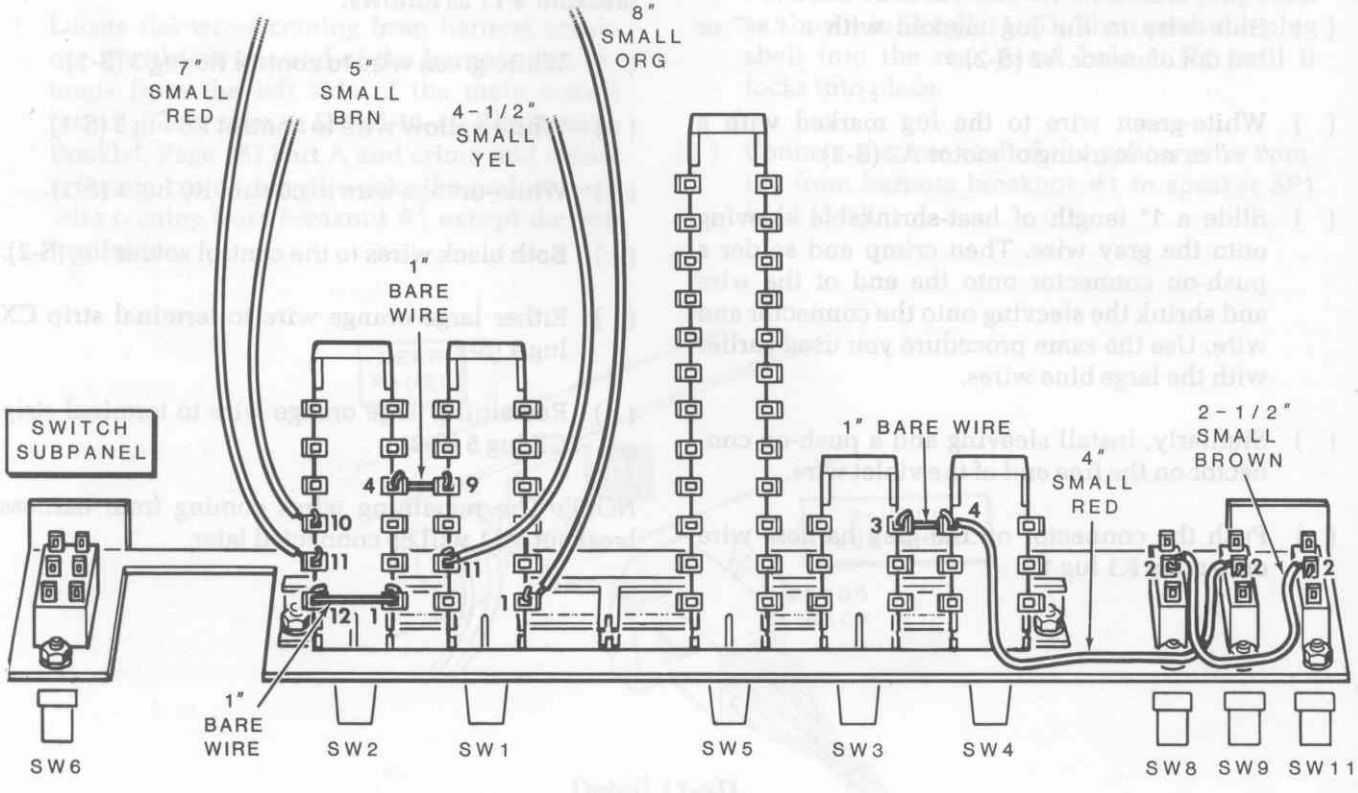
( ) Connect one end of a 5" small brown wire to switch SW2 lug 10 (S-1). The other wire end will be connected later.

( ) Connect one end of a 4-1/2" small yellow wire to switch SW1 lug 11 (S-1). The other wire end will be connected later.

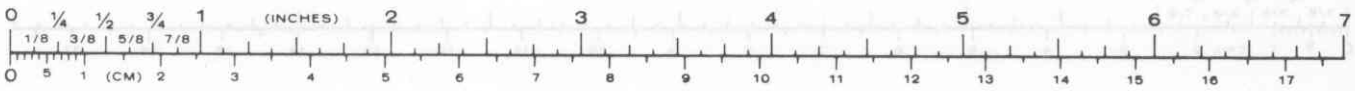
( ) Connect one end of an 8" small orange wire to switch SW1 lug 1 (S-1). The other wire end will be connected later.

( ) Connect a 4" small red wire from switch SW4 lug 4 (S-2) to switch SW9 lug 2 (S-1).

( ) Connect a 2-1/2" small brown wire from switch SW8 lug 2 (S-1) to switch SW11 lug 2 (NS).



PICTORIAL 11-6



Refer to Pictorial 11-7 (Illustration Booklet, Page 37) for the following steps.

( ) Position the switch subpanel near the chassis as shown in the Pictorial.

NOTE: In the next three steps, make mechanically secure connections.

( ) Connect the large black wire coming from the rear of the chassis to switch SW6 lug 3 (S-1).

( ) Connect the large black wire coming from the front of the chassis to switch SW6 lug 2 (S-1).

( ) Connect the large red wire coming from the rear of the chassis to switch SW6 lug 5 (S-1).

Connect the wires coming from harness breakout #13 to the switches on the switch subpanel as follows:

( ) Large red wire to switch SW6 lug 4 (S-1).

( ) White-orange wire to switch SW2 lug 2 (S-1).

( ) Either white-violet wire to switch SW2 lug 5 (S-1).

( ) Gray wire to switch SW1 lug 12 (S-1).

( ) Green wire to switch SW1 lug 10 (S-1).

( ) Remaining white-violet wire to switch SW1 lug 8 (S-1).

( ) Blue wire to switch SW1 lug 2 (S-1).

Connect the wires coming from harness breakout #12 to switch SW5 as follows:

( ) White-red wire to lug 24 (S-1).

( ) White-black wire to lug 23 (S-1).

( ) White-brown wire to lug 22 (S-1).

( ) Orange wire to lug 21 (S-1).

( ) White-orange wire to lug 20 (S-1).

NOTE: Be sure to skip lug 19.

( ) White-green wire to **lug 18** (S-1).

( ) Green wire to lug 17 (S-1).

NOTE: Be sure to skip lugs 15 and 16.

( ) Either white wire to lug 14 (S-1).

( ) Remaining white wire to lug 13 (S-1).

( ) White-gray wire to lug 1 (S-1).

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

( ) Brown wire to lug 3 (S-1).

( ) Yellow wire to lug 4 (S-1).

( ) White-yellow wire to lug 5 (S-1).

( ) White-blue wire to lug 6 (S-1).

( ) Violet wire to lug 7 (S-1).

( ) White-violet wire to lug 8 (S-1).

( ) Blue wire to lug 9 (S-1).

Connect the wires coming from harness breakout #11 to the switches on the front subpanel as follows:

( ) White-violet wire to switch SW3 lug 2 (S-1).

( ) Red wire to switch SW3 lug 3 (S-2).

( ) Gray wire to switch SW4 lug 5 (S-1).

( ) Orange wire to switch SW8 lug 3 (S-1).

( ) Yellow wire to switch SW8 lug 1 (S-1).

( ) White-gray wire to switch SW9 lug 3 (S-1).

( ) White-red wire to switch SW9 lug 1 (S-1).

( ) Green wire to switch SW11 lug 3 (S-1).

( ) Brown wire to switch SW11 lug 2 (S-2).

( ) Violet wire to switch SW11 lug 1 (S-1).

( ) Refer to Pictorial 11-8 (Illustration Booklet, Page 38) and mount the switch subpanel to the chassis as shown. Use three 6-32 × 1/4″ screws. Be careful not to pinch any wires between the subpanel and the chassis.

Refer to Pictorial 11-9 (Illustration Booklet, Page 39) for the following steps.

( ) Position the front panel assembly (set aside earlier) as shown in the Pictorial.

( ) Cut a 1″ bare wire. Then connect the wire between control R1 lugs 2 (NS) and 3 (S-1).

( ) Look at the lugs on the back of meter M2. Then remove and discard any shorting wire that may be connected between the lugs.

( ) C4: Cut both leads of a .001 μF ceramic capacitor to 3/4″. Then connect the capacitor between meter M2 lugs 1 (NS) and 2 (NS).

( ) Look at the lugs on the back of meter M1. Then remove and discard any shorting wire that may be connected between the lugs.

( ) C3: Cut both leads of a .001 μF ceramic capacitor to 3/4″. Then connect the capacitor between meter M1 lugs 1 (NS) and 2 (NS).

( ) R2: Cut both leads of a 75 Ω (viol-grn-blk) resistor to 3/4″. Then connect the resistor from control R3 lug 1 (S-1) to the nearby control solder lug (NS). Be sure to position the resistor as shown so the leads cannot touch the other lugs on the control.

( ) Prepare the following lengths of small gray wire:

One 4-1/2″

One 2-1/2″

Two 4″

( ) Connect a 4-1/2″ small gray wire from meter M2 lug 1 (S-2) to solder lug DH (NS).

( ) Connect a 2-1/2″ small gray wire from meter M1 lug 1 (S-2) to solder lug DH (S-2).

( ) Connect a 4″ small gray wire from the control solder lug near control R3 (NS) to switch SW7B lug 11 (S-1).

( ) Connect one end of a 4″ small gray wire to the control solder lug near control R3 (S-3). The other wire end will be connected later.

Refer to Pictorial 11-10 (Illustration Booklet, Page 40) for the following steps.

( ) Position the front panel assembly near the front of the chassis as shown in the Pictorial.

( ) Connect the free end of the brown wire, coming from switch SW2 on the switch subpanel, to control R1 lug 1 (S-1).

( ) Connect the free end of the yellow wire, coming from switch SW1 on the switch subpanel, to control R1 lug 2 (S-2).

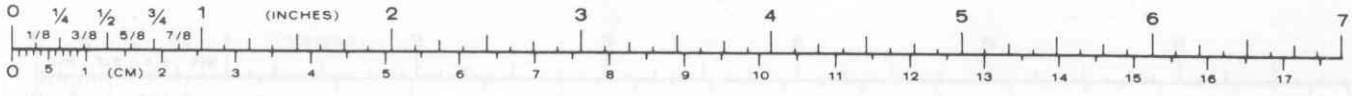
( ) Connect the free end of the red wire, coming from switch SW2 on the switch subpanel, to meter M2 lug 2 (S-2).

( ) Connect the free end of the orange wire, coming from switch SW1 on the switch subpanel, to meter M1 lug 2 (S-2).

Connect some of the wires coming from harness breakout #14 to control R3 on the front panel assembly as follows:

( ) Violet wire to control R3 lug 3 (S-1).

( ) White-violet wire to control R3 lug 2 (S-1).



Refer to Pictorial 11-11 (Illustration Booklet, Page 41) for the following steps.

( ) Position the display circuit board near the front panel assembly as shown in the Pictorial.

Connect the remaining wires coming from harness breakout #14 to the holes in the display circuit board as follows. Solder each wire to the foil and cut off any excess wire end as you connect it.

( ) Blue wire to hole F.

( ) White wire to hole LO.

( ) White-brown wire to hole HI.

( ) White-gray wire to hole BN.

( ) White-red wire to hole CE.

( ) White-black wire to hole BZ.

( ) Red wire to hole H.

( ) White-blue wire to hole CD.

( ) Black wire to hole CF.

( ) Orange wire to hole CJ.

( ) Brown wire to hole CH.

( ) Yellow wire to hole CK.

( ) Connect the gray wire coming from the control solder lug on the front panel, near control R3, to display circuit board hole CG (S-1).

( ) Refer to Detail 11-11A (Illustration Booklet, Page 41) and use the following procedure to mount the display circuit board to the front panel assembly:

1. Refer to Part A of the Detail and make sure each of the lamps on the foil side of the display circuit board is perpendicular to the circuit board.

2. Refer to Part B of the Detail and carefully position the circuit board onto the front panel so each of the lamps lines up with its corresponding hole in the front panel, and the shaft of switch detent DF passes through the large hole in the circuit board.

3. Use four 4-40 x 5/16" screws and four #4 lockwashers to secure the display circuit board to the front panel at DC, DD, DE, and DJ. Note that the screw at DC goes through the mounting tab for U205.

Refer to Detail 11-11B and connect the wires coming from harness breakout #9 to switch SW7 as follows. Solder each wire and cut off any excess wire end as you connect it.

( ) Yellow wire to SW7A lug 2 (S-1). NOTE: There is no lug 1 on this wafer of the switch.

( ) Green wire to SW7A lug 3 (S-1).

( ) Blue wire to SW7A lug 4 (S-1).

( ) White-black wire to **SW7B** lug 1 (S-1).

( ) White-brown wire to SW7B lug 2 (S-1).

( ) White-red wire to SW7B lug 3 (S-1).

( ) White-orange wire to SW7B lug 4 (S-1).

( ) White-yellow wire to SW7B lug 5 (S-1).

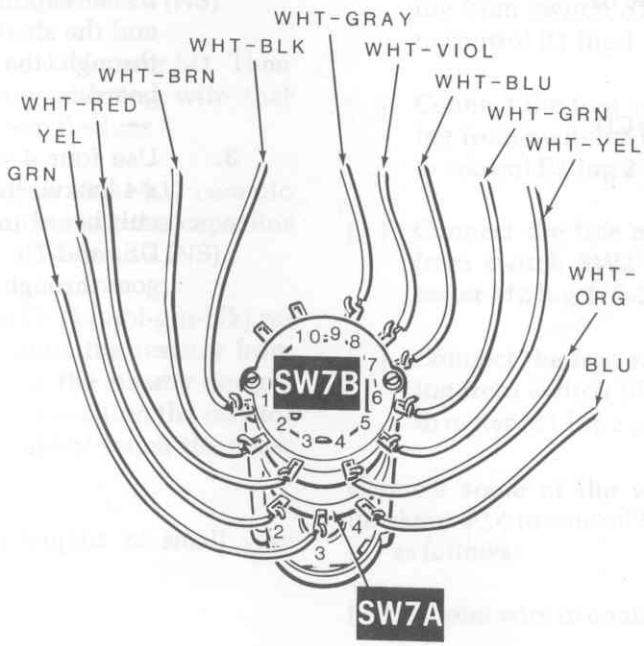
( ) White-green wire to SW7B lug 6 (S-1).

( ) White-blue wire to SW7B lug 7 (S-1).

( ) White-violet wire to SW7B lug 8 (S-1).

( ) White-gray wire to SW7B lug 9 (S-1).

NOTE: No wire will be connected to switch SW7B lug 10.



Detail 11-11B

Refer to Pictorial 11-12 for the following steps.

( ) Start two 6-32 × 3/16″ setscrews into the shaft coupler. Then slide the shaft coupler onto the 16″ shaft (coming through a hole in the center shield). Do not tighten the setscrews yet. Also, be careful not to turn the shaft when you perform this step.

( ) Use the following procedure to mount the front panel assembly onto the chassis:

1. Position the front panel into the front of the chassis. Be careful not to pinch any wires between the front panel and the chassis or the switch subpanel.

2. Use five 6-32 × 1/4″ screws to secure the front panel assembly to the chassis.

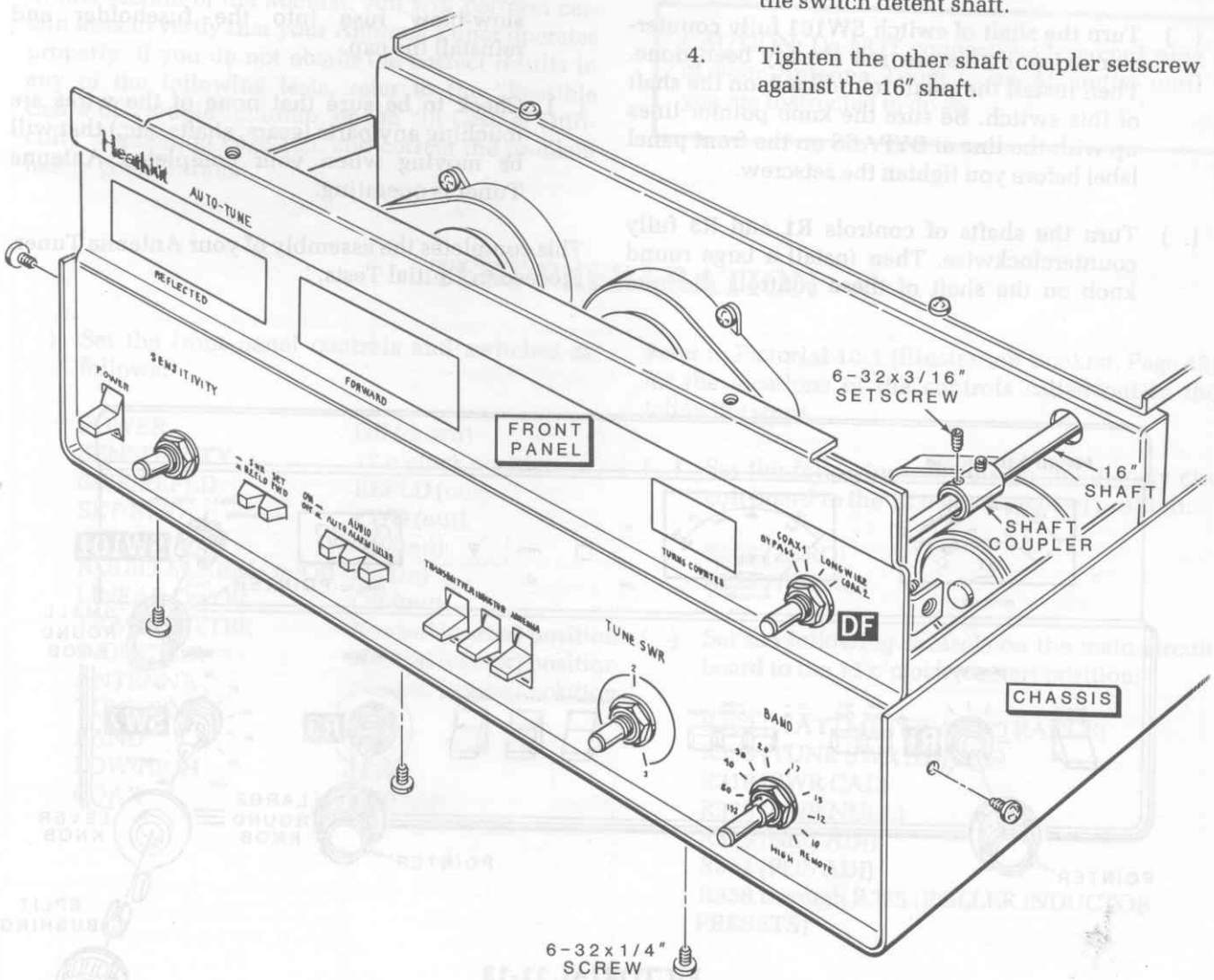
( ) Use the following procedure to tighten the setscrews in the shaft coupler:

1. Turn the shaft of switch detent DF fully counterclockwise (as viewed from the front panel), if this has not already been done.

2. Pull the 16″ shaft forward so it just touches the shaft of switch detent DF.

3. Slide the shaft coupler forward so it is half way on each shaft. Then tighten the shaft coupler setscrew against the flat on the switch detent shaft.

4. Tighten the other shaft coupler setscrew against the 16″ shaft.



PICTORIAL 11-12

Detail 11-13A

Refer to Pictorial 11-13 for the following steps.

( ) Refer to Detail 11-13A and start a 6-32 × 3/16" setscrew into each of the three large round knobs and a 6-32 × 1/8" setscrew into the small round knob.

( ) Turn the shaft of switch SW101 fully counterclockwise, if this has not already been done. Then install the small round knob on the shaft of this switch. Be sure the knob pointer lines up with the line at BYPASS on the front panel label before you tighten the setscrew.

( ) Turn the shafts of controls R1 and R3 fully counterclockwise. Then install a large round knob on the shaft of these controls. Be sure each knob pointer lines up with the line at the 7 o'clock position on the front panel before you tighten the setscrew.

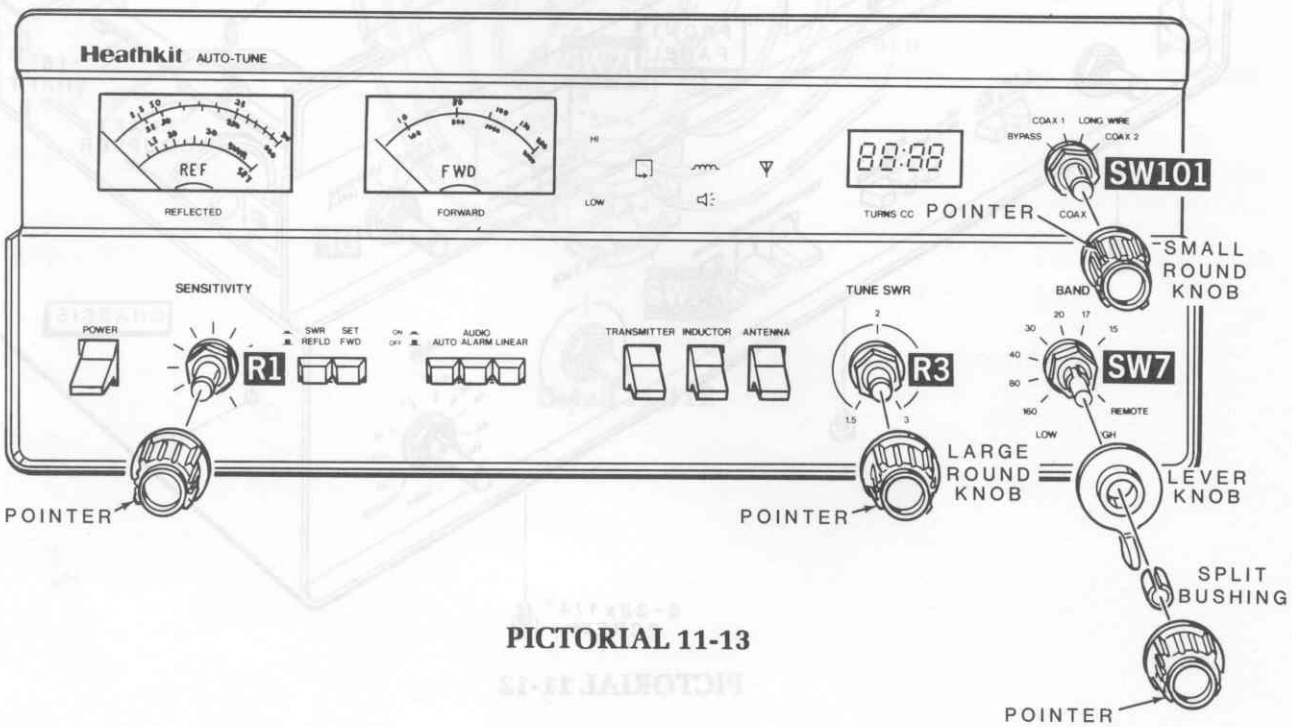
( ) Turn both shafts of switch SW7 fully counterclockwise. Then install the lever knob on the larger shaft so the lever lines up with HIGH on the front panel.

( ) Push the split bushing into the remaining large round knob. Then install the large round knob and split bushing on the smaller shaft of switch SW7. Be sure the knob pointer lines up with the line at 160 on the front panel before you tighten the setscrew.

( ) F1: Remove the cap from the fuseholder on the rear panel. Then insert the 1/4-ampere, slow-blow fuse into the fuseholder and reinstall the cap.

( ) Check to be sure that none of the wires are touching any parts (gears, shafts, etc.) that will be moving when your completed Antenna Tuner is operating.

This completes the assembly of your Antenna Tuner. Proceed to "Initial Tests."



PICTORIAL 11-13

INITIAL TESTS

In this section of the Manual, you will perform certain tests to verify that your Antenna Tuner operates properly. If you do not obtain the correct results in any of the following tests, refer to the "Possible Cause of Trouble" column, or the "In Case of Difficulty" section on Page 126, and correct the problem before you continue.

CAUTION: Do NOT connect the line cord plug of your Antenna Tuner to an AC outlet until you are instructed to do so.

TEST PREPARATION

( ) Set the front panel controls and switches as follows:

POWER	Off (down)
SENSITIVITY	12 o'clock position
SWR/REFLD	REFLD (out)
SET/FWD	FWD (out)
AUTO On/Off	Off (out)
AUDIO ALARM On/Off	On (in)
LINEAR On/Off	Off (out)
TRANSMITTER	Neutral (center) position
INDUCTOR	Neutral (center) position
ANTENNA	Neutral (center) position
TUNE SWR	2
BAND	80
LOW/HIGH	LOW
COAX	BYPASS

Refer to Pictorial 12-1 (Illustration Booklet, Page 42) for the locations of the controls called out in the following steps.

( ) Set the following controls on the display circuit board to the 12 o'clock (center) position:

R204 (ZERO)
R233 (TURNS)

( ) Set the following controls on the main circuit board to the 12 o'clock (center) position:

R302 (WATTMETER AUTO RANGE)
R335 (TUNE SWR ADJUST)
R318 (SWR CAL)
R326 (SWR NULL)
R379 (NEG ADJ)
R381 (POS ADJ)
R358 through R375 (ROLLER INDUCTOR PRESETS)

PRIMARY WIRING TESTS

IMPORTANT: A wiring error in the primary wiring circuit (line cord, power switch, etc.) of your kit could cause you to receive a severe electrical shock. These "Primary Wiring Tests" will help you eliminate any such wiring errors that may exist.

( ) Be sure the line cord plug is not connected to an AC outlet.

( ) Be sure the POWER switch is off.

NOTE: If you do not have an ohmmeter, carefully check the line cord, switch SW6, and the transformer wiring against the wiring shown in Pictorials 11-3 and 11-5. Make sure there are no fine strands of wire or solder globs touching adjacent terminals or the chassis. Then proceed to "Power On Tests."

If you have an ohmmeter, perform the following resistance measurements. NOTE: You will be instructed to connect one of the ohmmeter leads to ground. You may use the GROUND post on the rear panel for this.

( ) Turn on your ohmmeter and allow it to warm up, if necessary.

( ) Set the ohmmeter to the R × 10 range.

NOTES:

1. The resistance readings in the following steps were taken with a Heathkit Model IM-5218 VTVM. Readings taken with other ohmmeters (because of different measuring voltages and currents) may be considerably different.
2. The internal wiring of most ohmmeters is such that the negative terminal of the meter battery is connected to the negative (black) or common test lead. In some ohmmeters this wiring is interchanged, and erroneous readings may result. Interchange the ohmmeter leads if the measurements do not check out correctly the first time.

METER CONNECTIONS		METER READING	POSSIBLE CAUSE OF TROUBLE
POSITIVE LEAD	COMMON LEAD		
( ) Either flat prong of the line cord plug.	Ground.	INFINITE with the POWER switch on or off.	A. Wiring of switch SW6. B. Wiring of transformer T1.
( ) Other flat prong of the line cord plug.	Ground.	INFINITE with the POWER switch on or off.	A. Wiring of switch SW6. B. Wiring of transformer T1.
( ) Round prong of the line cord plug.	Ground.	0 Ω with the POWER switch on or off.	A. Green wire not properly connected from line cord to solder lug L. See Pictorial 3-1 (Illustration Booklet, Page 20).
( ) Either flat prong of the line cord plug.	Other flat prong.	INFINITE with the POWER switch off.	A. Wiring of switch SW6. B. Wiring of transformer T1.
( ) Either flat prong of the line cord plug.	Other flat prong.	Approximately 20 Ω to 40 Ω with the POWER switch on.	A. Wiring of switch SW6. B. Wiring of transformer T1.

This completes the "Primary Wiring Tests." Proceed to "Power Off Tests."

POWER OFF TESTS

These ohmmeter tests provide you with a very important means to check the circuits in your Antenna Tuner so they will not become damaged when you apply power. Therefore, if you do not have an ohmmeter, you may wish to borrow one.

If you do not obtain the indicated results in any test, refer to the "Possible Cause of Trouble" column. If you do get the correct results, proceed with the next step.

( ) Turn on your ohmmeter and allow it to warm up, if necessary.

( ) Set the ohmmeter to the R × 10 range.

( ) Be sure the Antenna Tuner line cord plug is not connected to an AC outlet.

( ) Be sure the POWER switch is in the off (down) position.

Make a check (√) next to each item listed as you verify the readings in the following chart.

METER CONNECTIONS		METER READING	POSSIBLE CAUSE OF TROUBLE
POSITIVE LEAD	COMMON LEAD		
( ) Brown wire at feedthrough capacitor C8.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C8 or C303. B. Check sensor assembly. C. Check U301.
( ) Red wire at feedthrough capacitor C9.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C9 or C304. B. Check sensor assembly. C. Check U301.
( ) Black wire at feedthrough capacitor C7.	Ground.	0 Ω.	A. Check capacitor C7. B. Check sensor assembly.
( ) Green wire at feedthrough capacitor C5.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C5 or C301. B. Check sensor assembly. C. Check U301.
( ) White wire at feedthrough capacitor C6.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C6 or C302. B. Check sensor assembly. C. Check U301.

METER CONNECTIONS		METER READING	POSSIBLE CAUSE OF TROUBLE
POSITIVE LEAD	COMMON LEAD		
( ) Pin 1 of socket S2.	Ground.	0 Ω.	A. Large black wire not connected from pin 1 of socket S2 to solder lug GA. See Pictorial 11-1 (Illustration Booklet, Page 32).
( ) Pin 2 of socket S2.	Ground.	INFINITY with the POWER switch off. Minimum 10 kΩ with the POWER switch on.	A. Check wiring of switch SW6. B. Check D331 and D332. C. Check U1.
( ) Pin 1 of socket S1.	Ground.	INFINITY.	A. Check wiring of relay K1.
( ) Pin 3 of socket S1.	Ground.	INFINITY.	A. Check wiring of relay K1.
( ) Center pin on sensor assembly's INPUT jack.	Ground.	INFINITY.	A. Check sensor assembly.
( ) Center pin on sensor assembly's COAX 1 jack.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) Center pin on sensor assembly's COAX 2 jack.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) Center pin on sensor assembly's BYPASS jack.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) SINGLE WIRE post on rear panel.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) Lead of ferrite bead FB304.	Ground.	Minimum 50 Ω.	
( ) Plus (+) lead of capacitor C331.	Ground.	Minimum 10 kΩ.	A. Check D331 and D332. B. Check U1. C. Check C331.

( ) Place the COAX switch in the BYPASS position.

( ) Center pin on sensor assembly's INPUT jack.	Center pin on sensor assembly's BYPASS jack.	0 Ω.	See * on page 109.

( ) Repeat the last step for each of the three remaining COAX switch position. Each time, the meter should read "INFINITY."

( ) Place the COAX switch in the COAX 1 position.

( ) Center pin on sensor assembly's COAX 1 jack.	Feedthrough insulator C. Set inset drawing #2 on Pictorial 12-1.	0 Ω.	See * on page 109.

( ) Place the COAX switch in the COAX 2 position.

( ) Center pin on sensor assembly's COAX 2 jack.	Feedthrough insulator C.	0 Ω.	See * below.

( ) Place the COAX switch in the LONG WIRE position.

( ) SINGLE WIRE post on rear panel.	Feedthrough insulator C.	0 Ω.	See * below.

NOTE: For each position (except REMOTE) of the BAND switch, only one particular pin on plug P1 should be connected to ground (displayed as 0 Ω on your ohmmeter) as indicated in the following chart. The ohmmeter should indicate INFINITY for the remaining eight plug pins for each BAND switch setting.

Make a check (√) next to each band listed as you verify the readings in the following chart.

BAND	PLUG P1 PIN NO.								
	1	2	3	4	5	6	7	8	9
( ) 160	0 Ω								
( ) 80		0 Ω							
( ) 40			0 Ω						
( ) 30				0 Ω					
( ) 20					0 Ω				
( ) 17						0 Ω			
( ) 15							0 Ω		
( ) 12								0 Ω	
( ) 10									0 Ω
( ) Remote									

( ) Disconnect the ohmmeter leads from the Antenna Tuner.

This completes the "Power Off Tests." Proceed to the "Power On Tests."

* If your meter does not read 0 Ω for any of the COAX switch positions, refer to Pictorial 11-12 on Page 103 and loosen the rear setscrew in the shaft coupler installed on the 16" shaft. Slowly turn that shaft in either direction until the meter reads 0 Ω. Then retighten the setscrew.

POWER ON TESTS

CAUTION: When the line cord plug is connected to an AC outlet, the AC voltage will be present at several places on the Antenna Tuner chassis, as shown in Pictorial 12-1 (Illustration Booklet, Page 42). Be careful that you do not contact this voltage because an electrical shock will result.

A DC voltmeter is required for the following tests. This voltmeter should have a 10 MΩ (or higher) input impedance.

Refer to Pictorial 12-1 for the following steps.

NOTES:

1. If you fail to obtain the desired readings in each of the following tests, push the POWER switch to off and refer to the "In Case of Difficulty" section of this Manual.

2. Set your voltmeter to the proper DC voltage range to obtain meaningful readings in the following steps. Be sure to switch your voltmeter leads or voltmeter polarity switch to check for negative (−) voltages.

3. Be sure to touch only the indicated circuit point. To do otherwise might short a connection and damage an integrated circuit (IC) or transistor, for example.

4. All voltages were taken with a vacuum-tube voltmeter (VTVM). The readings that you get should be within ± 5% of those indicated in the steps.

( ) Turn on your voltmeter and allow it to warm up, if necessary.

( ) Position the chassis as shown in the Pictorial.

( ) Connect the line cord plug to a 120 VAC outlet.

( ) Connect the common (negative) lead of your DC voltmeter to the GROUND post on the rear panel of your Antenna Tuner.

( ) Place the POWER switch in the on (up) position. The digital turns counter should light. The audio alarm may sound and the visual alarm may light. Also, both capacitor motors may turn until the slot in each decoder disk is located between the posts of the respective optical couplers (U1 and U2).

( ) Touch the test probe of your DC voltmeter to FB304 (on the main circuit board). The meter should indicate +12.0 volts.

( ) Touch the test probe of your DC voltmeter to TP303. The meter should indicate between +5.0 and +12.0 volts.

( ) Touch the test probe of your DC voltmeter to the O (output) pin of U205 (on the display circuit board). The meter should indicate +5.0 volts.

( ) Touch the test probe of your DC voltmeter to pin 4 of U317 (on the main circuit board). The meter should indicate +10.0 volts.

( ) Touch the test probe of your DC voltmeter to TP304. The meter should indicate between −5.0 and −12.0 volts. NOTE: Exchange your voltmeter leads or switch polarity as required.

( ) Touch the test probe of your DC voltmeter to the indicated lead of resistor R382 (680 Ω, blu-gry-brn). The meter should indicate between −3.0 and −3.5 volts.

( ) Touch the test probe of your DC voltmeter to the indicated lead of resistor R383 (56 Ω, grn-blu-blk). The meter should indicate between −.05 and −.2 volt.

( ) Disconnect the voltmeter leads from the Antenna Tuner.

( ) Place the POWER switch in the off (down) position.

This completes the "Power On Tests." Proceed to "Adjustments."

ADJUSTMENTS

You will need the following equipment as you make the necessary adjustments in your Antenna Tuner:

- A DC voltmeter.
- An RF source (transmitter, transceiver, etc.) covering the desired amateur bands and capable of delivering a minimum of 200 watts of RF power.
- A 50 Ω nonreactive load capable of dissipating at least the power produced by your RF source.

( ) Set the Antenna Tuner front panel controls and switches as follows:

POWER	Off
SENSITIVITY	12 o'clock position
SWR/REFLD	REFLD (out)
SET/FWD	FWD (out)
AUTO On/Off	Off (out)
AUDIO ALARM On/Off	Off (out)
LINEAR On/Off	Off (out)
TRANSMITTER, INDUCTOR, ANTENNA	Neutral (center position)
TUNE SWR	2 (12 o'clock position)
BAND	80
LOW/HIGH	LOW
COAX	COAX 1

NOTE: If you do not obtain the proper results in the following steps, place the POWER switch of your Antenna Tuner in the off position, refer to the "In Case of Difficulty" section of this Manual, and correct any difficulties before you proceed.

Refer to Pictorial 13-1 (Illustration Booklet, Page 43) for the following steps.

( ) Check transmitter matching capacitor C1 to see that the rotor is half meshed (half closed). If it is not, turn the POWER on and push the TRANSMITTER lever switch up or down until the rotor reaches the half-mesh position. Then release the lever switch (to its neutral position).

( ) In the same manner, if necessary, use the ANTENNA lever switch to place the rotor for antenna matching capacitor C2 in the half-mesh position.

( ) Place the POWER switch in the off position.

( ) Check and see if the slot on the disk decoder, which is installed on the small shaft of motor A1, is positioned between the two posts of optical coupler U2. If it is not, temporarily loosen the 4-40 × 1/8" setscrew installed in the collar of the decoder disk and rotate the decoder disk to position it properly; then tighten the setscrew.

( ) In the same manner, if necessary, position the slot in the other decoder disk between the two posts of optical coupler U1.

Refer to Pictorial 13-2 (Illustration Booklet, Page 44) for the following steps.

( ) Turn on your DC voltmeter and allow it to warm up, if necessary.

( ) Connect the common (negative) lead of your DC voltmeter to the GROUND post on the rear panel of your Antenna Tuner.

( ) Make sure control R6 is turned fully clockwise.

( ) Place the POWER switch in the on position.

( ) Touch the test probe of your DC voltmeter to the indicated lug of ZERO control R204 (on the display circuit board). Then adjust control R204 for a voltmeter reading of +3.0 volts.

NOTE: When you operate the lever switch for the roller inductor, be careful that the roller contact does not turn past its end stops. This could cause the roller contact to jump off the wire turns on the inductor.

( ) While viewing the roller contact through the left side of the chassis and the plates of matching capacitor C1, check and see if it is positioned at the end of its travel near the rear panel. If it is not, push and hold the front panel near the rear panel INDUCTOR switch down until the roller contact just reaches this position. Then release the switch.

1. ( ) Rotate the shaft of inductor position control R6 until the front panel digital turns counter reads 00:0.

2. ( ) Carefully reinstall the spur gear on the shaft of control R6. Be sure the digital turns counter still reads 00:0. If it does not, rotate the shaft of control R6, as necessary, until it does. Then tighten the setscrew in the bushing of the spur gear.

( ) Push and hold the INDUCTOR lever switch up until the roller contact just reaches the end of its travel, near the front panel. Then release the switch.

( ) Adjust TURNS control R233, on the display circuit board, for a reading of 40:0 on the turns counter.

( ) Push and hold the INDUCTOR lever switch down until the roller contact just reaches the end of its travel, near the rear panel. Then release the switch.

( ) Be sure the turns counter still reads 00:0. If it does not, again loosen the setscrew in the bushing of the spur gear, and temporarily remove the gear. Then repeat steps 1 and 2.

( ) Push and hold the INDUCTOR lever switch up until the roller contact just reaches the end of its travel, near the front panel. Then release the switch.

( ) Be sure the turns counter still reads 40:0. If it does not, adjust TURNS control R233 until it does.

( ) Place the Antenna Tuner COAX switch in the COAX 1 position if this has not already been done.

( ) Connect a length of 50 Ω coaxial cable from the antenna output connector on your transmitter (or transceiver) to the Antenna Tuner INPUT jack.

( ) Connect a 50 Ω nonreactive load to the Antenna Tuner COAX 1 jack.

( ) Touch the test probe of your DC voltmeter to TP301 on the main circuit board. Then adjust POS ADJ control R381 for a voltmeter reading of 1.0 volt.

( ) Touch the test probe of your DC voltmeter to TP303 and record the voltmeter reading: + _____ volts.

( ) Touch the test probe of your DC voltmeter to TP304 and adjust NEG ADJ control R379 for the same reading you obtained in the last step, except for having negative polarity: − _____ volts.

( ) Repeat the previous three steps.

NOTE: In the following step, as you slowly turn the control clockwise from its preset center position, the voltage you measure will vary quite rapidly from about −1.0 volt, through 0 volt to +1.0 volt. As soon as your voltmeter reading does not increase any more (approximately +1.0 volt), immediately stop turning the control.

( ) Touch the test probe of your DC voltmeter to pin 4 of U304. Then adjust SWR NULL control R326 for a voltmeter reading as noted above.

( ) First touch the test probe of your DC voltmeter to TP301 and then to pin 4 of U304. The two meter readings should be within ±.05 volt.

( ) Touch the test probe of your DC voltmeter to TP302 and adjust TUNE SWR ADJ control R335 for a voltmeter reading of +.7 volt.

NOTE: In the following step, you will be transmitting an RF signal. Be sure you have a suitable load connected to the COAX 1 jack of your Antenna Tuner. Also, transmit just long enough to obtain the desired result.

( ) Turn the transmitter power on and allow the transmitter time to warm up, if necessary.

( ) Connect a CW key to the transmitter key jack.

( ) Select the **low** 80-meter operating frequency that you wish to preset your roller inductor for. Then set the transmitter to that frequency.

( ) Tune up the transmitter, if necessary.

( ) Key your transmitter and adjust its output power to 10-20 watts, as indicated by the Forward (FWD) meter on your Antenna Tuner.

( ) Adjust roller inductor L1 by holding the INDUCTOR lever switch up or down, as necessary, until you obtain the lowest reading (null) on the Reflected (REF) meter on your Antenna Tuner.

( ) Release the key.

SETTING PRESET CONTROLS

NOTES:

A. In the following steps, you will adjust the reference preset controls for the roller inductor for each of the bands you intend to operate on. The reference preset label has been provided to help you locate the proper controls on the main circuit board. You may find it convenient to select two presets (one for the low end and one for the high end) for each BAND switch position, as indicated on the preset label. CAUTION: Make sure you do not adjust any of the reference preset controls so the roller inductor runs against the stops and stalls the motor.

B. The setting of the reference preset controls may vary between different antennas you are using.

1. Set the LOW/HIGH switch on your Antenna Tuner to LOW, if this has not already been done. Also, be sure the BAND switch is set to 80.

2. Locate control 80L on the preset label; then locate the corresponding preset control (R361) on the main circuit board.

3. Slowly adjust control R361 until LED (light-emitting diode) D359 lights.

4. Select the **high** 80-meter operating frequency that you wish to preset your roller inductor for. Then set the transmitter to that frequency.

5. Tune up the transmitter, if necessary.

6. Set your Antenna Tuner's LOW/HIGH switch to HIGH.

7. Locate control 80H on the preset label; then locate the corresponding control (R360) on the main circuit board.

8. Key the transmitter and adjust its output power to 25-50 watts, as indicated on the Forward meter of your Antenna Tuner.

9. Adjust roller inductor L1 by holding the INDUCTOR lever switch up or down, as necessary, until you obtain the lowest reading (null) on the Reflected (REF) meter on your Antenna Tuner.

10. Release the key.

11. Slowly adjust control R360 until LED D359 lights.

12. Repeat the last eleven steps for each position of the BAND switch that you intend to operate on. NOTE: You may not be able to obtain a null reading on 160 meters. Instead, adjust roller inductor L1 until you obtain a minimum reading on the REF meter.

NOTE: In the following steps, you will set up the automatic SWR circuit for a 2:1 standing wave ratio. Read the next four steps through before you complete these steps.

( ) Key the transmittter and adjust its output power to 50 watts, as indicated by the Forward meter on your Antenna Tuner.

( ) Use the TRANSMITTER and ANTENNA lever switches, as necessary, to tune the two variable capacitors until you obtain a 5-watt reading on the Reflected meter on your Antenna Tuner.

( ) Readjust the transmitter's ouput power, as necessary, until you obtain readings of 50 watts and 5 watts on the Forward and Reflected meters, respectively, on your Antenna Tuner.

( ) Touch the test probe of your DC voltmeter to pin 5 of U302.

( ) Key the transmitter and, with 50 watts on the Forward meter and 5 watts on the Reflected meter, adjust SWR CAL control R318 for a +.5-volt reading.

SETTING AUTO-RANGE CONTROL

NOTES:

1. In the following steps, you will set the transition point where the auto-range wattmeter circuitry switches from one power scale to the other (by adjusting control R302 on the main circuit board). This control would normally be set to the 200-watt level. However, you may wish to set it to a different level, provided it does not exceed 200 watts.

2. Turning control R302 clockwise (as viewed from the front or "knob" side of the control) increases the power level you wish to establish for the transition point.

( ) Place an amplifier in line with your RF source, if the RF source does not deliver sufficient RF power for the auto-range wattmeter circuitry to operate properly. NOTE: Make sure you connect your transmitting equipment as shown in Pictorial 15-1 (Illustration Booklet, Page 46).

( ) Turn the amplifier on (if you placed it in line with your RF source) and allow it to warm up, if necessary.

( ) Key the transmitter and adjust the power output to the level you wish to use for the power scale transition point, as indicated on the Forward meter on your Antenna Tuner.

( ) Continue to key the transmitter while you, at the same time, watch the Forward meter. Slowly turn control R302 first in one direction, then the other direction (if necessary), until the auto-range wattmeter circuitry switches to the other scale on the Forward meter. Immediately stop turning the control.

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

FINAL ASSEMBLY

Refer to Pictorial 14-1 (Illustration Booklet, Page 45) for the following steps.

( ) Position the chassis assembly as shown in the Pictorial.

( ) Look at the cabinet top. Notice that the mounting holes are closer to one edge than they are to the other. When you install the cabinet top, in the next step, be sure to position the top so the wider space is toward the front of the chassis.

( ) Position the cabinet top down onto the chassis. Then use eight 6-32 × 1/4" screws to secure the top to the chassis. NOTE: If necessary, first loosen the two outside screws on each side of the main chassis until the cabinet top is secured to the chassis. Then retighten these four screws.

( ) Carefully peel the backing paper from the blue and white label. Then press the label onto the rear panel in the lower right-hand corner (just below the model number). Be sure to refer to these numbers in any communications you may have with the Heath Company about your kit.

This completes the assembly, Initial Tests, and Final Assembly of your Antenna Tuner. Proceed to "Applications and Installation."

APPLICATIONS AND INSTALLATION

APPLICATIONS

This Antenna Tuner will match a reactive and/or resistive load to a nonreactive, 50-ohm load. You can adjust it to tune out load reactance and, when necessary, transform the load impedance to the required 50-ohm transmitter (or amplifier) output impedance. The Tuner uses a roller inductor along with two variable capacitors to provide an almost unlimited matching range, and features 160-meter through 10-meter coverage.

An optional 4-to-1 (**bal**anced-to-**un**balanced) balun coil, on the output side of the Antenna Tuner, permits the use of balanced feed lines. You can use the Tuner to match into coaxial lines, random-length end-fed wires, or balanced feeders.

INSTALLATION

Pictorial 15-1 (Illustration Booklet, Page 46) shows a typical fixed-station installation. This Pictorial shows an installation where its internal coaxial switch (SW101) may be used to feed the RF source through your Antenna Tuner to any one of several 50-ohm antennas or RF loads. When the Coax switch is in the BYPASS position, your Antenna Tuner is switched out of the line; therefore, a straight-through connection is made. If an amplifier is not used, connect the cable from the transmitter's antenna connector directly to the RF input jack on the rear panel of the Antenna Tuner sensor.

Use coaxial cable, like RG-58/U or RG-8/U, to interconnect the various pieces of equipment. NOTE: Cables should be no longer than necessary.

A ground post is located on the rear panel of the Antenna Tuner. Connect this ground post to a good earth ground or a metal water pipe. **Use the shortest and heaviest connection possible.**

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

Refer to various publications, such as the ARRL Radio Amateur Handbook, for more information concerning grounds.

CONNECTIONS

Use the following information to connect various types of antennas to your Antenna Tuner.

Coaxial-Fed Antennas

An antenna fed with coaxial line, such as a beam antenna or a center-fed dipole, can easily be matched with your Antenna Tuner to provide a good match to the transmitter across the entire band. This is particularly beneficial when, for example, you use an 80-meter dipole that has been cut for a particular portion of the band.

For coax-to-coax feeder matching, connect the antenna feed line to COAX 1 connector J1 (or to BYPASS jack J7 for a 50-ohm nonreactive dummy load) on the rear panel of your Antenna Tuner. NOTE: When you use BYPASS jack J7, the meters will still indicate forward and reflected power. However, the matching circuits will not have any effect.

Single-Wire Antennas

If possible, use a quarter-wavelength antenna or an odd multiple of a quarter wavelength. Such an antenna has low impedance and reduces the chances of high RF voltages appearing on the Antenna Tuner or associated equipment.

For end-fed antennas, random length antennas, or Windom-type antennas, connect the antenna to SINGLE WIRE connector J3 on the Antenna Tuner rear panel. Be sure the shorting bar is not connected to connector J3.

Balanced Feed Line Antennas

For antennas that use balanced feeders, connect the shorting bar between connectors J3 and J4 on the rear panel of your Antenna Tuner. Connect the antenna feed line between BALANCED FEED LINE connectors J4 and J5.

OPERATION

FRONT PANEL CONTROLS

Refer to Pictorial 16-1 (Illustration Booklet, Page 47) to identify the front panel meters, switches, controls, and the counter readout. A description of each is included.

REFLECTED (REF) METER (M2)
This meter indicates reflected power in watts on 2 scales (0-50 or 0-500). It also indicates standing wave ratio (SWR).

FORWARD (FWD) METER (M1)
This meter indicates forward power in watts on 2 scales (0-200 or 0-2000).

HI-LOW INDICATORS
Whichever indicator is lit corresponds to the power range (0-200 or 0-2000 watts) that is being selected by the Tuner's auto-range wattmeter circuitry.

This indicator lights whenever the transmitter capacitor is being turned.

This indicator lights whenever the roller inductor is being turned.

This indicator flashes on and off whenever the SWR, as "seen" by the Antenna Tuner, exceeds the setting of the front panel TUNE SWR control.

This indicator lights whenever the antenna capacitor is being turned.

TURNS COUNTER
This display indicates the number of active turns (00:0 to 40:0) used for a certain setting of the roller inductor.

COAX SWITCH
This switch is used to route the RF output power to any of three coaxial output jacks (one of which is a bypass), or to a long wire antenna.

POWER SWITCH
This switch turns the 120 VAC line power or the external 12 VDC power to the Antenna Tuner on or off. NOTE: 12 VDC and 120 VAC power cannot be connected to the Antenna Tuner at the same time.

SENSITIVITY CONTROL
Use this control to set the pointer of the reflected (REF) meter to the SET line with both the SWR-REFLD and SET-FWD switches pushed in.

SWR-REFLD SWITCH*
With this switch in the SWR (in) position, meter M2 indicates standing wave ratio. In the REFLD (out) position, meter M2 indicates reflected power.

SET-FWD SWITCH*
With this switch in the SET (in) position and the SWR switch pushed in, adjust the SENSITIVITY control for a full-scale reading (SET) on reflected meter M2. In the FWD (out) position, read forward power on meter M1.

AUTO SWITCH
In the AUTO (in) position, the Antenna Tuner automatically tunes the two variable capacitors until the SWR, as "seen" by the Antenna Tuner, corresponds to a value no higher than the setting of the TUNE SWR control (if that SWR value can be obtained in the manual mode for the same load).

In the manual (out) position, three lever switches (labeled TRANSMITTER, INDUCTOR, and ANTENNA) are used to activate the motors that turn the two variable capacitors and the roller inductor.

AUDIO ALARM SWITCH
With this switch pushed in, an audible alarm lasting for 1-2 seconds will sound whenever (1) the SWR, as "seen" by the Antenna Tuner, exceeds the setting of the TUNE SWR control and (2) if the auto control cannot match the load within about 20 seconds.

LINEAR SWITCH
Use this switch when you place an amplifier in the line with the transmitter. After the Antenna Tuner has been set up so the transmitter "looks into" a load that corresponds to an SWR that is equal to or less than the preset SWR, and you are ready to load up the amplifier, first place the AUTO switch in the manual (out) position. Then push the LINEAR switch to ON (in), apply RF power from the transmitter, and load up the amplifier as you normally would. At this time, you may push the AUTO switch to ON (in). Now, if the SWR exceeds the setting of the SWR TUNE control, the visual alarm will light and, if the AUDIO ALARM switch is ON (in), the audible alarm will sound. The amplifier is automatically bypassed while the Tuner is being retuned to the preset SWR. After the tuning has been completed, release the LINEAR switch to OFF (out). Then wait three seconds and push the LINEAR switch to ON (in); the amplifier is now back on line. NOTE: This applies only when you are in the AUTO mode.

TRANSMITTER SWITCH**
This lever switch activates the motor that turns the transmitter capacitor.

INDUCTOR SWITCH**
This lever switch activates the motor that turns the roller inductor.

ANTENNA SWITCH**
This lever switch activates the motor that turns the antenna capacitor.

TUNE SWR
Use this control to preset a maximum SWR that you consider as being acceptable for the antenna that you are using.

BAND SWITCH
This switch, along with the LOW-HIGH lever switch, selects as many as 18 different preset positions for the roller inductor. For your operating convenience, the BAND switch has nine band positions (10 through 160 meters and REMOTE), which are marked on the Antenna Tuner front panel. However, you may use all the preset positions on any band, if you wish. That is, you may use all the presets for frequencies withing the 80-meter band. By using the presets in this manner, you may operate on any desired frequency with a limited amount of time required for tune-up.

You may select nine of the 18 presets with the BAND switch in the REMOTE position. The setting of the HIGH-LOW lever switch determines which nine presets are selected. A switch contact grounds the proper remote line when you select the desired preset position. NOTE: Be sure one of the pins of REMOTE BANDSWITCH plug P1 (on the rear panel) is connected to ground before you place the BAND switch in the REMOTE position.

* Your Antenna Tuner will not work in the AUTO mode when either of these switches is in the "in" position.

** With this switch down, the motor rotates in a clockwise direction; it rotates in a counterclockwise direction with the switch up.

IMPORTANT: If you plan to use your Antenna Tuner in a remote location, be sure it is operating within its limitations (high or low temperatures, high humidity, etc.).

LOW-HIGH SWITCH
Selects one of the two roller inductor preset position for each of the nine BAND switch settings.

REAR PANEL CONTROLS AND CONNECTIONS

Refer to Pictorial 16-2 (Illustration Booklet, Page 48) to identify the rear panel controls and connections. A description of each is included.

COAX 1 JACK
Provides a connection for a 50-ohm system, such as a beam antenna, center-fed dipole antenna, or vertical antenna.

COAX 2 JACK
Provides a connection for a second 50-ohm system, such as a beam antenna, center-fed dipole antenna, or vertical antenna.

BYPASS JACK
This jack bypasses the Tuner and provides a connection for a 50-ohm RF dummy load or resonant antenna.

INPUT JACK
Provides a connection for the output jack of your transmitter, transceiver, or amplifier.

SINGLE WIRE POST
Provides a connection for an end-fed wire, random length wire, or Windom antenna.

BALANCED FEED LINE POSTS (optional)
Provides a connection for a balanced feed line antenna.

GROUND POST
Provides a station ground connection for the Antenna Tuner.

REMOTE BAND-SWITCH SOCKET
Provides a remote band-switch port that can be used to externally control the Antenna Tuner's inductor preset controls. This is accomplished by grounding the appropriate socket pin when the BAND switch is in the REMOTE position.

12 VDC SOCKET
This is an interconnect socket so the Tuner can be powered by an external 12 VDC source.

FUSE
This fuse provides AC overcurrent protection for the electronic circuitry of the Antenna Tuner. NOTE: If you are using an external DC source to power your Antenna Tuner, be sure that source is fused.

ANT RELAY SOCKET
Provides a switch which is placed in the antenna relay line connected between the transmitter and the linear amplifier (contacts 3 and 5 of relay K1 are connected to the socket terminals). With LINEAR switch SW4 to ON (in), and the Antenna Tuner tuned to the preset value of the TUNE SWR control, this switch closes and allows the linear amplifier to operate. NOTE: Be sure to use this socket when you operate with a linear amplifier.

INITIAL ACTIONS

EQUIPMENT HOOK-UP

Before you proceed, make sure you connect your transmitting equipment as shown in Pictorial 15-1 (Illustration Booklet, Page 46). NOTE: If you are not using an amplifier, connect the coaxial cable from the transmitter's RF output connector directly to input connector J6 on the rear panel of the Antenna Tuner.

EXCITER TUNE-UP

The final stage of some transmitters must be tuned up before they can be placed on the air. It is important that you tune up a transmitter on a "dummy load" before you use it with your Antenna Tuner. You can use any load that presents a constant, resistive impedance of 50 ohms to the transmitter and can dissipate the required power for a reasonable length of time. As an example, the Heathkit "Cantenna" is a satisfactory load. NOTE: Do NOT use light bulbs as a "dummy load" since their resistance varies with current and their reactance varies with frequency.

COUPLER TUNING

This part of the "Operation" section includes the procedure for using your Antenna Tuner with various antenna systems.

NOTES:

1. When the roller inductor is turning, be careful that you do not allow it to turn past its end stops (00.0 or 40.0). This could cause the roller contact to jump off the wire turns on the inductor.

2. The "ARRL Antenna Book" is readily available and includes comprehensive information on transmission lines and antennas. You can purchase other similar radio amateur handbooks and some are available in public libraries.

IMPORTANT:

1. During the tuning procedure, apply a minimum of 10 watts of RF power from the transmitter to get a meaningful reading on REF meter M2. When the Antenna Tuner is at or near resonance, as indicated by minimum reflected power, you may increase the power from the transmitter. At this time, you can make final adjustments (in the manual mode) to the Antenna Tuner.

2. When you tune your transmitter, be sure to observe the duty cycle limitations, if any.

3. Many solid-state transmitters have automatic VSWR shut-down circuitry. During the following tuning procedure, a decrease in VSWR should correspond to an increase in forward power.

TUNING PROCEDURE

Use the following procedure to match your antenna to your transmitter:

1. Be sure your antenna is connected to the rear panel of the Antenna Tuner as described in the "Applications and Installation" section of this Manual.
2. Set COAX switch SW101 to the position that corresponds to the antenna you intend to use.
3. Set SENSITIVITY control R1 to the most sensitive (fully clockwise) position.
4. Set TUNE SWR control R2 to the desired position.
5. Set SWR/REFLD switch SW2 to the REFLD (out) position.
6. Set SET/FWD switch SW1 to the FWD (out) position to measure the forward power on FWD meter M1.
7. Set AUTO/Manual switch SW5 to the AUTO (in) position.
8. Set AUDIO ALARM switch SW3 to the ON (in) position, if you desire an audible warning when the lowest SWR your Antenna Tuner can be tuned to exceeds your setting of TUNE SWR control R2 (for a particular antenna and a specific operating frequency). Otherwise, set this switch to the OFF (out) position.
9. Set LINEAR switch SW4 to the OFF (out) position.
10. Set BAND switch SW7B to the band you intend to operate on.
11. Set LOW/HIGH switch SW7A to the position that corresponds to the portion of the band you intend to operate on.
12. Turn the transmitter's power on.
13. With the transmitter in either the tune or CW mode, advance the transmitter's carrier level (or power output) control for a reading of 20 to 100 watts on FWD meter M1.
14. Allow the Antenna Tuner enough time to tune itself to the preset SWR. Then advance the transmitter's carrier level (power output) control for full output power.
15. If you intend to use an amplifier, set LINEAR switch SW4 to the ON (in) position (Refer to "Linear Switch" on Page 119). NOTE: You do not have to retune your Antenna Tuner after you place the amplifier in the line.

SWR MEASUREMENTS

The ratio of maximum rms voltage (or current) to minimum rms voltage (or current) along a transmission line defines the standing wave ratio. To obtain an SWR indication on your REF meter:

1. Set your transmitter to the desired frequency.
2. Perform the tuning procedure that corresponds to the antenna you are using and which is described under "Coupler Tuning."
3. Set SET/FWD switch SW1 to the FWD (out) position.
4. Turn the transmitter on and advance its RF output level for the desired forward indication on FWD meter M1.
5. Set SET/FWD switch SW1 to the SET (in) position.
6. Set SWR/REFLD switch SW2 to the SWR (in) position.
7. Adjust SENSITIVITY control R1 to position the pointer of REF meter M2 over the "Set" marking on the meter.
8. Set SET/FWD switch SW1 to the FWD (out) position and read the SWR on the SWR scale of REF meter M2. At this time, FWD meter M1 will indicate the forward power. NOTE: If the SWR is greater than 3:1, read the forward and reflected power levels. Then use these power levels and the SWR Chart on Page 124 to determine the SWR.

FORWARD POWER MEASUREMENTS

Use the following procedure to determine the level of power that is being coupled to the antenna:

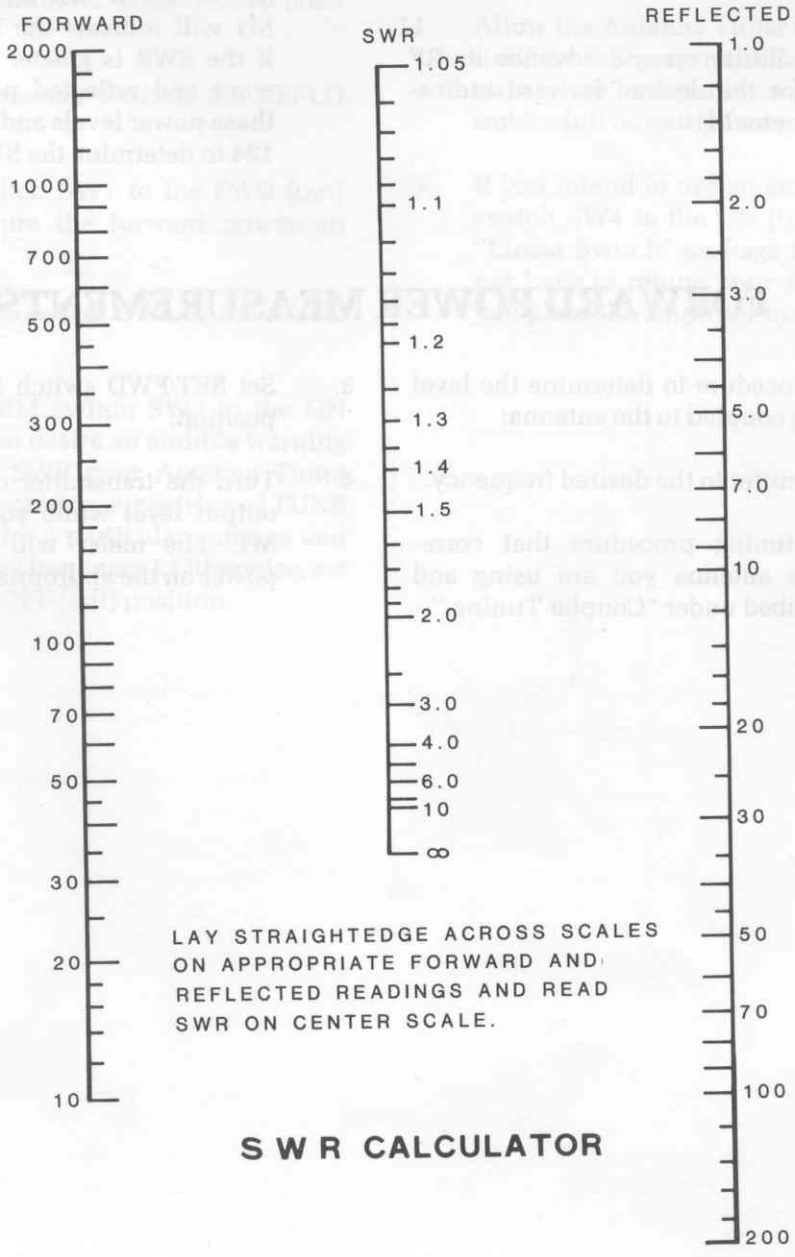
1. Set your transmitter to the desired frequency.
2. Perform the tuning procedure that corresponds to the antenna you are using and which is described under "Coupler Tuning."
3. Set SET/FWD switch SW1 to the FWD (out) position.
4. Turn the transmitter on and advance its RF output level while you observe FWD meter M1. The meter will indicate the forward power on the appropriate power scale.

REFLECTED POWER MEASUREMENT

Use the following procedure to determine the level of power that is being reflected back towards the transmitter (due to a mismatch in the antenna system).

1. Set your transmitter to the desired frequency.
2. Perform the tuning procedure that corresponds to the antenna you are using and which is described under "Coupler Tuning".
3. Set SWR/REFLD switch SW2 to the REF (out) position.
4. Turn the transmitter on and advance its RF output level while you observe REF meter M2. The REF meter will indicate the reflected power on the appropriate power scale.

SWR CHART



TYPICAL OPERATING CHARACTERISTICS

- A severe mismatch may cause a transmitter to become unstable until the SWR is reduced to a low value (1.5:1 or less). This is especially true of broadband solid-state transmitters. However, this can also occur with tube-type transmitters.
- In the AUTO mode, the roller inductor will return to the selected preset position whenever you change the BAND switch setting or the setting of the LOW/HIGH switch.
- On initial turn-on, the two matching capacitors rotate to the half-mesh position and, if in the AUTO mode, the roller inductor returns to the preset condition.
- In the AUTO mode, the two variable capacitors rotate to the half-mesh position whenever the roller inductor starts turning.
- In some cases, when your Antenna Tuner is used in the AUTO mode, it will not be able to find a match. This may happen if the antenna's impedance is outside the range of the Antenna Tuner or the setting of the tuning components is very critical.
- If you want a better match than you can obtain in the AUTO mode, place the AUTO/Manual switch in the Manual (out) position. Then use the lever switches to turn one or both matching capacitors, as necessary.
- Your Antenna Tuner will, if possible, tune for a match with an SWR below the setting of the TUNE SWR control. If a match with the preset SWR cannot be found in approximately 20 seconds, the alarm indicator will flash and, if the Audio Alarm switch is on (in), the audible alarm will sound.
- The alarm circuits may be activated under the following conditions:

  1. Upon initial power turn-on.
  2. When the standing wave ratio (SWR) as "seen" by the Antenna Tuner, exceeds the setting of the TUNE SWR control.
  3. The tune time in the AUTO mode exceeds 15-20 seconds.
  4. When you are making measurements to determine the standing-wave ratio.

- You may use any or all roller inductor presets for any of the 10 BAND positions.
- Your Antenna Tuner will not operate in the AUTO mode if either the SWR or SET switches are placed in the IN position.
- When the SWR of an antenna exceeds the setting of the TUNE SWR control for any reason (change of operating frequency, antenna problem, etc.), the alarm indicator will flash and, if the AUDIO ALARM switch is ON (in), the audible alarm will sound. Also, the Antenna Tuner will attempt to retune to this new condition (if in the AUTO mode).
- In the AUTO mode, it is normal for the Antenna Tuner to retune if the SWR of the antenna or dummy load you are using increases over the preset level as you start to apply more RF power to the antenna. NOTE: In cold weather, for example, an iced-up antenna may have an SWR that is considerably higher than it is in warm weather.

IN CASE OF DIFFICULTY

NOTE: It is important that you read the entire "General Troubleshooting Information" sections which follow, before you attempt to service your Antenna Tuner.

This section of the Manual is divided into three parts. The first part, titled "General Troubleshooting Information," describes what to do about the difficulties that may occur right after your Antenna Tuner is assembled.

The second section, titled "Troubleshooting Precautions," points out the care that is required when you service the Antenna Tuner to prevent damage to the components.

The third part, titled "Troubleshooting Charts," is provided to assist you in servicing the Antenna Tuner if the "General Troubleshooting Information" fails to clear up the problem, or if difficulties occur after your Antenna Tuner has been in use for some time. The "Troubleshooting Charts" list a number of possible difficulties that could arise along with several possible solutions to those difficulties. Refer to the "Circuit Board X-Ray Views" (Illustration Booklet, Pages 50 and 51) for the physical location of parts on the circuit boards.

GENERAL TROUBLESHOOTING INFORMATION

1. Recheck the wiring. Trace each lead with a colored pencil on the Pictorial as you check it. 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 service do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by checking all connections to make sure that they are soldered correctly. Reheat the connections, if necessary, but be careful so you do not create any solder bridges.

3. Check the values of all the parts. Be sure that the proper part has been installed at each location on the circuit boards. Refer to the "Circuit Board X-Ray Views" for the physical location of parts on the circuit boards.

4. Be sure that all the wires and leads have been trimmed as close as possible to their connecting points.

5. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring or in the components on the circuit boards.

6. Check very carefully to be sure there are no solder bridges between different circuit board foils. If you are not sure a solder bridge exists, compare the circuit board foil with the "Circuit Board X-Ray Views". Remove any solder bridges by holding a clean, hot soldering iron tip between the two points that are bridged until the excess solder flows down onto the tip.

7. The antenna you use should be insulated along its entire length from any contact with any parts of building, trees, etc. Keep the antenna as far as possible from all objects for maximum operation efficiency.

If you still cannot locate and correct the trouble after you have completed the checks listed above, and if a voltmeter is available, check the voltages in the Antenna Tuner against the Schematic. A review of the "Circuit Description" and Schematic may also help you to locate any difficulties in the kit.

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.

TROUBLESHOOTING PRECAUTIONS

- Integrated circuits U301, U305, U307, and U315 are CMOS (complimentary metal-oxide semiconductor) devices and they can be damaged by static electricity. Therefore, make sure you remove these ICs in the same manner that you installed them. Refer to Page 18 for the correct technique.
- Be sure you do not short any adjacent terminals or foils when you make tests or voltage measurements. If a probe or test lead slips for example, and shorts together two adjacent connections, it is very likely to cause damage to one or more ICs, transistors, or diodes.
- Be especially careful when you test any circuit that contains an IC or a transistor. Although these components have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than many other parts.
- In several areas of the circuit boards, the foil patterns are quite narrow. When you unsolder a part to check or replace it, avoid using excessive heat while you remove the part. A suction-type desoldering tool will make removal considerably easier. You may also use desoldering braid to remove the solder.

TROUBLESHOOTING CHARTS

These charts list the condition and possible causes of several malfunctions. If a particular part is mentioned (U302, for example) as a possible cause, check that part to see if it was installed correctly. Also, check it and the parts connected to it for poor connections. It is also possible, on rare occasions, for a part to be faulty and require replacement.

GENERAL

CONDITION	POSSIBLE CAUSE OR TEST
Tuner is completely inoperative.	A. Line cord plug not connected to an AC outlet. B. Check external DC supply, if used. C. Check fuse F1. D. Check U1 and its socket.
The meters fail to register.	A. Shorting wires across meter lugs. B. Sensitivity control R1 incorrectly wired. C. No RF input to the sensor assembly or no output from it.

DISPLAY CIRCUIT BOARD

CONDITION	POSSIBLE CAUSE OR TEST
Turns counter does not light.	A. Check for 12 volts at H. B. Check for 3.2 volts at F. C. Check for 5 volts at pin 1 of U204.
One or more display segments of the turns counter not lit.	A. Check U204. B. Check U201 through U203. C. Check Q201 through Q203. D. Check display tube V201.

MAIN CIRCUIT BOARD

CONDITION	POSSIBLE CAUSE OR TEST
The motors cannot be operated by the lever switches.	A. Auto switch SW5 is on (in). B. Check for DC voltage on lug 2 of each manual switch.
Inductor presets do not function properly.	A. Auto switch SW5 in manual (out) position. B. Check Band switch SW7 or its wiring. C. Check U316 and/or U317. D. Check wiring of control R6.
Transmitter (C1) and/or antenna (C2) capacitor(s) do not return to half-mesh position while roller inductor L1 is turning.	A. Auto/Manual switch SW5 is in th Manual (out) position. B. Decoder disk has not been adjusted properly. C. Check U2 and/or U3. D. Check Q316 through Q319. E. Check D351. F. Check Q342 through Q345. G. Check D368. H. Check U315.
Auto-range wattmeter circuitry does not operate properly.	A. Check setting of control R302. B. The RF input power is too low to switch to the high range. C. Check U302.
Auto SWR circuit cannot be adjusted.	A. Check to verify that the +8 and −8 volt supplies are adjusted correctly. B. Check U303. C. Check U304.
Nothing happens when the Tuner "looks into" an SWR that is higher than the preset SWR.	A. Auto/Manual switch SW5 is in the Manual (out) position. B. Check setting of control R335. C. Check U302. D. Check U307.

CONDITION	POSSIBLE CAUSE OR TEST
Only the alarm light and/or audible alarm sounds when the Tuner "looks into" an SWR that is higher than the preset SWR.	A. Auto/Manual switch SW5 is in the Manual (out) position. B. Check U305 and/or U306. C. Check Q303.
Alarm light functions properly, but the audio alarm is inoperative.	A. Audio alarm switch SW3 is in the off (out) position. B. Check U313. C. Check SP1.
Linear enable circuit does not function properly.	A. Linear enable switch SW4 is in the off (out) position. B. Check relay K1. C. Check D345. D. Check Q312. E. Capacitor motors are turning.

SPECIFICATIONS

Frequency Range (continuous tuning)	1.8 to 30 MHz.
Input Power Capability	
SSB	2000 watts (peak).
CW	1000 watts.
Input Impedance	50 ohms.
Output Impedance	Wide range.
Impedance Transformation	Optional 4:1 balun (**bal**anced to **un**balanced).
Meter Functions	Forward and reflected average power, and SWR.
Meter Ranges	
Forward (2 ranges)	Low — 0-200 watts. High — 0-2000 watts.
Reflected (3 ranges)	Low — 0-50 watts. High — 0-500 watts. SWR — 1:1 to 3:1
Wattmeter Accuracy (full scale)	
200 watts and 2000 watts (FWD), 500 watts (REFLD)	±5% (average).
50 watts (REFLD)	±7.5% (average).
Auto-range Wattmeter	User selected.

Insertion SWR	Less than 1.1:1
Automatic Tune Requirements	
Cycle Time	Approximately 15 seconds.
Input Power Level	10 watts min. (35 watts min. to obtain SWR SET)
VSWR	User selected.
Power Requirements	120 VAC, 50/60 Hz at .250 ampere maximum (internally); 12VDC, at 1 ampere maximum (externally).
Operating Temperature Range	32°F to 104°F (0°C to 40°C)
Dimensions Overall	14-1/2"(W) × 20"(D) × 6-3/4"(H) (36.8 × 50.8 × 17.1 cm)
Net Weight	19 lbs (8.6 kg). (including the optional balun)
Optional Accessory	4:1 balun.

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

CIRCUIT DESCRIPTION

Refer to the Block Diagram (Illustration Booklet, Page 49) and the Schematic Diagram (fold-in) as you read the following "Circuit Description." The component numbers are arranged in the following groups to help you locate specific components on the Schematic, circuit boards, and chassis.

1-99	Parts on the chassis.
101-199	Parts on the sensor circuit board.
201-299	Parts on the display circuit board.
301-599	Parts on the main circuit board.

Tuner Circuit

The Antenna Tuner is an adjustable RF transformer that will match an unknown load presented by an antenna and its feedline to the required 50-ohm transmitter impedance.

Antenna capacitor C2 modifies the load impedance fed back to the tuned circuit formed by capacitor C1 and inductors L1 and L2 in series. The total resonant impedance across the tuned circuit depends on the L/C ratio of C1 and L1 + L2, and the load impedance as transformed by C2. Capacitor C1 performs capacitive tapping which results in a 50-ohm impedance at RF input connector J6.

The reactive loads at switched output connectors J1, J2, and J3 are compensated for as you adjust C1 and C2 to resonance.

An optional 4:1 balun (**bal**anced-to-**un**balanced) coil, T1, is used for balanced line operation.

Meter Operation

From input jack J6 on the sensor, the RF is routed through toroid coil L101, through the contacts of coaxial switch SW101, and to either the bypass output at J7, or through the Tuner circuits to outputs J1, J2, or to the feedthrough single- or double-wire outputs at J3, J4, and J5.

L101 is a current pickup element for both the forward and reflected power which passes through the sensor. A transmitted signal passing through the sensor induces a voltage in the toroid coil. This voltage is directly proportional to the amount of RF current. A voltage sampled directly from the transmission line is summed with the voltage at L101. The sum of the voltages is then rectified by diode D102 and filtered by capacitor C104. The sensor is factory calibrated to within 5% accuracy by control R106 for the 0 – 2000-watt circuit and by control R107 for the 0 – 200-watt circuit.

The out-of-phase (reflected) current-induced voltage that was summed with the sampled voltage is rectified by diode D101 and filtered by capacitor C103. With a very good load, one with less than 1.05:1 VSWR, the two voltages will be about equal and out of phase, and no reflected voltage will register in the reflected circuit. Reflected power is factory calibrated by control R104 for the 0 – 50-watt scale and by R105 for the 0 – 500-watt scale.

The calibrated voltages from the sensor are routed through a 5-wire cable, via switch-shield mounted

feedthrough capacitors C5-C9 to bilateral switch U301. Capacitors C5-C9, C301-C304, and ferrite beads FB1-FB5 provide RF line filtering.

IMPORTANT: The sensor is factory aligned and calibrated; tampering with its components may void the Warranty of your Antenna Tuner.

Switching Circuits

NOTE: The forward and reflected circuits are virtually identical. In the following discussion, we will explain the operation of the forward circuits. Where differences exist between the basic operation of the two circuits, further detail will be supplied.

The forward signal from the sensor is coupled through bilateral switch U301 and routed directly to SET-FWD switch SW1. When SW1 is in the SET (in) position, the forward (FWD) meter is temporarily disconnected from the circuit. The low-current input from the sensor is coupled directly through SW1, through Sensitivity control R1, to the contact of SWR-REF switch SW2. The SET position of SW1 is used only in conjunction with SW2 when SW2 is in the SWR position. At that time, the REF (reflected) meter Set index is used to calibrate the meter for SWR readings.

When switch SW1 is in the FWD (out) position, the FWD meter is again enabled to indicate forward power, while switch SW2, in the SWR position, indicates the amount of standing wave present at the point where the sensor is inserted in the transmission line. When SW2 is in the REF (out) position, the power reflected through the transmission line from the antenna, dummy load, etc., is indicated on the REF meter in watts.

When switch SW1 is in the FWD position, the signals coupled from U301 are direct-coupled to the FWD and REF meters.

Coaxial Switch (SW101)

The coaxial switch will select any one of four output positions. When this switch is in the Bypass position, signals are routed through the sensor and directly out of the Tuner, bypassing the tuner load-matching function.

The other coaxial jacks are used for feedlines to tribanders, center-fed doublet antennas, etc. In addition, the output signal is fed internally to connector J3, on the rear panel, when antenna switch SW101 is in the Long-wire position. This allows the signal to be fed to single-wire antennas.

With the optional SA-2500-1 balun installed, the shorting bar is connected between connectors J3 and J4; connectors J4 and J5 are usable for balanced feed line antennas.

All input signals, other than those routed to Bypass jack J7, are routed through the meter and the tuner circuits. Those signals routed to J7 will affect only the meter circuits.

Auto-Range Wattmeter Circuits

To explain how this circuit functions, we will follow the low forward (LOW FWD) signal.

When an RF signal is applied to the sensor input (J6), a forward signal is applied to pin 1 of quad bilateral switch U301. This signal is also coupled to pin 13 of operational amplifier U302D. Because this stage has a high input impedance, there is no loading of the signal applied to it. Control R302 is used to set a reference level for pin 12 of U302D. Feedback resistor R303, along with R302, provide a hysteresis path for U302D. The output (pin 14) of U302D, which is usually high, is applied to pin 9 of U302C, to pins 12 and 13 of U301, and to voltage divider R309 and R310. The high at the junction of resistors R309 and R310 is applied to the base of transistor Q301. This causes Q301 to turn on and its collector to go low. A low applied to the base of Q302 prevents it from turning on; therefore, its collector remains high. The low on the collector of Q301 is also applied to one side of low range indicator PL202, which will turn on.

Voltage divider R304 and R305 provides a reference level for pin 10 of U302C by the path provided by R306. The output (pin 8) of U302C is normally low, and this low is applied to pins 5 and 6 of U301.

U301 requires that a high be applied to a control port to close the switch and pass the signal through it. As previously noted, a high is applied to pins 12 and 13 (control ports) of U301. The two corres-

ponding sections of the quad bilateral switch are closed, while a low is applied to the other two control ports (pins 5 and 6) of U301. Thus, the two remaining switch sections are open. Under this condition, the LOW FWD and LOW REF (low reflected) signals are applied to the meter circuit.

When the LOW FWD signal on pin 13 of U302D exceeds the reference signal applied to pin 12, U302D changes state. This results in the output (pin 14) of U302D going from a high to a low. The low on pin 14 is applied to pin 9 of U302C, pins 12 and 13 of U301, and the base of Q301. The low on the base of Q301 turns this transistor off, which allows the collector to go high. The high on the collector of Q301 causes Q302 to turn on and its collector goes low. The result of this causes PL202 to turn off and high level indicator PL201 to turn on. With a high on pins 5 and 6 of U301 and a low on pins 12 and 13, the HI FWD (high forward) and HI REF (high reflected) signals are applied to the meter circuit.

This state will remain in effect until the LOW FWD signal drops below the reference level on pin 12 of U302D. The level at which this state changes from low to high is adjustable by control R302. However, it would normally be adjusted close to the 200-watt level.

As stated before, R303 provides hysteresis. This means that the circuit changes state at 200 watts (low to high), but the RF level needs to drop to the 180-190 watts level before the circuit changes back from high to low.

Automatic SWR Circuit

This circuit consists of dual buffer circuit U303 and U304 which is an analog mulitplier. L301 provides a path for the LOW FWD signal to voltage divider R315 and R316 and to pin 5 of U303B. R314 and R317 make up a feedback network to establish a gain of "1" for the buffer. The output from pin 7 is applied to pin 5 of U304 by R319, with C308 acting as a bypass. L302 provides a path for the LOW REF signal to pin 3 of U303. R322 with R327 paralleled by the series combination of R328 and D303 will provide a variable gain, depending on the level of the input signal. The output (pin 1) of U303A is applied to pin 1 of U304 via R331, with C311 providing a bypass.

U304 will "log" each input (pins 1 and 5) and then gives the difference between the logged signals. Pin 4 of U304 is the output port, which can be calibrated by R318 (SWR CAL) using a known input. Zener diode D304 with voltage divider R334, R333, and R332 provides a constant load for the output of U304.

R326 (SWR NULL), which is part of a voltage divider with R324 and R329, is used to compensate for the gain difference between the two buffers. R325 connects the wiper of R326 to pin 3 of U303A.

TUNE SWR Control/Trip Circuit

R335 is used to calibrate the voltage going to control R3 (TUNE SWR). This adjustment sets the 1.5 SWR point of the control. The wiper of R3 is connected to pin 6 of U302B and to pin 8 of SW1 (SET-FWD). The output from U304 is connected to pin 5 of U302B, and also to pin 5 of U314B and pin 12 of U314D.

With no input signal, or 1:1 match, the signal level at pin 5 of U302B will be 1.0 VDC. If a mismatch occurs, however, the signal level drops and, with a 2:1 SWR, the calibrated output will be .5 VDC. The output (pin 7) of U302B remains high until the voltage on pin 5 drops below the reference voltage on pin 6. C313 prevents spikes from tripping the circuit. U302A, with associated components, acts as a buffer and pulse-shaper; U302A's output (pin 1) is normally low.

U305 is a quad bilateral switch; two of the switch sections are used to keep the master control line open, and two sections are used to control which of the variable capacitor motors should be turned on. R344, C321, C322, and R345 shape the pulse going to dual flip-flop U307. Pin 12 of U307 is normally high and pin 13 is low unless a pulse is received.

When a change of state takes place, pin 12 goes low and shuts off the switches controlled by pins 8 and 9 of U305. Pin 13 goes high and this high is applied across D308 and voltage divider R409/R411 to the base of Q313. A high on the base of Q313 causes the collector to go low. This causes visual alarm PL206 to light and, if switch SW3 is on, the audio alarm (which is made up of U313 and SP1) will sound. This change of state of U307, which lasts 1-2

seconds, is controlled by a timing circuit which is made up of R348 and C325.

U306 is a 555 timer circuit which is set for approximately 3-second cycles. The base of Q303 is conected to the output (pin 3) of U306. The control ports (pins 12 and 13) of U305 are constantly switching (from low to high - or from high to low). The outputs of U305 either go to pin 3 of U314A and pin 6 of U314B or to pin 10 of U314C and pin 13 of U314D.

U314 is a quad operational amplifier package. However, in this application, it is used to provide two window comparators. In the following paragraphs, we will describe only one of these comparators, since they both operate in the same manner.

Pin 5 of U314B receives its reference voltage from U304. When the level at pin 3 of U314A and pin 6 of U314B is higher than the level at pin 5 of U314B, a low is applied to the base of Q314. A low on the base allows the collector of Q314 to go high; this high is connected to the base of pass transistor Q315. The voltage at the emitter of Q315 will increase to the same level (minus a .6-volt drop). When switch SW5 is in the Auto position, the high (9 VDC) at the emitter of Q315 is applied to the motor drive circuit.

Motor Drive Circuit

All three motor drives function in the same manner. Therefore, we will describe only the transmitter capacitor's motor drive circuit.

The motor drive circuit allows for both clockwise and counterclockwise travel. When a high level (6-9 VDC) is applied to AX on the main circuit board, it is applied to the base of Q321 by voltage divider R439/R441. It is also applied to the base of Darlington transistor Q324 by voltage divider R446/R447. Q321 is a pass transistor; therefore, the 6-9 VDC on its base will be present on its emitter (minus a .6-volt drop).

The voltage from Q321 is applied to motor A1, and also to the collector of Q324 through the motor windings. With the base of Q324 being high, Q324 turns on and its collector voltage is .6 VDC with respect to ground. With 6-9 VDC present on one side of the motor, and .6 VDC on the other side, the motor turns in one direction.

When a high is applied to AY, transistor Q322 and Darlington transistor Q323 operate as previously described; therefore, the motor turns in the opposite direction. D353 and D354 make up a sensing device that passes a high on the base of Q325. This transistor will turn on and indicator PL203 lights, indicating that this motor is turning.

50% Capacitor Circuit

Both the transmitter and antenna capacitors use the same type of circuit to allow them to be placed in a preset position in the Auto mode. When inductor motor A2 turns, D363 or D364 passes a high across pins 13 and 14 of switch SW5D and to the pulse-shaping network consisting of C366, R484, R483, C364, and R479. From this network, the pulse is applied to pins 3 and 5 of U315A. Pin 1 of U315A goes high, and this pulse is applied to the gate of SCR D351.

The slot in the decoder disk, which is mounted on the shaft of motor A1, fits into optical coupler U2. When the slot is lined up between the two posts of U2, its pin 2 goes high. If the slot is not positioned between the posts, however, pin 2 remains low.

Assume that a low is present on pin 2 of U2. A low from U2 is applied to the base of Q316, which remains turned off. The collector of Q316 goes high, which turns transistor Q317 on. The collector of Q317 goes low and this causes Q318 to turn off. The collector of Q318 goes high, which causes pass transistor Q319 to apply a high to the anode of SCR D351 via diode D349.

When the anode of SCR D351 is high, and a high pulse is being sensed on the SCR's gate, the SCR fires and a high is passed to the motor drive circuit by D352/R438. This allows the motor to turn and rotate the decoder disk until the slot appears between the posts of U2. Pin 2 of U2 goes high which turns Q316 on; this turns Q317 off. When Q317 is turned off, the collector of Q317 goes high. This turns Q318 on and its collector goes low. Pass transistor Q319 turns off SCR D351, which in turn shuts the motor off.

Alarm Circuit

Q308 and Q309 make up a long-tune alarm circuit. When the capacitor motor is turning, a high is applied to Q308, Q306, and the base of Q311. The voltage on the base of Q309 drops as C345 discharges through R394 and R395. After approximately 20 seconds, this voltage drops below .6 VDC. At that time, Q309 shuts off causing its collector to go high. This high is applied to pin 8 of U312, which is a 555 timer. U312, which has a 1-2 second cycle, turns Q313 on and off at this rate. Q313 control U313, which is the audio speaker alarm, and visual alarm PL206.

Linear Circuit

With linear switch SW4 closed, 12 VDC is applied to relay K1. Also, a positive pulse fires SCR D345. D345 will cause Q312 to turn on, which causes its collector to go low. This condition causes relay K1 to pull in and contacts 3 and 5 to close.

When the capacitor motors turn, Q311 turns on. This causes its collector to go low and shuts D345 off. This causes the collecter of Q312 to go high; relay K1 drops out, and contacts 3 and 5 of K1 open.

Inductor Presets

U317 is a window comparator and, as its name implies, is a specialized form of comparator designed to detect the presence of a voltage between two prescribed voltage limits — that is, within a voltage window. This is accomplished by logically combining the outputs of two single-ended comparators, one indicating greater than a lower limit, and the other indicating less than an upper limit. If both comparators indicate a true condition, the output is true. If either is not true, the output is not true.

The window we desire exists when both pins 8 and 14 of U317 or low. The window reference voltage is set up by the voltage divider made up by R452, R454 and one of the preset controls R358 through R375. The voltage that corresponds to the desired window is applied to pins 3, 6, 10, and 13 of U317 from inductor position control R6. R6 is controlled by the worm gear that is connected to the shaft of inductor motor A2.

When the voltage coming from R6 is above the window, output pins 1 and 7 of U317 go low, which causes Q326 to shut off. The collector of Q326 goes high, which applies a high to the motor drive circuit. The motor turns, which causes R6 to turn, resulting in the change of the voltage going back to U317 until the voltage is in the window.

When the voltage from R6 is below the window, the output (pin 14) of U317 goes high. This turn Q328 on, forcing its collector low and shuts Q329 off. The collector of Q329 goes high and this high is applied to the opposite side of the motor drive circuit, causing the inductor motor to turn in the opposite direction. This forces R6 to turn the other way until the voltage on pin 2 falls into the window again.

When the R6 control voltage is in the window, Q327 shuts off and light-emitting diode D359 lights. By adjusting the preset control, the window can be moved up or down. This will cause the roller contact to move to a different position. The BAND switch selects which pair of the preset controls that will be used, and the LOW-HIGH switch (SW7A) selects which one of the two controls will be part of the voltage divider circuit.

Turns Counter

U204 is an A/D converter that takes an analog voltage and converts it to digital information. R7 provides the analog voltage to the input (CK on the display circuit board) via TURNS control R233.

U201, U202, and U203 are open-ended drivers that supply the proper level to the V201 display tube. Q201, Q202, and Q203 are used to drive the 7th segment of each digit. U205 is a 5-volt regulator that supplies the proper voltage to U204 and V201.

As the inductor turns, the voltage from R7 changes. In other words, the turns counter is similar to a simple digital voltmeter. Controls R204 and R233 are used to calibrate the voltmeter to correspond with the position of the roller contact as it travels over the approximately 40 turns of inductor L1.

Power Supply Circuits

The operating power required by the various circuits of the Antenna Tuner is provided by four regulated power supplies, which are derived from a single input. This input, which is nominally 12 VDC and present at filter capacitor C331, is provided either from a line-voltage-derived source or from an external voltage source. Each of these circuit areas are covered in the following paragraphs.

During line operation, AC power is applied through slow-blow fuse F1 and power switch SW6 and then across the primary winding of power transformer T1. The input at capacitor C331 is produced from the secondary winding of transformer T1, in conjunction with the full-wave rectifier circuit of diodes D331 and D332. Capacitors C11 – C13 provide filtering of line-conducted noise signals. Capacitors C326 – C329 suppress noise generated by the three tuner motors to prevent the noise from getting onto the AC power line.

When an external voltage source is used to power the Antenna Tuner, a nominal 12 VDC source is connected to plug P2 on the rear panel of the Tuner. Diode D329 provides reverse polarity protection for the Tuner.

DC-DC Converter

This circuit is made up of transistors Q304 and Q305, transformer T301, and associated circuitry. Q304 and Q305 act as a switch, cycling the input voltage source to the primary winding of T301. This switching action results in a square wave primary voltage, inducing secondary voltages which are rectified and filtered to provide +12- and −12 VDC outputs.

Regulators

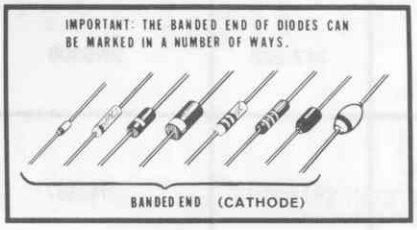
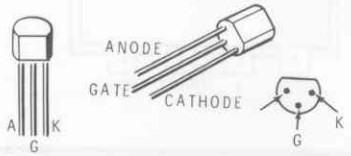
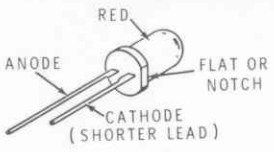
The 12 VDC output voltage from the DC-DC converter is applied to the input of voltage regulator U311 to provide an 8 VDC source that may be adjusted by control R381.

The −12 VDC output voltage from the DC-DC converter is applied to the input of voltage regulators U308 and U309. Regulator U308 provides a −8 VDC source that may be adjusted by control R379. Regulator U309 produces a −3.2 VDC source. Resistors R382 and R383 form a voltage divider to establish a −.1 VDC source.

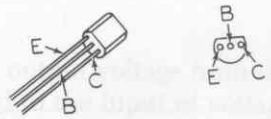
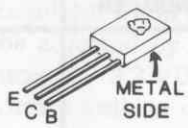
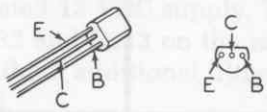
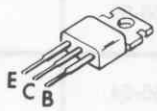
The voltage at C331 is fed to U1 which produces a well-regulated 12 VDC supply. This voltage is filtered by C332 and C333 on the main circuit board. It is used without additional filtering on the display circuit board.

SEMICONDUCTOR IDENTIFICATION CHARTS

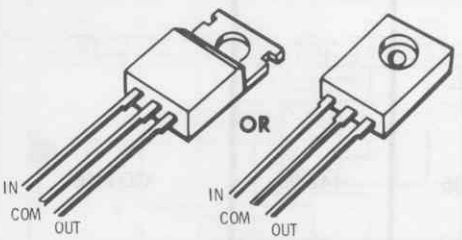
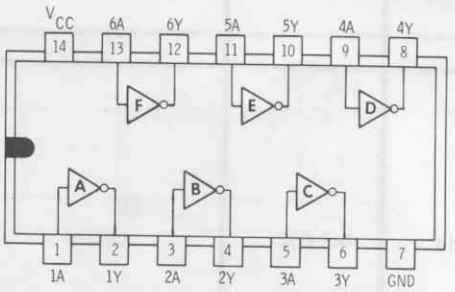
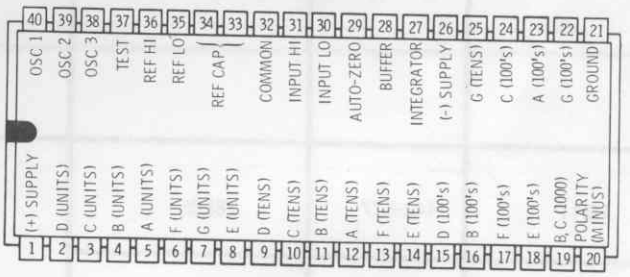
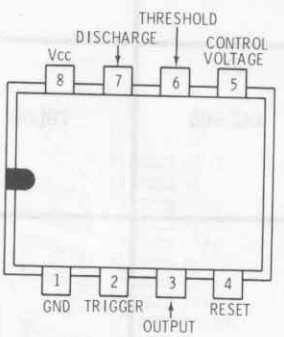
DIODES

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
D301, D302, D305 through D328, D336, D337, D338, D339, D342, D343, D344, D347, D348, D349, D352, D353, D354, D355, D356, D357, D358, D361 through D372. (10's not used)	56-56	1N4149	
D334, D335	56-89	GD510	
D333	56-94	12.8V Zener	
D304	56-97	1N3017B	
D329, D331 D332, D346	57-27	1N2071	
D341, D345, D351, D368	57-624	2N5061 SCR	
D359	412-640	LST5053 LED	

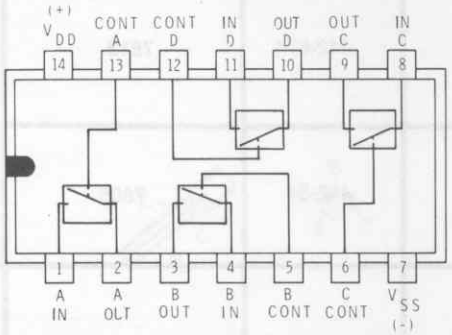
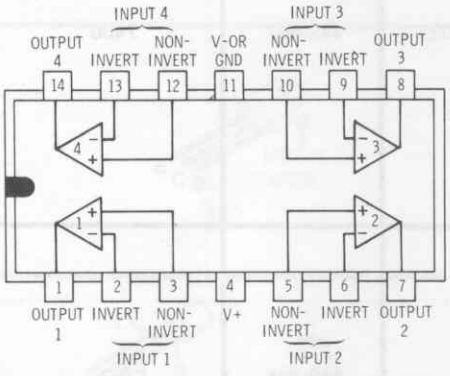
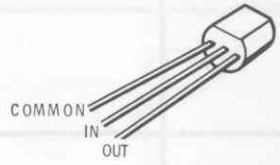
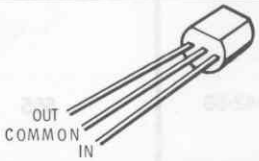
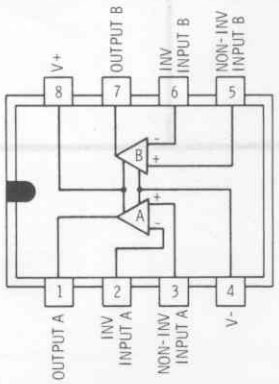
TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
Q305	417-801	MPSA20	
Q201-Q203, Q301-Q303 Q306, Q307 Q311, Q313-Q319, Q325-Q329, Q335-Q337, Q342-Q345, Q347 (10's not used)	417-864	MPSA05	
Q308	417-865	MPSA55	
Q304	417-819	MJE171	
Q312, Q321, Q322, Q331, Q332, Q338, Q339	417-818	MJE181	
Q309	417-222	2N5308	
Q323, Q324, Q333, Q334, Q341, Q346	417-918	2N6387	

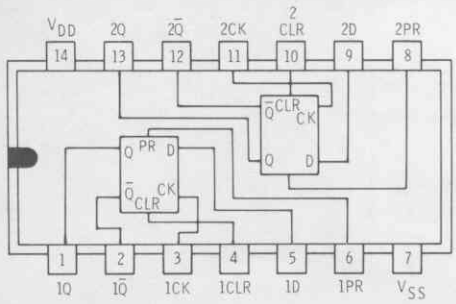
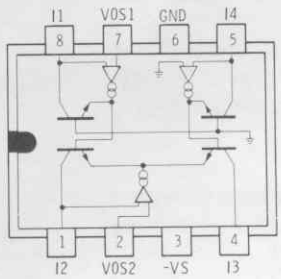
INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U1	442-674	7812	
U205	442-54	7805	
U201, U202 U203	443-967	7406	
U204	442-724	7107	
U306, U312, U313	442-53	555	

Integrated Circuits (cont'd)

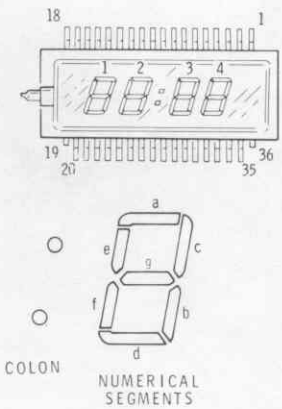
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U301, U305	442-99	CD4016	
U302, U314 U317	442-602	LM324	
U311	442-627	78L05	
U316	442-687	78L10	
U308, U309	442-665	79L05	
U303	442-707	LF353	

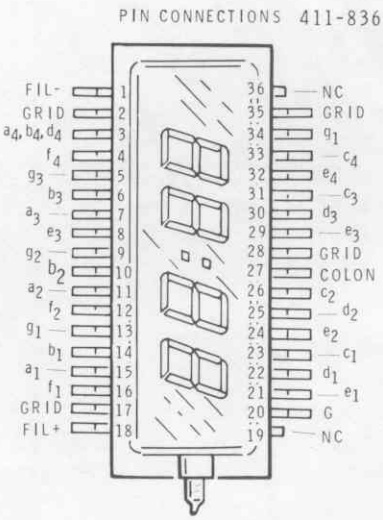
Integrated Circuits (cont'd)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U307, U315	443-607	MC14013	
U304	443-1164	RC4200	

READOUT TUBE V201

Heath #411-836,
Manufacturer's Number FUTABA 4BT-04





CIRCUIT COMPONENT	HEATH PART NUMBER	MAY BE REPLACED WITH		MAY BE REPLACED WITH	HEATH PART NUMBER	CIRCUIT COMPONENT

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:

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Benton Harbor, Michigan 49022

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