PRICE $2.00

Assembling and Using your

CONAR

Solid-State Oscilloscope

Model 251

QUALITY EQUIPMENT BUILT ON A HALF CENTURY OF SERVICE IN ELECTRONICS

Dear Customer

No matter what your experience has been with equipment, there's a new and even greater satisfaction awaiting you in this CONAR product.

CONAR is a division of the National Radio Institute — a pioneer of more than 50 years in the Electronics field. True, age alone is seldom a compliment. Yet there is no substitute for the priceless ingredient of experience. Intelligent design and engineering, clear-cut instructions written for the user, top-grade components are your assurance you have made a wise choice — a sound dollar investment.

The purpose of this book is to tell you how to get maximum value from this CONAR product. Please read these instructions carefully and follow them faithfully. Then you can rely on the dependable service of CONAR quality.

We reserve the right to make changes in design or improvement when such changes or improvements represent an equal or greater value to our customers.

WARRANTY

All CONAR products are guaranteed against factory defects for ONE FULL YEAR. Any part or component that becomes defective and such defect is not the result of accidental damage, improper use or wiring errors, will be replaced when returned to CONAR.

There are four conditions under which you may have to write us about this CONAR product:

(1) It arrives damaged. First, examine the package to determine the method by which it was shipped to you. Then, follow the instructions on the form packed with this instrument advising proper procedures in case of damage.

(2) Parts are missing. If anything is missing, and you find no substitute or other instructions after carefully examining the packing for small items, write us a letter explaining.

(3) A part has a defect. DEFECTIVE MATERIALS MUST BE RETURNED BEFORE A REPLACEMENT CAN BE MADE. TWO THINGS MUST BE WITH EVERY PACKAGE YOU RETURN TO US: (1) Your name and address, (2) Your reason for returning it. You may enclose a letter in the package, if you mark the package "first class letter enclosed." Such a package requires a stamp in addition to the regular parcel post charge. Unless examination shows an obvious defect, write first, and tell us why you think the part is defective. Some other part may be causing the trouble.

(4) You lose or damage parts. Use the parts order form packed with this instrument. Be sure to enclose your remittance as ordered parts are not sent C.O.D. or on account.

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Introduction

The Model 251 oscilloscope you are going to build has many desirable features, including dc to 5 MHz frequency response, automatic triggering, and all solid-state circuitry. The Model 251 is a high-performance, general-purpose oscilloscope, and is ideally suited to many servicing or laboratory needs.

In short, the Model 251 oscilloscope is an instrument of which you can be very proud. Just remember, the more you know about your scope, the better you can use it and the more valuable a tool it will be in your daily work.

CAUTION

The cathode-ray tube supplied in this kit is highly evacuated. Breaking the tube could result in serious injury from flying glass. Do not open the box in which the tube is packed until you are told to do so. When handling the tube, be careful not to strike it against anything. Do not use excessive force when installing it.

PREPARING FOR THE ASSEMBLY

Most of the parts in this kit are packed in plastic bags. The bags have identifying labels on them so that you can collect the bag or bags that you will need for a particular assembly stage.

For example, the first bag that you will need has a label that reads in part, 3A-41T. This bag is divided into separate compartments. The parts in each compartment are used in the assembly of the power supply circuit board. Do not remove the parts from the individual compartments until they are called for in the instructions.

The parts list with each of the assembly stages gives the part number, quantity, description, and price of each of the parts. You should refer to the parts lists if you ever have to order a replacement part for your instrument.

It is not necessary for you to check all of the parts of this kit at one time. Instead, gather and check the parts called for in each of the assembly steps. If you find that a part is missing or damaged, go ahead with your assembly and write to us for a replacement.

The larger parts such as chassis pieces, transformers, etc., are packed separately because of their bulk and for extra protection. Examine each part separately for damage. If any part was damaged in shipment, write to us. A replacement will be sent to you.

You may find an occasional substitution, such as a 600 volt capacitor for a 400 volt capacitor, a 400 volt capacitor for a 200 volt capacitor, or a 5 percent resistor instead of a 10 percent resistor. These changes are minor and will not affect the operation of your instrument. If any other changes are made, a special notice will be enclosed with your training kit. Be sure to read all enclosures before you start the assembly and your experiments.

ASSEMBLY HINTS

There is no satisfaction like that of building a kit and having it work perfectly the first time you try it. Here are some suggestions that will help you reach that goal.

It's a good idea to read over the entire assembly section before beginning actual construction. This way you get an overall picture of what is to be done and how each stage of the assembly relates to the others. When you are ready to begin construction, read each step carefully and make sure you clearly understand what must be done before proceeding. After you perform each step, check it off in the space ( ) provided and proceed to the next step.

Follow the Instructions. Perform each step in the exact order given. Don't try shortcuts such as omitting steps or assembling the kit from the schematic diagram. Our experience has shown that even veteran kit builders make wiring errors when they fail to follow directions. Tracking down and correcting wiring errors in completed kits can be a tedious and time-consuming process. By far, the quickest shortcut is to follow the assembly instructions to the letter.

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Do a Good Soldering Job. Poor soldering is the greatest single cause of problems in completed units. A large part of the soldering in this kit will be done on printed circuit boards. This makes it easy to do a professional-looking construction job. To do the soldering in this kit you will need a small pencil-type soldering iron. A 25 to 50 watt iron is satisfactory.

To mount components on the circuit boards, unless you are told to do otherwise, first bend the leads to fit the holes in the board using your longnose pliers. Next, pass the leads through the holes and press the component down until it rests squarely on the surface of the board. You may bend the leads on the other side of the board slightly outward so the component stays put when you turn the board over for soldering.

To solder the component leads to the foil pads, apply the tip of your iron so that it touches both the lead and the foil. At the same time, feed the end of the solder to the lead and the foil until a small mound of molten solder surrounds the lead and covers the pad. When this happens, withdraw the solder, then the iron.

After the solder has solidified, clip off the lead close to the solder mound with your diagonal cutters. When soldering components on the circuit boards, watch out for solder bridges that cause short circuits. Each time you solder a connection, make sure that the solder mound covers only that connection and does not run over to a nearby pad or foil path.

When you connect wires and components to terminal lugs, controls, and other parts of the chassis, be sure the mechanical connection of the wire or lead to the terminal lug is secure before you solder. Do this by hooking the wire or lead through or around the terminal lug, and then crimp it with your longnose pliers.

Each chassis wiring step will include a notation such as (NS), (S1), (S2), or (S3). These notations tell you whether to solder the connection made in that step and, if so, the total number of wires to be connected at that point. Each time you make a solder connection, check to see that you have the correct number of wires connected to the terminal lug. The notation (NS) indicates that a connection should not yet be soldered because other wires will be added. When you install the last wire, you will solder the terminal. This will be indicated by the letter S followed by a number, as explained previously. This number tells you how many leads are supposed to be connected to the terminal before it is soldered. For example, if a step says, "Connect a wire to lug 6 (S3)," there should be three leads connected to this terminal before it is soldered. In cases where a wire or component lead passes through a terminal or lug and connects to another terminal or lug, it counts as two leads, one entering and one leaving the terminal or lug.

As we stated before, poor soldering is the greatest single cause of problems in equipment returned to us for repair. You can greatly reduce the possibility of poorly soldered connections in your receiver if you clean the leads on resistors and capacitors before installing them. Do this by scraping the leads lightly with a knife, or twisting them between two pieces of fine sandpaper.

You can further guard against poor soldering by using a clean, hot iron at all times. Be sure that enough heat is applied to the solder connection to avoid rosin joints. This is of the utmost importance! Another important point to remember is to avoid using too much solder. Use only enough to lightly cover the leads and terminal you are soldering. Let any excess solder flow onto the tip of your iron and wipe it off with a rag. Big blobs of solder on terminals or circuit board pads are almost certain to result in trouble.

Finally, use only the solder supplied in this kit. If you buy more solder locally, make sure the container is marked "rosin-core solder." DO NOT USE ACID-CORE SOLDER OR SOLDER PASTE FLUX. If you use either of these, you will ruin your oscilloscope. *We cannot service any equipment on which acid-core solder or solder paste flux has been used.*

Use the Figures. Pictorial diagrams throughout this manual show the placement of parts and the details of construction steps. In some cases a part may fit into position in more than one way, only one of which is correct. Study the figures carefully and make sure that you know exactly how a part is to be mounted before proceeding. In some cases the illustrations may be slightly distorted to show certain details. In most instances the illustrations in this manual show all parts in proper perspective.

You are now ready to begin an exciting project. The oscilloscope you are going to build is a valuable test instrument that will give you many years of service.

For this reason, we urge you to take your time and do careful work. Some students get impatient to finish the oscilloscope quickly without reading

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all of the instructions. However, it is best to exercise care during assembly and perform all of the steps as they are presented. By doing this you will be assured of obtaining a quality, well-built, reliable piece of equipment.

You will be assembling your oscilloscope in several stages. Be sure to check your work carefully after each stage to ensure that all steps were completed correctly. You will now begin building your oscilloscope.

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Circuit Board Assemblies

POWER SUPPLY MODULE ASSEMBLY

You will begin building your oscilloscope by assembling the power supply module. The power supply module contains most of the components and circuitry for the three voltage sources (+5, +9, and - 8 volts). It also contains the components and circuitry for the final vertical deflection amplifier.

Gather the following parts:

Part No.	Quan.	Description	Price Each
EC116	1	Power supply circuit board	2.75
From bag 3A-41T:			
HA900	20'	Rosin-core solder	.30/ft
SO96	21	Circuit board receptacles	.05

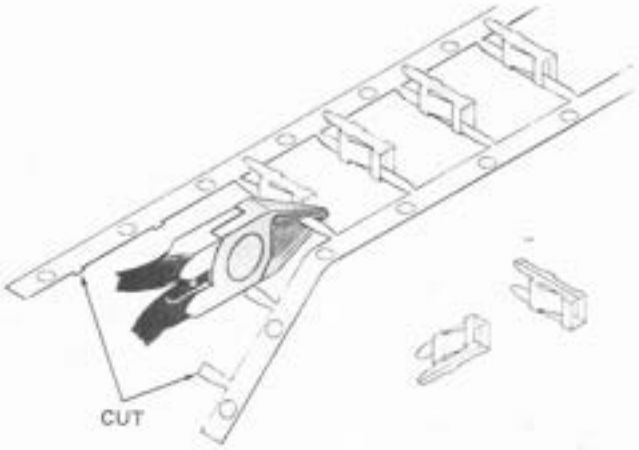

Figure 1. Detail A.

Refer to Fig.1 and begin the module assembly by mounting and soldering the circuit board receptacles. The details shown with Fig.1 show how the receptacles are installed.

We have supplied an extra receptacle in case you lose or damage one. When you have completed installing the receptacles, check your work and proceed to the next step.

Remove the following parts from bag 3A-41T:

Part No.	Quan.	Description	Price Each
CN261	2	1 μF tantalum	.75
CN291	1	360 pF, 500 V silver mica	.40
CN329	1	0.1 μF tantalum	.45
RE126	2	330 ohms, 5%	.24
RE153	1	1.5k, 5%	.24
RE202	1	4.7k, 5%	.24
RS37	2	3k, 10 watt	.61
RS89	2	5.6k, 5 watt	.40

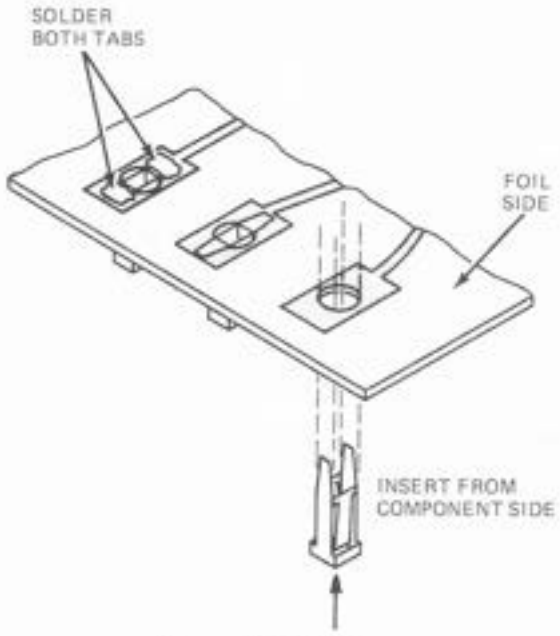

Figure 1. Detail B.

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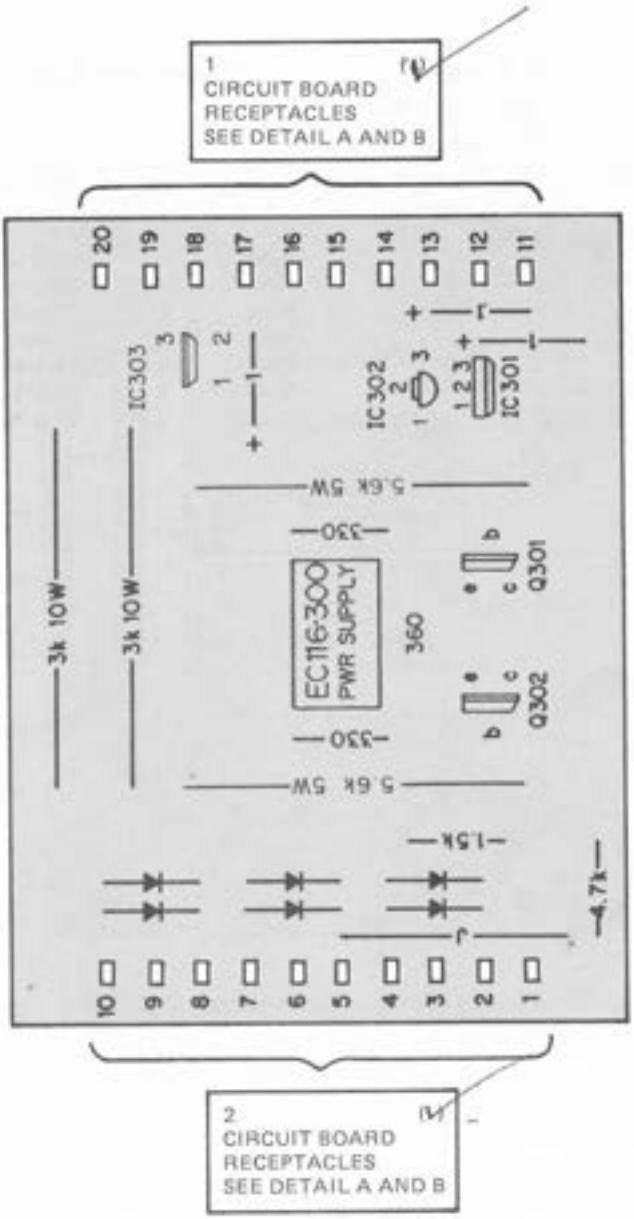

Figure 1. Installing the circuit board receptacles on the power supply module.

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Refer to Fig.2 and continue with the module assembly. Be sure you correctly identify the positive lead of each tantalum capacitor and install it with the correct polarity on the circuit board. Except when you are told to do otherwise, mount all parts flush against the surface of the circuit board. Solder all parts carefully and clip off the excess lead lengths.

Use black hookup wire for all of the circuit board jumpers. When bare wire is specified, strip off the required amount of insulation.

Remove the following parts from bag 3A-41T:

Part No.	Quan.	Description	Price Each
IG38	1	7805 voltage regulator, 5 volts	2.50
IG98	1	78L09 voltage regulator, 9 volts	1.00
IG99	1	79M08 voltage regulator, −8 volts	2.50
SR17	4	1N4001 silicon diodes, 1 A, 50 PIV	.21
SR24	2	1N4007 silicon diodes, 1 A, 1000 PIV	.85
TS34	2	D40N1 or MPSU10 transistors	.75
WR909	2'	Black hookup wire	12'/.25

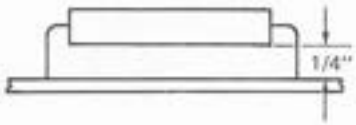

Figure 2. Detail A.

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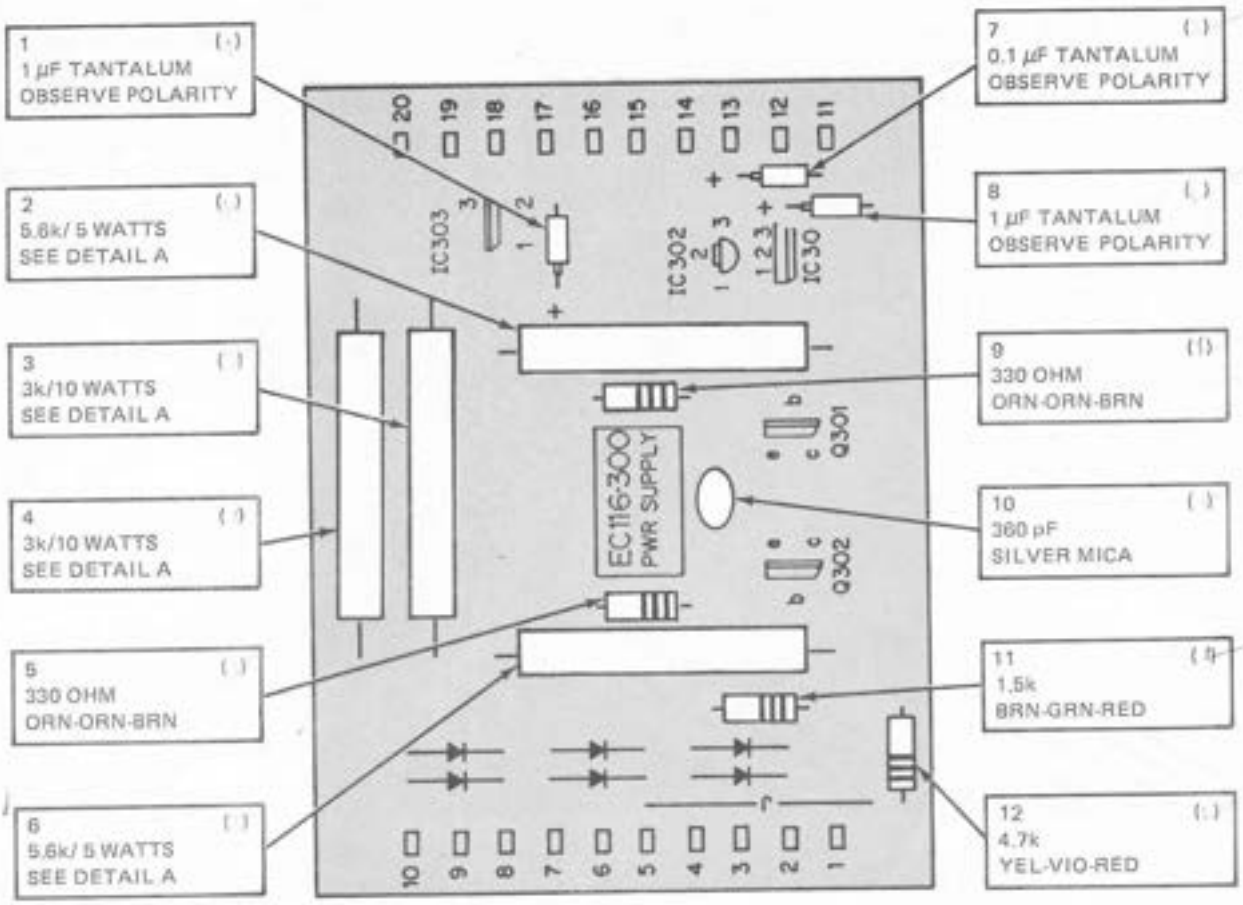

Figure 2. Installing the resistors and capacitors on the power supply module.

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Refer to Fig.3 and continue with the module assembly. Be sure you identify the cathode lead of each diode and observe the correct polarity when installing the diodes on your circuit board. Remember, the cathode is the marked or banded lead. Also, when installing the transistors and voltage regulators, be sure that the leads are positioned properly as you insert them in the circuit board. Figure 3, Detail A shows the lead identification for the transistors used in this kit. For proper heat dissipation, the transistors and regulators should be mounted so that their bodies are about 3/16" to 1/4" above the surface of the circuit board.

When you are asked to install a jumper, cut the length specified from the black hookup wire. Then, remove 1/4" of insulation from each end of the wire. Finally, install the jumper on the circuit board.

After you complete the power supply module, carefully check the board to be sure that each connection is secure, that there are no solder bridges on the foil side, and that each component is installed correctly. Set the completed circuit board aside.

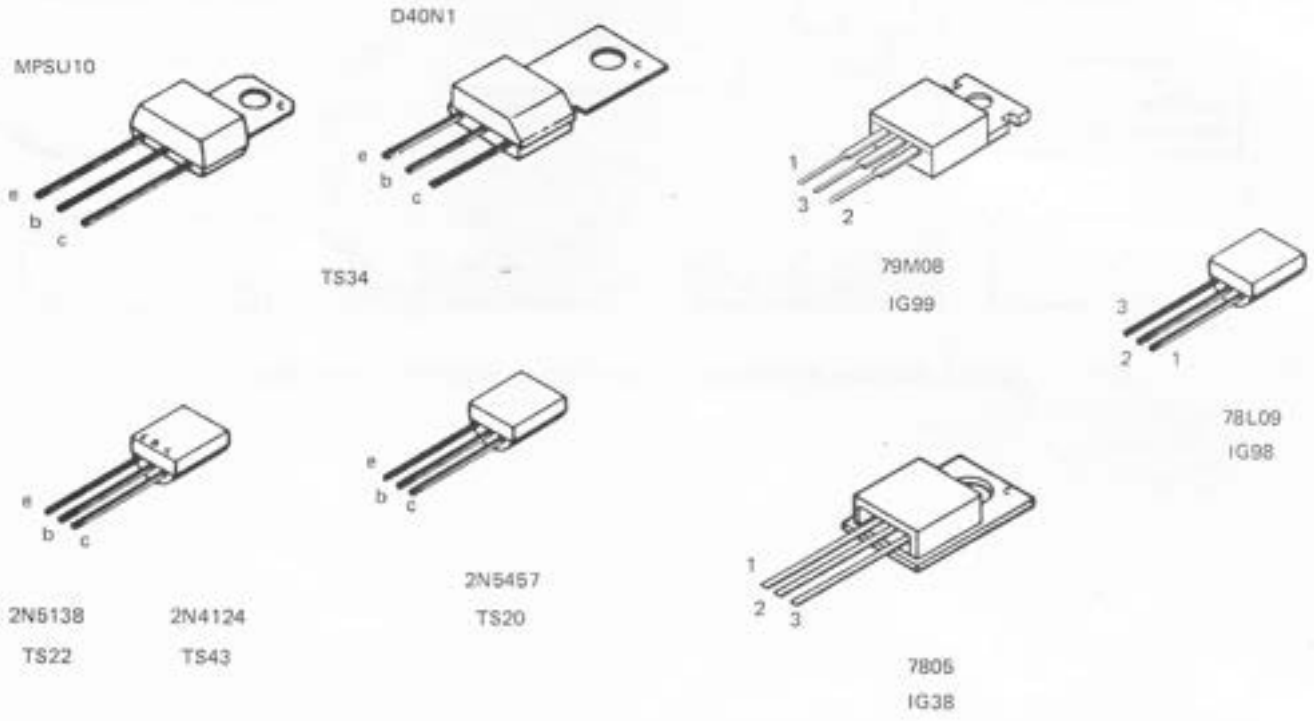

Figure 3. Detail A.

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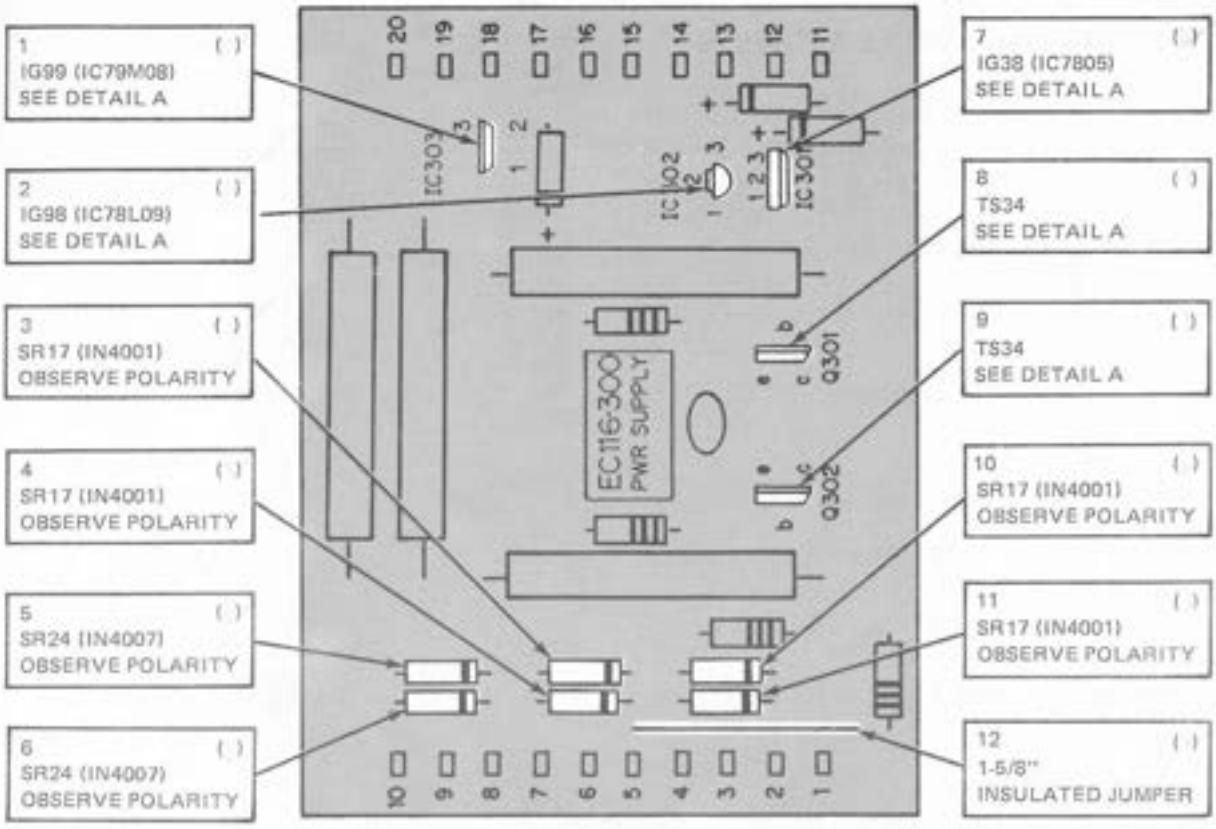

Figure 3. Installing the remaining components on the power supply module.

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SWEEP/TRIGGER MODULE ASSEMBLY

You are now going to build the sweep/trigger circuit board module. Follow the same general procedures you used in building the power supply module.

Gather the following parts:

Part No.	Quan.	Description	Price Each
EC114	1	Sweep/Trig circuit board	2.75
From bag 4B-41T:			
SO96	16	Circuit board receptacles	.05

Refer to Fig.4 and begin the module assembly by mounting and soldering the circuit board receptacles. After you have installed the receptacles, you will install the resistors.

Remove the following parts from bag 4B-41T:

Part No.	Quan.	Description	Price Each
RE10	1	100k, 5%	.24
RE73	2	1M, 5%	.24
RE74	1	10k, 5%	.24
RE102	1	3k, 5%	.24
RE126	1	330 ohm, 5%	.24
RE145	1	12k, 10%	.15
RE159	1	180 ohm, 5%	.24
RE160	1	1.8k, 5%	.24
RE161	1	470 ohm, 5%	.24
RE164	2	1k, 5%	.24
RE169	1	47k, 5%	.24
RE179	2	2.7k, 5%	.24
RE180	4	22k, 5%	.24
RE186	1	120 ohm, 5%	.24
RE189	1	620 ohm, 5%	.24
RS5	1	10k, 1 watt, 10%	.20

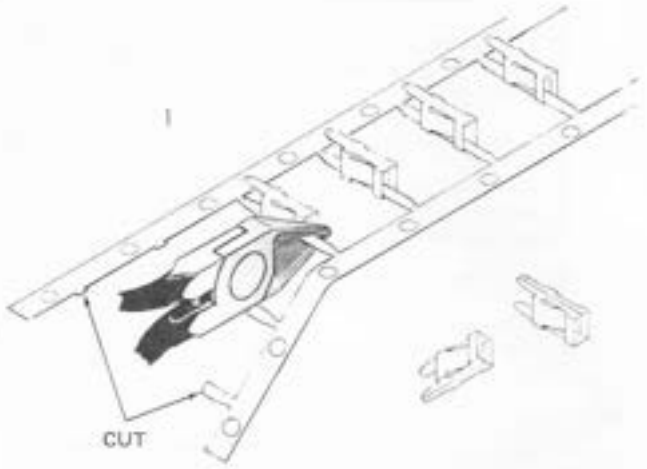

Figure 4. Detail A.

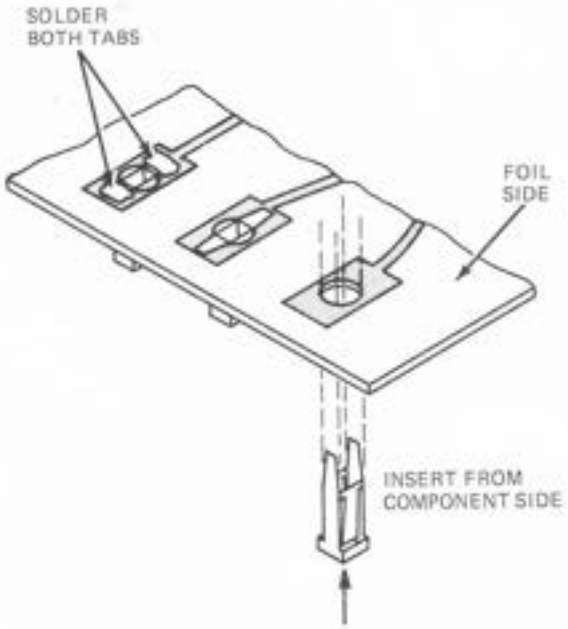

Figure 4. Detail B.

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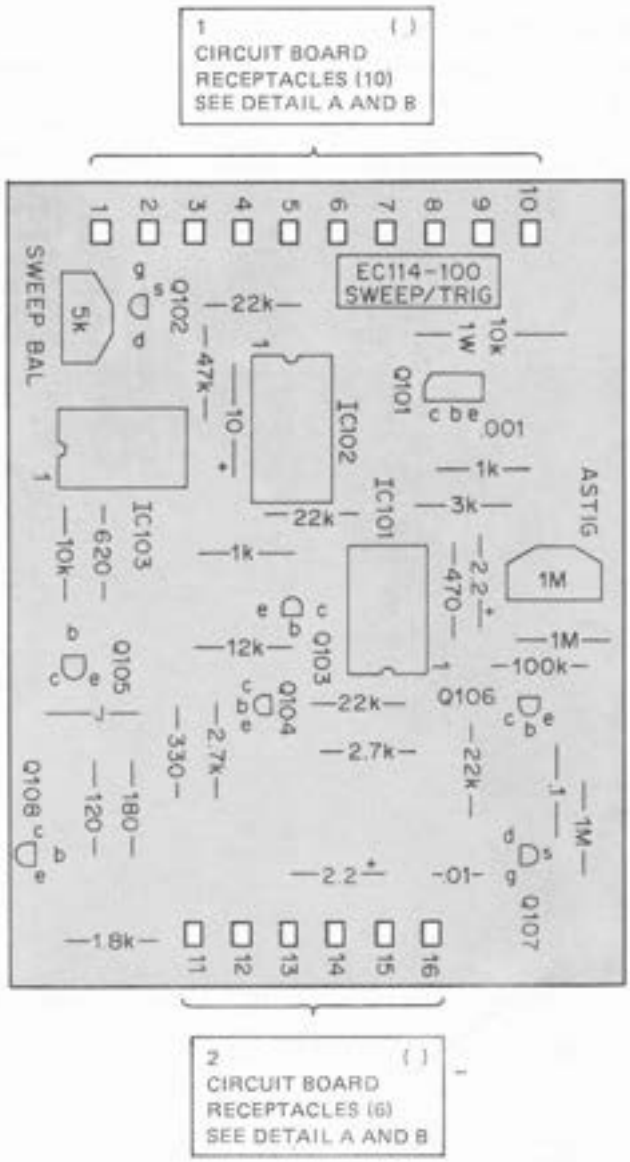

Figure 4. Installing the circuit board receptacles on the sweep/trigger module.

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Refer to Fig.5 and continue with the module assembly. After you have installed the resistors you will install the capacitors, IC sockets, and transistors.

Remove the following parts from bag 4B-41T:

Part No.	Quan.	Description	Price Each
CN34	1	0.001 μF, disc	.15
CN102	1	0.01 μF, disc	.40
CN104	1	0.1 μF, disc	.40
CN253	2	2.2 μF, tantalum	.75
CN300	1	10 μF, tantalum	.50
PO121	1	5k, trim pot	.45
PO122	1	1M, trim pot	.45
SO84	2	14-pin IC sockets	.75
SO86	1	16-pin IC socket	.75
TS20	2	2N5457 n-channel JFETs	1.00
TS22	1	2N5138 transistor	.40
TS34	1	D40N1, D40V1, or MPSU10 transistor	.75
TS43	4	2N4124 transistors	.40

Figure 5. Detail A.

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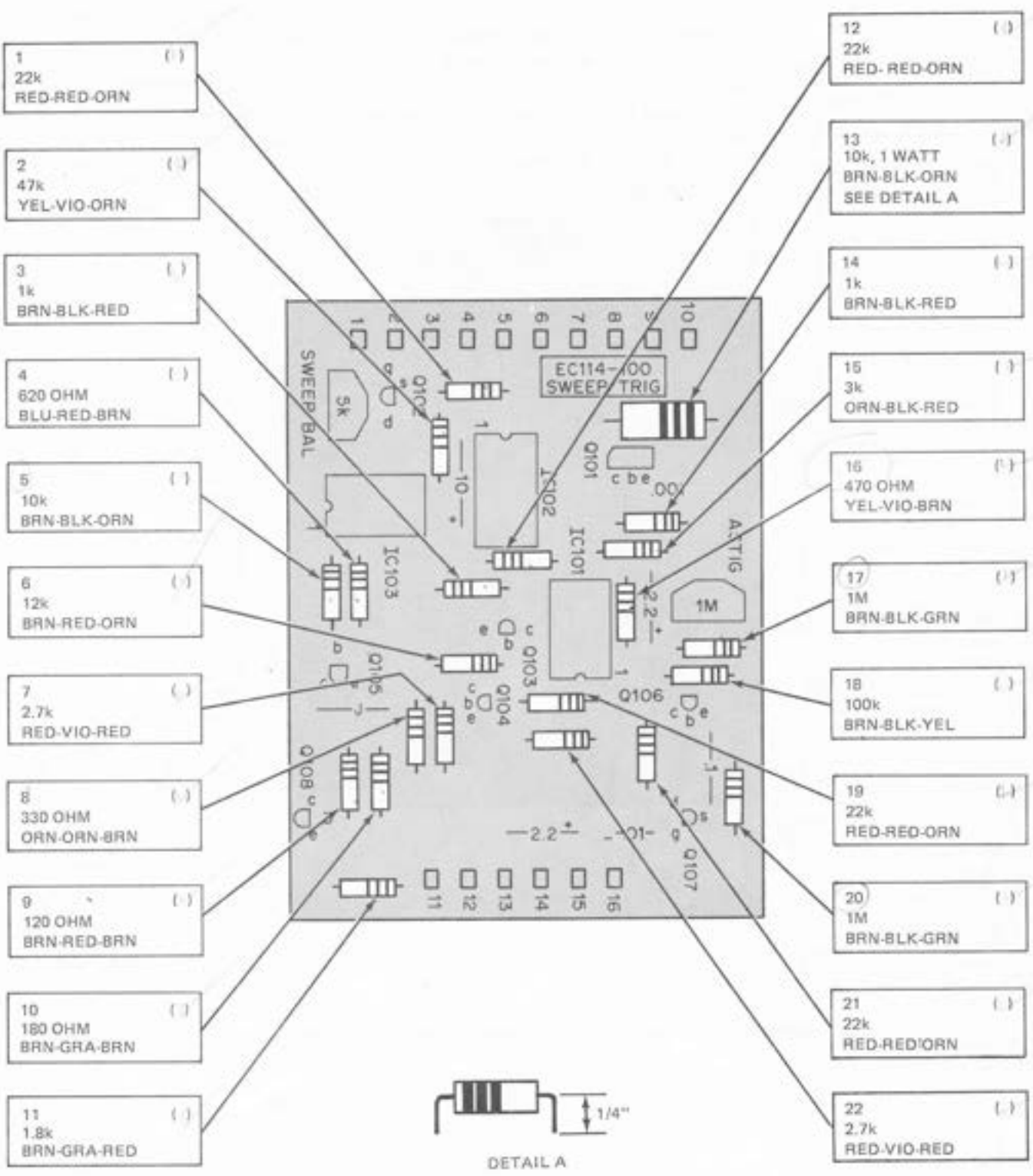

Figure 5. Installing the resistors on the sweep/trigger module.

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Refer to Fig.6 and continue with the module assembly. You will now install the ICs in their sockets.

Remove the following parts from bag 4B-41T:

Part No.	Quan.	Description	Price Each
IG37	1	760 comparator IC	5.20
IG64	1	74132 quad 2-input NAND Schmitt trigger TTL IC	1.25
IG97	1	74123 dual retriggerable one-shot IC	.85

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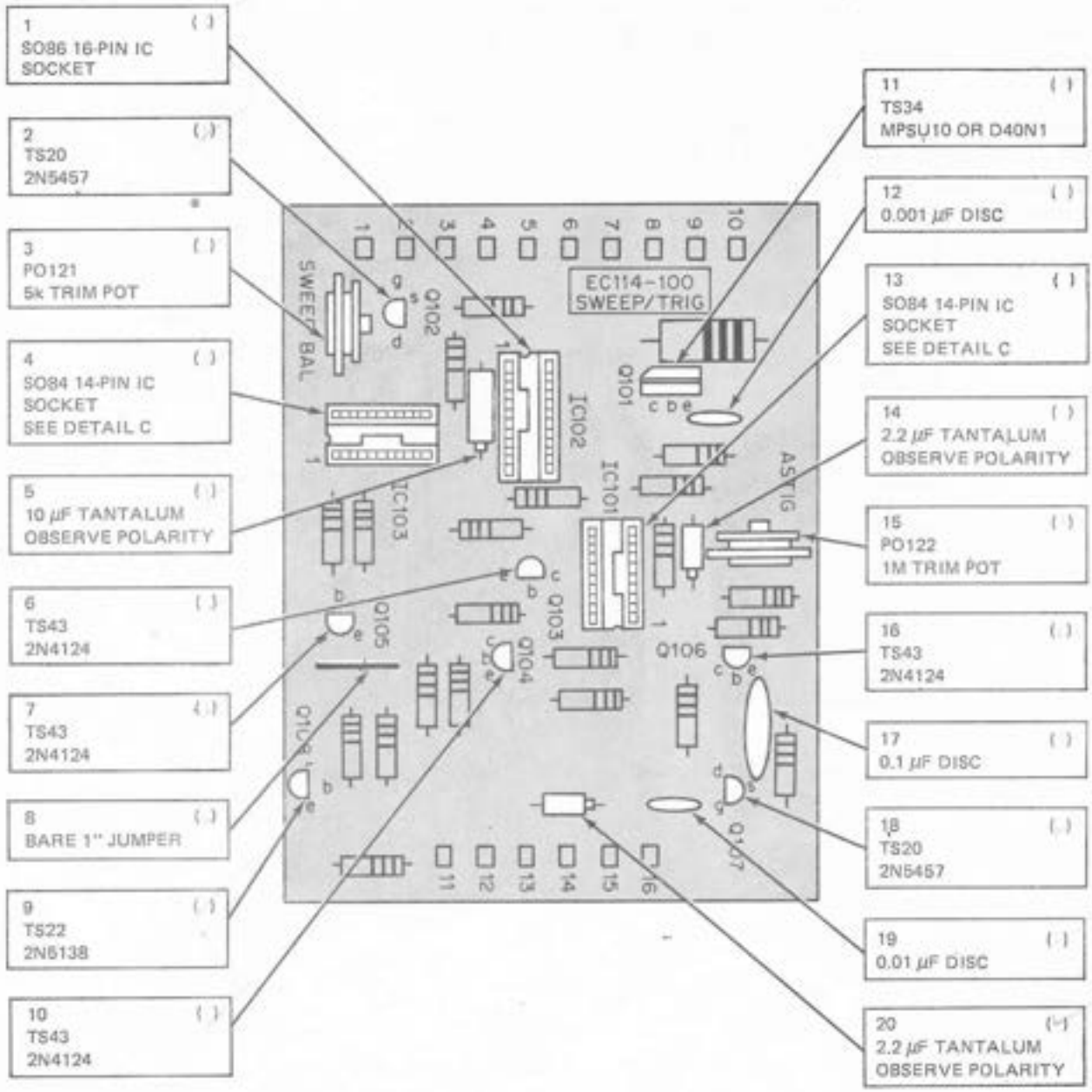

Figure 6. Installing the remaining components on the sweep/trigger module.

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Refer to Fig.7 and install the integrated circuits. Be sure to correctly locate pin 1 of each integrated circuit.

When you have finished assembling this module, carefully check your board to be sure that all of the components are installed correctly and that there are no solder bridges or poor solder connections. Set the board aside and continue with the next assembly stage.

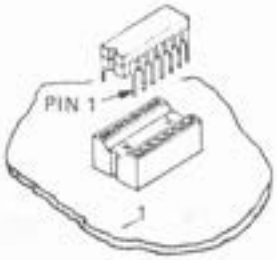

Figure 7. Detail A.

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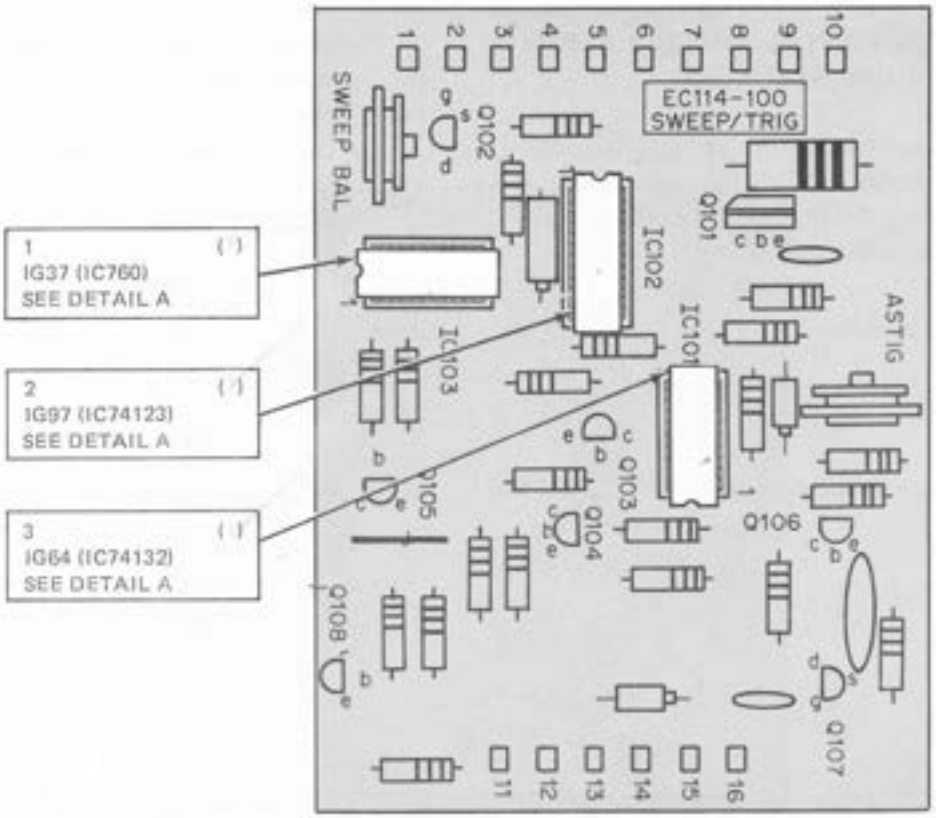

Figure 7. Installing the integrated circuits on the sweep/trigger module.

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VERTICAL/HORIZONTAL AMPLIFICATION MODULE ASSEMBLY

You will now build the vertical/horizontal amplifier circuit board. Follow the same procedure you used in building the other two boards.

Gather the following parts:

Part No.	Quan.	Description	Price Each
EC115	1	Vert/Hor amplifier circuit board	2.75
From bag 5C-41T:			
SO96	15	Circuit board receptacles	.05

Refer to Fig.8 and begin the module assembly by mounting and soldering the circuit board receptacles.

Gather the following parts from bag 5C-41T:

Part No.	Quan.	Description	Price Each
RE3	1	100 ohm, 5%	.24
RE73	2	1M, 5%	.24
RE74	1	10k, 5%	.24
RE157	1	56 ohm, 10%	.15
RE161	3	470 ohm, 5%	.24
RE164	2	1k, 5%	.24
RE175	2	680 ohm, 5%	.24
RE178	1	2.2k, 5%	.24
RE206	1	910 ohm, 5%	.24

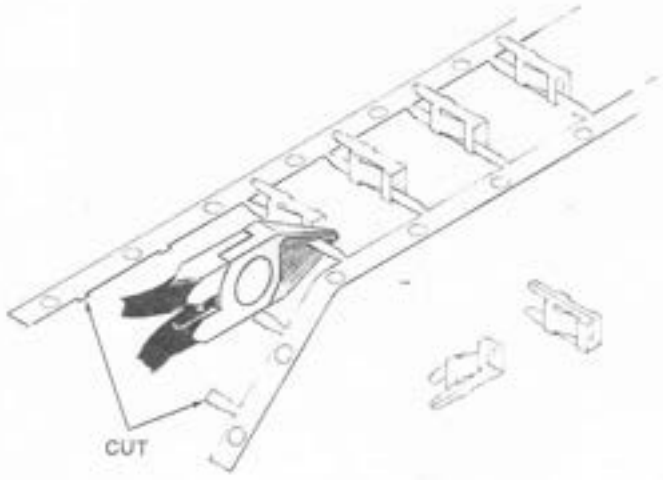

Figure 8. Detail A.

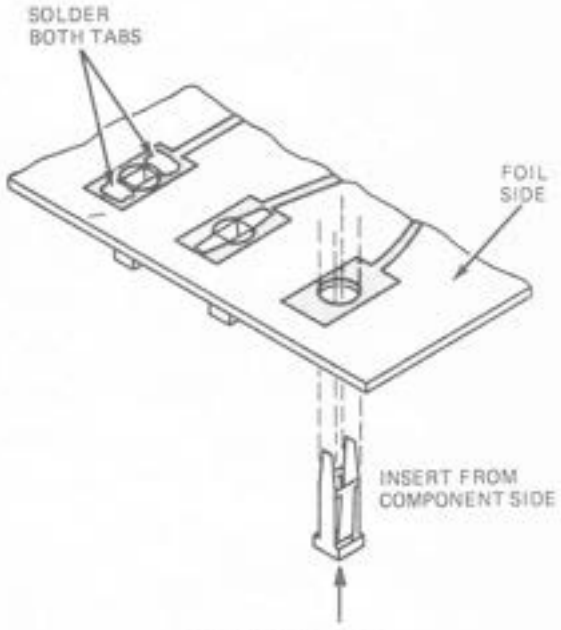

Figure 8. Detail B.

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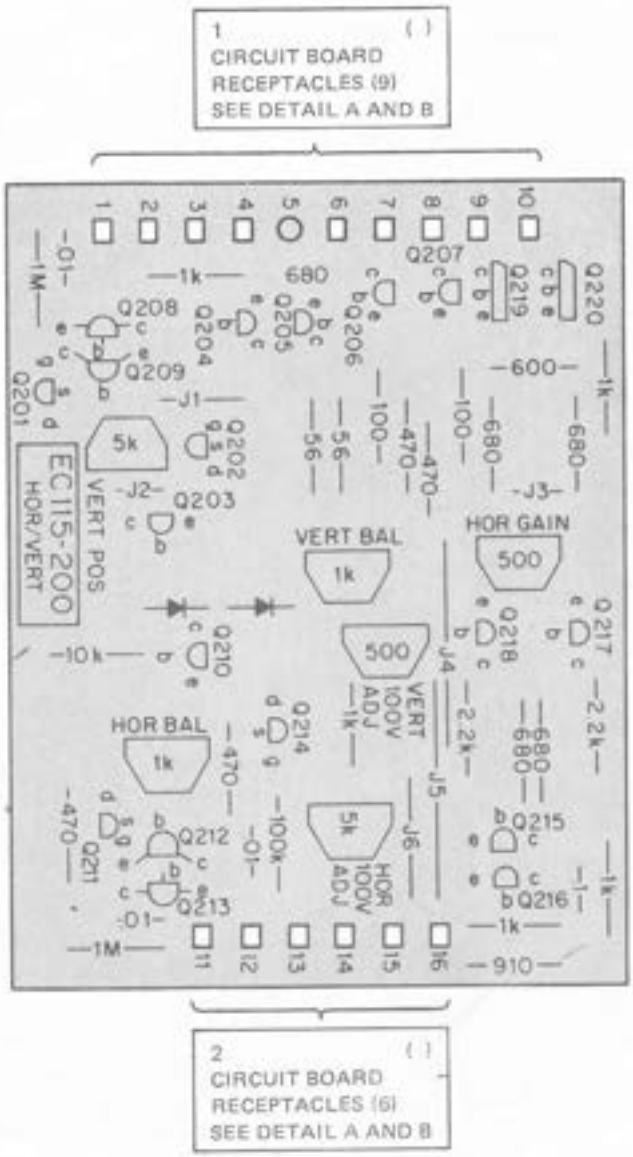

Figure 8. Installing the circuit board receptacles on the vertical/horizontal amplification module.

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Refer to Fig.9 and continue with the module assembly.

Gather the following parts from bag 5C-41T:

Part No.	Quan.	Description	Price Each
RE3	1	100 ohm, 5%	.24
RE10	1	100k, 5%	.24
RE161	1	470 ohm, 5%	.24
RE164	3	1k, 5%	.24
RE175	2	680 ohm, 5%	.24
RE178	1	2.2k, 5%	.24
RE189	1	620 ohm, 5%	.24

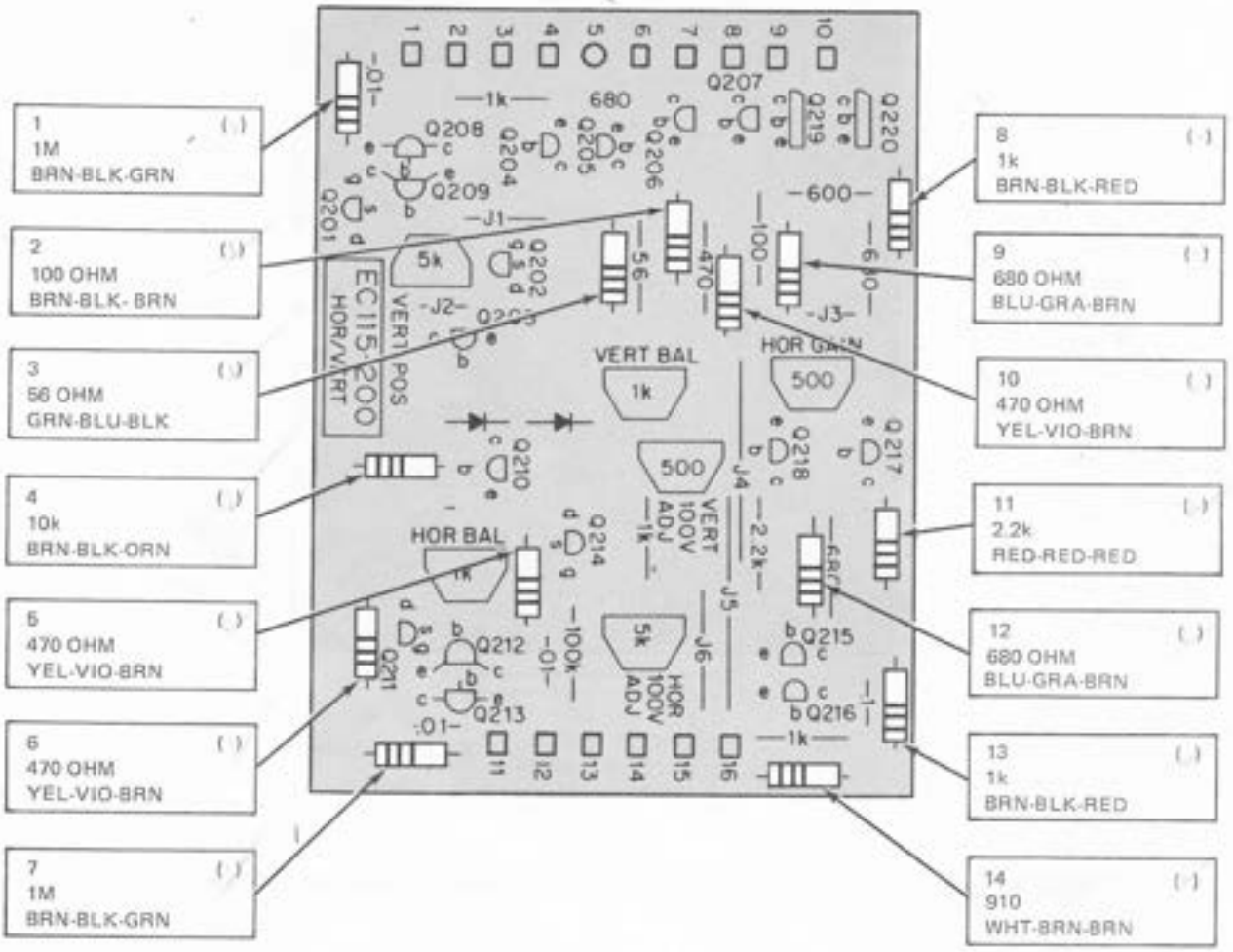

Figure 9. Installing the resistors on the vertical/horizontal amplification module, Part 1.

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Refer to Fig.10 and continue with the module assembly.

Gather the following parts from bag 5C-41T:

Part No.	Quan.	Description	Price Each
CN102	3	0.01 μF, disc	.38
CN104	1	0.1 μF, disc	.36
CN225	1	680 pF, 20% disc	.15
CN293	1	600 pF, disc	.15
CR23	2	1N914 diodes	.40
PO103	2	500 ohm trim pots	.30
PO104	2	1k trim pots	.30
PO121	2	5k trim pots	.45

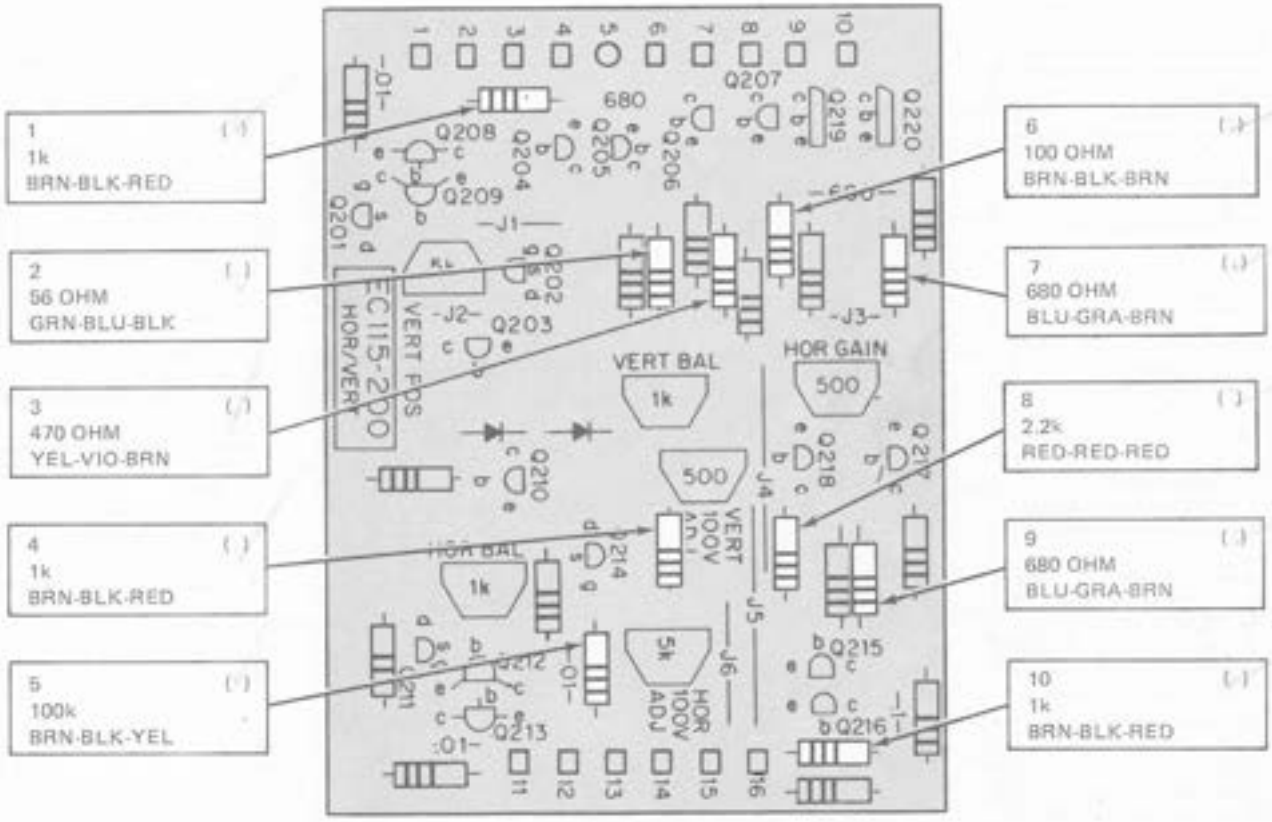

Figure 10. Installing the resistors on the vertical/horizontal amplification module, Part 2.

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Refer to Fig.11 and continue with the module assembly.

Gather the following parts from bag 5C-41T:

Part No.	Quan.	Description	Price Each
TS20	4	2N5457 n-channel JFETs	1.00
TS22	2	2N5138 pnp transistors	.40
TS34	2	D40N1, D40V1, or MPSU10 transistors	.75
TS43	12	2N4124 npn transistors	.40

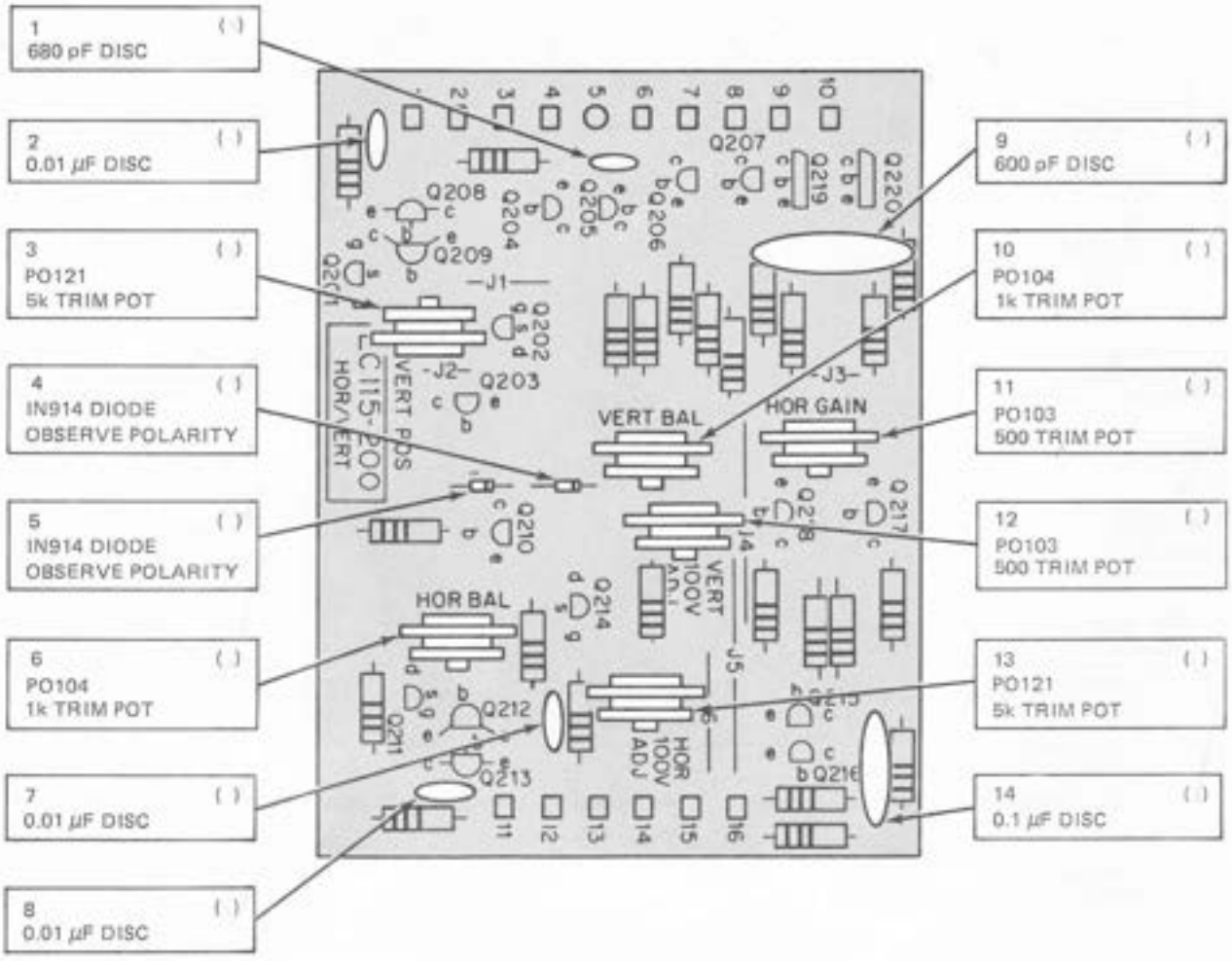

Figure 11. Installing the capacitors, diodes, and potentiometers on the vertical/horizontal amplification module.

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Refer to Fig.12 and continue with the module assembly.

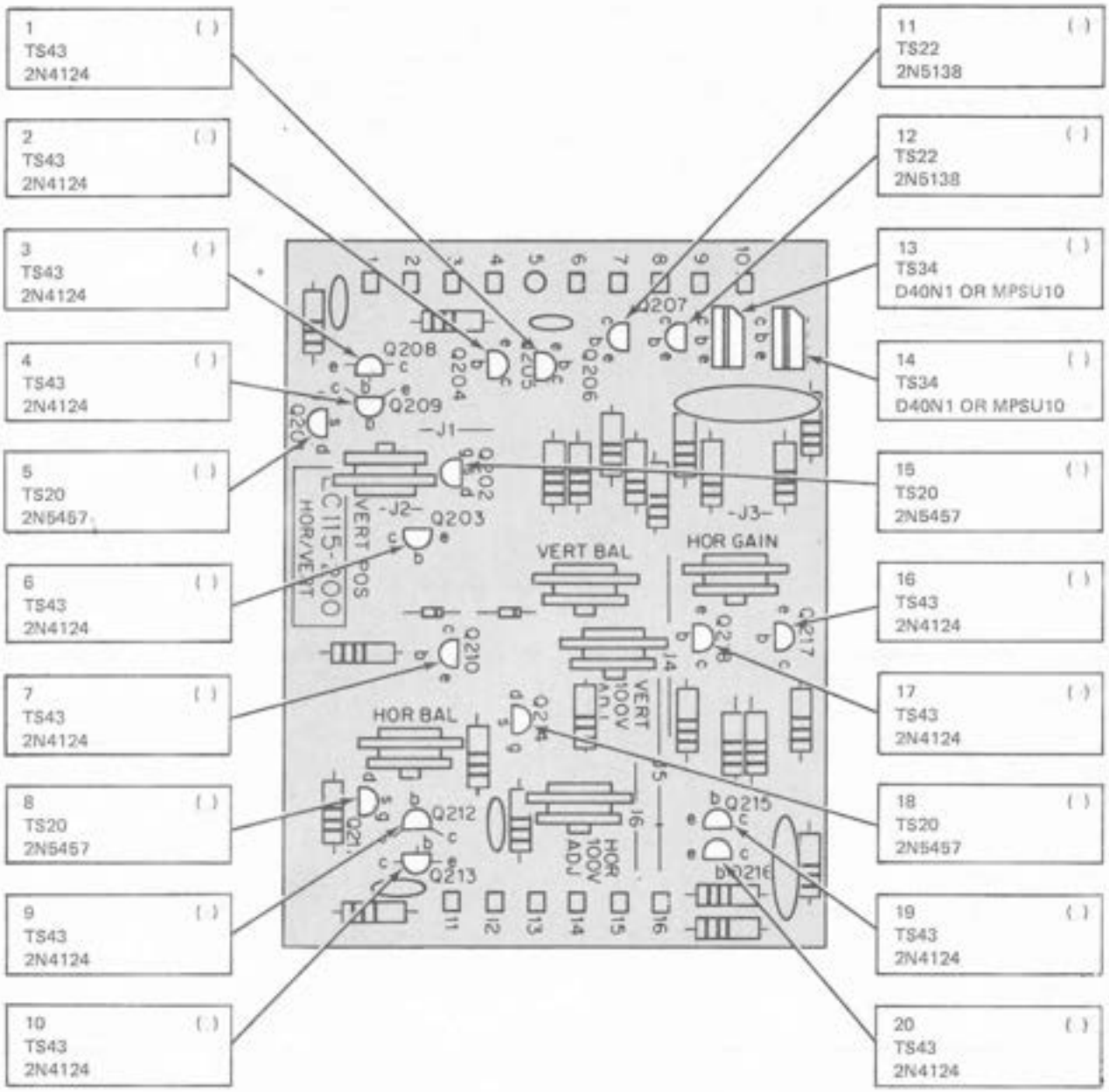

Figure 12. Installing the transistors on the vertical/horizontal amplification module.

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Refer to Fig.13 and complete the module assembly by installing the jumpers shown.

This completes the assembly of your vertical/horizontal amplifier module. Check your work carefully to be sure that all components are installed correctly and that there are no solder bridges or poor connections. Set your finished board aside. You are now ready to begin the chassis assembly.

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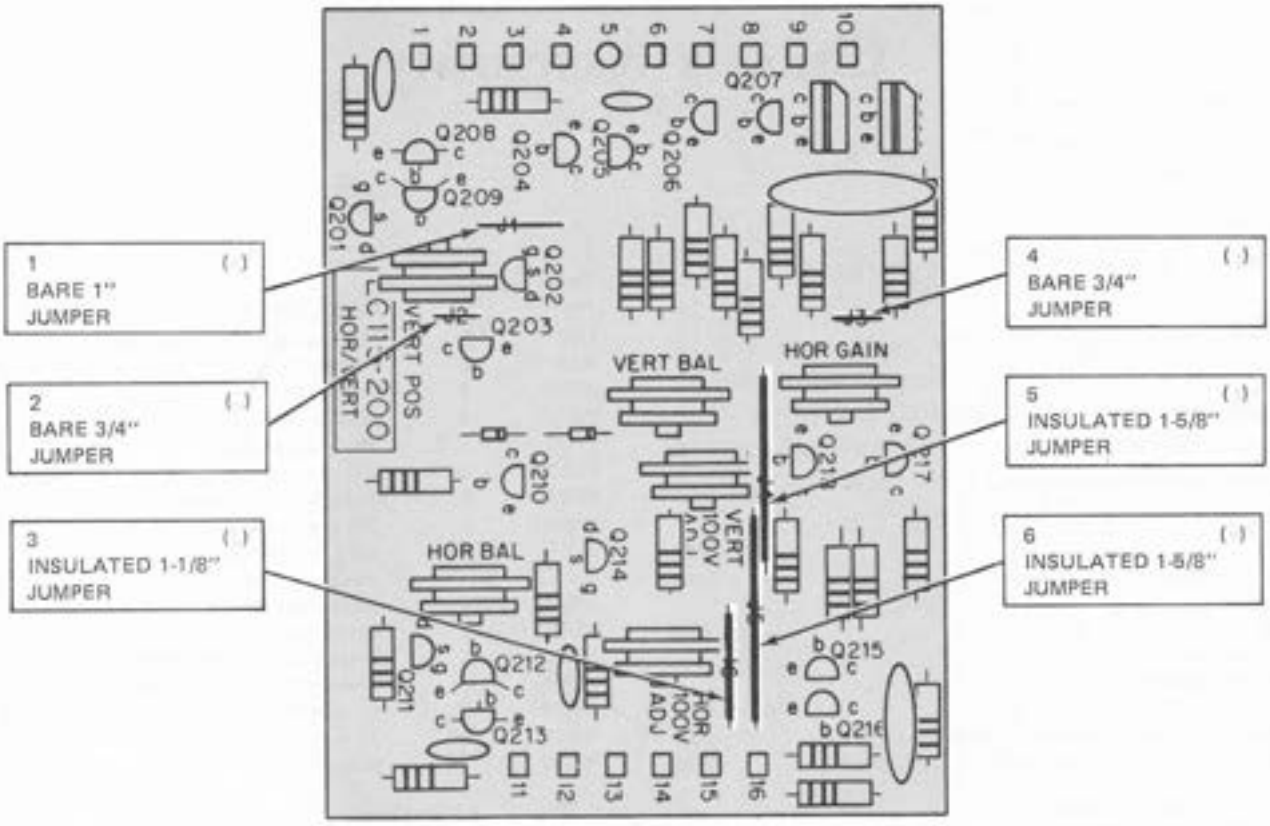

Figure 13. Installing the jumpers on the vertical/horizontal amplification module.

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Chassis Assembly

FRONT PANEL ASSEMBLY

The front panel of your oscilloscope will be assembled in two stages. First, you will mount all of the potentiometers, switches, and jacks. Then you will mount the other components and some of the wiring that connect to those parts.

Gather the following parts:

Part No.	Quan.	Description	Price Each
PA68	1	Front panel	4.50
From bag 2D-41T:			
HA99	3	Control ground lugs	.10
JA8	3	Red banana jacks with nuts	.25
JA9	2	Black banana jacks with nuts	.25
NU1	6	6-32 nuts	12/.25
NU15	8	Control nuts	6/.25
PO30	1	500k intensity control	2.75
PO33	1	2M focus control	2.75
PO128	2	100 ohm position controls	1.50
PO134	1	5k vertical gain control	.70
PO148	1	25k sweep speed control	1.50
SC97	6	6-32 × 3/8" black Phillips-head machine screws	6/.25
SW13	1	Vertical attenuator switch	1.10
SW38	1	Sweep range switch	1.15
SW61	1	Three-position slide switch	.25
SW63	2	Two-position slide switches	.25
WA14	8	Control flat washers	12/.15
WA15	6	No.6 lockwashers	12/.15
WA25	5	Control lockwashers	6/.15

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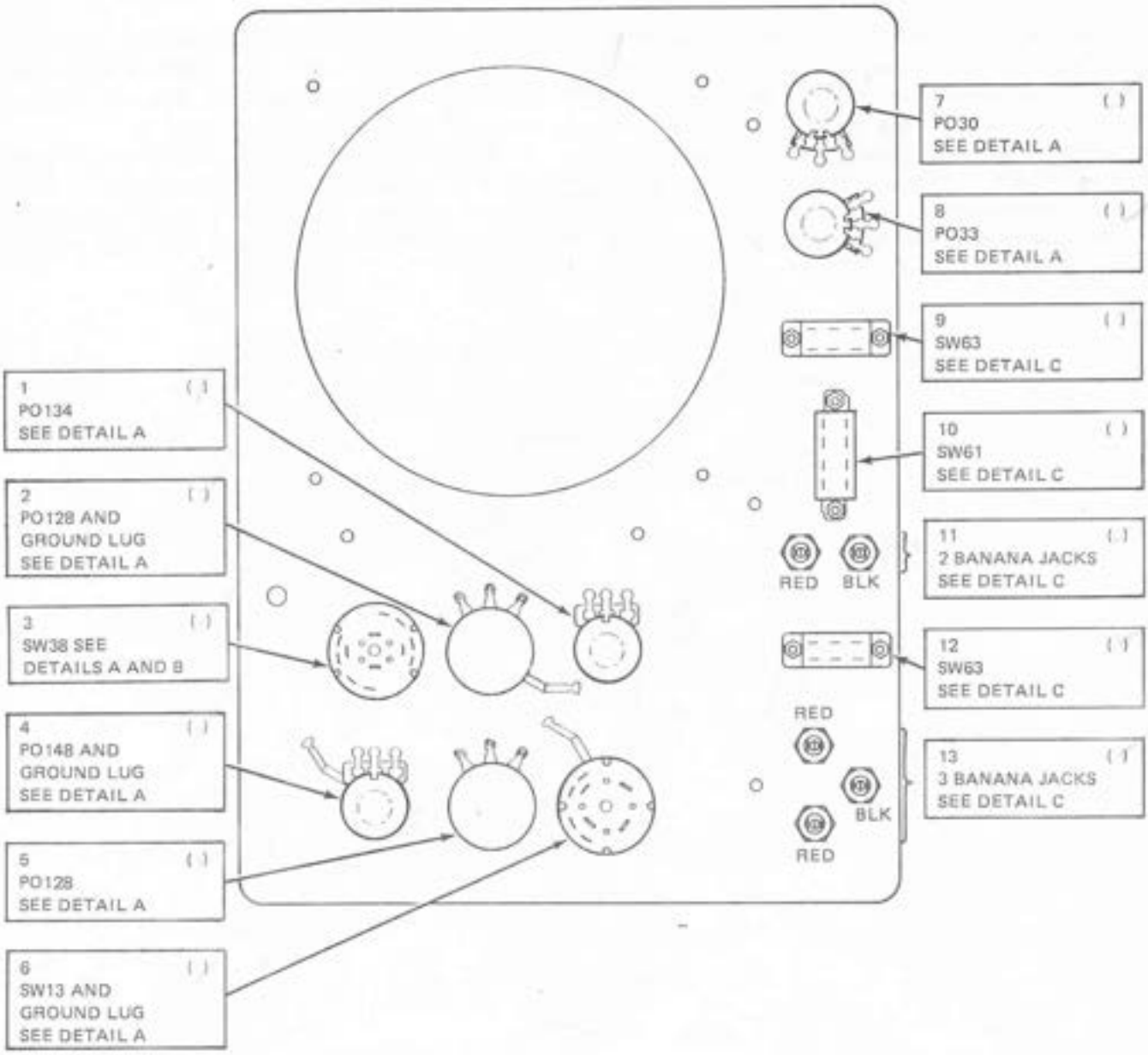

Figure 14. Installing the potentiometers, switches, and jacks on the front panel.

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Refer to Fig.14 and Fig.14, Details A and B for installing the controls and jacks on the front panel. Note that in three steps, you will install a control ground lug instead of a lockwasher. Be sure to position the lug as shown before you tighten the control. Position each control as shown and tighten the nut securely after you have done so.

In Step 3 you will first need to break off the locating tab as shown in Fig.14, Detail B. Also, before tightening the nut, rotate the shaft fully counterclockwise with your pliers while holding the body of the switch. Then align the "flat" on the shaft as shown in Fig.14, Detail B.

When you have finished this assembly stage, check to be sure that all parts are installed in the proper position and that they are positioned correctly. Then continue with the next assembly stage.

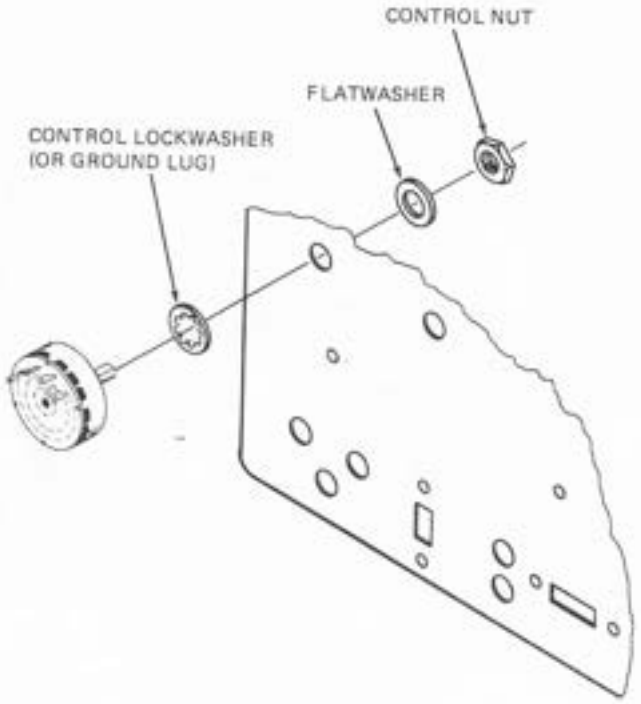

Figure 14. Detail A.

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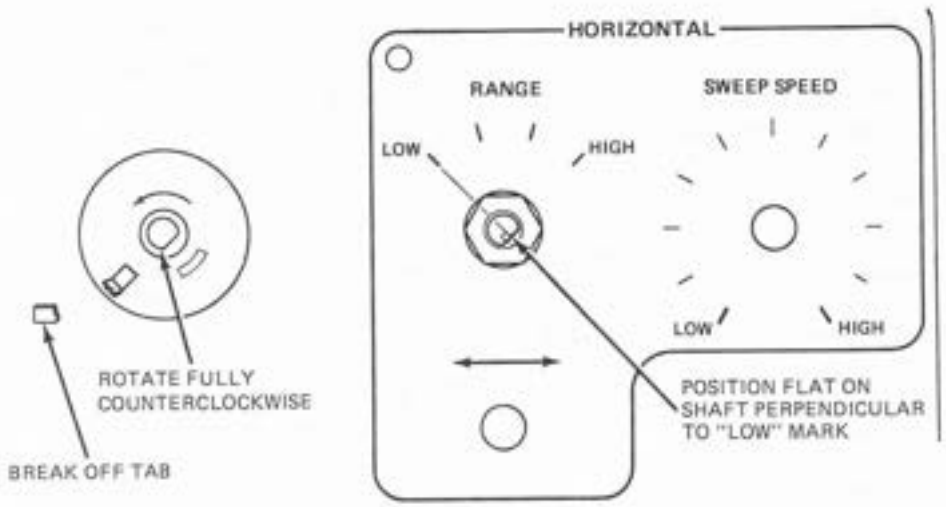

Figure 14. Detail B.

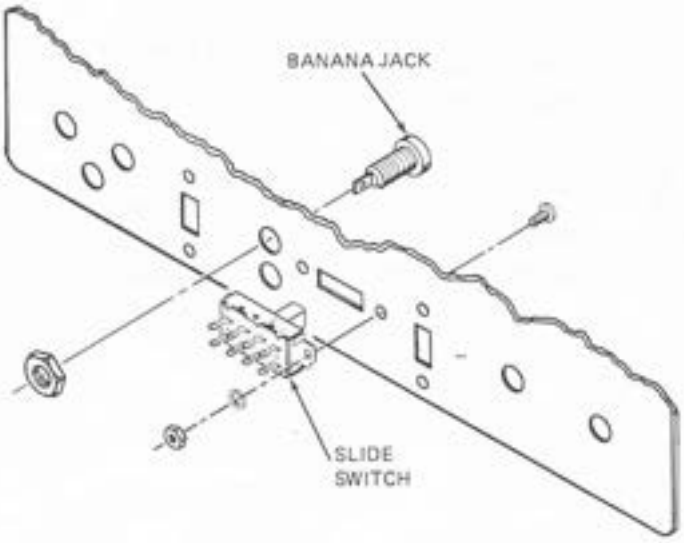

Figure 14. Detail C.

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PREWIRING THE FRONT PANEL

In this section you will perform the initial wiring on the front panel. You will need the following parts:

From wire bag:

Part No.	Quan.	Description	Price Each
CA910	4'	Miniature coaxial cable	.20/ft

From bag 2E-41T:

CN102	1	0.01 μF, disc, 10%	.20
CN104	1	0.1 μF, disc	.40
CN151	1	56 pF, disc	.10
CN259	1	820 pF, disc	.10
CN261	1	1 μF, tantalum	.75
CN300	1	10 μF, tantalum	.50
CN329	1	0.1 μF, tantalum	.75
CN358	1	8-50 pF trimmer	1.50
RE10	1	100k, 5%	.24
RE73	1	1M, 5%	.24
RE74	1	10k, 5%	.24
RE185	1	910k, 5%	.24
RE189	1	620 ohm, 5%	.24

In the following steps you will prewire the range switch, vertical position control, and vertical attenuation switch. Then position all components as shown in Fig. 15.

(1) Connect a 0.01μF capacitor from lug 1 (S1) of the range switch to the ground lug on the sweep speed control (NS) . . . . . ( )

(2) Connect the positive lead of a 0.1μF capacitor to lug 2 (S1) of the range switch. Connect the other lead to the ground lug on the sweep speed control (NS) . . . . . ( )

(3) Connect the positive lead of a 1μF capacitor to lug 3 (S1) of the range switch. Connect the other lead to the ground lug on the sweep speed control (NS) . . . . . ( )

(4) Connect the positive lead of a 10 μF capacitor to lug 4 (S1) of the range switch. Connect the other lead to the ground lug on the sweep speed control (S4) . . . . . ( )

(5) Connect a 0.1 μF capacitor from lug 3 of the vertical position control (NS) to the ground lug on the horizontal position control (NS) . . . . . ( )

(6) Connect a 620 ohm resistor from lug 3 of the vertical position control (S2) to the ground lug on the horizontal position control (S2) . . . . . ( )

(7) Connect a 910k resistor to the 8-50 pF trimmer capacitor as shown in Fig.15, Details A and B. Be careful not to bend the capacitor terminal identified in Detail A, or it may break off. Solder both terminals of the capacitor . . . . . ( )

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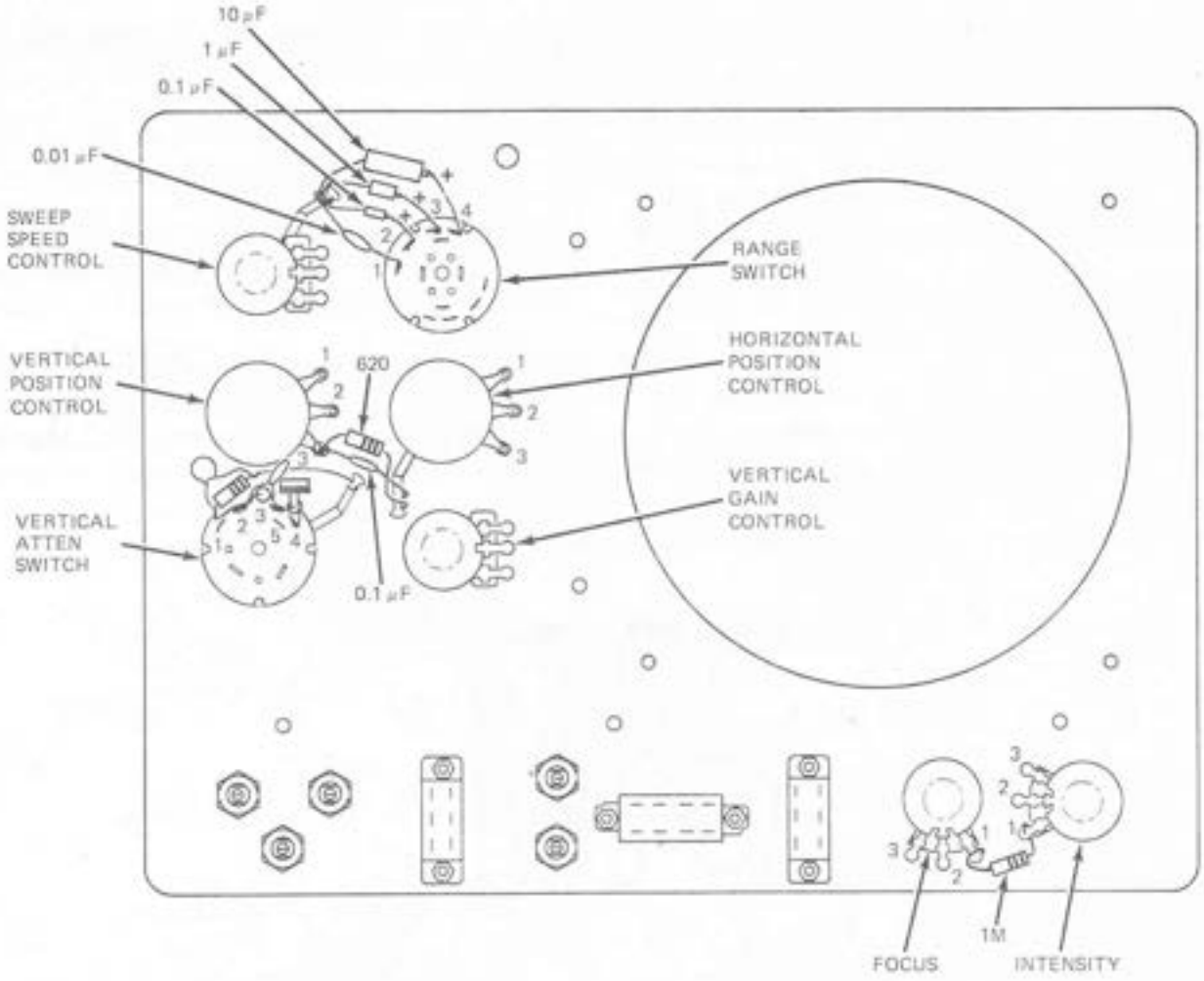

Figure 15. Prewiring the front panel.

Figure 15. Detail A.

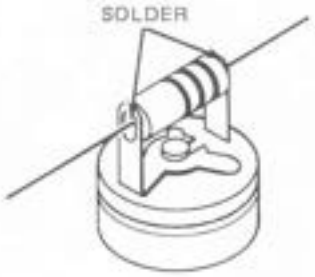

Figure 15. Detail B.

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(8) Connect the resistor/trimmer you just assembled from lug 4 (NS) to lug 3 (NS) of the vertical attenuator switch. The resistor leads must be as short as possible and the resistor/trimmer combination must be positioned as shown in Fig.15, Details C and D, with its open end facing toward the top of the front panel ..... ( )

(9) Connect a 100k resistor to a 56 pF capacitor as shown in Fig.15, Detail E ..... ( )

(10) Connect the 100k/56 pF combination from lug 3 (S2) to lug 2 (NS) of the vertical attenuator switch. Again, keep the leads as short as possible and position this combination perpendicular to the front panel as shown in Fig.15, Detail C ..... ( )

(11) Connect a 10k resistor to an 820 pF capacitor as shown in Fig.15, Detail E ..... ( )

(12) Connect the 10k/820 pF combination from lug 2 (S2) to the ground lug (NS) mounted under the vertical attenuator switch ..... ( )

(13) Connect a 1M resistor from lug 1 (S1) of the focus control to lug 1 (S1) of the intensity control. Position this resistor as shown in Fig.15 and keep the leads as short as possible ..... ( )

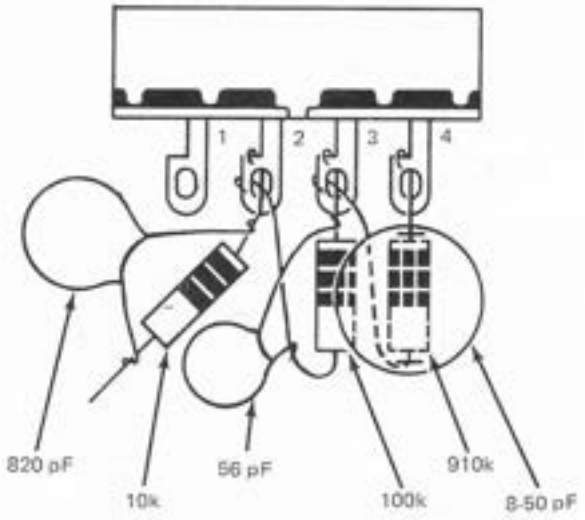

Figure 15. Detail C.

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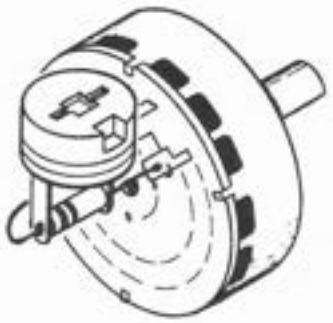

Figure 15. Detail D.

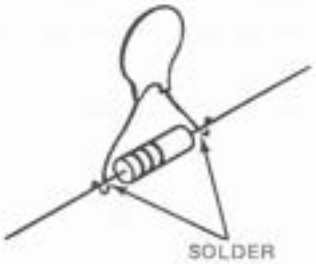

Figure 15. Detail E.

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In the next steps you will prepare and install two shielded cables. One end of each cable will be left free for later connection to other parts of the oscilloscope. Refer to Fig.16.

(14) Cut a 4-1/2" length of single-conductor shielded cable and prepare it as shown in Fig.16, Detail A. Lightly tin both the center conductor and the shield lead with your soldering iron . . . ( )

(15) At the end of the 4-1/2" shielded cable with the shield lead intact, connect the center conductor to lug 4 (S2) of the vertical attenuator switch, and the shield lead to the ground lug (NS) under the attenuator switch. Position the cable as shown ( )

(16) Cut a 9" length of single-conductor shielded cable and prepare it as shown in Fig.16, Detail B. Tin all leads lightly . . . . . ( )

(17) Connect the center conductor (either end) of the 9" shielded cable to lug 5 (S1) of the vertical attenuator switch, and connect the shield lead to the ground lug (S3) under the attenuator switch ( )

This completes the prewiring of the front panel. Check your work carefully to be sure all of the components are mounted in the proper position and are connected to the right lugs. Be sure all of the lugs that have components or leads connected to them have been soldered. Set the front panel aside for now.

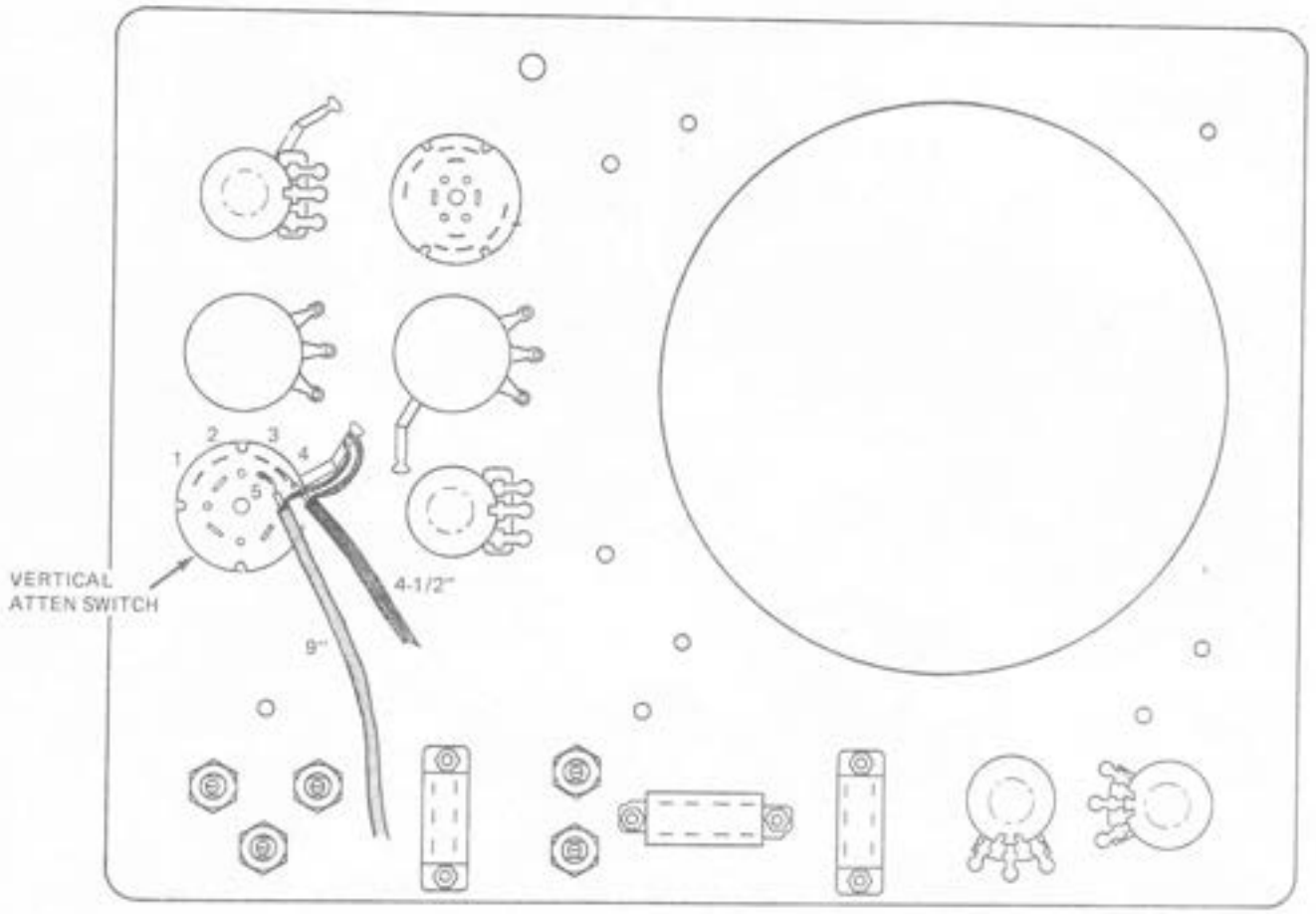

Figure 16. Installing the coaxial cables on the front panel.

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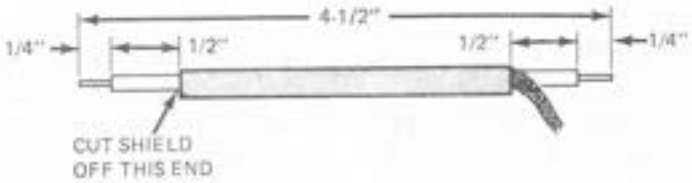

Figure 16. Detail A.

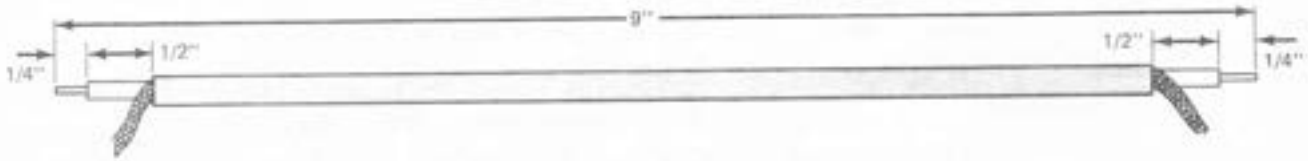

Figure 16. Detail B.

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BACK PANEL ASSEMBLY

You will now install the fuseholder and line cord on the back panel of your oscilloscope. You will need the following parts:

Part No.	Quan.	Description	Price Each
PA69	1	Back panel	4.00
From bag 2E-41T:			
FU8	1	1 A slow blow fuse	.35
GR11	1	Line cord strain relief	.15
IN21	1	Fuseholder with mounting hardware	.85
PC1	1	Power cord	.60

Refer to Fig.17 and Fig.17, Detail A, and complete the following steps.

(1) Locate the fuseholder assembly (IN21) and fuse (FU8). Install the fuse in the fuseholder. Remove the cap of the fuseholder by pushing it inward toward the body of the fuseholder, while at the same time rotating the cap counterclockwise. Insert the fuse into the end of the cap. Reinstall the cap on the body of the fuseholder by pushing inward on the cap and rotating it clockwise . . ( )

(2) Install the fuseholder on the back panel as shown in Fig.17. Position the fuseholder with the side terminal facing the closest edge of the panel. Tighten the nut securely . . . . . ( )

(3) Locate the power cord and the line cord strain relief. Insert the end of the power cord through the hole in the back panel from the painted side. Insert the cord until the ends of the wires extend about 2-1/2" inside the panel. Refer to Fig.17, Detail A, and secure the power cord with the strain relief as shown . . . . . ( )

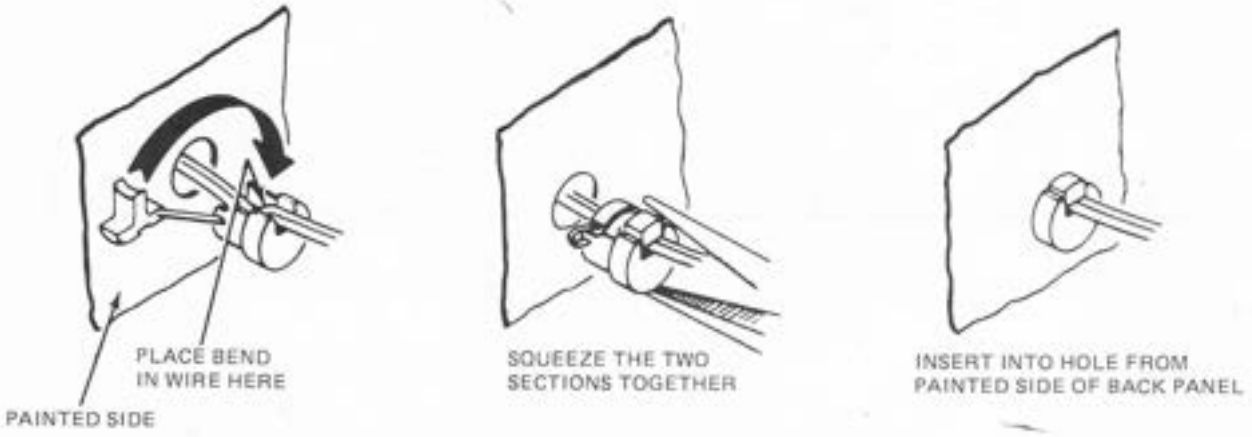

Figure 17. Detail A.

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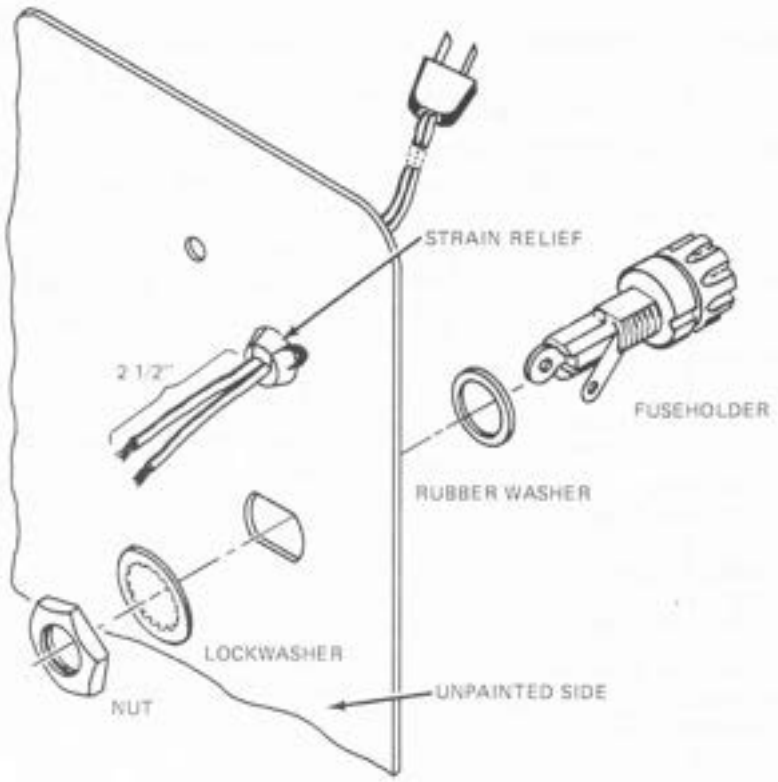

Figure 17. Mounting the components on the back panel.

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MAIN CHASSIS PARTS ASSEMBLY

In the next steps you will connect the front and back panels to the main and support chassis sections. You will need the front and back panel assemblies and the following parts:

Part No.	Quan.	Description	Price Each
CH108	1	Main chassis	4.50
CH109	1	Support chassis	2.50
From bag 3F-41T:			
NU1	13	6-32 nuts	12/.25
SC13	8	6-32 X 3/8" screws	12/.25
SC97	5	6-32 X 3/8" black Phillips-head screws	6/.25
ST28	1	4-lug terminal strip (mounting foot on left lug)	.15
ST41	1	5-lug terminal strip (mounting foot on left lug)	.15
ST42	1	5-lug terminal strip (mounting foot on center lug)	.15
WA15	13	No.6 lockwashers	12/.15

In some of the assembly steps we will refer to the use of No.6 hardware, which consists of a 6-32 × 3/8" screw, a No.6 lockwasher, and a 6-32 nut. Where other than a 6-32 × 3/8" screw is used, we will state the screw type. For example: "Use No.6 hardware with a black Phillips-head screw."

Refer to Figs.18 and 19 and their accompanying details to complete the following steps.

(1) Locate the front panel assembly and the main chassis. Position the two sections as shown in Fig.18. Fasten the two sections together as shown using No.6 hardware with black Phillips-head screws. Tighten the nuts securely . . . . . ( )

(2) Locate the back panel assembly. Position the back panel as shown and fasten it to the chassis using No.6 hardware. Tighten the nuts securely . . . . . ( )

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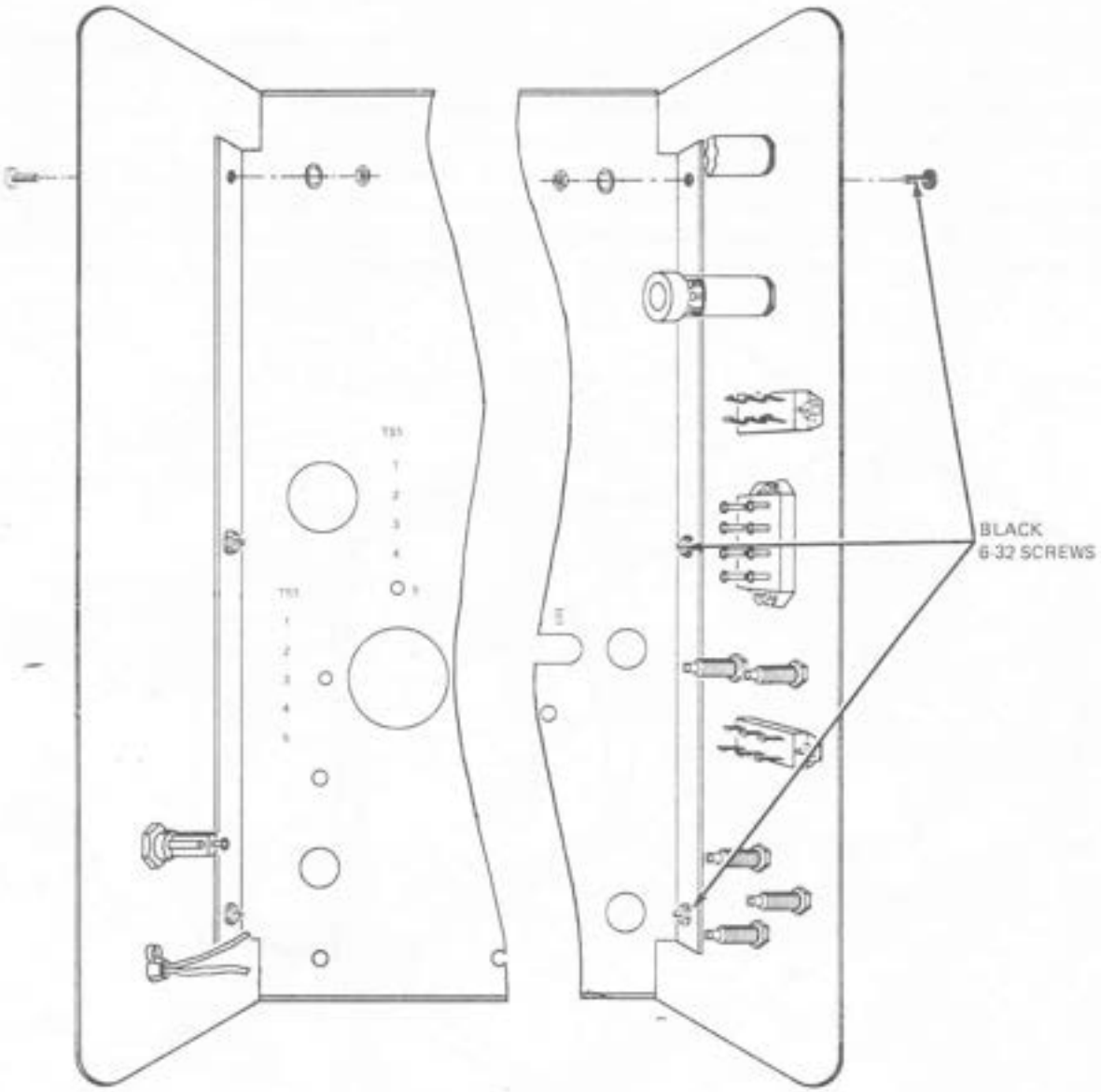

Figure 18. Mounting the front and back panel assemblies to the main chassis.

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(3) Refer to Fig.19. Locate the support chassis. Position it on the main chassis as shown. Fasten the support chassis to the main chassis at positions 1, 2, and 4 only, using No.6 hardware . . . . . ( )

(4) Refer to Fig.19, Detail A (located on a fold-out at the end of the manual) and secure the support chassis and main chassis at point 3 using No.6 hardware. Mount a 5-lug terminal strip (ST41) on the wiring side of the chassis in the position shown . . . . . ( )

(5) Refer to Fig.19, Detail A, and secure the chassis sections together at point 5. Use No.6 hardware and mount a 5-lug terminal strip (ST42) in the position shown . . . . . ( )

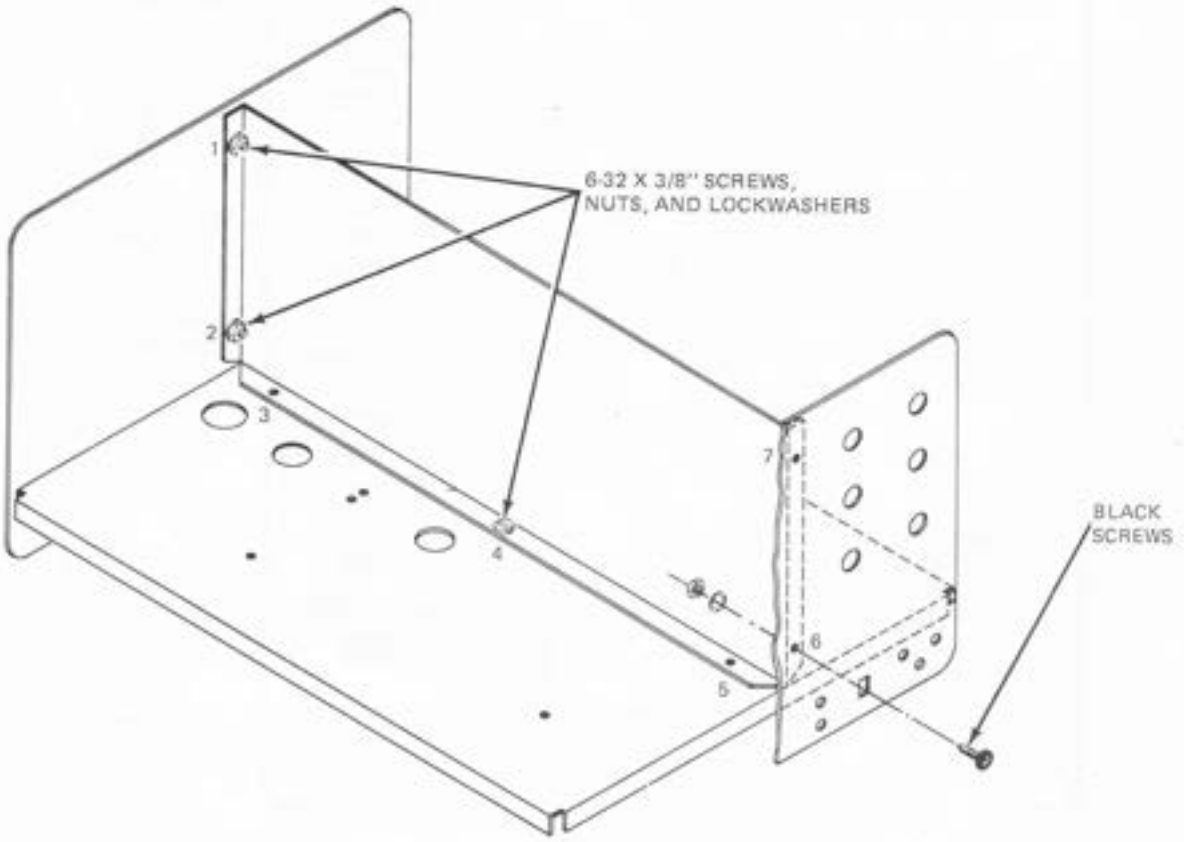

Figure 19. Mounting the support chassis.

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(6) Refer to Fig.19, Detail B, and secure the support chassis to the front panel at positions 6 and 7 using No.6 hardware with black screws. Install a 4-lug terminal strip (ST28) at hole 7 in the position shown . . . . . ( )

This completes the assembly of the panels and chassis sections.

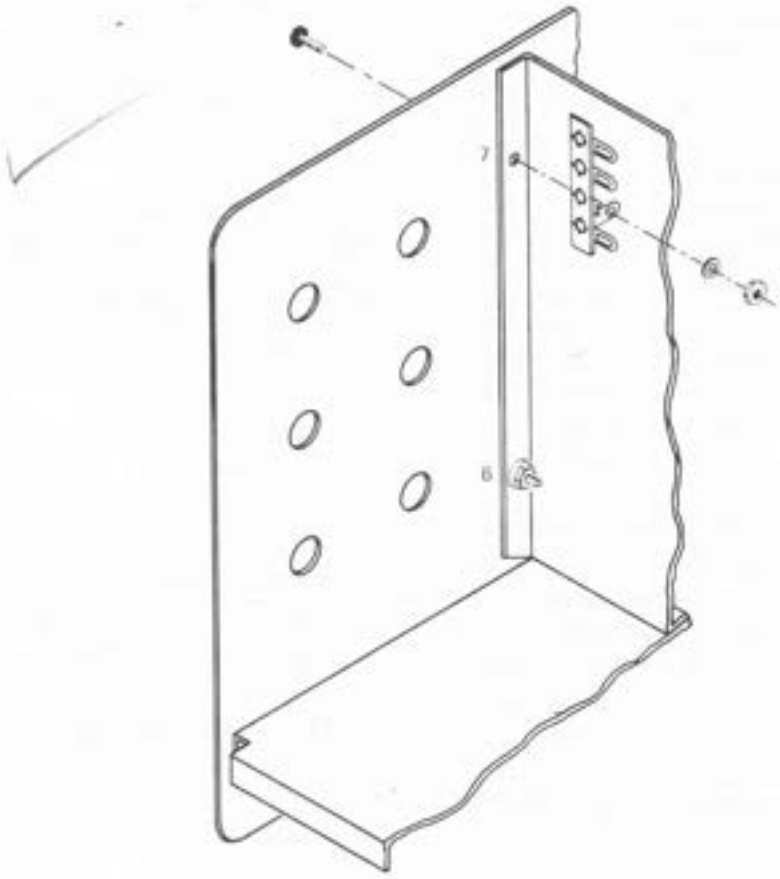

Figure 19. Detail B.

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At this time you will mount some parts on the main chassis section. Now turn the chassis assembly over so that the bottom of the chassis (wiring side) is facing upward and the front panel is on your right. Refer to Fig.20 (located on a foldout at the end of the manual) for the following steps.

You will need the following parts from bag 3F-41T:

Part No.	Quan.	Description	Price Each
CL56	3	Wedge-lock cable clamps	.05
HA86	9	Circuit board standoffs	6/.25
HA104	3	Adhesive-backed mounts	.30
LU10	4	No.6 ground lugs	12/.25
NU1	7	6-32 nuts	12/.25
PL13	4	10-pin PC connectors	.85
PL18	2	6-pin PC connectors	.50
SC63	7	6-32 X 1/4" screws	12/.25
ST13	1	2-lug terminal strip	.10
ST42	1	5-lug terminal strip	.15
ST46	1	6-lug terminal strip	.15
WA15	3	No.6 lockwashers	12/.15

To make it easier to install the circuit board standoffs (HA86) and to prevent them from breaking, place them in a bowl of warm-to-hot water for a few minutes before you install them.

(1) Locate the four 10-pin PC board connectors and install one at each of the four large slots as shown in Fig.20, Detail A. Be sure you install these connectors from the bottom (side facing upward toward you) as shown. Otherwise, the pins will not protrude above the chassis high enough to properly connect with the sockets on the PC boards. The "hump" of the connector should be on the circuit board side of the chassis as shown in Fig.20, Detail B . . . . . ( )

(2) Locate the two 6-pin PC board connectors and repeat the procedure you used in Step 1 . . . . . ( )

(3) Refer to Fig.20 (located on a foldout at the end of the manual) and install a ground lug at positions 2, 3, 4, and 6. Use No.6 hardware with a 1/4" screw. Be sure that the end of the screw is on the circuit board (top) side of the chassis. The nut should be on the same side as the ground lug. Orient the lugs as shown and tighten them securely . . . . . ( )

(4) Locate the 5-lug terminal strip and install it at position 1 using No.6 hardware with a 1/4" screw ( )

(5) Locate the 6-lug terminal strip and install it at position 5 using No.6 hardware with a 1/4" screw. Be sure that the nut is on the same side of the chassis as the terminal strip and that the strip is positioned as shown . . . . . ( )

(6) Locate the 2-lug terminal strip and install it at position 7 using No.6 hardware with a 1/4" screw. Position the terminal strip as shown . . . . . ( )

(7) Peel the paper from the back of the three adhesive-backed mounts and install one in each of the three locations shown . . . . . ( )

(8) Take the three wedge lock cable clamps and install one in each of the mounts as shown in Fig. 20, Detail C. Adjust the clamp for a loop of about 1" in diameter . . . . . ( )

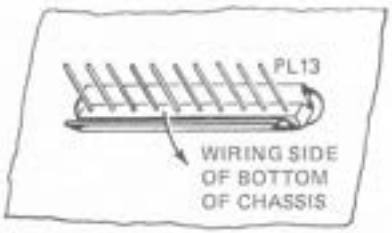

Figure 20. Detail A.

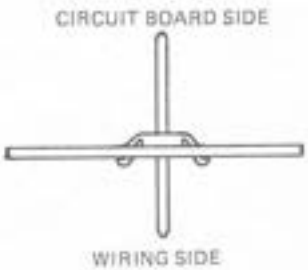

Figure 20. Detail B.

Figure 20. Detail C.

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(9) Turn the chassis over so that the circuit board side is facing upward. Locate the nine circuit board standoffs and mount one in each of the positions shown in Fig.21 . . . . . ( )

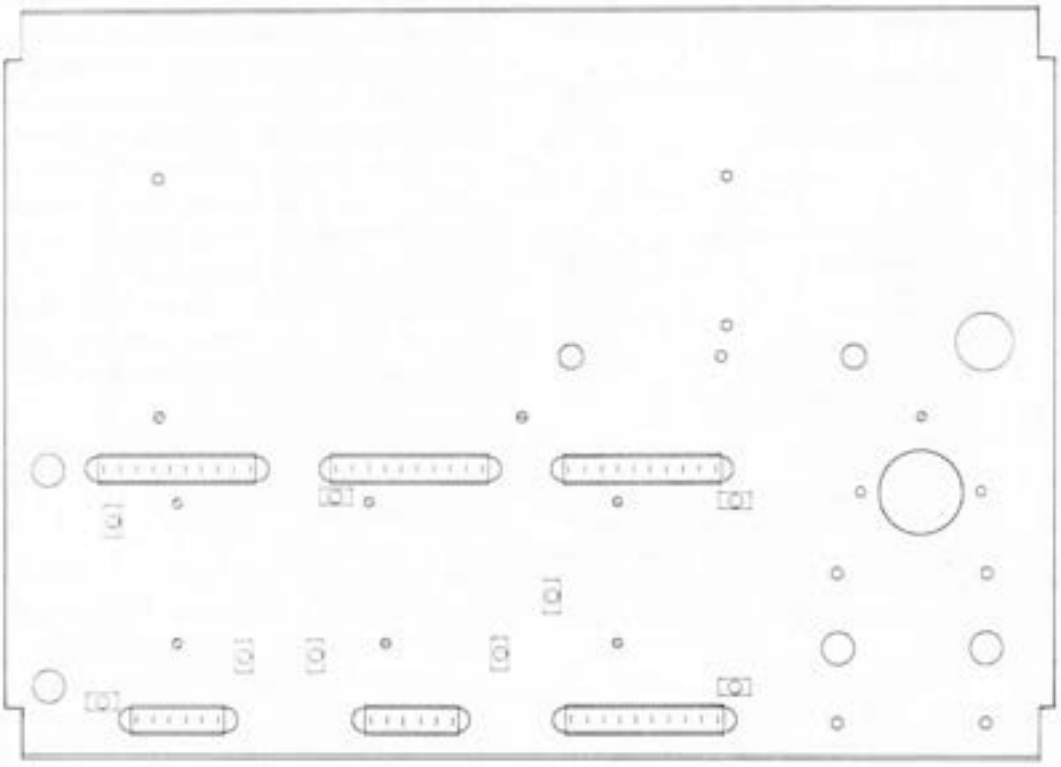

Figure 21. Mounting the circuit board standoffs on the circuit board side of the chassis.

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You will now install the filter capacitor and power transformer on the main chassis. Refer to Fig.22 and Fig.22, Detail A to complete the following steps. You will need the following parts:

Part No.	Quan.	Description	Price Each
CN361	1	Filter capacitor, two-section 300 μF/300 μF, 250 volts	6.00
TR92D-1	1	Power transformer	14.50
From bag 3F-41T:			
HA30	1	Filter capacitor mounting plate	.05
LU5	1	No.8 ground lug	12/.25
NU1	2	6-32 nuts	12/.25
NU3	4	8-32 nuts	12/.25
SC13	2	6-32 × 3/8" screws	12/.25
SC85	4	8-32 × 1/2" screws	12/.35
ST13	1	2-lug terminal strip	.10
ST42	1	5-lug terminal strip	.10
WA5	4	No.8 flatwashers	12/.15
WA15	2	No.6 lockwashers	12/.15
WA16	4	No.8 lockwashers	12/.15

Postion your chassis assembly with the wiring (bottom) side facing upward and the front panel on your right.

(1) Refer to Fig.22 and Fig.22, Detail A, and install the filter capacitor mounting plate so that the plate is positioned on the circuit board side of the chassis. Mount a 5-lug terminal strip at hole 1 on the wiring side of the chassis, as shown in Fig.22 Detail A, and then secure both the plate and the terminal strip using No.6 hardware. Position the terminal strip as shown . . . . . ( )

(2) Mount a 2-lug terminal strip at hole 2 on the wiring side of the chassis and secure the plate and strip using No.6 hardware. Position the terminal strip as shown . . . . . ( )

(3) Locate the power transformer and identify the two groups of wires coming from it. Mount the transformer on the circuit board side of the chassis as shown. Route the group of wires containing the gray wire through the hole in the chassis nearest the front panel. Route the group of wires containing the two brown wires through the hole nearest the back panel. Secure the transformer at holes 4, 5, and 6 using 8-32 × 1/2" screws, No.8 flatwashers, No.8 lockwashers, and 8-32 nuts. Before tightening this hardware, push the transformer as far forward as possible . . . . . ( )

(4) At hole 3, use a No.8 ground lug, as shown, and the same hardware you used in Step 3. Tighten securely . . . . . ( )

(5) Locate the filter capacitor and insert the four mounting tabs into the holes on the mounting plate from the component side. Position the capacitor terminals as shown. Then, while holding the capacitor flush against the mounting plate, twist each of the four mounting lugs about 45° to secure the capacitor firmly to the plate . . . ( )

This completes the mounting of the parts on the main chassis. Check your work to be sure that all parts are mounted properly and all nuts are tightened firmly.

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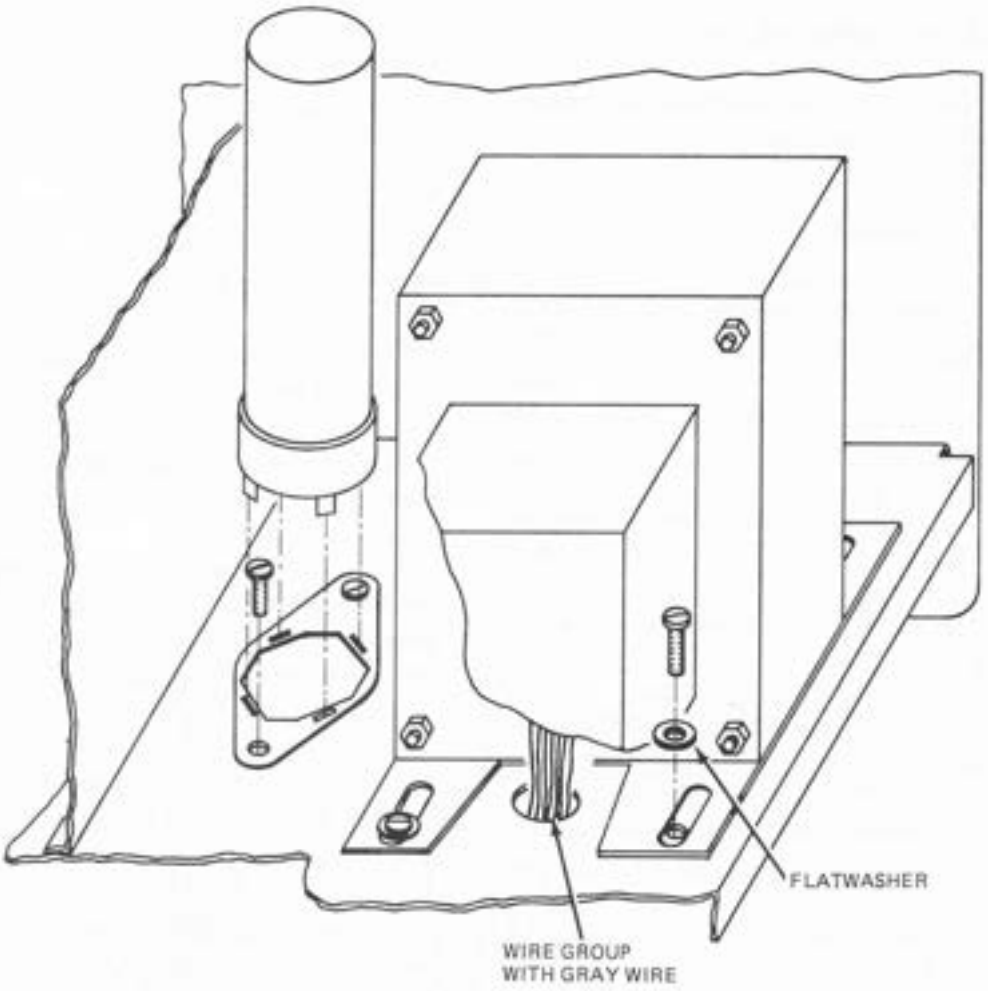

Figure 22. Installing the filter capacitor and power transformer.

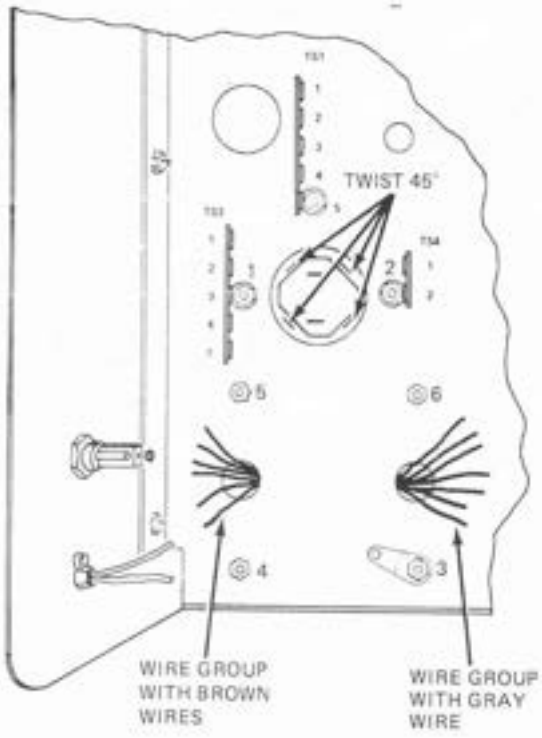

Figure 22. Detail A.

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POWER TRANSFORMER WIRING

In this section you will connect the power tranformer wires. You will need the following wire from the wire bag:

Part No.	Quan.	Description	Price Each
WR909	4"	Black hookup wire	12"/.25
WR910	3"	Black/white twisted pair	12"/.40

Refer to Fig.23 and route each wire as shown:

(1) Connect the red/green power transformer wire to terminal 310 (S1) . . . . . ( )

(2) Connect the red power transformer wire to terminal 309 (S1) . . . . . ( )

(3) Connect the green/yellow power transformer wire to terminal 306 (NS) . . . . . ( )

(4) Connect the red/yellow power transformer wire to terminal 306 (NS) . . . . . ( )

(5) Connect the green power transformer wire to terminal 305 (S1) . . . . . ( )

(6) Connect the yellow power transformer wire to terminal 304 (S1) . . . . . ( )

(7) Connect the gray power transformer wire to TS4-1 (NS) . . . . . ( )

(8) Connect the black power transformer wire to TS3-1 (NS) . . . . . ( )

(9) Connect the black/green power transformer wire to TS3-2 (NS) . . . . . ( )

(10) Connect the black/yellow power transformer wire to TS3-4 (NS) . . . . . ( )

(11) Connect the black/red power transformer wire to TS3-5 (NS) . . . . . ( )

(12) Cut either of the brown power transformer wires to a length of 7". Save the leftover piece of brown wire for use in the next step. Now connect the 7" brown transformer wire to TS1-1 (NS) . ( )

(13) Connect one end of the brown wire you cut off in Step 12 to TS1-1 (NS). Route the other end of this brown wire through the chassis hole as shown in Fig.23 . . . . . ( )

(14) Route the other brown power transformer wire through the chassis hole as shown . . . . ( )

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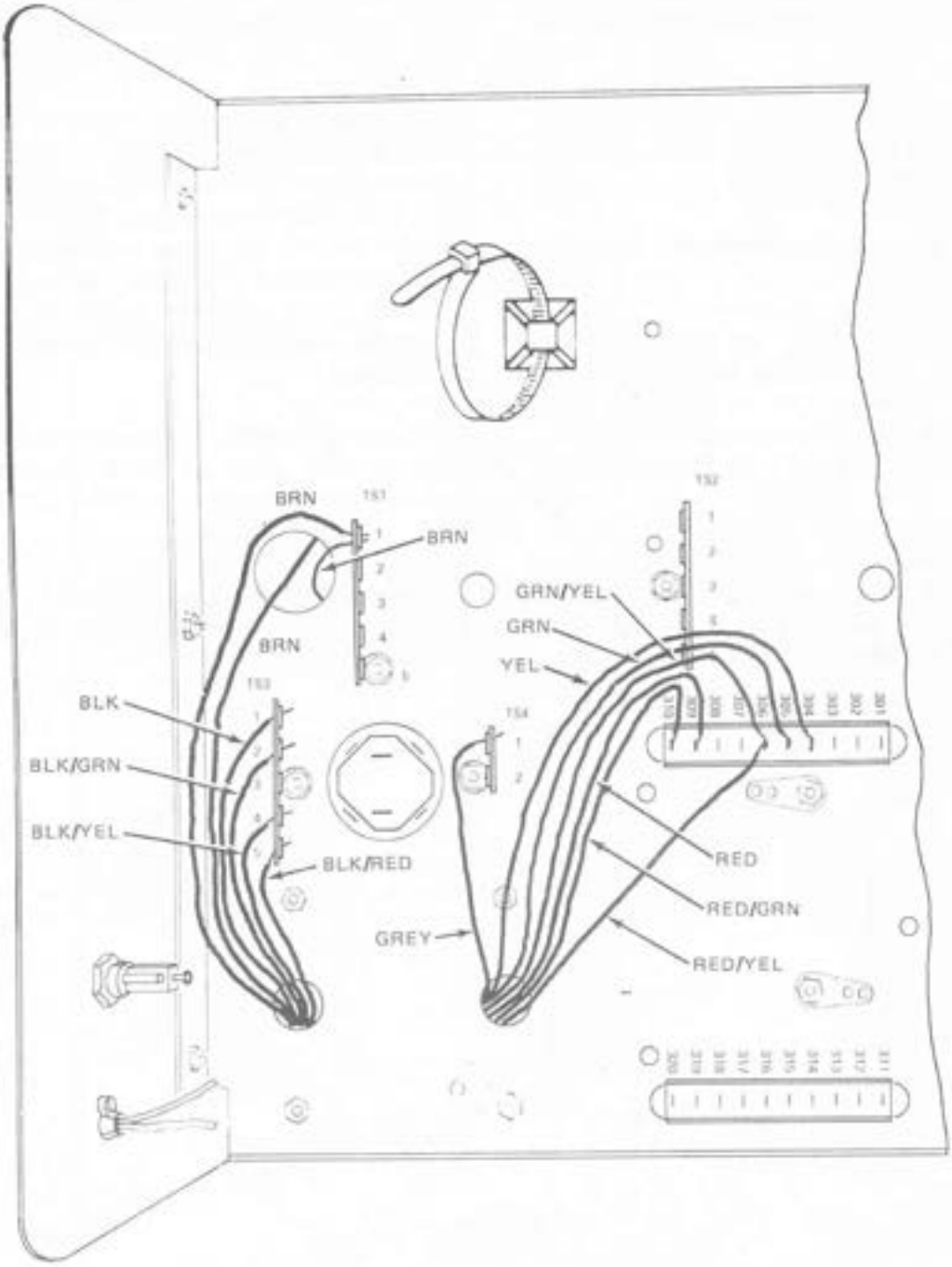

Figure 23. Connecting the power transformer wires.

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Refer to Fig.24 and complete the following steps:

(1) Separate the two conductors of the line cord and connect one wire to F1-2 (S1) . . . . . ( )

(2) Connect the other line cord wire to TS3-5 (NS) . . . . . ( )

(3) Prepare a 19" length of the black-and-white twisted pair wire by untwisting both ends two or three turns and stripping 1/4" of insulation from the ends of both wires at each end. Connect the black wire to F1-1 (S1) and the white wire to TS3-1 (NS) . . . . . ( )

(4) Route the pair as shown in Fig.24 and then connect the black wire, at the other end, to pin 1 of the ON/OFF switch (S1). Connect the white wire to pin 2 of the ON/OFF switch (S1) . . . . . ( )

WIRING CONNECTIONS FOR 115 VAC OPERATION

Your oscilloscope can be wired to operate from either 115 volts or 230 volts ac. The scope will operate on either 50 or 60 Hz when connected for 115 V or 230 V operation. The following steps explain how to wire your oscilloscope for 115 V operation because this is the standard line voltage in the U.S. To wire your oscilloscope for 230 V operation, see the instructions given at the end of this manual.

(1) Refer to Fig.24. Remove all of the insulation from a 3/4" piece of black hookup wire and connect the wire between TS3-1 (S3) and TS3-2 (S2) . . . . . ( )

(2) Remove all the insulation from another 3/4" piece of hookup wire and connect this wire from TS3-4 (S2) to TS3-5 (S3) . . . . . ( )

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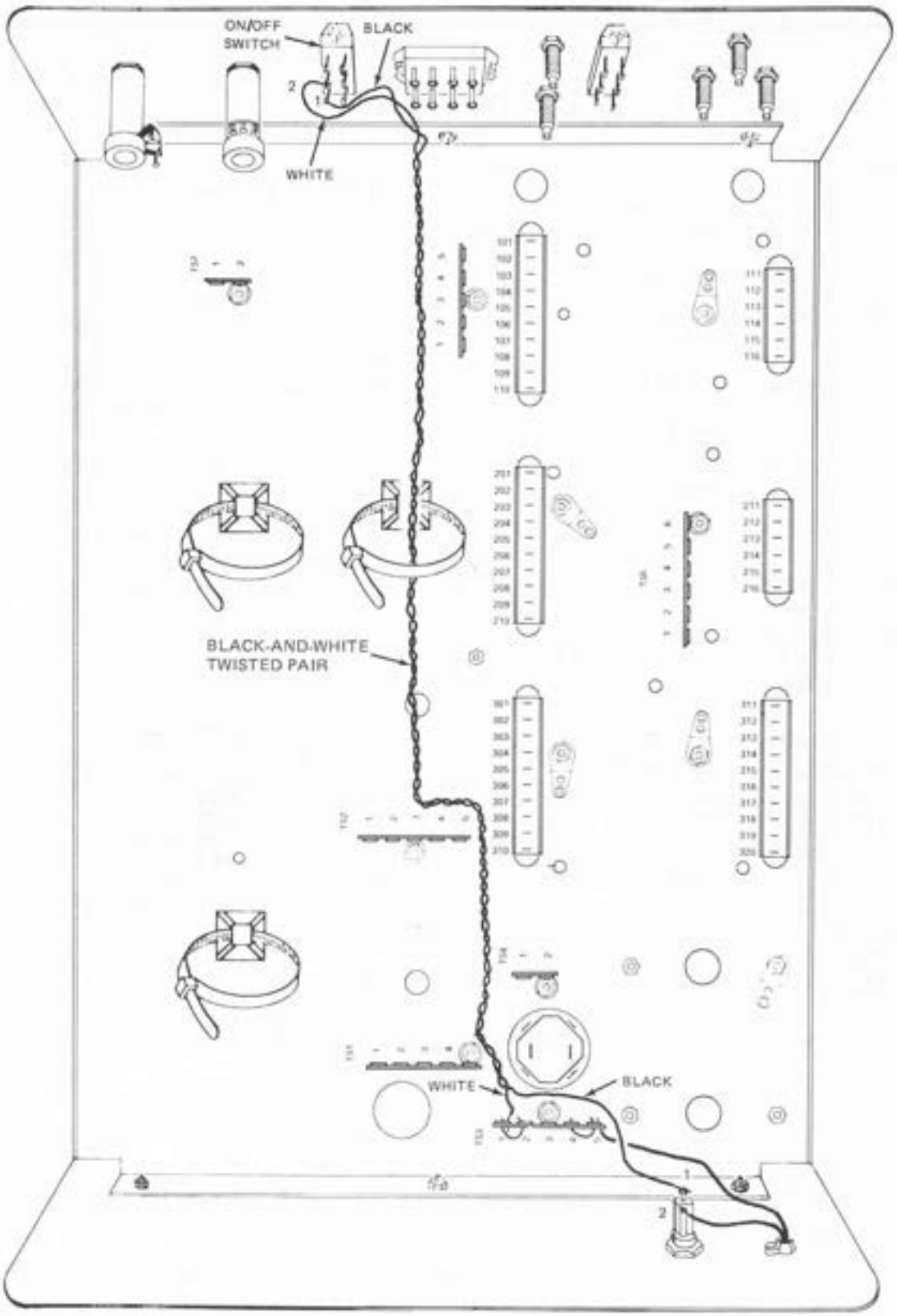

Figure 24. Wiring connections for 115 V operation.

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POWER SUPPLY PARTS INSTALLATION

Remove the following parts from bag 2G-41T:

Part No.	Quan.	Description	Price Each
CN147	3	0.05 μF, 20%, 3000 volt	.35
CN149	1	50 μF, 250 volt	.85
CN347	2	1000 μF, 25 volt	1.00
IN901	5"	Spaghetti tubing (small)	.40/ft
RE37	1	220k, 10%	.15
SR15	2	High-voltage rectifiers	1.35

For the following steps, refer to Fig.25.

(1) Pass one lead of a 0.05 μF capacitor through TS2-1 (S2) and connect it to TS2-3 (NS). Connect the other lead of this capacitor to TS1-1 (NS) . ( )

(2) Connect another 0.05 μF capacitor from TS2-3 (S2) to TS1-3 (NS) . . . . . ( )

(3) Connect one lead of the remaining 0.05 μF capacitor to TS2-5 (NS). Connect the other lead to TS4-1 (S2) . . . . . ( )

(4) On the high-voltage diode, SR15, the cathode end is identified by a stripe or by a "+" mark. Connect the cathode lead of an SR15 diode through TS2-4 (S2) to TS2-5 (NS). Connect the other end of the diode through TS1-4 (S2) to TS1-3 (NS) . . . . . ( )

(5) Connect the cathode lead of the other SR15 diode to TS1-5 (S1). Connect the other end of the diode to TS2-5 (S3) . . . . . ( )

(6) Connect the positive (+) lead of the 50 μF electrolytic capacitor to terminal 320 (S1). Position the capacitor as shown and connect the other lead to the ground lug (S1) attached to the transformer mounting screw . . . . . ( )

(7) Connect the positive (+) lead of a 1000 μF capacitor to terminal 302 (S1). Connect the other lead to ground lug 1 (NS) as shown . . . . . ( )

(8) Locate the spaghetti tubing and cut a 3/4" length from it. Slip this section of tubing over the negative lead of the other 1000 μF capacitor, and then connect this lead to terminal 307 (S1). Connect the positive lead to ground lug 1 (NS) ( )

(9) Connect a 220k resistor (red-red-yel) from TS1-1 (NS) to TS1-3 (S3) . . . . . ( )

This completes installation of the power supply components.

To install the remaining chassis-mounted components, remove the following parts from bag 2G-41T:

Part No.	Quan.	Description	Price Each
CN34	1	0.001 μF, disc	.15
CN209	1	0.033 μF (33 nF), mylar	.15
CN213	1	0.1 μF, 600 volt, mylar	.60
RE10	1	100k, 5%	.24
RE23	1	3.3M, 5%	.24
RE50	1	6800 ohm, 5%	.24
RE73	1	1M, 5%	.24
RE164	1	1000 ohm, 5%	.24
RS6	1	100 ohm, 1 watt, 10%	.20
RS126	2	18k, 2 watt, 10%	.35

You will also need the leftover piece of spaghetti tubing.

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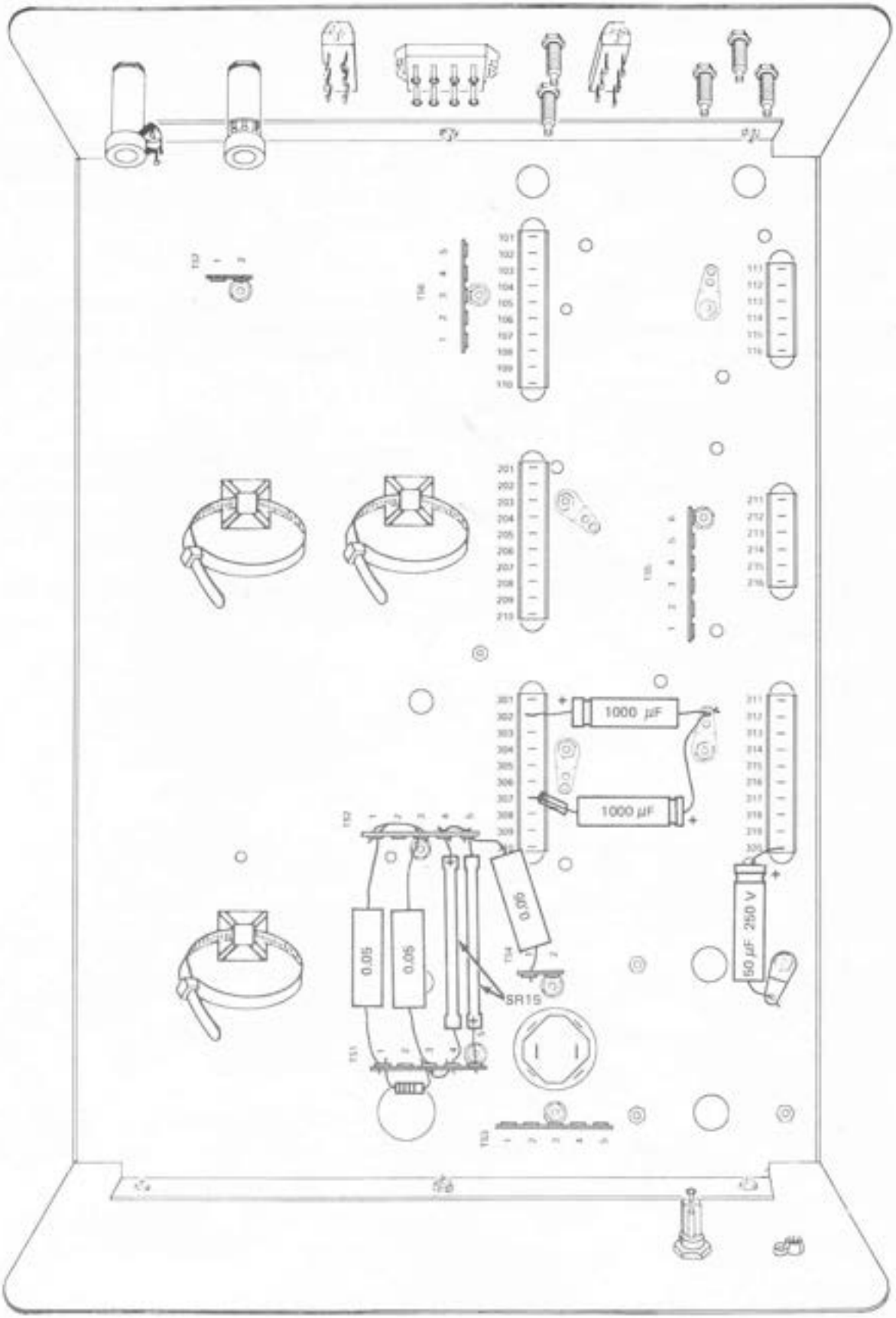

Figure 25. Installing the chassis-mounted power supply components.

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For the following steps, refer to Fig.26:

(1) Connect an 18k, 2 watt resistor (brn-gra-orn) from terminal 210 (NS) to TS5-1 (NS) . . . . (✓)

(2) Connect one end of the other 18k, 2 watt resistor (brn-gra-orn) to terminal 209 (NS) and connect the other end to TS5-2 (NS) . . . . . (✓)

(3) Connect a 6.8k (blu-gra-red) resistor from TS5-3 (NS) to TS5-4 (NS) . . . . . ( )

(4) Connect a 1k (brn-blk-red) resistor from TS5-4 (NS) to TS5-5 (NS) . . . . . ( )

(5) Connect a 0.001 μF capacitor from terminal 105 (NS) to TS6-4 (NS) . . . . . (✓)

(6) Connect a 0.033 μF capacitor from terminal 105 (S2) to TS6-5 (NS) . . . . . (✓)

(7) Connect a 100k resistor (brn-blk-yel) from TS7-1 (NS) to pin 2 (S1) of the intensity control . . . . . ( )

(8) Connect a 100 ohm, 1 watt resistor (brn-blk-brn) from TS6-3 (NS) to pin 5 (S1) of the ON/OFF switch . . . . . ( )

(9) Connect a 3.3M resistor (orn-orn-grn) from TS7-2 (S1) to pin 3 (S1) of the focus control. Be sure that the resistor lead does not touch the back of the control . . . . . ( )

(10) Connect a 1M resistor (brn-blk-grn) from the red hor/trig input jack (NS) to the black ground jack (NS) located just below the hor/trig input jack . . . . . ( )

(11) Shorten both leads of the 0.1 μF capacitor to 3/4". Then connect the 0.1 μF capacitor from the ac input jack (S1) to the dc input jack (NS) . ( )

This completes the installation of the chassis-mounted components.

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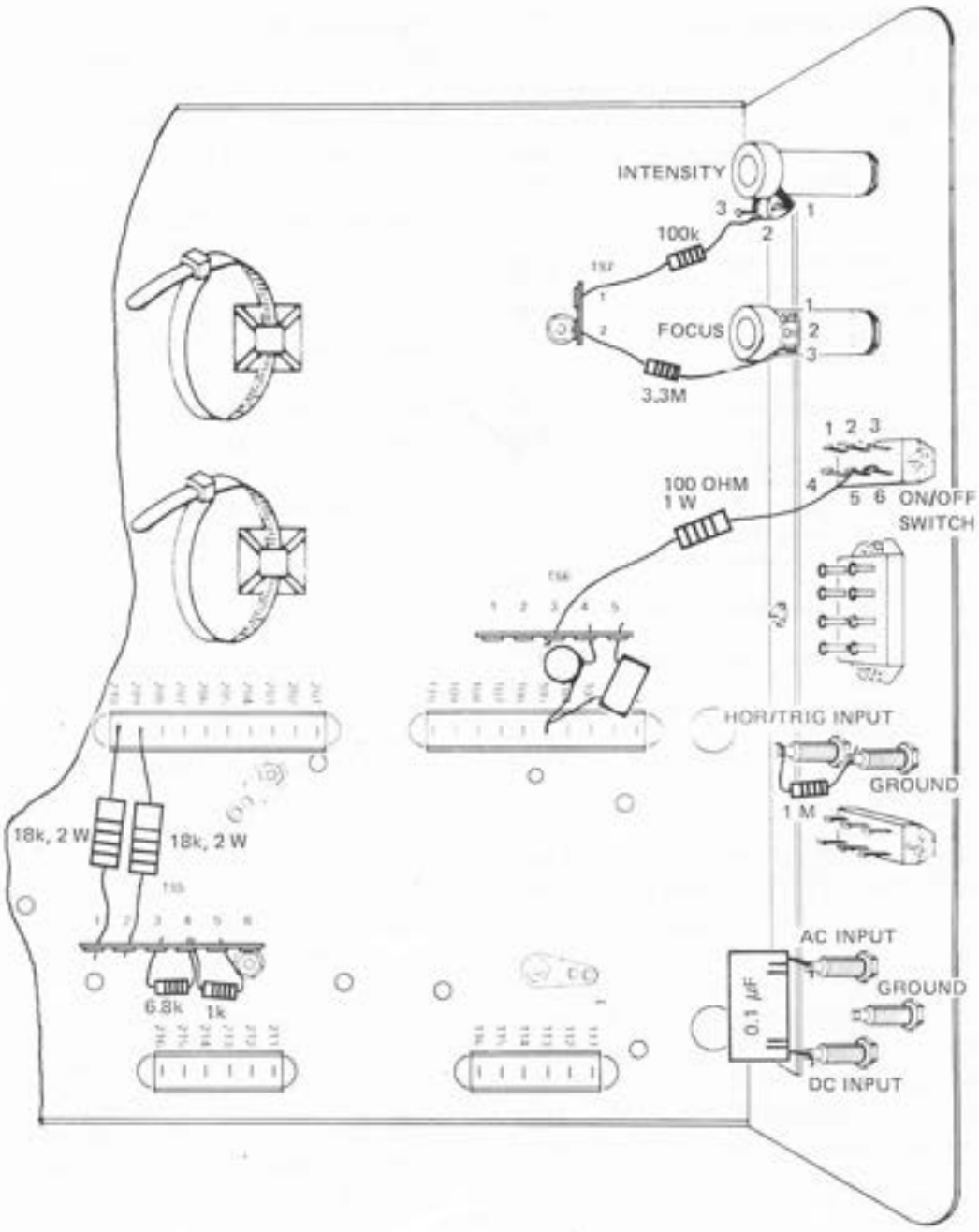

Figure 26. Installing the remaining chassis-mounted components.

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CHASSIS WIRING

Remove the following wire from the wire bag:

Part No.	Quan.	Description	Price Each
WR901	4'	Red hookup wire	12'/.25
WR902	2'	Green hookup wire	12'/.25
WR903	3'	Blue hookup wire	12'/.25
WR904	1'	White hookup wire	12'/.25
WR905	2'	Brown hookup wire	12'/.25
WR906	3'	Orange hookup wire	12'/.25
WR907	2'	Yellow hookup wire	12'/.25
WR908	2'	Violet hookup wire	12'/.25
WR911	4'	300 ohm twin lead	.10/ft
WR921	2'	Blue stranded wire	12'/.40
WR923	2'	Red stranded wire	12'/.40
WR927	2'	Yellow stranded wire	12'/.40
WR928	2'	Green stranded wire	12'/.40
WR938	1'	Hookup wire, orange with black tracer	12'/.25
WR939	2'	Hookup wire, white with black tracer	12'/.25
WR940	2'	Hookup wire, yellow with black tracer	12'/.25
WR941	2'	Hookup wire, green with black tracer	12'/.25
WR951	2'	White (red strip) stranded wire	12'/.40

You will also need the leftover pieces of black and black/white twisted hookup wire and shielded cable.

In this section you will begin the main chassis wiring. Refer to Fig.27 (located on a foldout at the end of the manual) and complete the following steps. Be sure to route all wires as shown. Route the wires beneath any components the wires may pass. Remove required lengths of insulation from the black hookup wire when bare wires are called for.

(1) Connect a 1-1/4" length of black hookup wire from TS1-5 (S2) to the filter capacitor mounting lug as shown (S1) . . . . . ( )

(2) Connect a 1" length of bare hookup wire from terminal 306 (S3) to ground lug 2 (S1) . . . . ✓

(3) Connect a 1-1/2" length of bare hookup wire from terminal 311 (S1) to ground lug 1 (S3) . . ( )

(4) Connect a 1-1/4" length of bare hookup wire from terminal 202 (NS) to ground lug 3 (S1) ✓

(5) Connect a 2" length of black hookup wire from terminal 212 (NS) to TS5-6 (S1) . . . . ( )

(6) Connect a 2-1/4" length of black hookup wire from terminal 108 (S1) to TS6-3 (NS) . . . . ✓

(7) Connect a 2" length of black hookup wire from terminal 113 (S1) to solder lug 4 (NS) . ✓

(8) Connect a 4" length of black hookup wire from the black hor/trig input ground terminal (S2) to TS6-3 (S3) . . . . . ( )

(9) Connect a 3-1/4" length of black hookup wire from pin 4 of the hor/trig switch (S1) to ground lug 4 (NS) . . . . . ( )

(10) Connect a 3" length of black hookup wire from the black vertical input ground jack (S1) to ground lug 4 (S3) . . . . . ( )

(11) Connect a 15-1/2" length of red stranded wire from TS1-1 (S5) to pin 3 (S1) of the intensity control on the front panel . . . . . ( )

(12) Connect a 5" length of red hookup wire from pin 1 (S1) of the filter capacitor to terminal 308 (NS) . . . . . ✓

(13) Connect a 13-1/2" length of red hookup wire from terminal 308 (S2) to pin 6 (S1) of the ON/OFF switch . . . . . ✓

(14) Connect a 7" length of red hookup wire from pin 2 (S1) of the filter capacitor to terminal 319 (S1) . . . . . ( )

(15) Connect a 4-1/2" length of red hookup wire from terminal 320 (S2) to TS5-1 (NS) . . . . ( )

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(16) Connect a 3/4" length of bare wire from TS5-1 (S3) to TS5-2 (NS) . . . . . ✓

(17) Connect a 6" length of red hookup wire from TS5-2 (S3) to terminal 110 (S1) . . . . . ✓

(18) Connect a 4-1/2" length of blue hookup wire from terminal 318 (S1) to terminal 216 (NS) . . ( )

(19) Connect a 16" length of blue hookup wire from terminal 216 (NS) to terminal 101 (S1) . . ✓

(20) Connect a 5" length of blue hookup wire from terminal 216 (S3) to terminal 114 (S1) . . ✓

(21) Connect a 7" length of yellow hookup wire from terminal 312 (S1) to terminal 115 (NS) . . ✓

(22) Connect a 4-1/2" length of yellow hookup wire from terminal 115 (S2) to terminal 104 (NS) . . . . . ✓

(23) Connect a 3-1/2" length of green hookup wire from terminal 313 (S1) to terminal 215 (NS) . . . . . ( )

(24) Connect a 2" length of green hookup wire from terminal 215 (NS) to TS5-4 (S3) . . . . . ( )

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In this section you will continue the main chassis wiring. For these steps, refer to Fig.28:

(1) Connect an 11-1/2" length of brown hookup wire from terminal 301 (S1) to pin 5 (S1) of the trig source switch . . . . . ( )

(2) Connect a 17" length of orange hookup wire from terminal 317 (S1) to pin 8 (S1) of the trig source switch . . . . . ( )

(3) Connect a 10-1/2" length of violet hookup wire from terminal 116 (S1) to pin 2 (NS) of the trig source switch . . . . . ( )

(4) Connect a 1" length of bare wire from pin 7 (S1) through pin 6 (S2) to pin 2 (S2) of the trig source switch . . . . . ( )

(5) Connect a 1-3/4" length of white hookup wire from pin 3 (S1) of the trig source switch to the red hor/trig input jack (NS) . . . . . ( )

(6) Connect another 1-3/4" length of white hookup wire from the hor/trig input jack (S3) to pin 1 (S1) of the hor/trig switch . . . . . ( )

(7) Connect a 3-1/2" length of yellow with black tracer hookup wire from terminal 102 (S1) to pin 3 of the hor/trig switch . . . . . ( )

(8) Connect a 4" length of green with black tracer hookup wire from terminal 103 (NS) to pin 5 (S1) of the hor/trig switch . . . . . ( )

(9) Prepare a 6-1/2" length of black-and-white twisted pair by untwisting one end two turns and the other end about six or seven turns. Connect the black wire (short end) to terminal 208 (S1) and the white wire (short end) to terminal 207 (S1). Route the pair as shown in Fig.28 (under the two 1000 μF capacitors), and connect the black wire to terminal 303 (S1). Then connect the white wire to terminal 316 (S1) . . . . . ( )

(10) Prepare a 7" shielded cable as shown in Fig.28, Detail A. Lightly tin all wires. Connect the center conductor of either end to terminal 211 (S1) and the ground shield to terminal 212 (S2). Route the cable as shown in Fig.28 and connect the center conductor to pin 2 (S1) of the hor/trig switch. Finally, connect the ground shield to pin 4 (S2) of the hor/trig switch . . . . . ( )

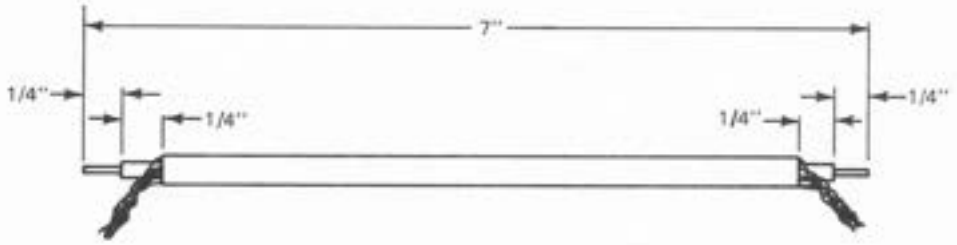

Figure 28. Detail A.

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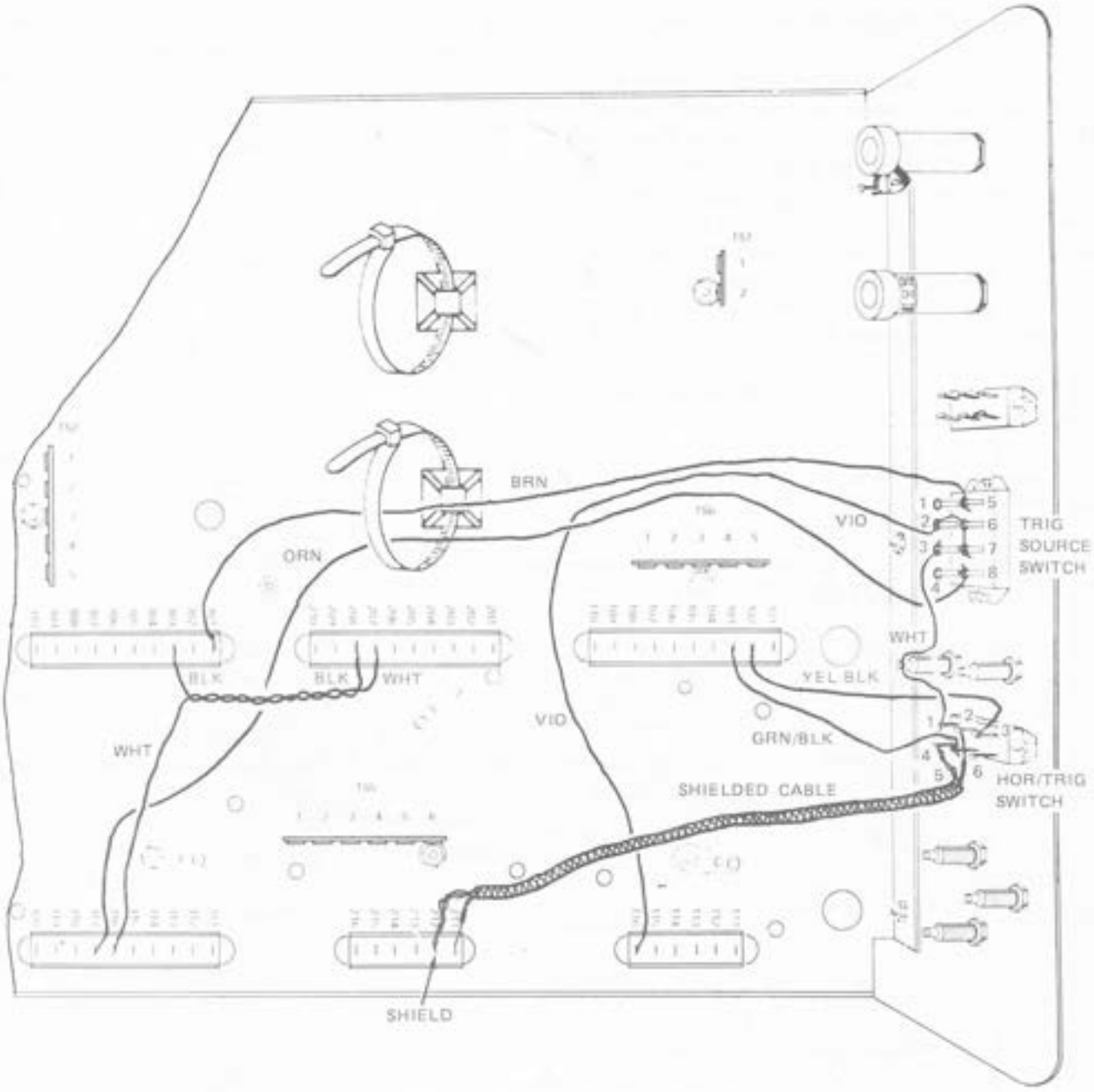

Figure 28. Chassis wiring, stage 2.

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CHASSIS/FRONT PANEL WIRING

In the following steps you will connect wires from the main chassis to the front panel controls. This wiring will be done in two stages. First, one end of each wire will be connected to the main chassis and then routed through a hole to the front panel. Once this is complete, you will then connect the wires to the front panel controls. You will need the wire left over from prior assembly steps. Be sure to route all wires as shown. Refer to Fig.29 and complete the following steps:

(1) Connect a 12-1/2" length of green hookup wire from terminal 215 (S3) through hole A . . ( )

(2) Connect a 12" length of violet hookup wire from terminal 214 (S1) through hole A . . . . . ( )

(3) Connect a 12-1/2" length of black hookup wire from terminal 213 (S1) through hole A . . ( )

(4) Connect an 11-1/2" length of orange with black tracer hookup wire from TS5-3 (S2) through hole A . . . . . ( )

(5) Connect a 13" length of white with black tracer hookup wire from TS5-5 (S2) through hole A . . . . . ( )

(6) Connect an 8" length of white hookup wire from terminal 111 (S1) through hole A . . . . . ✓

(7) Connect a 5" length of brown hookup wire from terminal 112 (S1) through hole A . . . . . ✓

(8) Connect a 12-1/2" length of green with black tracer hookup wire from terminal 206 (S1) through hole B . . . . . ✓

(9) Connect a 7" length of red hookup wire from TS6-5 (S2) through hole B . . . . . ( )

(10) Connect an 8" length of blue hookup wire from TS6-4 (S2) through hole B . . . . . ( )

(11) Connect a 9" length of orange hookup wire from terminal 103 (S2) through hole B . . . . . ✓

(12) Connect a 9-1/2" length of yellow with black tracer hookup wire from terminal 106 (S1) through hole B . . . . . ✓

(13) Connect a 9" length of yellow hookup wire from terminal 104 (S2) through hole B . . . . . ✓

(14) Prepare two shielded cables as shown in Fig.29, Detail A. Connect the center conductor of one cable to terminal 204 (S1). Connect the center conductor of the other cable to terminal 203 (S1). Finally, connect both ground shields to terminal 202 (NS). Route the free ends of each cable through hole B . . . . . ✓

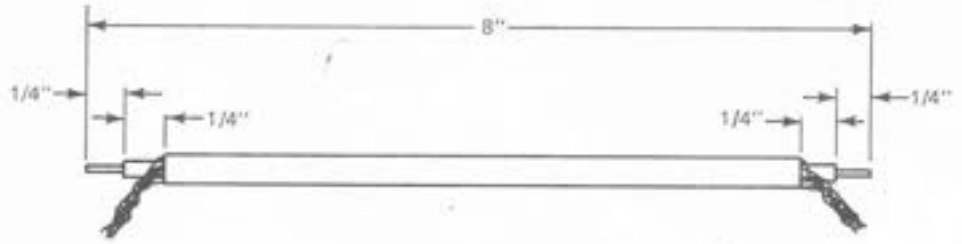

Figure 29. Detail A.

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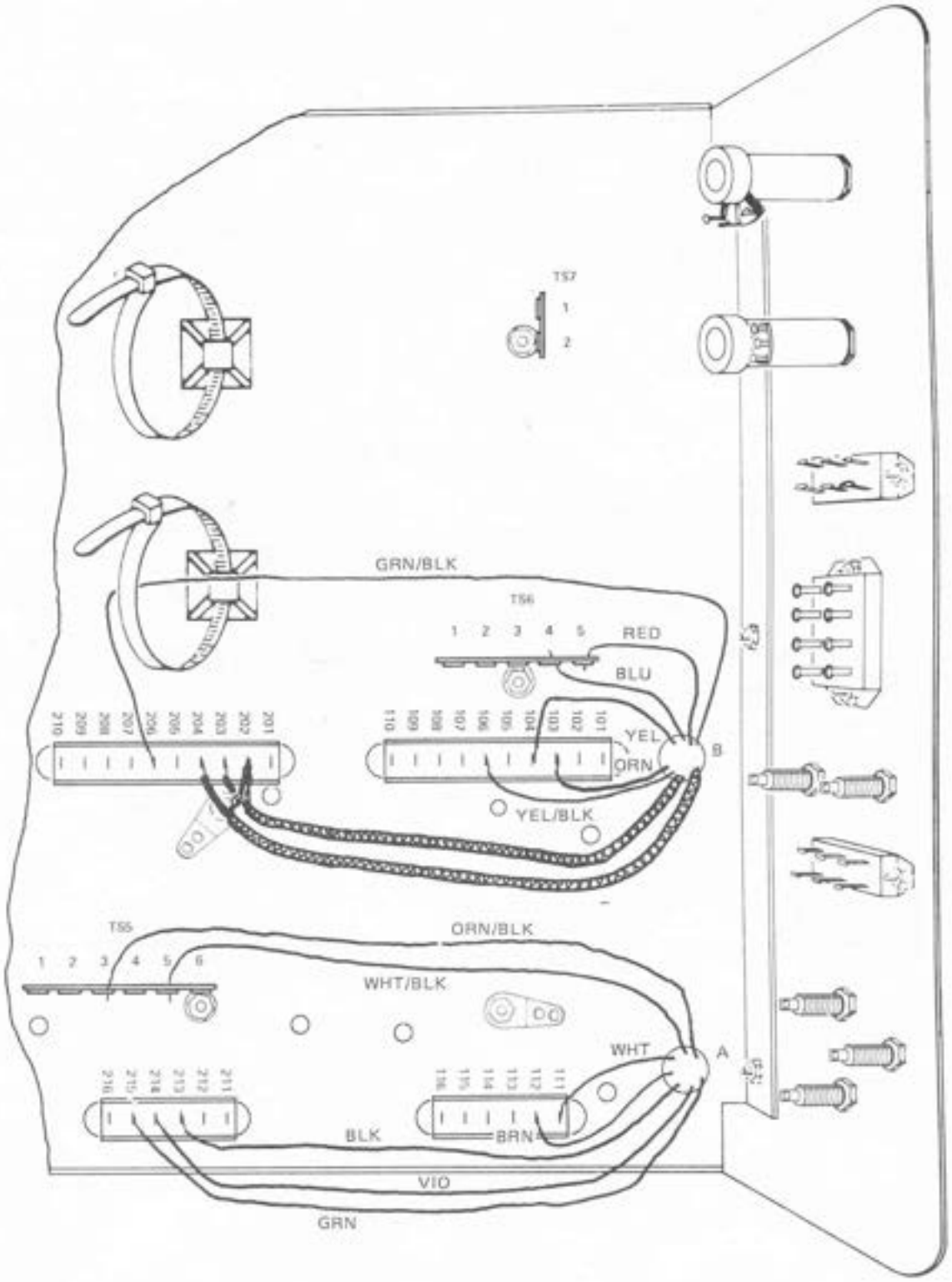

Figure 29. Wiring the main chassis to front panel.

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In the following steps you will connect wires to the front panel controls. For this stage, refer to Fig.30. Be sure to position the wires as shown.

(1) Connect the brown wire to pin 1 (S1) on the vertical attenuator switch ..... ( )

(2) Connect the orange with black tracer wire to pin 1 (S1) on the vertical position control .... ( )

(3) Connect the green wire to pin 3 (S1) of the sweep speed control ..... ( )

(4) Remove 1/2" of insulation from the end of the white wire. Then connect the white wire through pin 2 (S2) to pin 1 (S1) on the sweep speed control ..... ( )

(5) Connect the violet wire to pin 3 (S1) on the horizontal position control ..... ( )

(6) Connect the black wire to pin 2 (S1) on the horizontal position control ..... ( )

(7) Connect the white with black tracer wire to pin 1 (S1) on the horizontal position control . ( )

(8) Remove 1/2" of insulation from the end of the red wire. Then connect the red wire through pin 8 (S2) to pin 9 (S1) on the range switch ..... ( )

(9) Remove 1/2" of insulation from the end of the blue wire. Then connect the blue wire through pin 6 (S2) to pin 7 (S1) on the range switch ..... ( )

(10) Connect the yellow with black tracer wire to pin 10 (S1) on the range switch ..... ( )

(11) Connect the orange wire to pin 5 (S1) on the range switch ..... ( )

(12) Connect the yellow wire to TS8-1 (S1) .. ( )

(13) Connect the green with black tracer wire to pin 2 of the vertical position control (S1) .... ( )

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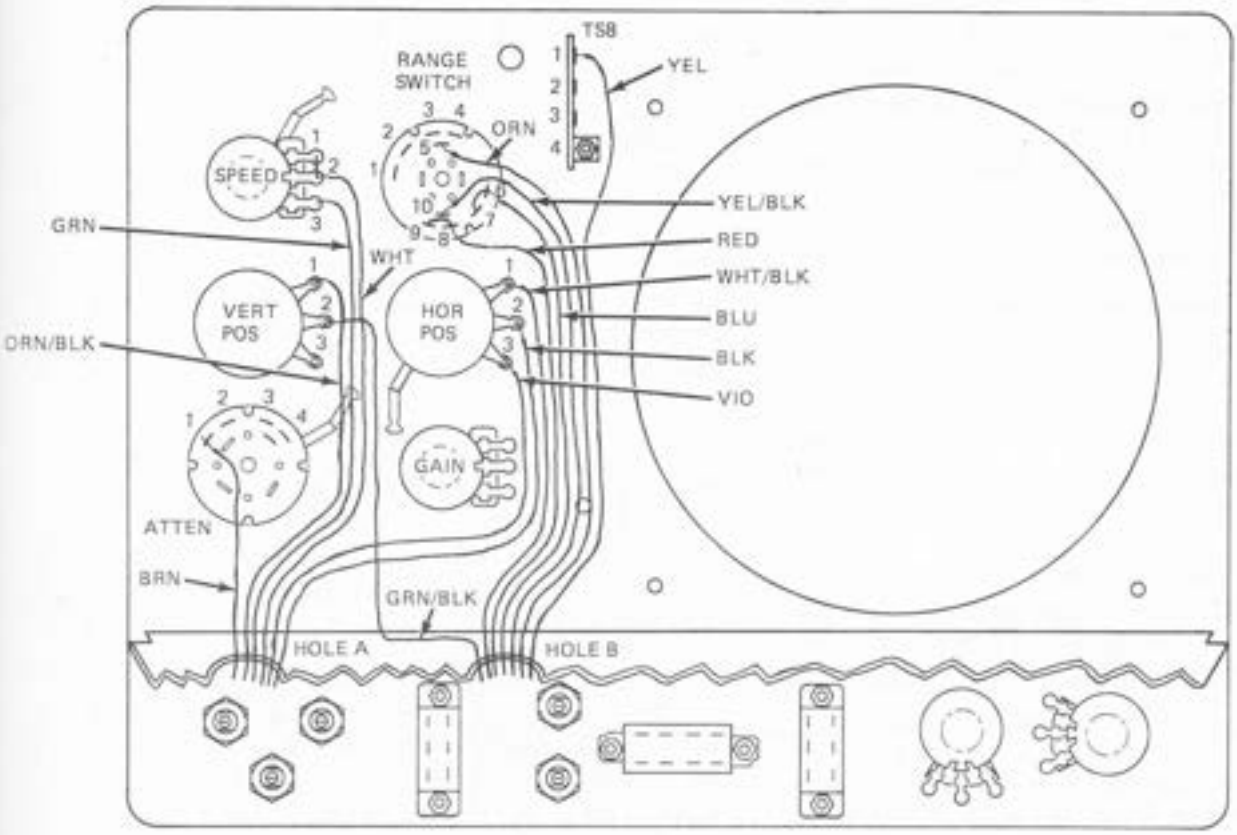

Figure 30. Front panel wiring.

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In the following steps you will connect the front panel LED circuit, the gain control cables, and position the vertical attenuator shielded cables. For these steps, refer to Fig.31.

Gather the following parts from bag 3H-41T:

Part No.	Quan.	Description	Price Each
LP17	1	Red light-emitting diode	.50
MS96	1	Red LED lens cap	.30
RE161	1	470 ohm, 5%	.24

(1) Install the red LED lens cap by pushing the cap into the hole in the top of the front panel. Insert the cap from the front side of the panel ( )

(2) Install the red LED into the lens cap by pushing the LED into the lens cap from the back of the front panel. Be careful to position the flat edge of the LED at the bottom as shown in Fig.31, Detail A ..... ( )

(3) Connect the upper LED lead to the bottom hole of TS8-1 (S1) as shown in Fig.31, Detail A ( )

(4) Connect the lower LED lead to the bottom hole of TS8-2 (S1) as shown in Fig.31, Detail A. Be sure that the leads of the LED do not touch each other ..... ( )

(5) Connect the 470 ohm resistor from TS8-2 (S1) to TS8-4 (S1) ..... ( )

(6) Connect the center conductor of the shielded cable from terminal 203 to pin 3 (S1) of the vertical gain control. Connect the shield of this cable to pin 1 (NS) of the same control ..... ( )

(7) Connect the center conductor of the shielded cable from terminal 204 to pin 2 (S1) of the vertical gain control. Connect the shield to pin 1 (S2) of the same control. Be sure that none of the cable leads connected to this control touch adjacent leads or pins ..... ( )

(8) Route each of the two shielded cables from the vertical attenuator control through hole A. Turn the chassis over and connect the center conductor of the shorter cable to the dc vertical input jack (S2). Next connect the center conductor of the longer cable to terminal 201 (S1) and the shield to terminal 202 (S4) ..... ( )

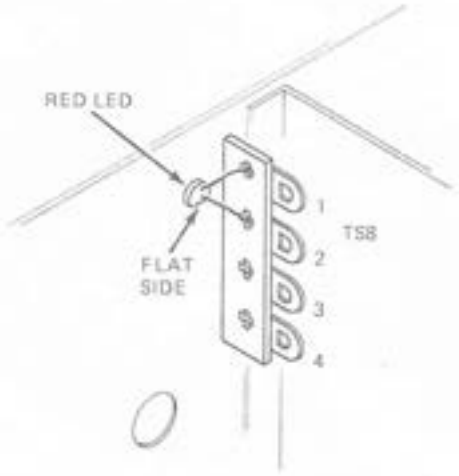

Figure 31. Detail A.

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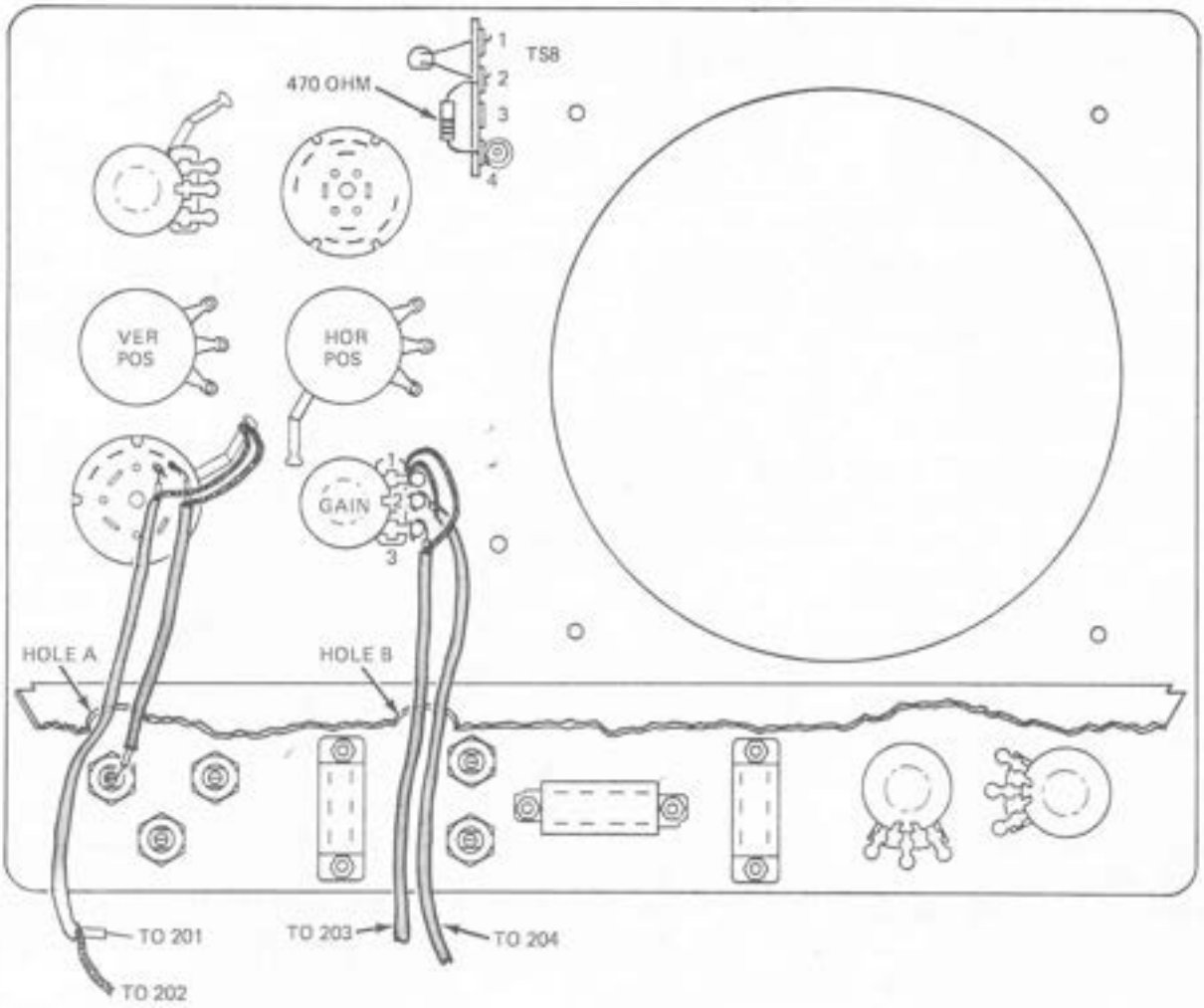

Figure 31. Final front panel wiring.

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Final Assembly

In the following steps you will complete the main chassis wiring. You will need the wire left over from previous sections. Refer to Fig.32 as you install each wire.

(1) Connect one end of a 23" length of blue stranded wire to pin 2 (S1) of the focus control. Route the other end through the crt access hole as shown ..... ( )

(2) Connect one end of a 22" length of yellow stranded wire to TS7-1 (S2). Route the other end through the crt access hole as shown ..... ( )

(3) Connect one end of a 20" length of green stranded wire to terminal 109 (S1). Route the other end through the crt access hole as shown ..... ( )

(4) Connect one end of a 21" length of white with red stripe stranded wire to terminal 107 (S1). Route the other end through the crt access hole as shown ..... ( )

(5) Prepare a 20" length of twin lead as shown in Fig.32, Detail A. Lightly tin each lead. To identify the leads cut a small notch in each end of the twin leads as shown. When making the notches, lay the twin lead out flat to be sure the long side of each notch is at the top as shown in Fig.32, Detail A. Connect the lead closest to the notch to terminal 210 (S2) and the other lead to terminal 209 (S2). Route this cable through the crt access hole as shown . ( )

(6) Prepare another 20" length of twin lead as shown in Fig.32, Detail A. Lightly tin each lead. Connect the lead closest to the notch to terminal 315 (S1) and the other lead to terminal 314 (S1). Route his cable through the crt access hole as shown ..... ( )

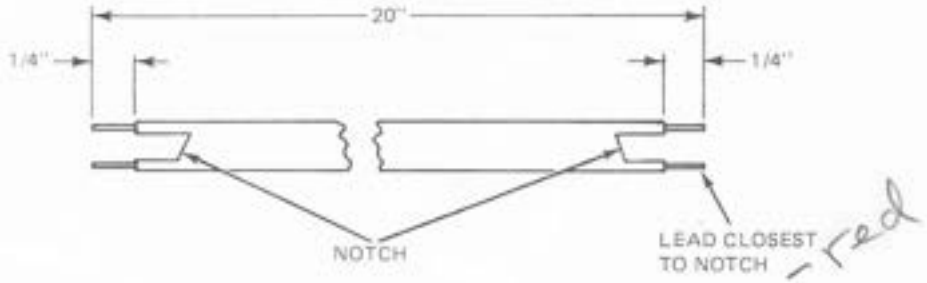

Figure 32. Detail A.

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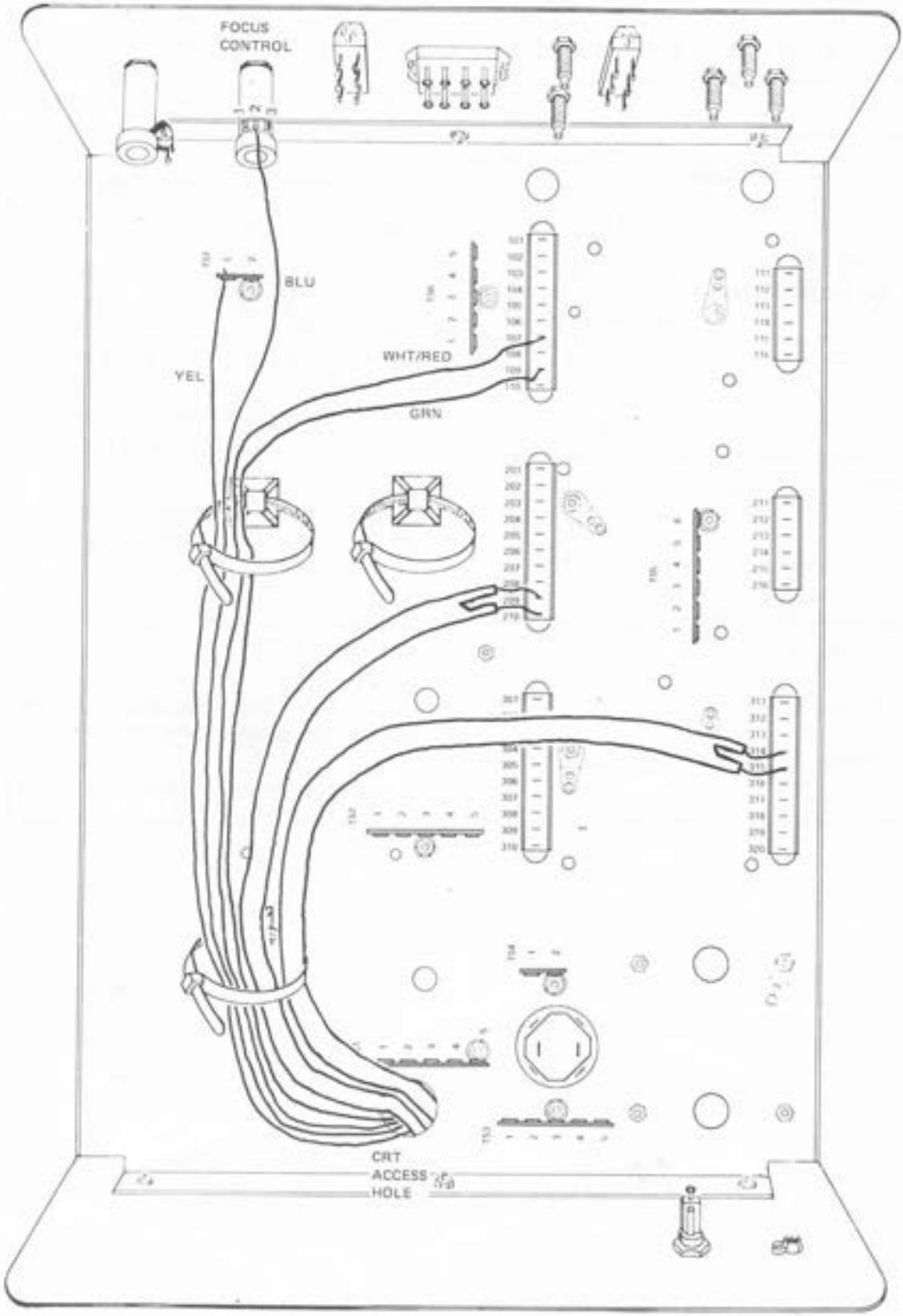

Figure 32. Main chassis crt socket wiring.

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CRT SOCKET WIRING

You will need the leftover length of spaghetti tubing and the following parts from bag 3H-41T:

Part No.	Quan.	Description	Price Each
CN43	1	0.001 μF, 3kV, disc	.30
RE73	1	1M, 5%	.24
S097	1	CRT socket	.25

To wire the crt socket, first position the crt socket on the main chassis (pins up) as shown in Fig.33. As you wire this socket, arrange each wire and component as shown.

(1) Cut two 1/2" sections of spaghetti tubing (IN901) and place one section over each lead of a 1M (brn-blk-grn) resistor. Connect one lead of this resistor to pin 12 (NS) and connect the other lead to pin 2 (NS) of the socket ..... ( )

(2) Shorten the leads of a 0.001 μF, 3kV capacitor to 3/4". Then cut two more 1/2" sections of spaghetti tubing (IN901) and place one section over each lead of the capacitor. Connect one lead of this capacitor to pin 2 (S2) and the other lead to pin 5 (NS) of the socket ..... ( )

(3) Connect either brown wire to pin 12 (S2) ( )

(4) Connect the other brown wire to pin 1 (S1) ( )

(5) Connect the yellow wire to pin 3 (S1) ... ( )

(6) Connect the blue wire to pin 4 (S1) ..... ( )

(7) Connect the white with red stripe wire to pin 5 (S2) ..... ( )

(8) Connect the green wire to pin 8 (S1) .... ( )

In the next four steps you will connect the twin lead cables of the crt socket. Be sure you identify the proper twin lead before you make the connections to the socket. If the twin lead cables are not correctly installed, the horizontal, vertical, or both horizontal and vertical deflections will be backwards. Continue to refer to Fig.33.

(1) Identify the twin lead coming from terminals 210 and 209. Connect the lead closest to the notch to pin 9 (S1) ..... ( )

(2) Connect the other conductor from this twin lead to pin 10 (S1) ..... ( )

(3) For the other twin lead, connect the lead closest to the notch to pin 6 (S1) ..... ( )

(4) Connect the other conductor from this twin lead to pin 7 (S1) ..... ( )

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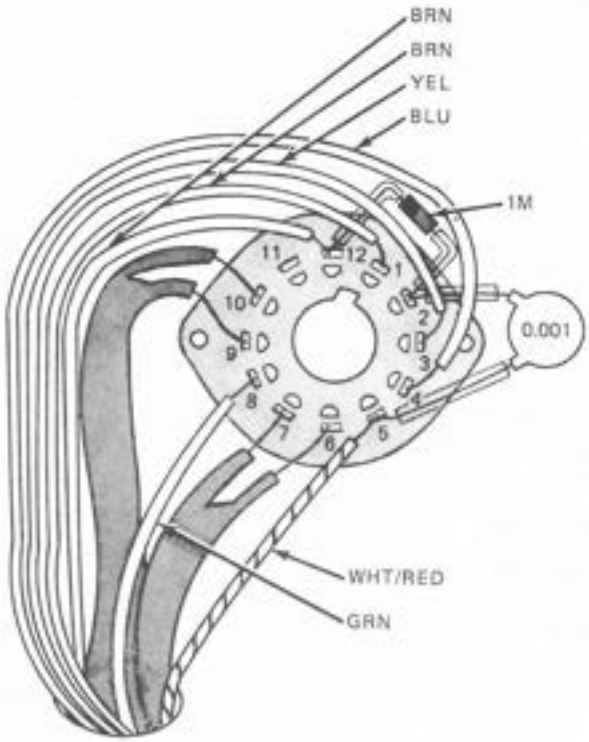

Figure 33. Wiring the crt socket.

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CRT INSTALLATION

You will now install the crt brackets and the crt. Locate the following parts:

Part No.	Quan.	Description	Price Each
BR91	1	CRT support bracket	1.00
BR106	4	Front panel crt brackets	.50
CL16	1	CRT clamp (back)	.48
CL59	1	CRT clamp (front)	1.00
HA904	18"	Foamstick tape	.25/ft
MS48	1	Graticule	2.75
MS48-1	1	Green screen	.20
MS49	1	Bezel	2.00
TU107	1	5" flat-face crt (RCA4572A)	52.00

CRT→

Gather from bag 3H-41T:

NU1	5	6-32 × 1/4" hexagonal nuts	12/.25
NU3	4	8-32 × 1/4" hexagonal nuts	12/.15
NU5	1	4-40 × 1/4" hexagonal nuts	12/.25
NU16	4	8-32 nylon cap nuts, black	4/.15
SC63	4	6-32 × 1/4" machine screws	12/.25
SC5	1	6-32 × 1" machine screw	6/.25
SC29	1	4-40 × 1-1/4" machine screw	6/.25
SC84	4	8-32 × 5/8" machine screws	12/.35
WA15	6	No.6 lockwashers	12/.15
WA16	4	No.8 lockwashers	12/.15

(1) Install the four BR106 crt brackets to the front panel using four 8-32 × 5/8" machine screws, lockwashers, and nuts as shown in Fig.34 and Fig.34, Detail A. These nuts should be only "finger tight" at this time ..... ( )

(2) In this step you will attach the foamstick tape to the inside of the front crt clamp (CL59). Refer to Fig.34, Detail B. Remove the protective tape from the foamstick. Next, center the foamstick material inside the clamp and then apply pressure to secure the foamstick in place ..... ( )

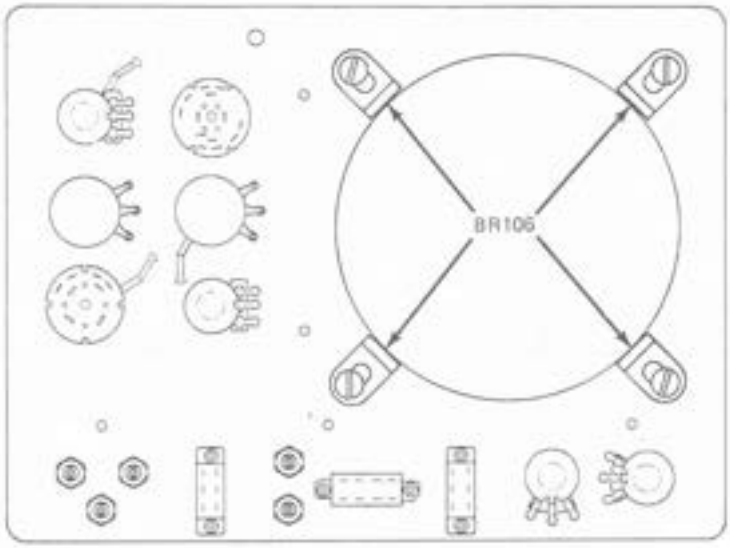

Figure 34. Installing crt brackets and clamps (front).

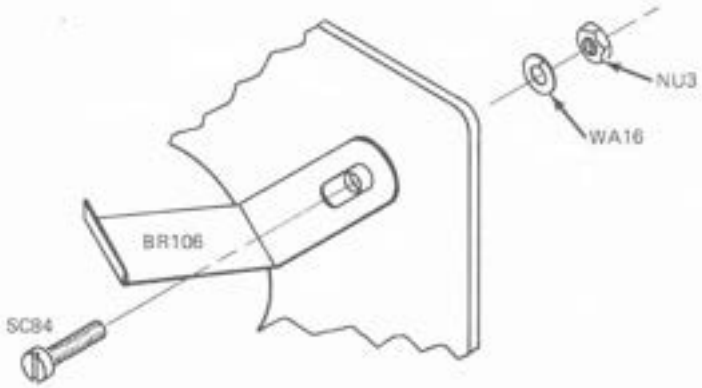

Figure 34. Detail A.

Figure 34. Detail B.

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(3) Position the crt clamp (CL59) so that it rests inside the flange of the crt front panel brackets. Use a 6-32 × 1" machine screw, lockwasher, and nut to secure the CL59. Position the screw as shown in Fig.35. Do not tighten the screw at this time .....( )

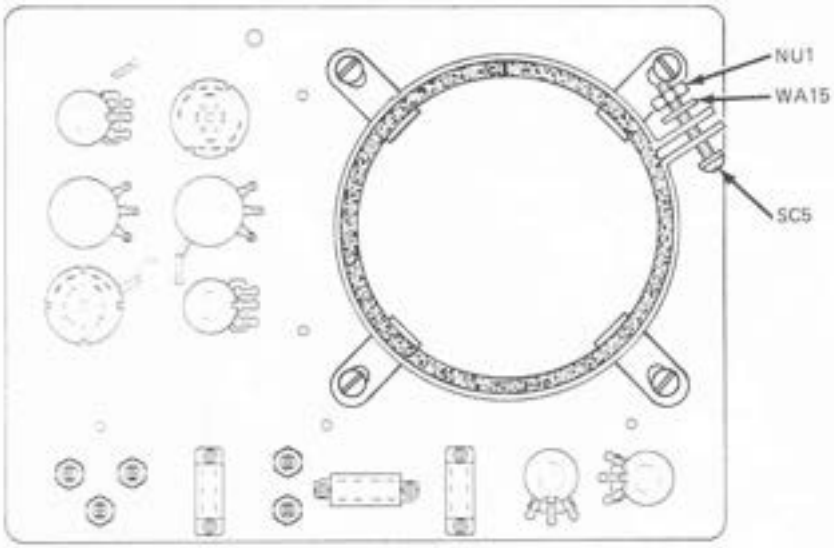

Figure 35. Installing CL59.

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(4) Install the crt clamp (CL16) on the crt support bracket (BR91) using the hardware shown in Fig.36. Do not tighten the nut on SC29 at this time. You will tighten this nut after you install the crt . ( )

(5) Install BR91 on the main chassis using two 6-32 × 1/4" machine screws, lockwashers, and nuts as shown in Fig.37. Do not tighten this hardware at this time ..... ( )

CAUTION

The cathode-ray tube is dangerous to handle. Be very careful with it and especially avoid scratching its glass surface or striking it against any hard objects. The crt is highly evacuated and if it should be accidentally broken, you could be injured by flying glass.

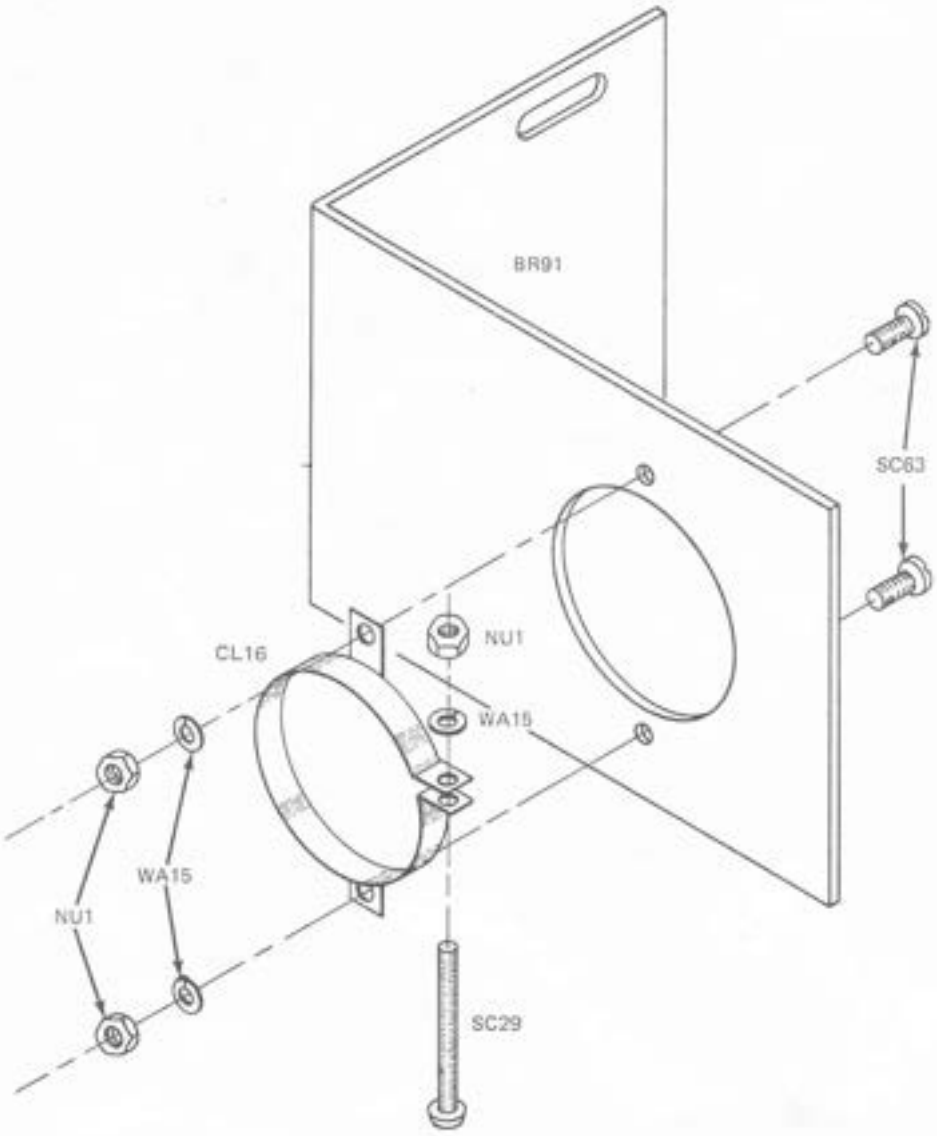

Figure 36. Installing the crt clamp (back).

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(6) Carefully remove the crt from its carton and slide it into the large opening at the front of the scope. Make sure the front and back crt clamps are loose as you install the crt. The back crt clamp must surround the plastic base of the crt. Position the locating key on the crt base toward the top of the oscilloscope. The face of the crt should be flush with the front panel ..... ( )

(7) Tighten the front and rear crt clamps and the hardware holding BR91 until the crt is held securely in place ..... ( )

(8) Gently push the crt socket onto the base of the tube. Because of the locating key, the socket will fit only one way ..... ( )

(9) Tighten the four nuts on the screws holding the front crt clamp in place. Then place the green filter over the crt face so that the long dimension is from left to right, centered between the four 8-32 screws ..... ( )

(10) Place the graticule over the crt and filter with the smooth side facing you. You will find the four 8-32 screws will pass through the holes in the graticule ..... ( )

(11) Now place the bezel over the four screws protruding through the front panel. Fasten the bezel in place with the four nylon cap nuts ... ( )

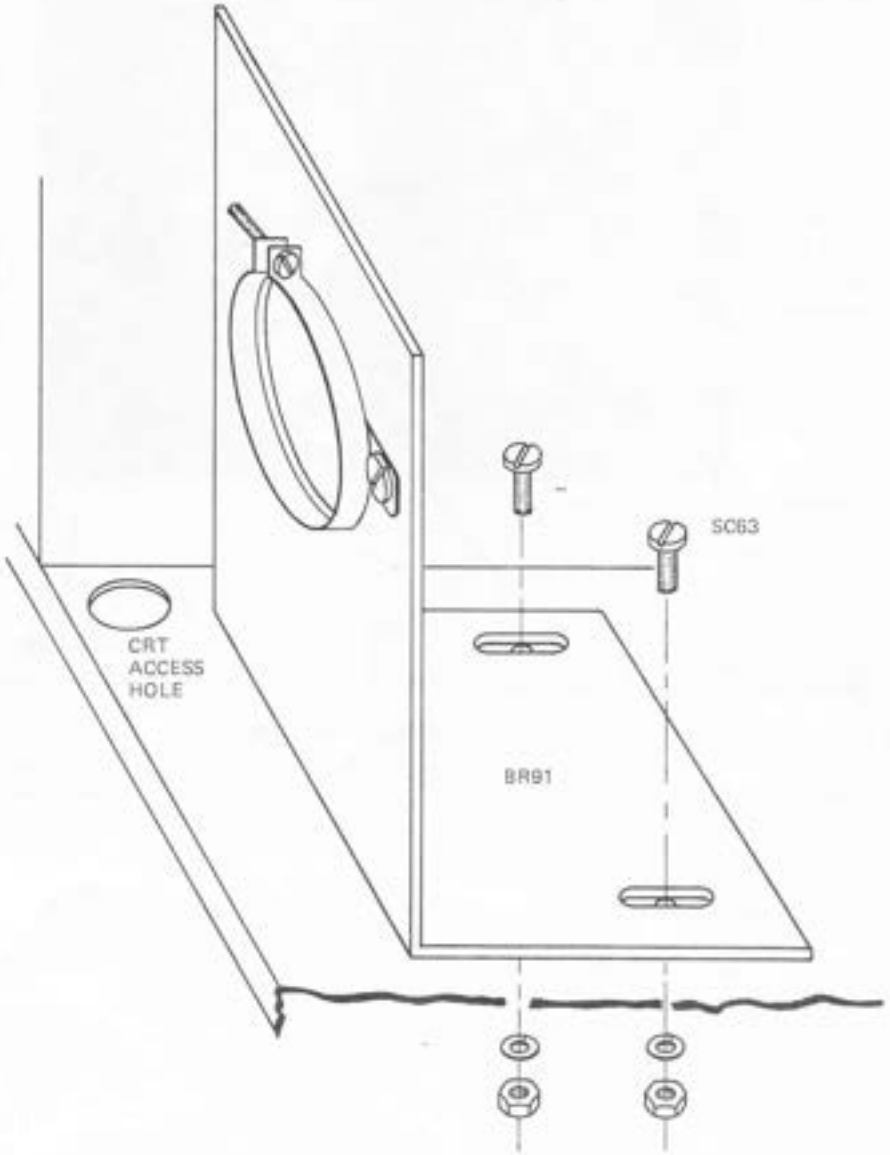

Figure 37. Installing BR91.

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INSTALLING KNOBS

Gather the following parts from bag 31-41T:

Part No.	Quan.	Description	Price Each
KN46	4	Large knobs	.40
KN51	4	Small knobs	.70

Turn all controls fully clockwise.

(1) Install the front panel knobs as shown in Fig.38. Postion the knob marks as shown. Secure the knobs on the shafts by tightening the set screw with a small-bladed screwdriver . . . . . ( )

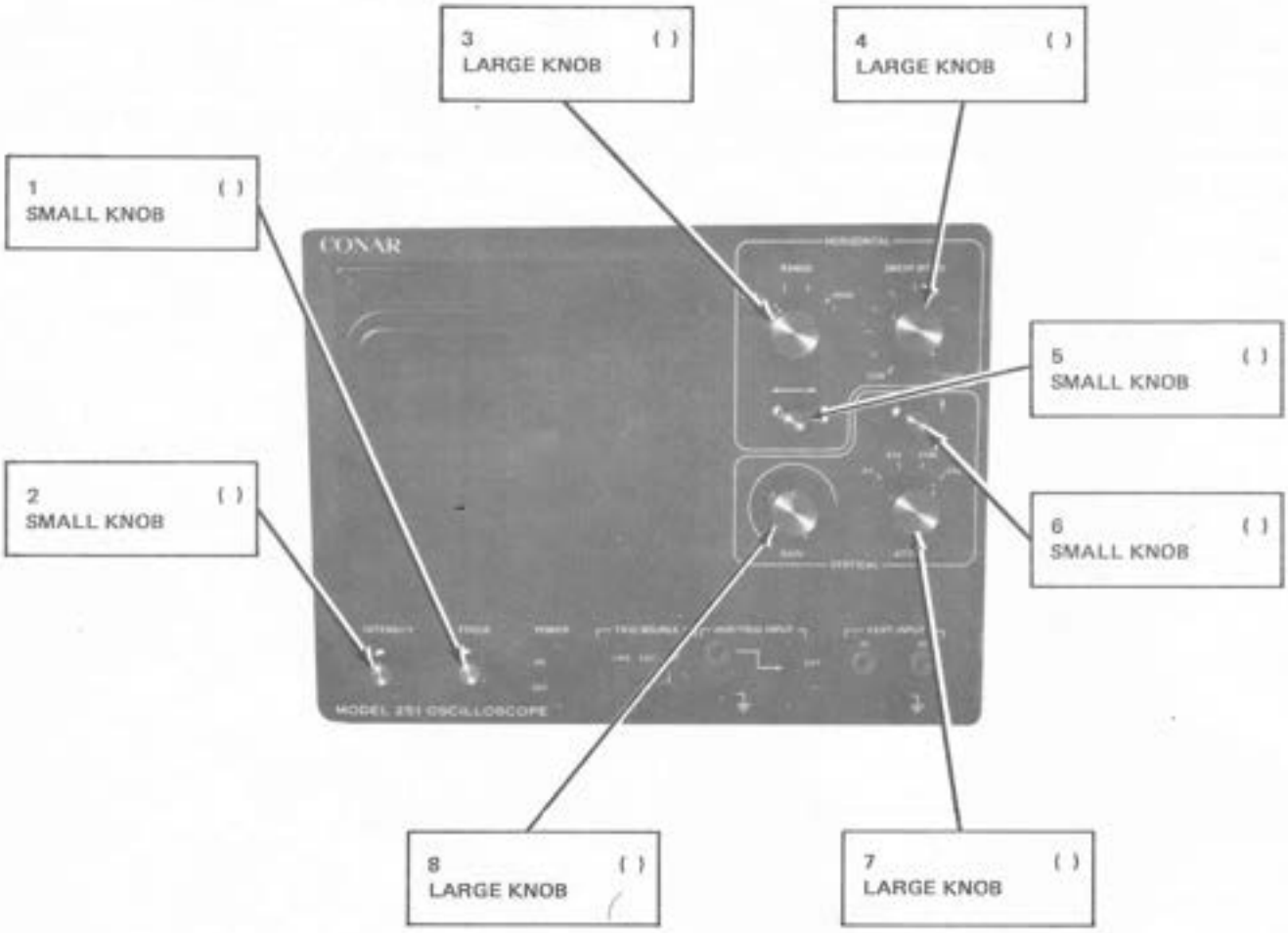

Figure 38. Installing the knobs.

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TESTING THE POWER SUPPLY

(1) Install the power supply module as shown in Fig.39. The circuit module stand-offs are arranged such that each module can only be installed in one position on the chassis. If these stand-offs are broken or removed, a module could be incorrectly installed and damaged. Note, for these tests you should have *only* the power module installed . . ( )

(2) Before applying power, check the resistance between terminals 312, 313, 318, 319, 320, and ground. You should read higher than zero ohms at each terminal. A measurement of zero ohms indicates a short to ground. Do not operate the scope if this condition exists, as you could damage the power supply parts. Check your operating manual for troubleshooting assistance . . . . . ( )

(3) Assuming you do not read zero ohms in the above step, switch your meter from ohms to dc, and plug in the oscilloscope line cord. Then move the power switch to the ON position and measure the voltage (to ground) at terminal 312 (4 to 6 volts), terminal 313 (8 to 10 volts), terminal 318 (-7 to -9 volts), terminal 319 (200 to 300 volts), and terminal 320 (200 to 300 volts). If you do not get the proper voltages, turn off the power and check the operating manual for troubleshooting assistance . . . . . ( )

(4) Turn off the oscilloscope and unplug the line cord . . . . . ( )

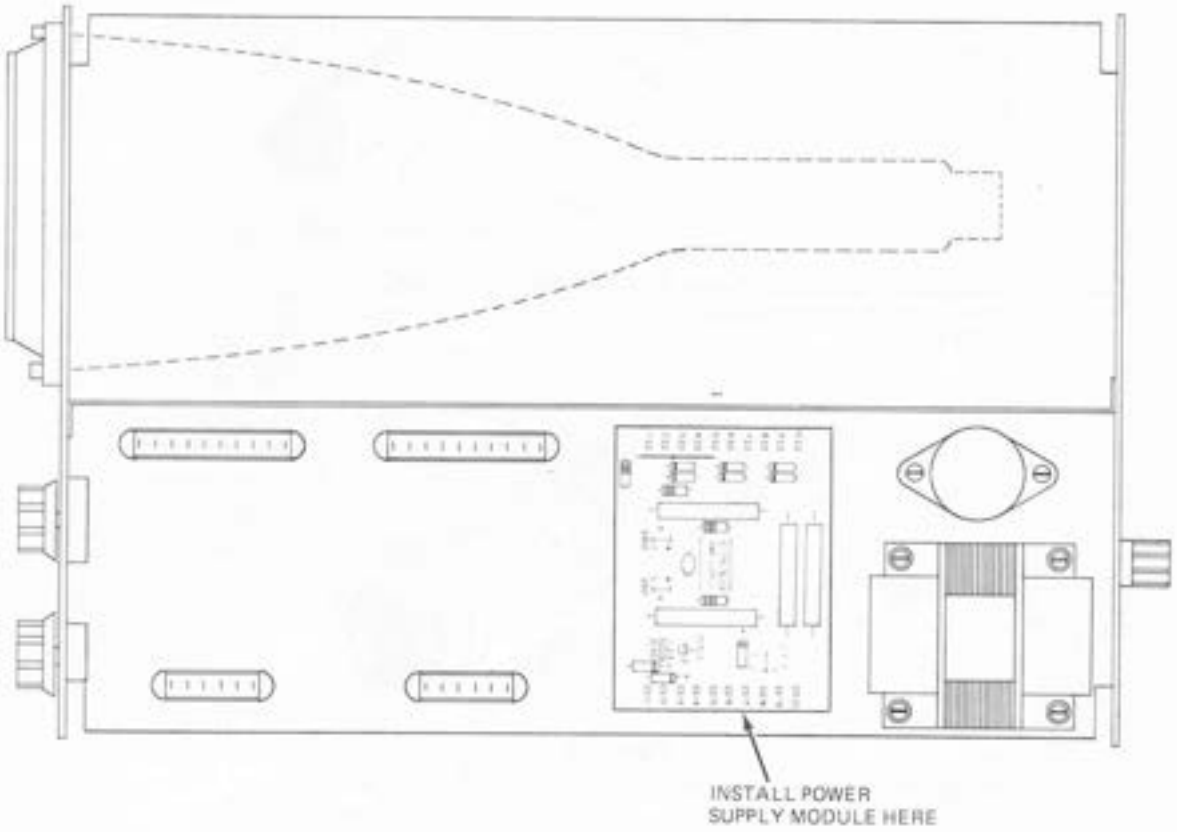

Figure 39. Installing the power supply module.

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INSTALLING THE CRT SHIELD

Gather the following parts:

Part No.	Quan.	Description	Price Each
SH45	1	Crt shield	1.65
From bag 3I-41T:			
CL56	1	Wedge lock cable clamp	.05

(1) Wrap the crt shield material around the neck of the crt as shown in Fig.40 . . . . . ( )

(2) Secure the crt shield in place with a wedge lock cable clamp as shown in Fig.40, Detail A. The cable clamp should be just tight enough to hold the shield firmly in place against the neck of the crt ( )

Figure 40. Installing the crt shield.

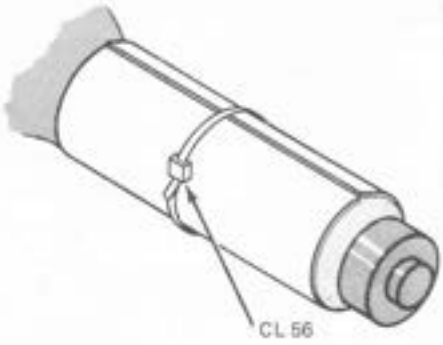

Figure 40. Detail A.

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INSTALLATION OF THE HOR/VERT MODULE AND THE SWEEP MODULE

You will need the following part from bag 3I-41T:

Part No.	Quan.	Description	Price Each
IN903	4"	Shrinkable tubing, large ID	.05/ft

(1) Install the hor/vert module as shown in Fig.41 ..... ( )

(2) Install the sweep module as shown in Fig.41 ..... ( )

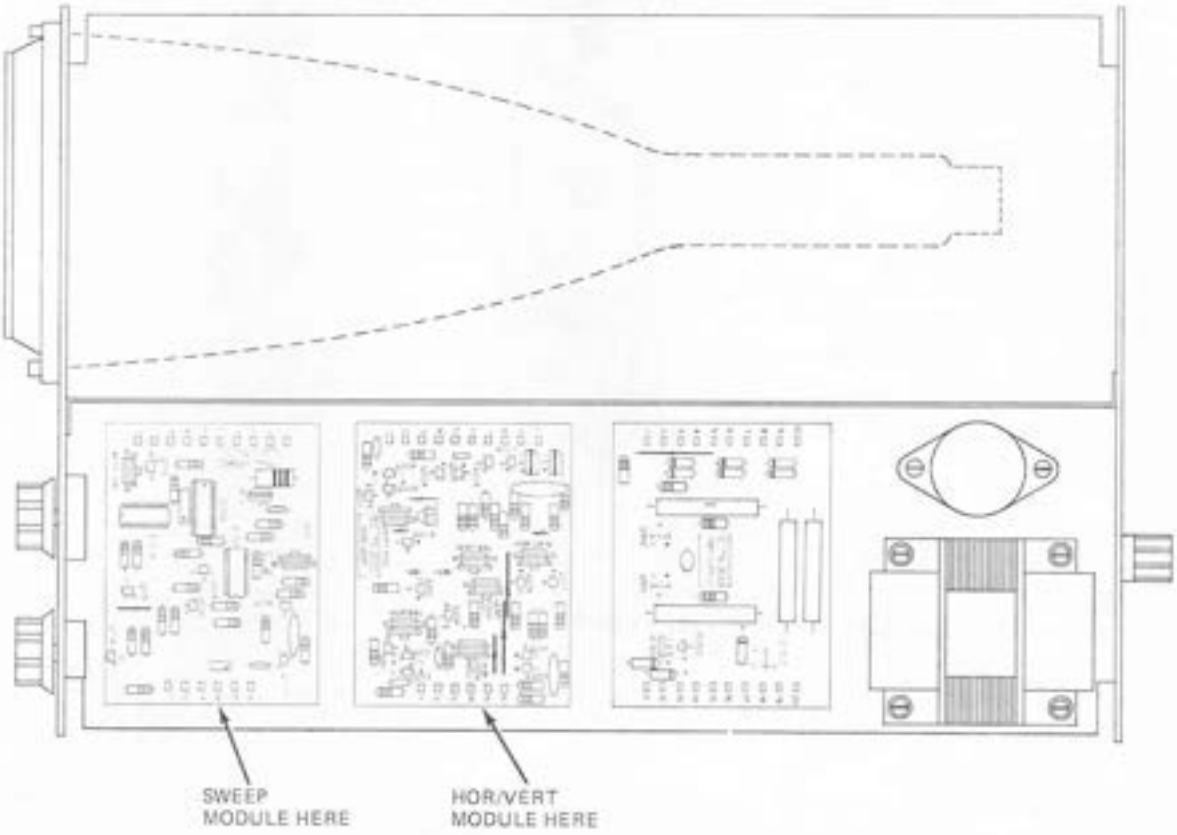

Figure 41. Installing the horizontal/vertical amplification and sweep/trigger modules.

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(3) Cut five 1/2" lengths of shrinkable tubing (IN903). Refer to Fig.42 and place one of these 1/2" sleeves over each of the following collector tabs: Q301, Q302, Q219, Q220, and Q101 . . . ( )

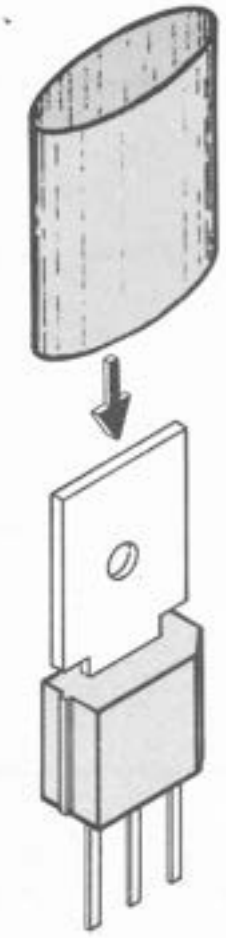

Figure 42. Installing heat-shrinkable tubing on transistor tabs.

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ALIGNMENT

You will now make the alignment adjustments that will place your scope in optimum operating condition.

(1) Set all trimmers on both the HOR/VERT module and the SWEEP/TRIG module to the mid position ..... ( )

(2) Center the Vertical and Horizontal position controls on the front panel ..... ( )

(3) Place the HOR/TRIG input control in the EXT position and the RANGE switch in the LOW position ..... ( )

(4) Place the ATTEN control in the X 10 position ( )

(5) Move the POWER switch to the ON position and again check the dc supply voltages: terminal 312 (4 to 6 volts), terminal 313 (8 to 10 volts), terminal 318 (-7 to -9 volts), terminal 319 (approximately 150 to 200 volts), and terminal 320 (approximately 200 volts) ..... ( )

(6) Set your voltmeter to measure a maximum voltage of about 300 volts dc. Assuming your voltages are within normal limits of Step 5 above, adjust the HOR BAL trimmer to obtain equal collector voltages at Q219 and Q220. As you adjust the HOR BAL trimmer, the collector voltage at either Q219 or Q220 will increase. As this happens, the collector voltage at the other transistor will decrease ... ( )

(7) After adjusting the HOR BAL trimmer, adjust the HOR 100 V ADJ trimmer to obtain a collector voltage at Q219 of about 100 volts ..... ( )

(8) Set your voltmeter to read a maximum voltage of 1 volt dc. Then set the front panel GAIN control to the mid position and adjust the VERT BAL trimmer for zero volts at terminal 204 .. ( )

(9) Measure the voltage at terminal 206 and note this voltage in the margin ..... ( )

(10) Adjust the VERT POS trimmer to give the same voltage at the base of Q204 as you measured in step 9 at terminal 206 (noted in margin) ... ( )

(11) Set your voltmeter to read a maximum voltage of 300 volts dc. Adjust the VERT 100 V ADJ trimmer to obtain a collector voltage at Q301 of about 100 volts ..... 80 Volts ( )

(12) At this point you should have a dot on the screen (you may need to adjust the front panel INTENSITY and FOCUS controls). Use the front panel vertical and horizontal position controls to center the dot ..... ( )

(13) Now switch the front panel HOR/TRIG switch to the INT position. You should now have a short horizontal line. The line may appear to "flash" or move. This is due to the slow sweep speed being used. Now, use the SWEEP BAL trimmer (on the SWEEP/TRIG) to center this line horizontally ..... ( )

(14) With the RANGE switch to the low (fully counterclockwise) position. Adjust the HOR GAIN trimmer (on the HOR/VERT module) so that the horizontal line expands to the full graticule (you may need to slightly adjust the SWEEP BAL trimmer to keep the trace centered) ..... ( )

(15) Switch the front panel ATTEN switch to the CAL position and advance the front panel GAIN control to the fully clockwise position. You should now see a rectangular wave on the screen. Adjust the SWEEP SPEED control for about three or four cycles of the CAL rectangular wave. While watching this display adjust the ASTIG trimmer on the SWEEP/TRIG module for best focus ..... ( )

(16) If your display is tilted, turn off the power and loosen the two nuts on the crt clamps slightly until you can rotate the crt easily. Turn the power on and grasp the wide front part to the crt with your hand. Rotate it until the display is level. Then turn off the power and retighten the nuts on the clamps until the crt is held securely ..... ( )

cannot get any voltage at 204

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CABINET ASSEMBLY

Gather the following parts:

Part No.	Quan.	Description	Price Each
BK105	2	Cabinet alignment brackets	.75
CB53	2	Cabinet halves	8.95
CB54	2	Trim strips	.85
HA81	1	Handle assembly	1.75
Remove the following parts from bag 2J-41T:			
HA93	4	Self-sticking plastic feet	4/.35
NU3	4	8-32 hex nuts	12/.15
NU18	12	Tinnerman nuts	4/.15
SC85	4	8-32 × 1/2" machine screws	12/.35
SC95	12	8-32 × 3/8" black Phillips-head screws	4/.25
WA16	4	No.8 lockwashers	12/.15

(1) Apply the four self-sticking plastic feet to one of the top/bottom panels as shown in Fig.44. The plastic feet supplied in your kit may be molded together into a block. To separate them, simply pull them apart with your fingers. To apply them to the bottom of the panel, remove the paper backing, and press the feet into place. This metal piece will now be known as the bottom cabinet. The remaining half will be used as the top of the oscilloscope ..... ( )

(2) Now carefully lift the oscilloscope and lower it inside the cabinet bottom ..... ( )

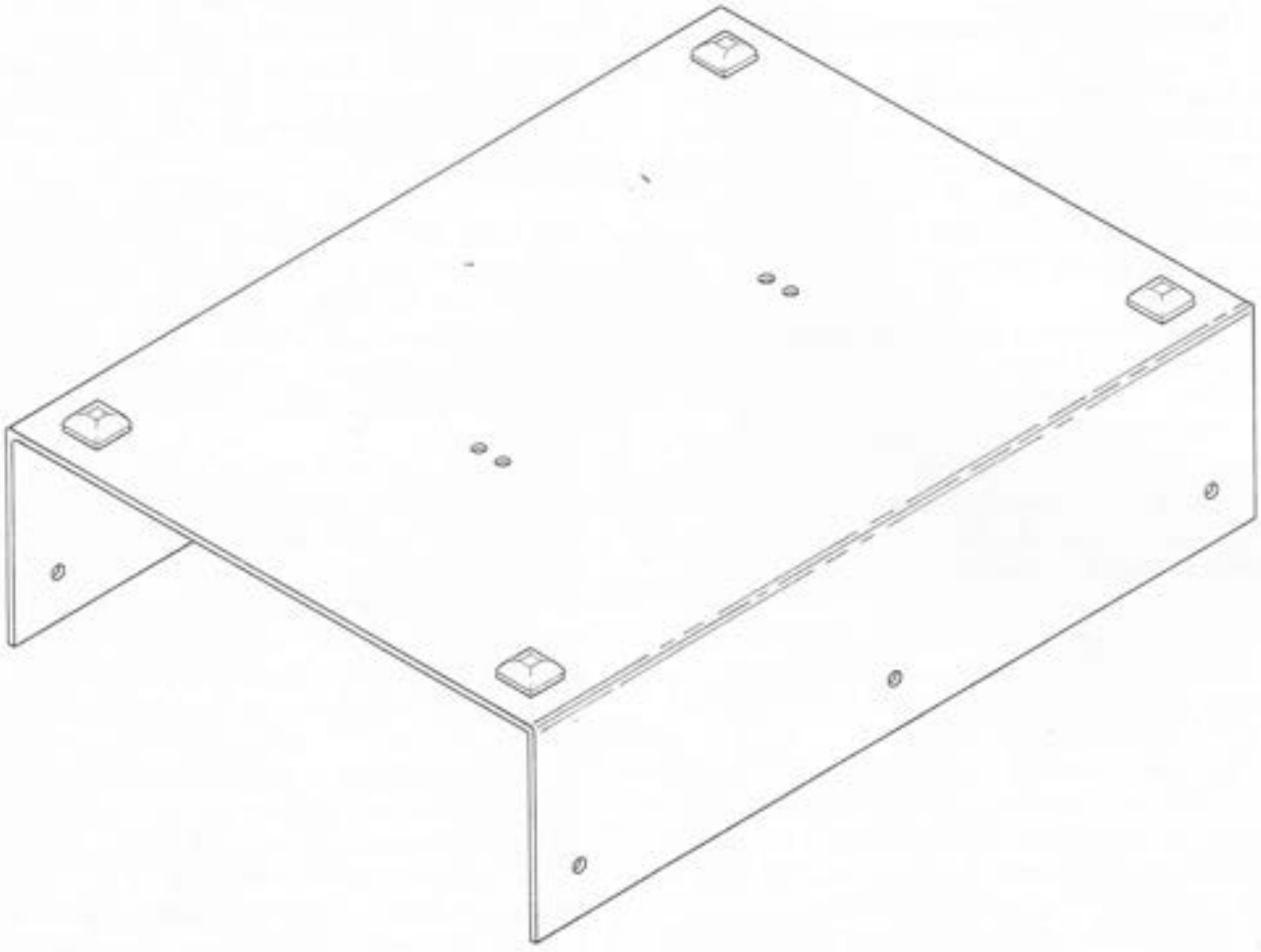

Figure 43. Installing plastic feet.

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(3) Locate the two cabinet alignment brackets (BR105) and mount six Tinnerman nuts on the brackets over the six holes as shown in Fig.44. The raised portion of the Tinnerman nut goes on the inside of the U-shaped brackets ..... ( )

(4) Next locate three of the 8-32 black Phillips-head screws. Put the screws through the three holes on one side of the black trim strip, and through the holes in the cabinet half on which you mounted the feet. Then screw them into the Tinnerman nuts on the cabinet aligning brackets as shown in Fig.45. Do not tighten the screws. Be sure the alignment brackets are on the *inside* of the front and back panels. Do the same thing with the second cabinet trim strip and alignment bracket on the other side of the cabinet bottom ..... ( )

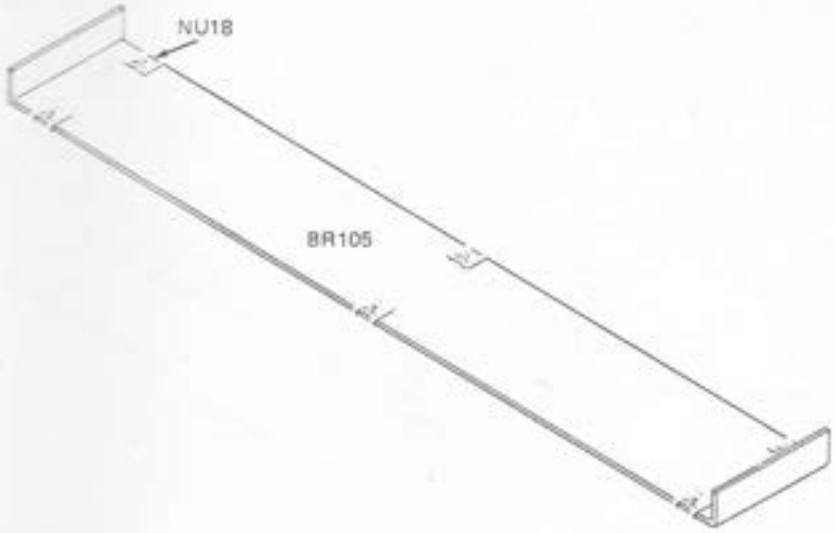

Figure 44. The alignment bracket with six Tinnerman nuts in place.

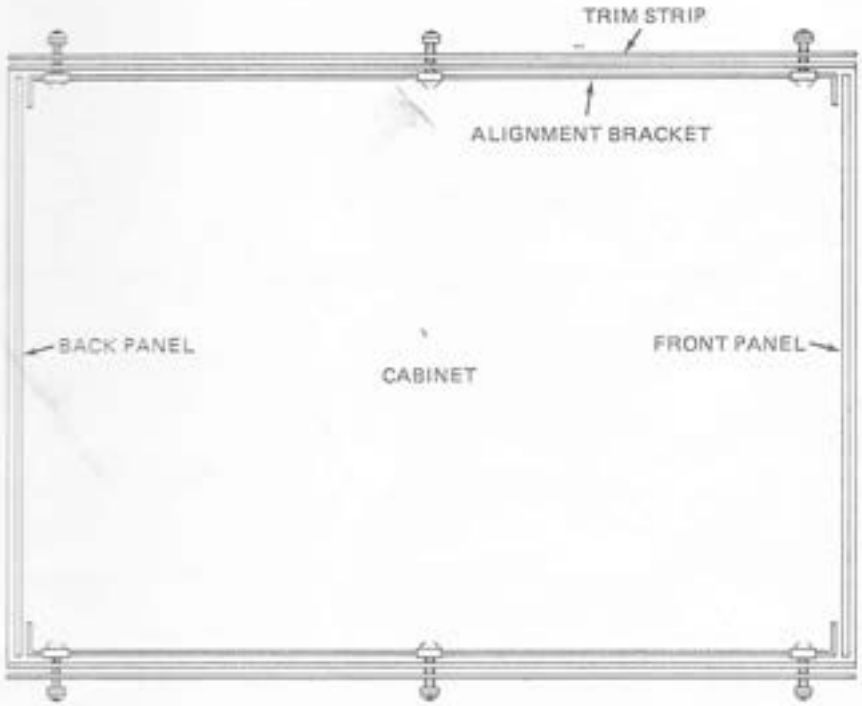

Figure 45. Mounting the trim strips and the alignment brackets on the cabinet bottom.

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(5) Refer to Fig.46 and attach the handle assembly to the top panel and to the chassis with four 8-32 × 1/2" machine screws, four No.8 lockwashers, and four 8-32 hex nuts. After all four screws are in place, tighten them and the two screws installed in the previous step. Finally snap the two chrome covers into place over the handle brackets ..... ( )

(6) Now take the top cabinet half and place it over the top of the oscilloscope, aligning the holes with the holes in the black trim strips. Secure it to the lower cabinet assembly with six 8-32 black Phillips-head screws ..... ( )

(7) Tighten all six of the black Phillips-head screws ..... ( )

This completes the assembly of your oscilloscope. Be sure to read the operating manual before you begin to use your scope. The operating manual explains in detail how your scope operates, how it can be used to observe various different waveforms, and how to troubleshoot your scope should you ever need to. You will now assemble the test leads used to connect various inputs to your scope.

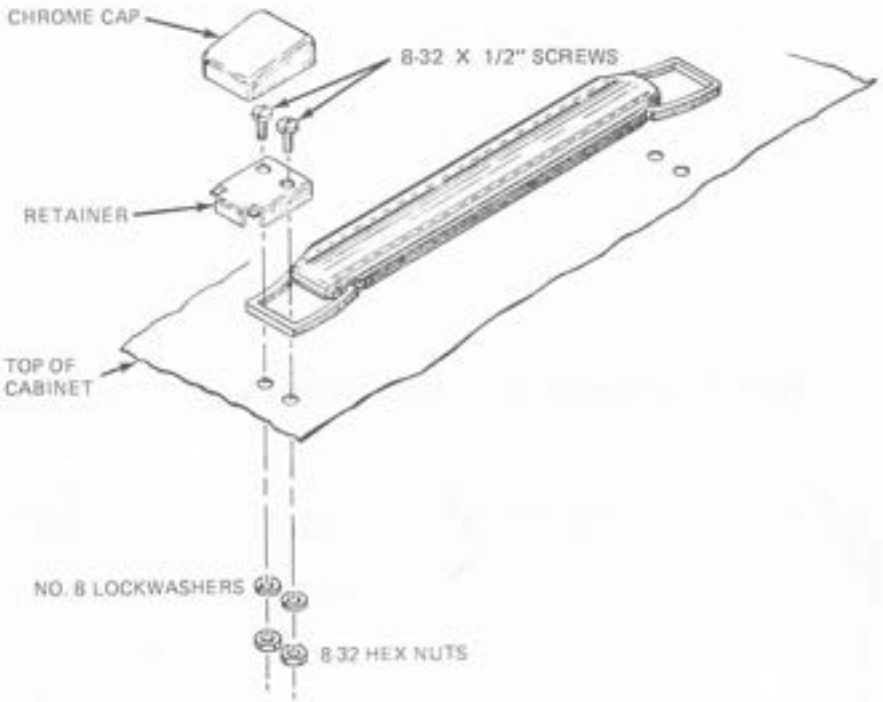

Figure 46. Installing the handle.

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TEST LEAD ASSEMBLY

Remove the following parts from bag 2J-41T:

Part No.	Quan.	Description	Price Each
CL46	3	Miniature alligator clips	.15
IN39	2	Red clip insulators	.10
IN40	1	Black clip insulator	.10
PL3	1	Black banana plug	.25
PL4	2	Red banana plug	.25
WR918	1	Black test lead wire	12'/.40
WR943	2	Red test lead wire	12'/.40

(1) Remove 1/2" insulation from one end of the black test lead wire and 1/4" from the other end. Lightly tin each end. At the end with the 1/2" insulation removed, attach the black banana plug as shown in Fig.47 ..... ( )

(2) At the other end of the black test lead wire, solder one of the miniature alligator clips. A simple lap joint is sufficient; it is not necessary to crimp the clip onto the wire ..... ( )

(3) Slip the large end of the black clip insulator over the end of the alligator clip attached to the black test lead wire. The slits in the narrow end of the insulator should line up with the edges of the clip jaws ..... ( )

(4) Use the remaining parts to assemble two red test leads following the procedures shown for the black test lead ..... ( )

This completes assembly of the oscilloscope. Refer to your operating manual for instructions on how to use your oscilloscope.

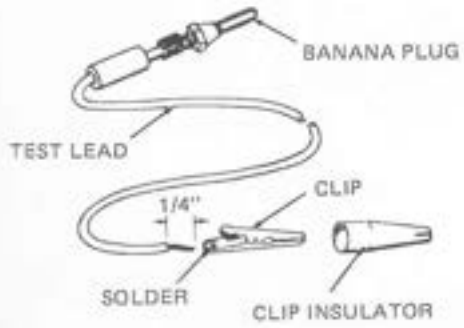

Figure 47. Assembling the test leads.

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Appendix I

230 VOLT WIRING

Refer to Fig.48.

(1) Solder TS3-1 (S2) ..... ( )

(2) Strip all the insulation from a 1-1/2" piece of hookup wire and connect this wire from TS3-2 (S2) to TS3-4 (S2) ..... ( )

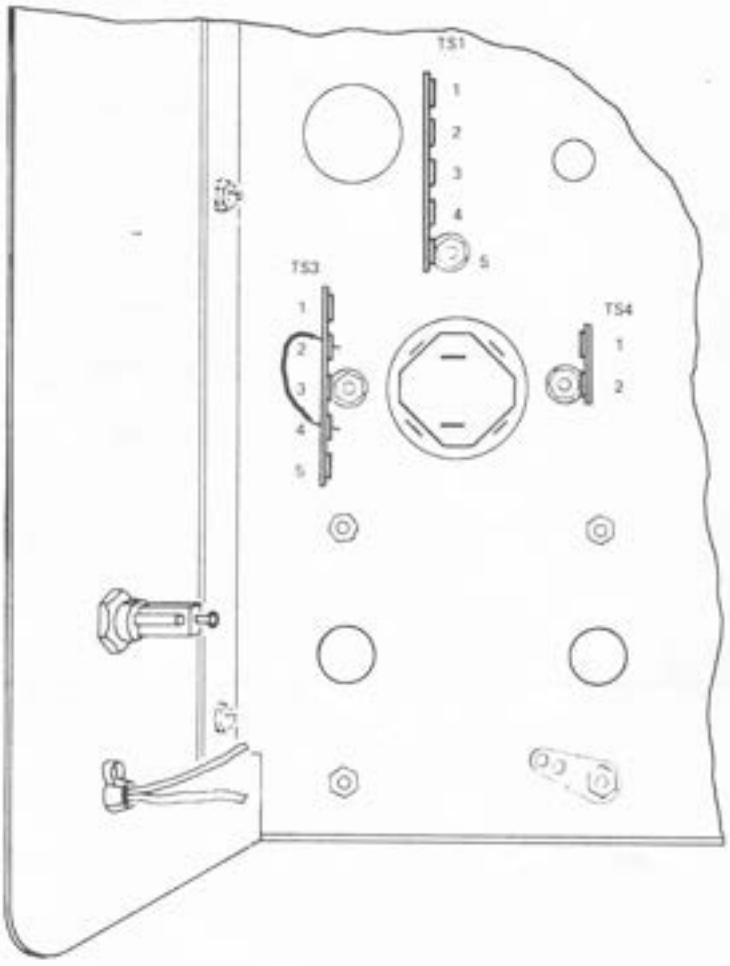

Figure 48. Installing 230 V wiring.

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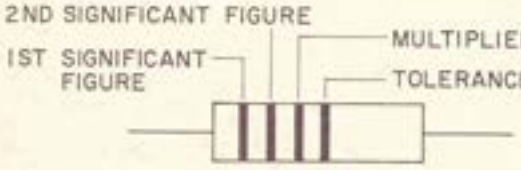
RESISTOR AND CAPACITOR COLOR CODES

JAN and EIA stand for the two common color codes (Joint Army-Navy and Electronics Industries Association). The two codes are the same except as indicated. We have not indicated temperature coefficients or characteristics of capacitors, because they are not necessary for identifying your parts.

COLOR	SIG. FIG.	MULTIPLIER	RESIS.	TOLERANCE			
				CERAMIC CAPACITORS		MICA CAPACITORS	PAPER
				10 MMF OR LESS	OVER 10 MMF	(As below, or ± 1 mmf, whichever is larger)	CAP
Black	0	1		± 2.0 MMF	± 20%	± 20%	20%
Brown	1	10		± 1.0 MMF	± 1%	± 1%	
Red	2	100			± 2%	± 2%	
Orange	3	1000			± 2.5%	± 2.5%	
Yellow	4	10,000					
Green	5	100,000		± 0.5 MMF	± 5%	± 5% (EIA)	5%
Blue	6	1,000,000					
Violet	7	10,000,000					
Gray	8			± 0.25 MMF			
White	9			± 1.0 MMF	± 10%		10%
Gold		.1	± 5%			5% (JAN)	5%
Silver		.01	± 10%			10%	10%
No color			± 20%				20%

RESISTORS — RESISTANCE GIVEN IN OHMS

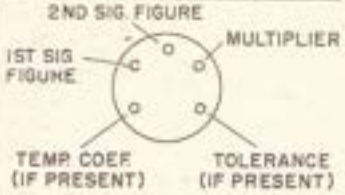


Black body = composition, non-insulated.
Colored body = composition, insulated.
Double width band for 1st sig. figure indicates wire-wound.

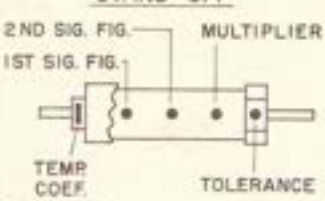
CAPACITORS — CAPACITY GIVEN IN MMF

CERAMIC

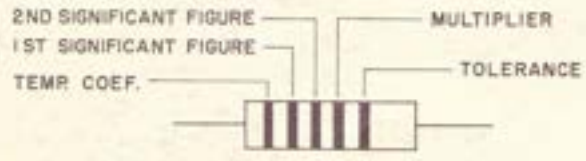
DISCS, BUTTON, OR FEED-THRU



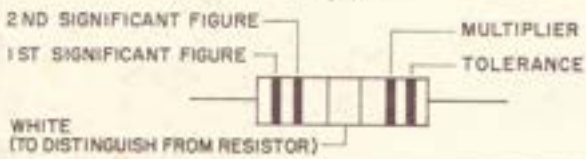
STAND-OFF



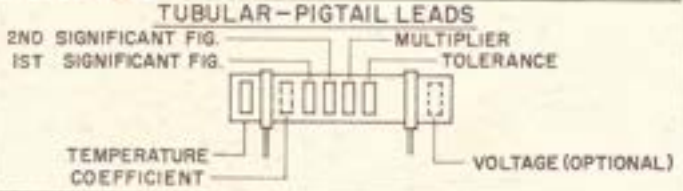
TUBULAR—AXIAL LEADS



— OR —



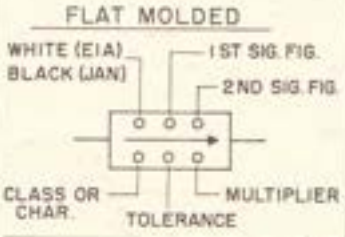
TUBULAR—PIGTAIL LEADS



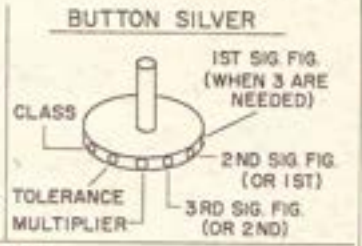
MICA

CLASS OR CHARACTERISTIC REFERS TO Q FACTOR, TEMPERATURE COEFFICIENT, AND PRODUCTION TEST REQUIREMENTS

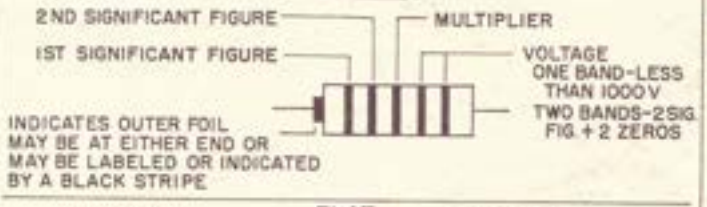
FLAT MOLDED



BUTTON SILVER

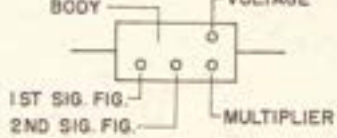


PAPER TUBULAR

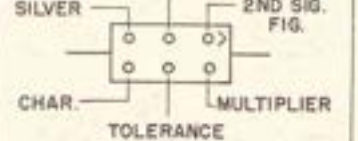


FLAT

EIA CODE



JAN CODE



USE THIS HANDY RULER FOR MEASURING LENGTHS OF WIRE

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Na
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