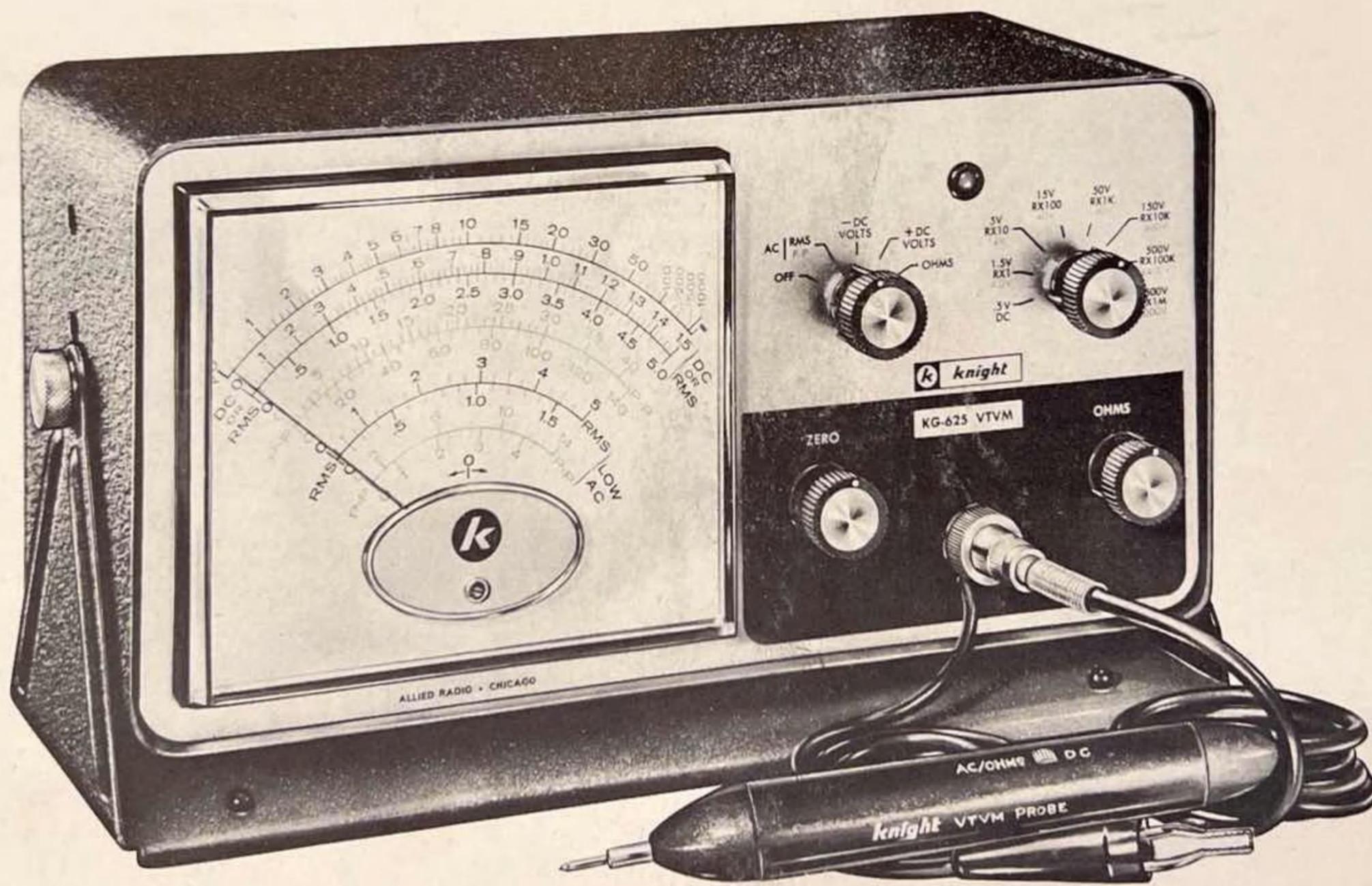


knight-kit[®]

ASSEMBLY
MANUAL



KG-625 6" VTVM

Thank You . . .

for your interest in Knight-Kits.

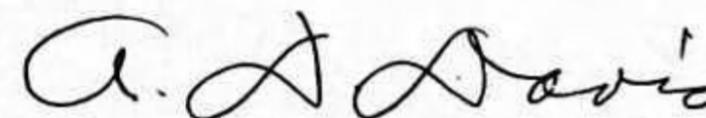
This Assembly Manual represents our many decades of experience in developing electronic kits which bring you outstanding performance at dollar-saving prices . . . and with maximum ease of construction.

As you go through the pages of this brochure, note how carefully each stage of construction is explained—how each diagram is magnified so that you almost have the feeling a good instructor is working at your side!

Knight-Kit's "do and check" method of kit-building insures accurate and simple assembly. Although your final product may represent a very complicated piece of electronic equipment, you will proceed with ease and assurance, step-by-step . . . and enjoy enormous satisfaction in your completed working unit.

Every Knight-Kit of your choice is available to you on the convenient Allied Credit Fund Plan.

It is always a pleasure to serve you.



A. D. Davis, President

MODEL KG-625 DELUXE 6-INCH ELECTRONIC VTVM

*for accurate, entirely electronic, direct-reading
measurement of AC, DC and ohms*

- Highly Sensitive 0.5 Volt DC Full Scale Range for Transistor Service Work
- Separately Calibrated Scales for 1.5 and 5 Volt RMS, 4.2 and 14-Volt P-P AC
- Gimbal Mount Assures Maximum Mounting Ease and Proper Viewing Angle

The large, 6" style meter movement has a fluorescent, knife-edge pointer, and a 2-color scale. 100° meter arc allows easy viewing from any angle. As a special feature, the movement is shorted out in the "Off" position on the function switch. This prevents accidental damage while carrying instrument. Precision 1% film-type resistors are used as multipliers for highest accuracy. 11 megohm input impedance on DC reduces circuit loading and assures true readings. Swivel stand assures mounting ease in any position — helps make scales more readable. A power transformer is used for line isolation and maximum efficiency.

The precision Model KG-625 VTVM stands unequalled in both performance and value. All the skill and know-how that over 40 years of research and development can provide are incorporated in this superb unit. Components of the finest quality, coupled with easy, positive assembly, produce the type of VTVM demanded by the technician, serviceman, and do-it-yourself electronics enthusiast.

CONSTRUCTION HINTS

You are about to start building one of the most useful test instruments available to a serviceman or technician.

This VTVM has been designed with the builder and user in mind. Highest quality parts are used throughout. The unique inverted-chassis design greatly simplifies construction. Much time and care has already been spent to provide you with the best vacuum tube voltmeter available; the rest is up to you.

Follow the instructions carefully and give attention to all the special notes. Above all — **TAKE YOUR TIME**. Very often a hasty job is a poor one. Take your time and you will have an instrument that will operate as it was designed to operate. You also will feel a greater pride of accomplishment with a neatly wired unit.

UNPACKING

This step is important because it gives you a chance to become familiar with the parts used in your kit.

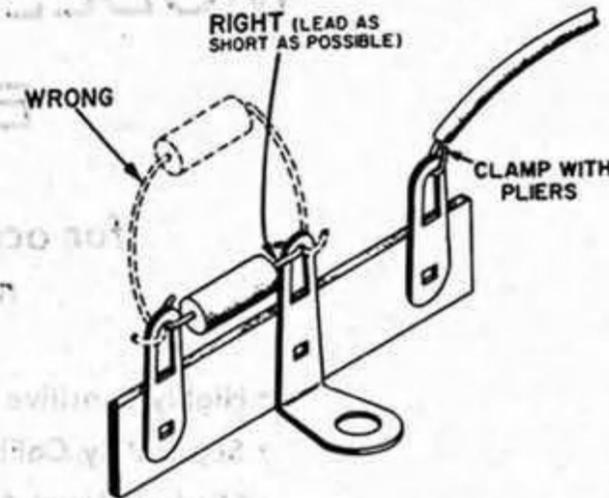
- Carefully unpack all the parts. Be especially careful with the meter and switches.
- Check the contents of your kit with the **PARTS LIST**. Use the parts identification photo for any parts you do not recognize. The controls and large resistors are too large to mount on the cards, so these spaces have been left vacant.
- Assort hardware by size. A plastic ice-cube tray or muffin baking pan is very handy for keeping small parts and hardware separate. It will also prevent misplacement.
- Leave the switches and meter in their containers until they are needed. This will protect them from damage.
- Also, leave the probe assembly in its container until it is needed.

WIRING HINTS

Follow the step-by-step instructions exactly. Do not attempt to wire your VTVM from only the schematic or pictorials.

A check box has been placed at the beginning of each step; use it to check off each step when it is completed.

As you wire, make good mechanical connections before soldering. Loop wires around terminals and clamp tightly with your pliers. When you mount resistors and capacitors, pull the leads through the terminals so the part is tightly mounted. Keep all leads short.



REMEMBER, THE MOST IMPORTANT PART OF CONSTRUCTION IS SOLDERING.

We suggest you spend some time studying the soldering instructions and pictures on page 3 before you proceed. The completed solder connection should have a shiny metallic finish. If it is not shiny, reheat it and add a little solder.

The wire supplied with your kit is precut and prestripped. Be sure to use the color that is called for. Flexible tubing is provided to cover bare wires and leads when called for, or whenever you think there is a possibility that a lead will touch nearby leads or the chassis.

You need only a screwdriver, longnose pliers, wire cutters and a soldering iron to construct your VTVM.

Check your work frequently. It is a good rule to go back over your work at the end of each page.

Remember to take your time and work slowly. Your efforts will be rewarded with a fine electronic instrument.

THIS KIT MUST BE PROPERLY SOLDERED!

USE ENOUGH HEAT

This is the main idea of good soldering. Apply enough heat to the metal surfaces you are joining to make the solder spread freely, until the contour (shape) of the connection shows under the solder.

AN ELECTRONIC UNIT WILL NOT WORK . . . unless it is properly soldered. Read these instructions carefully to understand the basic ideas of good soldering.

Enough heat must be used so the solder can actually penetrate the metal surfaces, making an unbroken path over which electricity can travel. You are not using enough heat if the solder barely melts and forms a rounded ball of rough, flaky solder.

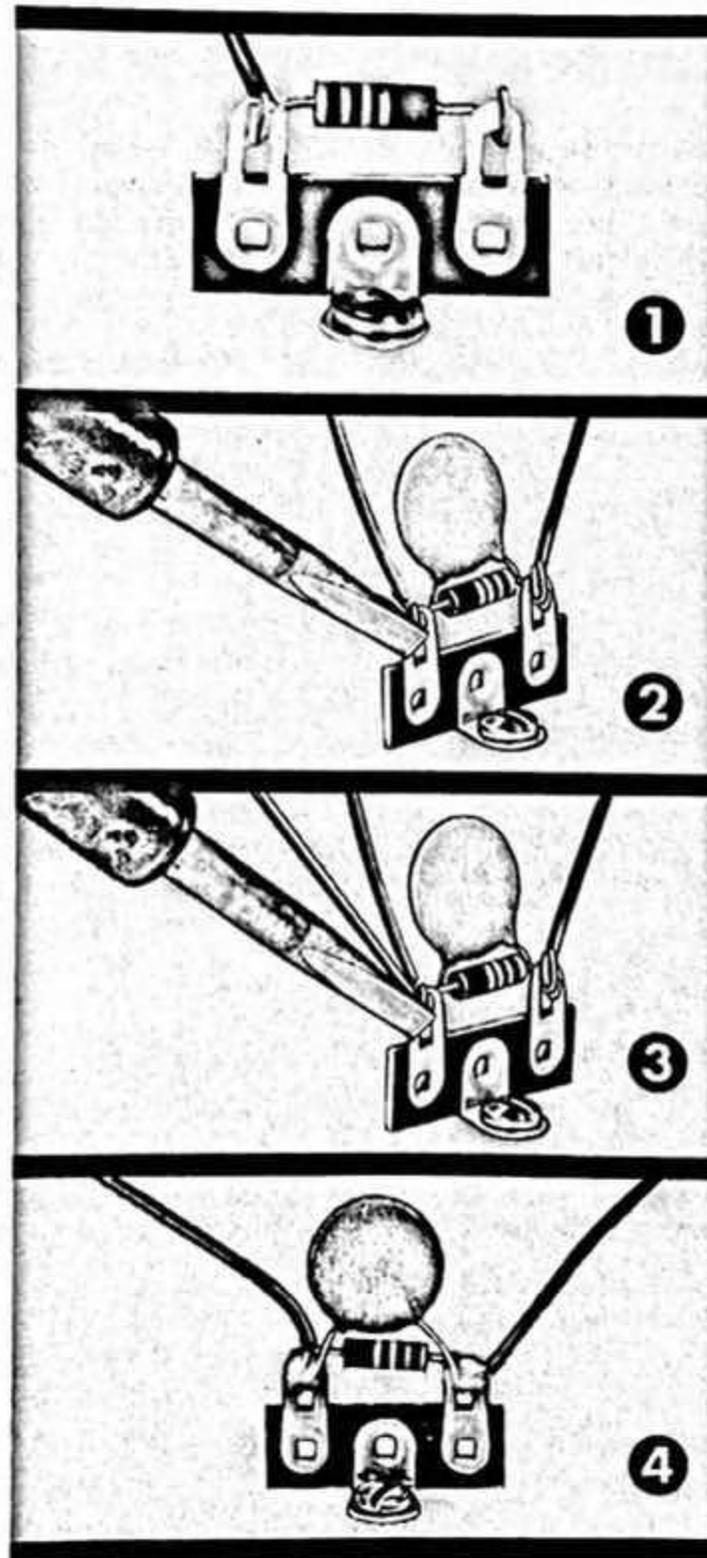
Use the Right Soldering Tool

A soldering iron in the 27-40 watt range is recommended. Any iron in this range with a clean, chisel-shaped tip will supply the correct amount of heat to make a good solder connection. You may also use a solder gun but make sure the tip reaches full heat before you solder.

Keep the iron or gun tip brightly coated with solder. When necessary, wipe the hot tip clean with a cloth. If you are using an old tip, clean it before you start soldering.

Use Only Rosin Core Solder

We supply the right kind of solder (*rosin core solder*). Do not use any other kind of solder! Use of Acid Core Solder, Paste, or Irons Cleaned on a Sal Ammoniac Block will ruin any Electronic Unit and will Void the Guarantee.



HERE'S HOW TO DO IT . . .

1. Join bare metal to bare metal; insulation must be removed. Make good mechanical connections and keep resistor and capacitor leads as short as possible, unless otherwise specified.

2. Coat the tip of a hot iron with solder. Then Firmly Press the Flat Side of the Tip against the parts to be soldered together. Keep the iron there while you . . .

3. Apply the solder between the metal to be soldered and the iron tip. Use only enough solder to flow over all surfaces of the connection, and all wires in the connection. Remove the iron.

Do Not Move Parts Until the Solder Hardens. If you accidentally move the wires as the solder is hardening, apply your iron and reheat.

4. Compare your soldering with the pictures on this page. You have a good connection if your solder has flowed over all surfaces to be connected, following the shape of the surfaces. It should appear smooth and bright and all wires in the connection should be well-soldered.

You Have Not Used Enough Heat: If your connection is rough and flaky-looking, or if the solder has formed a round ball instead of spreading.

The difference between good soldering (enough heat) and poor soldering (not enough heat) is just a few extra seconds with a hot iron firmly applied. **REMEMBER, LARGER METAL SURFACES TAKE A LONGER TIME TO HEAT.**

MOUNTING PARTS ON THE CHASSIS

SEE FIGURE 1.

Position the chassis in front of you as shown.

- R-21, 10K control (marked with part number 420-170). From the outside of the chassis, mount the control on the chassis with the terminals positioned upwards as shown. From inside the chassis, twist the flat mounting tabs $\frac{1}{4}$ turn with your pliers, to attach the control firmly to the chassis.
- R-30, 25K control (marked 420-174). Mount on the chassis as above.
- R-29, 10K control (marked (420-170)). Mount as above.
- R-28, 30K control (marked 420-175). Mount as above.
- TS-1, 9-terminal strip. Mount with two 6-32 x $\frac{3}{8}$ " screws, two lockwashers and nuts. Place each lockwasher between the nut and the chassis.
- TS-2, 9-terminal strip. Mount with two 6-32 x $\frac{3}{8}$ " screws, lockwashers and nuts.
- TS-3, 9-terminal strip. Position TS-3 with the mounting feet towards TS-2. Mount with two 6-32 x $\frac{3}{8}$ " screws, lockwashers and nuts.
- V-1, 7-pin tube socket. Mount V-1 on the chassis, with the keyway (blank space between pins) as shown. Use two 4-40 x $\frac{1}{4}$ " screws, lockwashers and nuts. Bend the ground terminals on the tube socket away from the socket pins and down toward the chassis.
- V-2, 9-pin tube socket. Mount V-2 on the chassis with the keyway as shown. Use two 4-40 x $\frac{1}{4}$ " screws, lockwashers and nuts. Bend the ground terminals on the tube socket away from the socket pins and down toward the chassis.
- $\frac{1}{2}$ " rubber grommet. Press into hole A in the center of the chassis.
- Two $\frac{3}{8}$ " rubber grommets. Press into holes B and C on the side of the chassis.
- 1-terminal tie-point, a 4-40 x $\frac{1}{4}$ " screw, lockwasher and nut. Mount and position the tie-point as shown.
- T-1 power transformer and a small plastic cable clamp — *not the clear one*. Mount the transformer with the four leads facing as shown. Place a #6 flatwasher on a 6-32 x $\frac{3}{8}$ " screw and mount the clamp to the side of T-1 shown. Fasten with a nut and lockwasher. Fasten the other side of T-1 with a 6-32 x $\frac{3}{8}$ " screw, lockwasher and nut.
- TS-4, 3-terminal strip. Mount TS-4 on the side of the chassis. Use a 6-32 x $\frac{3}{8}$ " screw, lockwasher and nut.
- Now check to be sure all screws are tightened securely — especially the transformer mounting screws.

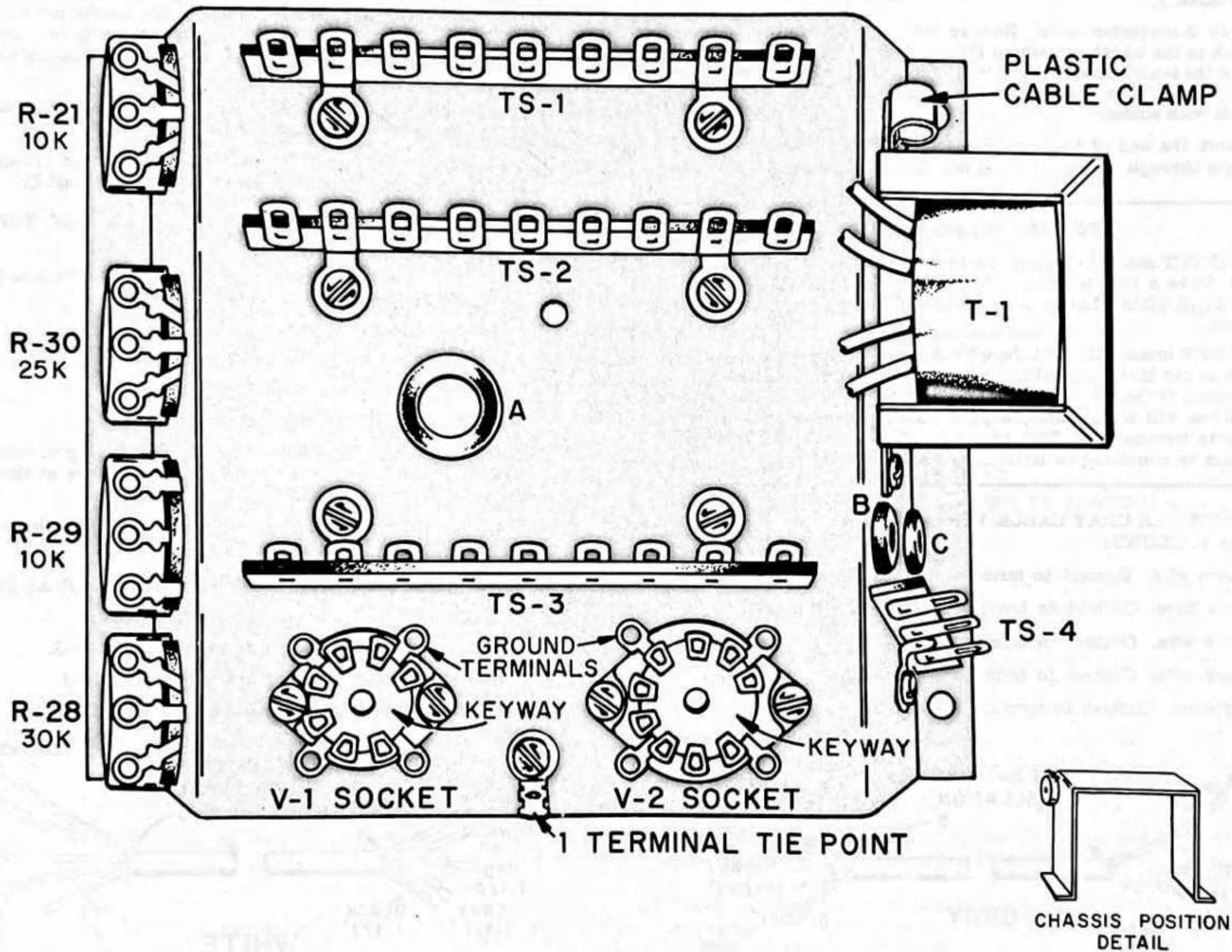


FIGURE 1. MOUNTING PARTS ON THE CHASSIS

FIRST WIRING ON THE CHASSIS

SEE FIGURE 2.

- Gray 5-conductor cable. Remove the outer insulation on each end back to the lengths shown on Figure 3. Be careful not to cut through into the inner wires. Cut the wire ends to the lengths shown. Remove $\frac{1}{4}$ " of insulation from the end of each wire and lightly coat the wire ends with solder.
- Insert the end of the gray cable with the longer white wire (5") down through grommet A and out through grommet B.

IMPORTANT WIRING INSTRUCTIONS

CONNECT means: Connect the wire or lead to the terminal specified. Make a firm mechanical connection, **BUT DO NOT SOLDER AT THIS TIME**. Later, other wires will be connected to that terminal.

SOLDER means: Connect the wire or lead to the terminal specified; then solder that wire and all other wires that are connected to that terminal. If there is more than one wire to be soldered, the number of wires will be indicated in parenthesis. Example: Solder a red wire to terminal 3 of TS-1 (4 wires). This means that four wires should be connected to terminal 3 when you solder it.

CONNECT THE GRAY CABLE WIRES AT THE TOP OF THE CHASSIS AS FOLLOWS:

- Brown wire. Connect to terminal 6 of TS-2.
- Black wire. Connect to terminal 7 of TS-2.
- Green wire. Connect to terminal 9 of TS-2.
- White wire. Connect to terminal 2 of R-28.
- Red wire. Connect to terminal 6 of TS-3.

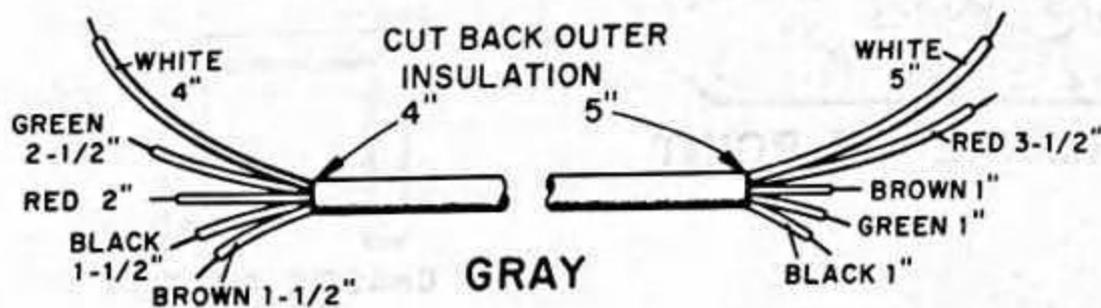


FIGURE 3. PREPARING THE GRAY CABLE

- White 5-conductor cable. Remove the outer insulation on each end back to the lengths shown on Figure 4. Be careful not to cut through into the inner wires. Cut the wire ends to the lengths shown. Remove $\frac{1}{4}$ " of insulation from the end of each wire and lightly coat the wire ends with solder.

NOTE: Do not confuse the black and the brown wires. Examine them carefully before connecting the wires.

- Insert the end of the white cable with the longer brown wire (5") down through grommet A and out through grommet C.

CONNECT THE WHITE CABLE WIRES AT THE TOP OF THE CHASSIS AS FOLLOWS:

- Black wire. Solder to terminal 1 of R-30. Be sure you pick up the black wire — not the brown one.
- Red wire. Connect to terminal 1 of TS-2.
- White wire. Connect to terminal 5 of TS-2.
- Gray wire. Solder to terminal 1 of R-29.
- Brown wire. Solder to terminal 1 of R-28.
- White/brown wire. Insert one end down through grommet A and out through grommet C. Connect the end of the wire at the top of the chassis to terminal 4 of TS-3.

NOTE: The other ends of these cables and the white/brown wire will be connected later.

CONNECT THE LEADS FROM T-1 TRANSFORMER AS FOLLOWS:

- Shorter red lead. Connect to terminal 9 of TS-1.
- Remaining red lead. Connect to terminal 9 of TS-3.
- Shorter yellow lead. Connect to terminal 8 of TS-1.
- Remaining yellow lead. Connect to pin 9 of V-2.

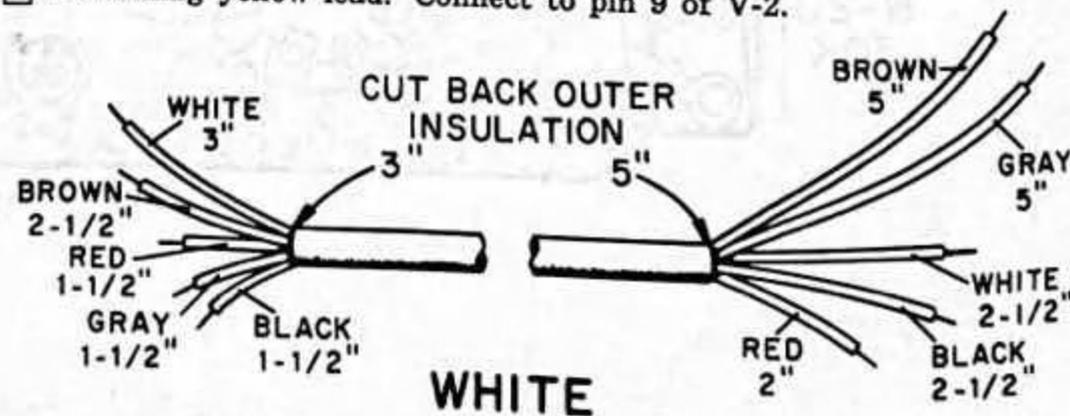


FIGURE 4. PREPARING THE WHITE CABLE

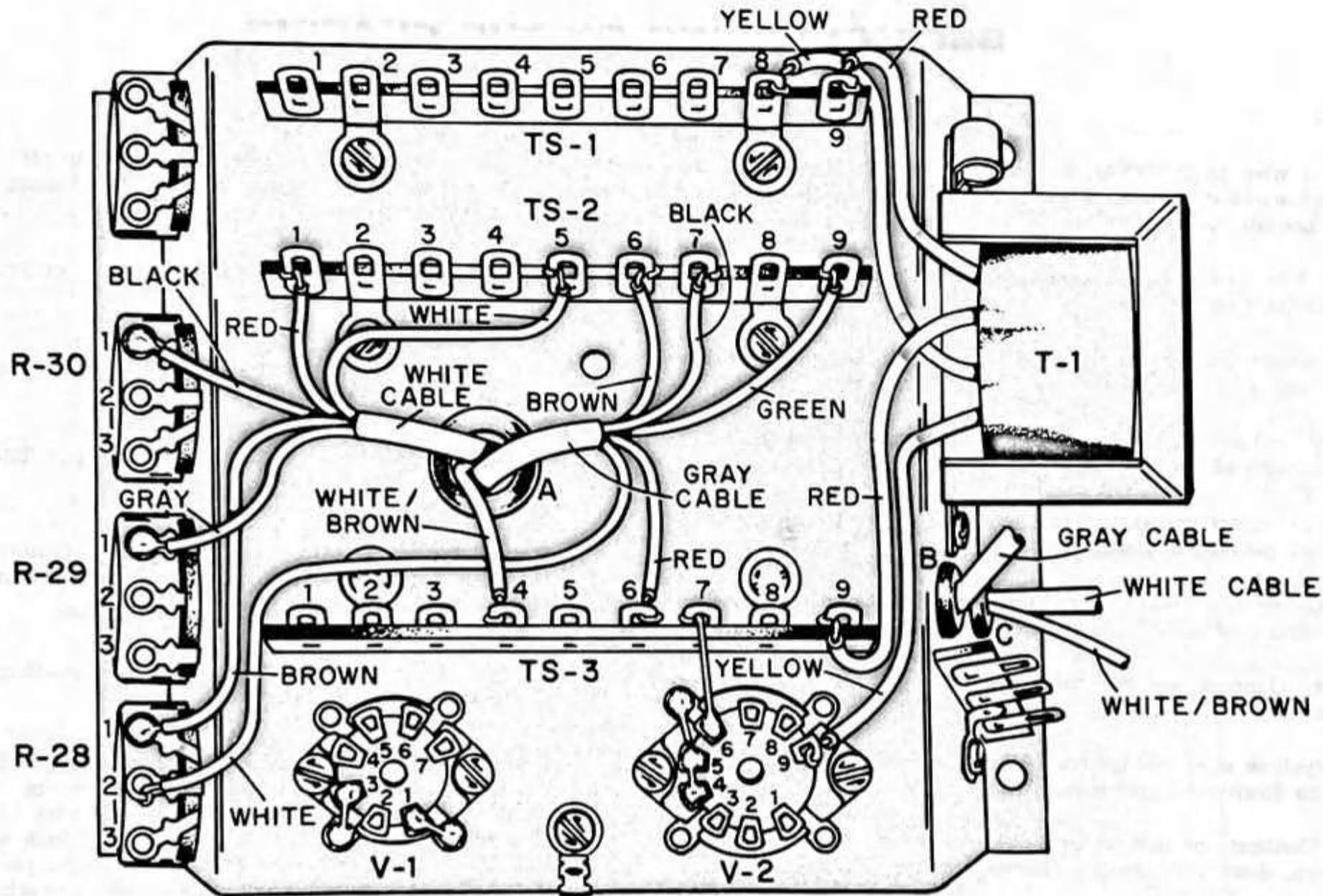


FIGURE 2. FIRST WIRING ON THE CHASSIS

- Cut a $\frac{1}{2}$ " piece of bare wire from the length supplied. Solder one end to pin 1 of V-1. Solder the other end to the ground terminal directly under pin 1.
- Cut a $\frac{1}{2}$ " length of bare wire. Solder one end to pin 3 of V-1. Solder the other end to the ground terminal directly under pin 3.
- Cut a 1" piece of bare wire. Thread one end through pins 4 and 5 of V-2 and solder it to the ground terminal shown. Solder pins 4 and 5.
- Cut a $\frac{3}{4}$ " piece of bare wire. Solder one end to pin 6 of V-2. Connect the other end to terminal 7 of TS-3.
- The first wiring on the chassis is now complete. Check your chassis wiring against Figure 2. All connections shown in this picture should be made on your VTVM chassis.
- Press all insulated wires down against the chassis. Push the cables tightly into grommet A so all wires are flat against the chassis.

SECOND WIRING ON THE CHASSIS

SEE FIGURE 5.

NOTE: As you wire your VTVM, it is extremely important that you keep all wires down near the chassis. Do not let leads project up in the air, away from the chassis.

- Red wire. Solder one end to terminal 1 of R-21. Solder the other end to terminal 2 of TS-1.
- Red wire. Solder one end to terminal 2 of R-21. Connect the other end to terminal 1 of TS-1.
- Orange wire. Solder one end to terminal 3 of R-21. Connect the other end to terminal 5 of TS-1.
- Green wire. Connect one end to terminal 6 of TS-1. Route the wire as shown and connect the other end to terminal 9 of TS-3.
- Red wire. Connect one end to terminal 7 of TS-1. Connect the other end to terminal 9 of TS-2.
- Yellow wire. Connect one end to terminal 2 of R-29. Connect the other end to terminal 7 of TS-3.
- 4½" white/yellow wire. Solder one end to terminal 2 of TS-2. Insert the other end down through grommet A.
- Blue wire. Connect one end to terminal 3 of TS-2. Route the other end as shown, down against the chassis. Solder this end to pin 3 of V-2.
- Violet wire. Connect one end to terminal 4 of TS-2. Route the other end as shown, down against the chassis. Solder this end to pin 8 of V-2.

- 4½" white/yellow wire. Solder one end to pin 4 of V-1. Route the other end as shown, down against the chassis. Solder this end to pin 9 of V-2 (2 wires).
- Red wire. Connect one end to terminal 1 of TS-3. Solder the other end to pin 2 of V-1.
- Red wire. Connect one end to terminal 5 of TS-3. Solder the other end to pin 7 of V-2.
- Red wire. Connect one end to terminal 6 of TS-3. Solder the other end to pin 1 of V-2.
- Are all your connections made properly? Compare your chassis wiring with Figure 5. Check each solder connection to be sure it has a shiny, metallic finish.
- Do any of the tube socket pins touch each other? They should not! Correct this before you go on.
- Check the white/yellow wire between V-1 and V-2 sockets and the red wires between TS-3 and V-1 and V-2 sockets. Is the insulation of these wires melted through, allowing the wire to touch a ground lug or a nearby terminal? If any wire does touch a nearby terminal or lug, the wire must be moved. Before you proceed, eliminate any possibility of bare wires or leads touching nearby terminals.

Always check for possible problem areas at the end of each wiring sequence. A little time spent now can save you much time later on if your instrument does not operate properly.

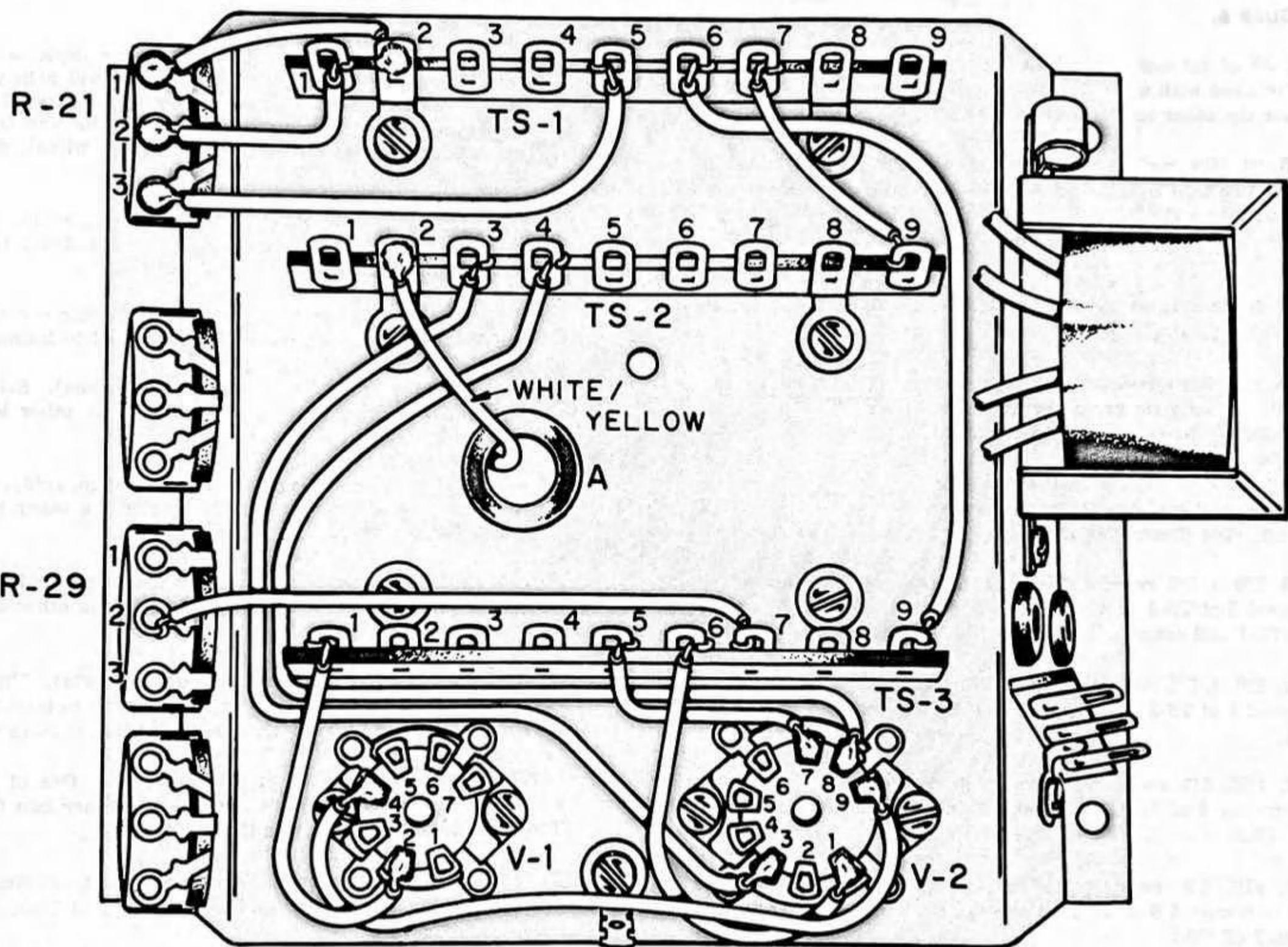


FIGURE 5. SECOND WIRING ON THE CHASSIS

FINAL WIRING ON THE CHASSIS

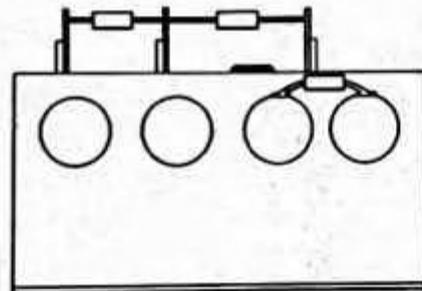
SEE FIGURE 6.

- ☑ C-6, 20 μf tubular electrolytic capacitor. Solder the lead from the end marked with a positive (+) sign to terminal 9 of TS-2 (3 wires). Solder the other lead to terminal 9 of TS-3 (3 wires).
- ☑ R-15, 91 Meg resistor, banded with white, brown and blue stripes. Solder one lead to terminal 1 of TS-1 (2 wires). Connect the other lead to terminal 1 of TS-2.

NOTES

The fourth color band on the resistors will not be noted unless it is gold, which indicates a 5% tolerance resistor.

Remember to keep resistor and capacitor leads only as long as necessary to reach the terminals. **Keep all component leads short.** The resistors should be mounted directly between terminals and should be placed horizontal with the chassis as shown in this side view illustration of the chassis.



- ☑ R-25, 220 Ω , 5% resistor (red, red, brown, gold). Solder one lead to terminal 3 of TS-2 (2 wires). Thread the other lead through terminal 3 of TS-1 and connect it to terminal 4 of TS-1. Solder terminal 3.
- ☑ R-24, 220 Ω , 5% resistor (red, red, brown, gold). Solder one lead to terminal 4 of TS-2 (2 wires). Connect the other lead to terminal 4 of TS-1.
- ☑ R-22, 12K, 5% resistor (brown, red, orange, gold). Solder one lead to terminal 4 of TS-1 (3 wires). Connect the other lead to terminal 6 of TS-1.
- ☑ R-16, 47K, 5% resistor (yellow, violet, orange, gold). Solder one lead to terminal 5 of TS-1 (2 wires). Connect the other lead to terminal 7 of TS-1.
- ☑ R-23, 27K, 5% resistor (red, violet, orange, gold). Solder one lead to terminal 6 of TS-1 (3 wires). Solder the other lead to terminal 8 of TS-1 (2 wires).

- ☑ CR-1 diode. Notice that one end of the diode is marked, either bullet-shaped or banded at one end. This will help you position the diode correctly. **It must be installed with the tapered end (or banded end) away from the transformer.** Solder the lead from the tapered or (banded) end to terminal 7 of TS-1 (3 wires). Solder the other lead to terminal 9 of TS-1 (2 wires).

- ☑ R-35, 12K, 5% resistor (brown, red, orange, gold). Slip a $\frac{1}{2}$ " piece of small tubing over each lead. Solder one lead to terminal 2 of R-30. Connect the other lead to terminal 2 of R-29.

- ☑ R-14, 22 Meg resistor (red, red, blue). Solder one lead to terminal 1 of TS-2 (3 wires). Connect the other lead to terminal 1 of TS-3.

- ☑ R-26, 3.3 Meg resistor (orange, orange, green). Solder one lead to terminal 5 of TS-2 (2 wires). Connect the other lead to terminal 5 of TS-3.

- ☑ R-19, 10K, 5% resistor (brown, black, orange, gold). Solder one lead to terminal 6 of TS-2 (2 wires). Solder the other lead to terminal 6 of TS-3 (3 wires).

- ☑ R-17, 10K, 5% resistor (brown, black, orange, gold). Solder one lead to terminal 7 of TS-2 (2 wires). Solder the other lead to terminal 7 of TS-3 (3 wires).

- ☑ R-32, 22K, 5% resistor (red, red, orange, gold). Slip a $\frac{1}{2}$ " piece of small tubing over each lead. Solder one lead to terminal 2 of R-29 (3 wires). Solder the other lead to terminal 2 of R-28 (2 wires).

NOTE: There are three .02 μf disc capacitors. One of them is marked 1 KV; set this capacitor aside and use the other two for C-3 and C-2. The capacitor marked 1 KV is C-1.

- ☑ C-3, .02 μf disc capacitor. Solder one lead to terminal 1 of TS-3 (3 wires). Solder the other lead to terminal 2 of TS-3.

- ☑ C-2, .02 μf disc capacitor. Thread one lead through terminal 3 of TS-3, through pin 7 of V-1 and solder to pin 5. Solder pin 7 of V-1 and terminal 3 of TS-3. Solder the other lead to terminal 4 of TS-3 (2 wires).

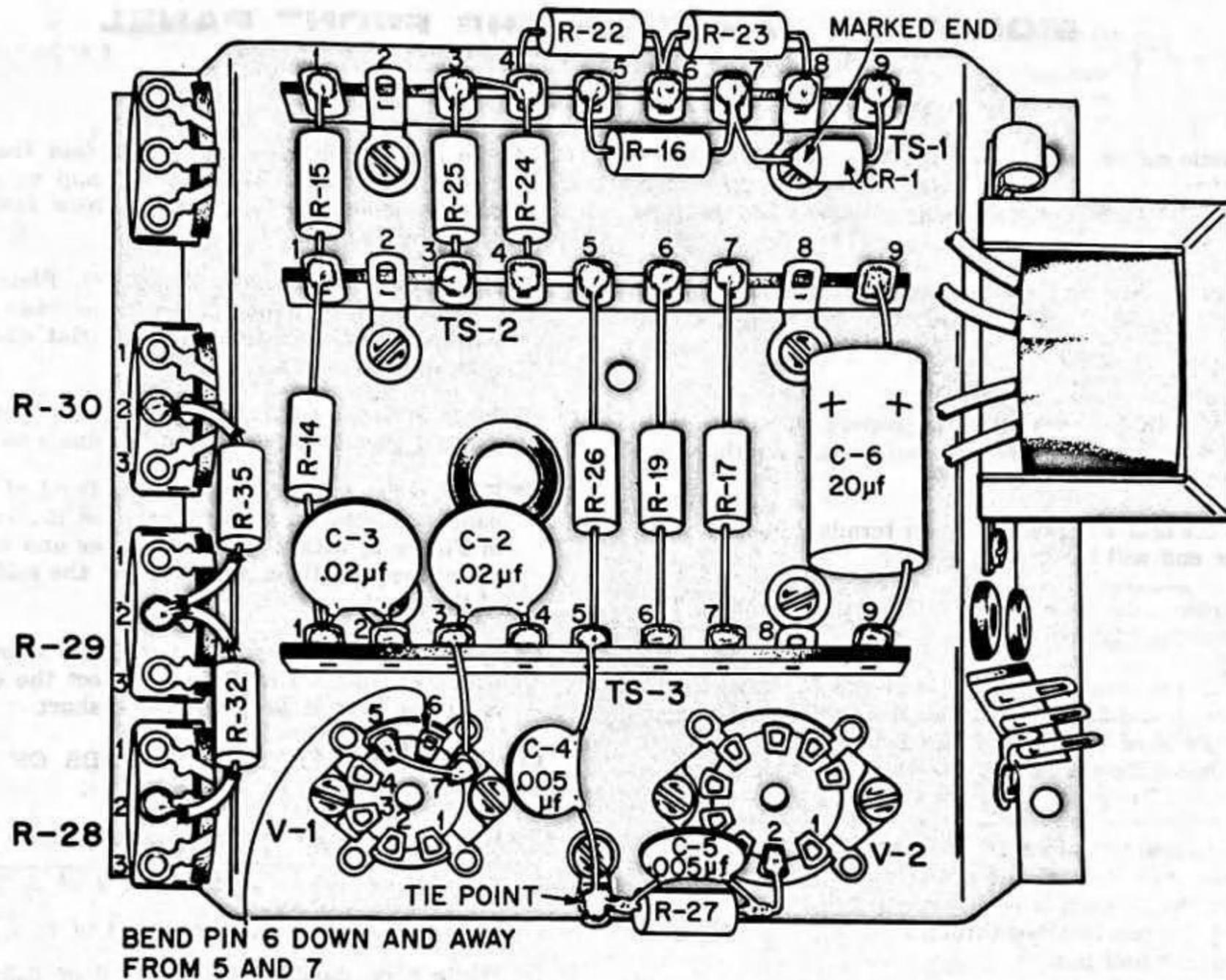
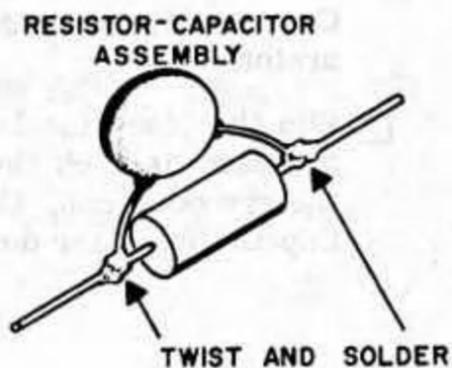


FIGURE 6. FINAL WIRING ON THE CHASSIS

- Bend pin 6 of V-1 socket down and away from pins 5 and 7.
- C-4, .005 μf disc capacitor. Solder one lead to terminal 5 of TS-3 (3 wires). Connect the other lead to the 1-terminal tie-point.
- R-27, 6.8 Meg resistor (blue, gray, green) and C-5, .005 μf disc capacitor. Solder the capacitor leads across the resistors as shown in the illustration. Solder one lead of this combination to pin 2 of V-2 socket. Solder the other lead of this combination to the 1-terminal tie-point (2 wires).



- There are 11 connections that you have just soldered in this sequence of wiring which contain 3 wires. Can you find all 11 connections? Are all 3 wires in each connection covered with solder? Reheat any connection in which all wires are not covered with solder; if necessary, add a little solder when you reheat the connection.
- Be sure the lead from R-27, C-5 combination that connects to V-2 socket is soldered to only pin 2 and does not touch either pin 1 or 3, or the ground lugs on the tube socket.
- Check to be sure no solder has dripped down between the chassis and the terminals of the four controls. Remove any loose solder before proceeding.

MOUNTING PARTS ON THE FRONT PANEL

SEE FIGURE 7.

- M-1 meter. The plastic meter face can be easily scratched, so from now on, lay the instrument on a soft surface to protect the meter while you work on it. Remove the wire connected between the terminals of the meter and discard this wire.
- Lay the meter face down on a soft cloth. Position it so the terminal marked with a + sign is to the left. Place the front panel down over the meter mounting screws as shown. Do not mount the chassis until so instructed.
- Assemble the hardware that comes with the meter, on each meter terminal as follows; a flat metal washer, a solder lug, another flat washer and secure with a nut.
- Blue wire. Solder to the solder lug on the meter terminal marked with a + sign. The other end will be connected later.
- Gray wire. Solder to the solder lug on the other meter terminal. The other end will be connected later.
- See Figure 8. Attach the small L-bracket and the battery clip to the battery bracket with a 6-32 x $\frac{3}{8}$ " screw, lockwasher and nut as shown in Figure 8. Be sure the foot of the L-bracket is up, when the battery bracket is positioned as shown—the + terminal to the left.
- Snap the bracket between the sides of the chassis, into the slots provided between the transformer and the controls. Be sure the terminal marked with the + sign is positioned to the left as shown. Mount with a 6-32 x $\frac{3}{8}$ " screw inserted through the top of the chassis. Fasten with a lockwasher and nut.
- Solder the free end of the white/yellow wire coming through grommet A (in the center of the chassis) to the — terminal on the battery bracket.
- Violet wire. Solder one end to the + terminal on the battery bracket. Insert the free end through grommet B; it will be connected later.
- Now position the chassis over the meter mounting terminals as shown—the transformer toward the center of the panel. Insert the free ends of the blue and the gray wires from the meter through grommet C; they will be connected later.
- Fasten the chassis to the front panel. Use the four lockwashers and four nuts provided with the meter and thread onto the four meter mounting screws.

- Slip a small plastic cable clamp (not the clear one) over the gray 5-conductor cable. Mount the clamp on the meter mounting screw directly under the transformer. Now fasten with a #6 flat-washer and a 6-32 nut.
- R-20, 10K control (marked 420168). Place a $\frac{3}{8}$ " lockwasher over the control shaft and mount from the rear of the panel, in the hole marked ZERO. Fasten with a $\frac{3}{8}$ flat washer and nut. Position the terminals as shown.
- R-31, 30K control (marked 420169). Mount as above in the hole marked OHMS. Position the terminals as shown.
- Front panel connector. From the front of the panel, mount the front panel connector in the hole between R-20 and R-31. Mount as shown in Figure 9, with a $\frac{3}{8}$ " lockwasher and the hardware supplied with the connector. Be sure to position the solder lug away from the edge of the panel.
- R-18, 10K, 5% resistor (brown, black, orange, gold). Connect one lead to terminal 1 of R-20. Connect the other lead to terminal 3 of R-20. Be sure to keep the leads short.

CONNECT THE FREE WIRE ENDS OF THE GRAY CABLE AS FOLLOWS:

- Black wire. Solder to terminal 3 of R-20 (2 wires).
- Green wire. Solder to terminal 2 of R-20.
- Brown wire. Solder to terminal 1 of R-20 (2 wires).
- White wire. Solder to terminal 2 of R-31.
- The red wire will be connected later.
- 48" black test lead. Tie a knot in the test lead, $1\frac{1}{2}$ " from one end. Strip back the outer insulation $\frac{3}{8}$ " on each end. Lightly coat the bare ends with solder.
- From the rear of the panel, thread the end of the black test lead without the knot, through the hole just below the chassis connector. Connect the short end to the solder lug under the front panel connector.
- Slip the black insulator, small end first, over the other end of the test lead. Attach the bare end of the lead to the screw terminal on the crocodile clip. Crimp the tabs on the clip tightly over the wire. Slip the insulator down over the clip.

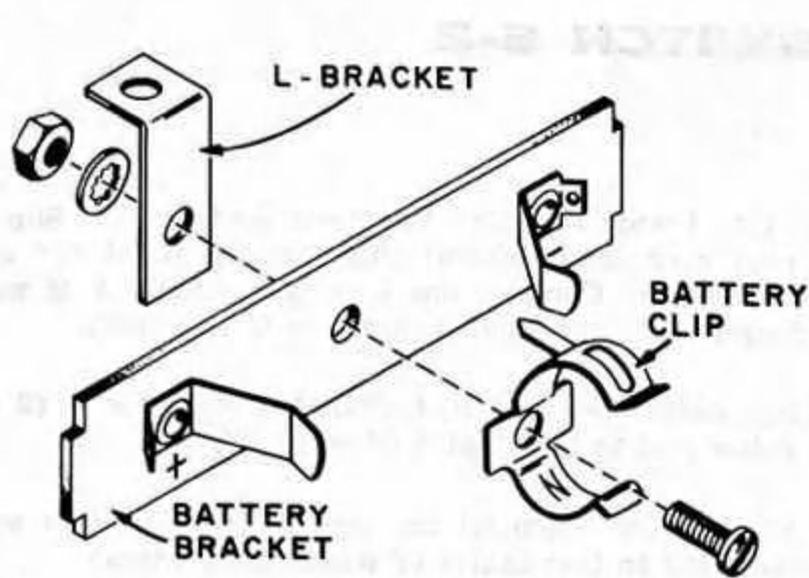


FIGURE 8

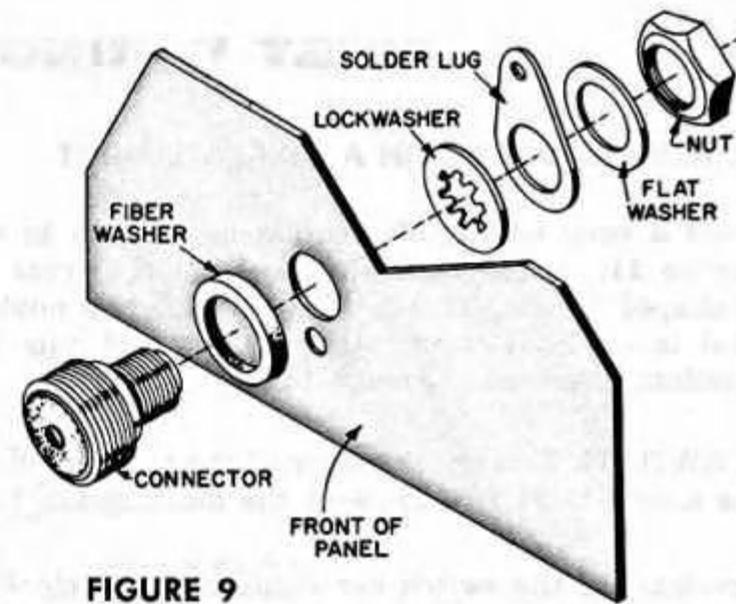


FIGURE 9

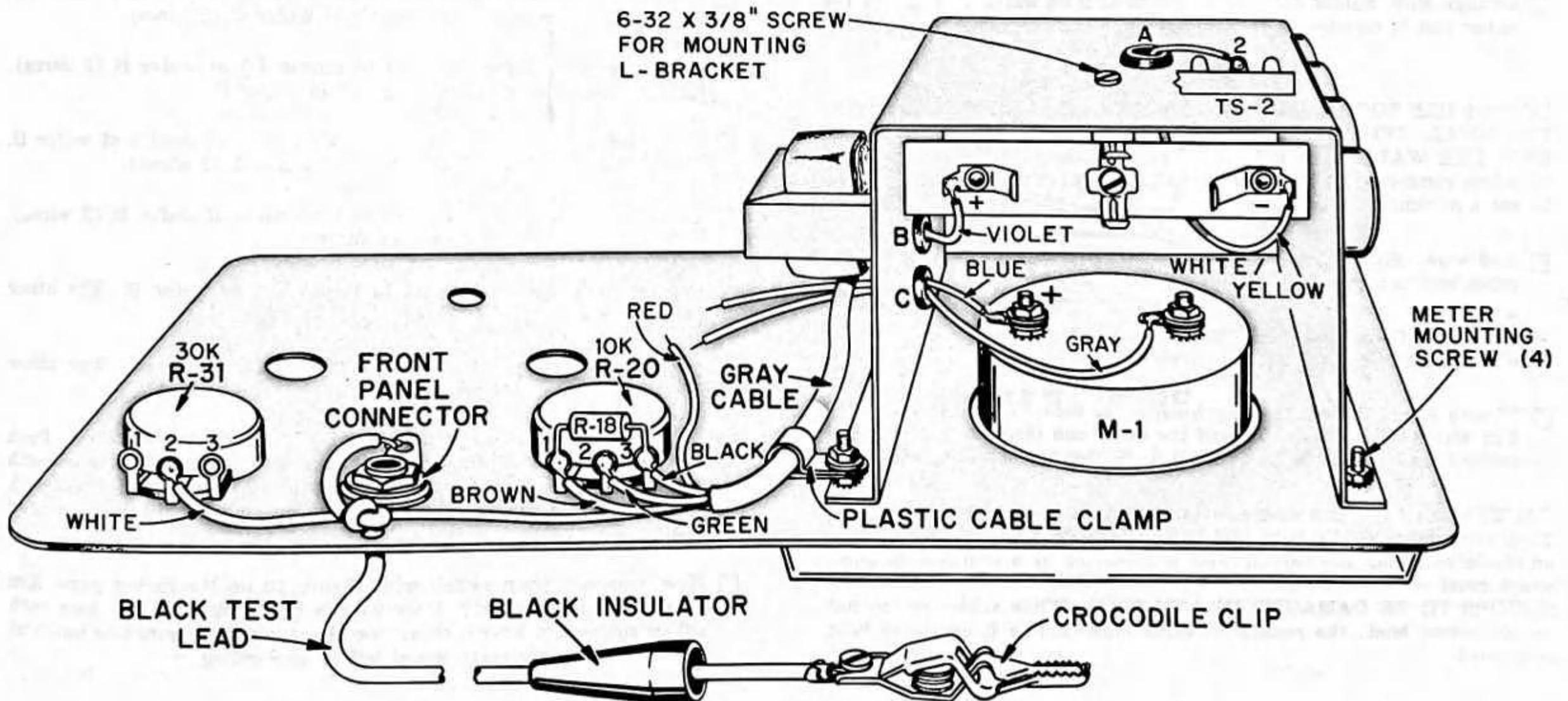


FIGURE 7. MOUNTING PARTS ON THE FRONT PANEL

FIRST WIRING OF THE RANGE SWITCH S-2

SEE FIGURE 10, ALSO FIGURE 11 ON A SEPARATE SHEET

We have provided a very unique illustration to aid you in wiring this switch. Use Figure 11, on the separate sheet, to construct an actual-size, cylindrical shaped drawing of S-2. You will find this novel presentation very helpful in checking your wiring. Construct this illustration using the instructions given with Figure 11.

- S-2 RANGE SWITCH. This is the longer of the two switches. Position the switch as shown in Figure 10, with the locating tab facing you.

NOTE: The terminals of the switch are numbered in a clockwise direction as you view the switch from the shaft end. Terminals on a wafer are numbered consecutively, whether they are on the front or rear of the wafer.

- Orange wire. Solder one end to terminal 2 of wafer A. Connect the other end to terminal 9 of wafer B.

CAUTION

DO NOT USE TOO MUCH SOLDER WHEN YOU SOLDER A SWITCH TERMINAL. DO NOT LET SOLDER RUN DOWN THE TERMINAL INTO THE WAFER. Before applying solder, be sure the terminal and all wires connected to it are completely heated. You will then be able to use a minimum of solder.

- Red wire. Solder one end to terminal 3 of wafer A. Connect the other end to terminal 6 of wafer B.
- Red wire. Connect one end to terminal 4 of wafer A. Connect the other end to terminal 2 of wafer B.
- 2" bare wire, cut from the length supplied. Solder one end to terminal 2 of wafer B (2 wires). Thread the other end through terminal 2 of wafer C and connect it to terminal 3. Solder terminal 2 of wafer C.

CAUTION: All 1% precision resistors must be handled very carefully. They are composed of a very thin layer of carbon material deposited on an insulated form. The carbon layer is protected by a thin coat of paint which must not be scratched or chipped. DO NOT ALLOW THESE RESISTORS TO BE DAMAGED IN ANY WAY. While soldering, do not use excessive heat; the resistance value may change if excessive heat is applied.

- R-10, 7 Meg, 1%, 1-watt resistor. Cut each lead to $\frac{3}{8}$ ". Slip $\frac{1}{4}$ " of thin tubing over each lead. Mount this resistor about $\frac{1}{4}$ " out and away from the switch. Connect one lead to terminal 4 of wafer B. Solder the other lead to terminal 3 of wafer C (2 wires).

- $1\frac{3}{4}$ " bare wire. Solder one end to terminal 4 of wafer B (2 wires). Connect the other end to terminal 4 of wafer C.

- R-9, 2 Meg, 1% resistor. Connect one lead to terminal 6 of wafer B. Solder the other lead to terminal 4 of wafer C (2 wires).

- $1\frac{3}{4}$ " bare wire. Solder one end to terminal 6 of wafer B (3 wires). Connect the other end to terminal 5 of wafer C.

- R-8, 700K, 1% resistor. Connect one lead to terminal 7 of wafer B. Solder the other lead to terminal 5 of wafer C (2 wires).

- $1\frac{3}{4}$ " bare wire. Solder one end to terminal 7 of wafer B (2 wires). Connect the other end to terminal 6 of wafer C.

- R-7, 200K, 1% resistor. Connect one lead to terminal 9 of wafer B. Solder the other lead to terminal 6 of wafer C (2 wires).

- $1\frac{1}{2}$ " bare wire. Solder one end to terminal 9 of wafer B (3 wires). The other end will be connected later.

- Orange wire. Solder one end to terminal 1 of wafer B. The other end will be connected later.

- Yellow wire. Solder one end to terminal 1 of wafer A. The other end will be connected later.

- R-11, 909K, 1%, 1-watt resistor and 1" piece of large tubing. Push the tubing over the body of the resistor. Position the resistor beneath wafer A as shown and connect one lead to terminal 6 of wafer A (keep this lead about $\frac{1}{2}$ " long). The other lead will be connected later.

- Now, compare your switch with Figure 10 on the facing page. Are all resistor leads short? Does your wiring look neat and does each solder connection have a shiny, metallic finish? Be sure this much of your switch is correctly wired before proceeding.

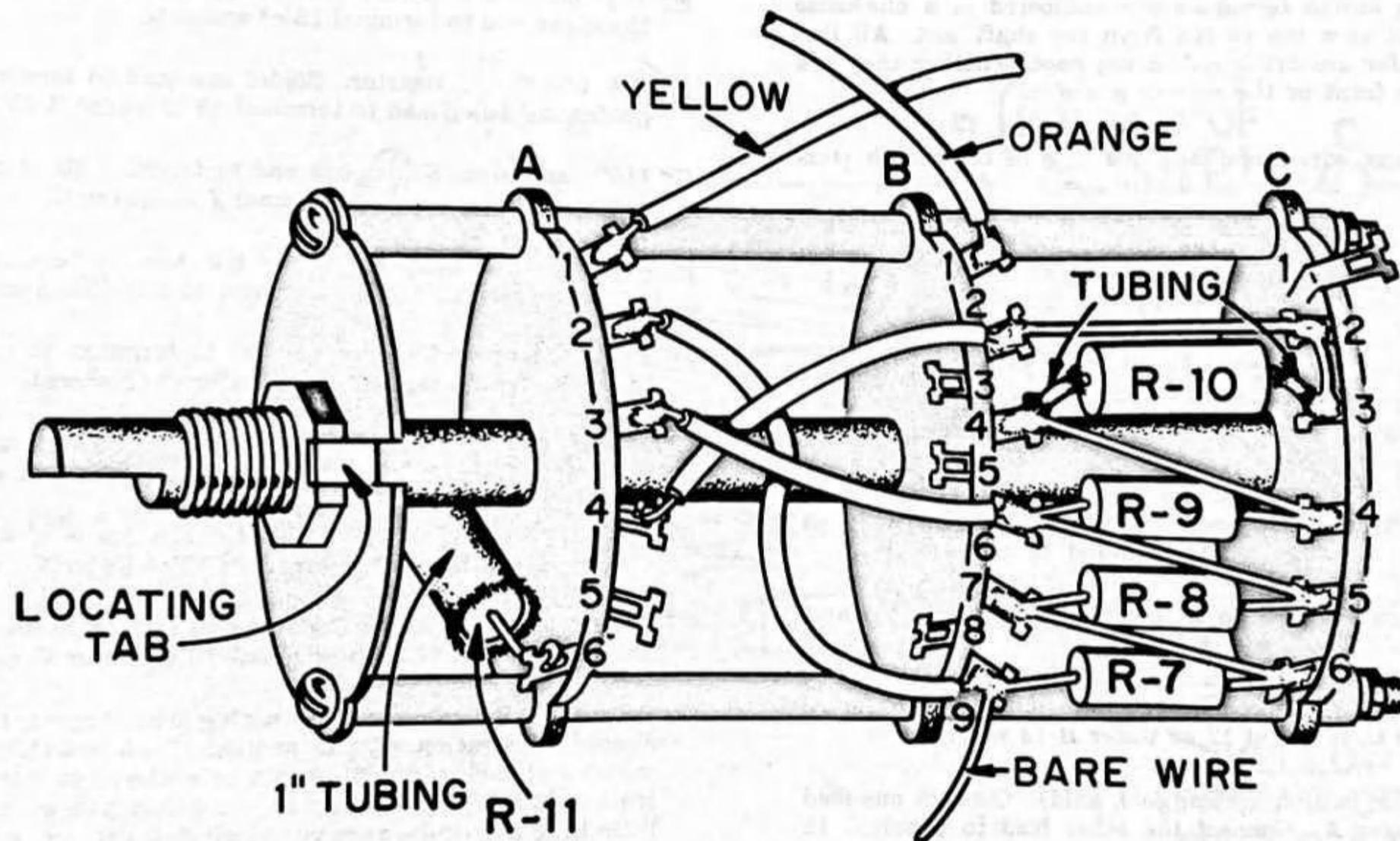


FIGURE 10. FIRST WIRING OF THE RANGE SWITCH, S-2

SECOND WIRING OF THE RANGE SWITCH S-2

SEE FIGURE 12, ALSO FIGURE 11 ON A SEPARATE SHEET.

- Position S-2 RANGE SWITCH as shown in Figure 12, with the locating tab away from you.

NOTE: Remember, the switch terminals are numbered in a clockwise direction as you view the switch from the shaft end. All terminals on a wafer are numbered in sequence, whether they are mounted on the front or the rear of a wafer.

- Free end of the orange wire from the other side of the switch (terminal 1 of B). Connect to terminal 9 of wafer A.
- Free end of the yellow wire from the other side of the switch (terminal 1 of A). Connect to terminal 10 of wafer C.
- Free lead of R-11. Connect to terminal 7 of wafer A.
- Free end of the bare wire from the other side of the switch (terminal 9 of B). Thread the free end through terminal 10 of wafer B and connect to terminal 11.
- R-12, 315K 1% resistor. Solder one lead to terminal 7 of wafer A (2 wires). Connect the other lead to terminal 12 of wafer B.
- 1 $\frac{3}{4}$ " bare wire. Solder one end to terminal 8 of wafer A. Connect the other end to terminal 12 of wafer B.
- R-13, 138K, 1% resistor. Connect one lead to terminal 9 of wafer A. Solder the other lead to terminal 12 of wafer B (3 wires).
- R-3, 9.1 Ω , 5% resistor (white, brown, gold, gold). Connect one lead to terminal 10 of wafer A. Connect the other lead to terminal 14 of wafer B.

- R-2, 91 Ω , 1% resistor. Solder one lead to terminal 10 of wafer A (2 wires). Connect the other lead to terminal 15 of wafer B.
- 1 $\frac{1}{2}$ " bare wire. Solder one end to terminal 12 of wafer A. Connect the other end to terminal 15 of wafer B.
- R-1, 900 Ω , 1% resistor. Solder one lead to terminal 13 of wafer A. Solder the other lead to terminal 15 of wafer B (3 wires).
- 1 $\frac{1}{2}$ " bare wire. Solder one end to terminal 10 of wafer B (2 wires). Solder the other end to terminal 7 of wafer C.
- R-6, 70K, 1% resistor. Solder one lead to terminal 11 of wafer B (2 wires). Connect the other lead to terminal 8 of wafer C.
- 1 $\frac{1}{2}$ " bare wire. Connect one end to terminal 13 of wafer B. Solder the other end to terminal 8 of wafer C (2 wires).
- R-5, 20K, 1% resistor. Solder one lead to terminal 13 of wafer B (2 wires). Connect the other lead to terminal 9 of wafer C.
- $\frac{3}{4}$ " bare wire. Solder one end to terminal 9 of wafer C (2 wires). Connect the other end to terminal 10 of wafer C.
- R-4, 10K, 1% resistor. Connect one lead to terminal 14 of wafer B. Solder the other lead to terminal 10 of wafer C (3 wires).
- Compare your range switch wiring with Figure 11, the cylindrical-shaped illustration of the switch. Each resistor and wire should match up; each terminal should be soldered or left open as the illustration shows. Correct any errors before you go on. If you spend a little time now to be sure your switch is correct, you may save hours of troubleshooting later.

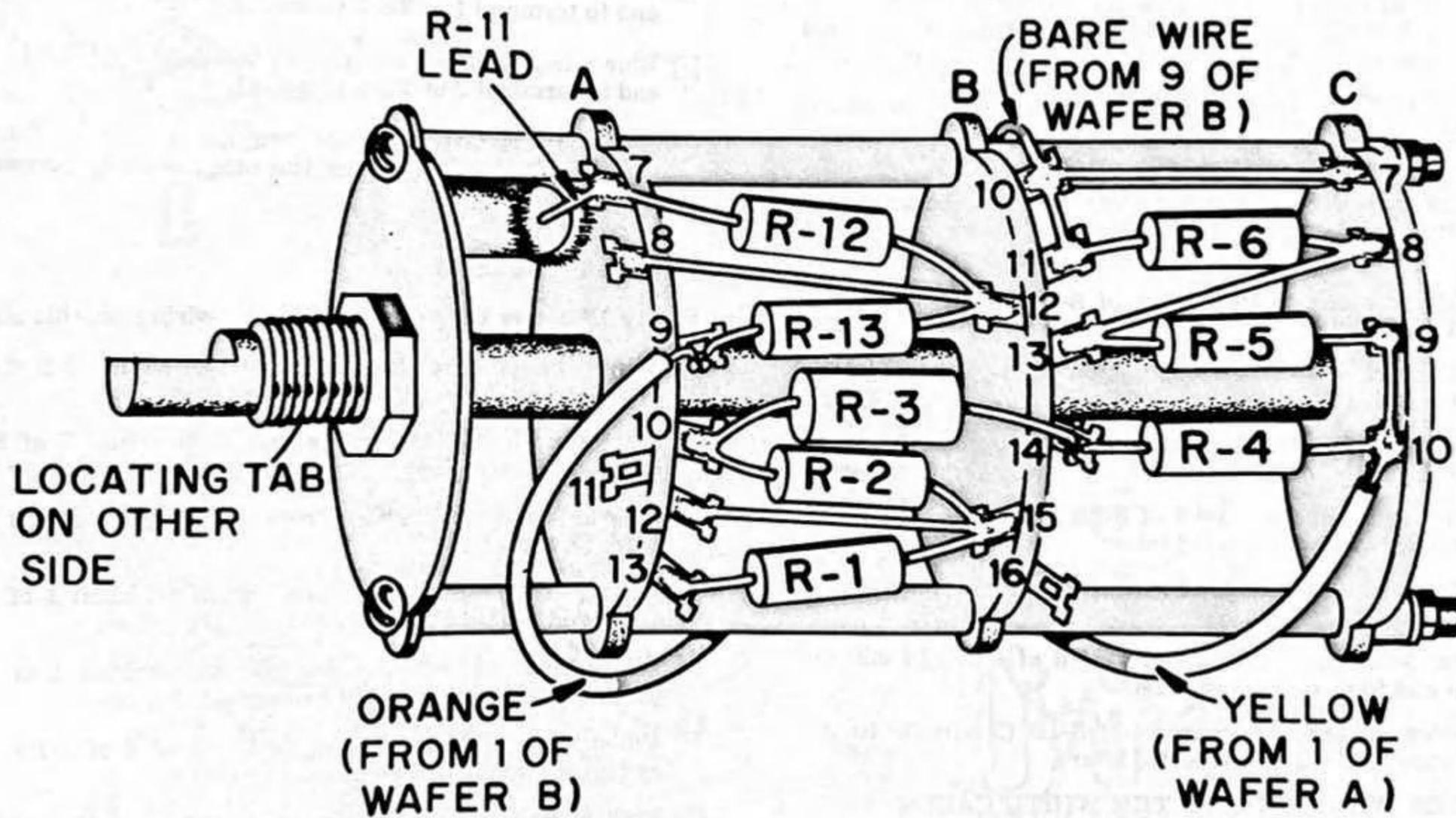


FIGURE 12. SECOND WIRING OF THE RANGE SWITCH, S-2

MOUNTING AND FIRST INTERWIRING OF SWITCHES

SEE FIGURES 13 and 14.

- Switch support bracket, TS-5 a 2-terminal strip, and the large, clear plastic cable clamp. Mount the clear cable clamp and the terminal strip on the bracket with a 6-32 x $\frac{3}{8}$ " screw, lockwasher and nut, as shown in Figure 14.
- S-2, pre-wired RANGE SWITCH. Place a $\frac{3}{8}$ " flatwasher over the shaft. Position the switch support bracket on the back of the panel as shown. Mount S-2 so the locating tab on the switch is positioned in the slot on the bracket. Fasten the switch from the front of the panel with a $\frac{3}{8}$ " flatwasher and nut.
- S-1 FUNCTION SWITCH. Place a $\frac{3}{8}$ " flatwasher over the shaft. Mount S-1 so the locating tab is positioned in the slot in the bracket as shown. Fasten with a $\frac{3}{8}$ " flatwasher and nut.
- Slip the remaining cable clamp over the white cable and mount it on the meter mounting screw shown. Fasten with a #6 flatwasher and 6-32 nut.
- Violet wire. Solder one end to terminal 1 of S-2C. Solder the other end to terminal 3 of S-1B.
- $\frac{1}{2}$ " bare wire. Connect one end to terminal 6 of S-1A. Solder the other end to terminal 7 of S-1A.
- Green wire. Solder one end to terminal 3 of S-2B. Solder the other end to terminal 6 of S-1A (2 wires).
- Blue wire. Solder one end to terminal 4 of S-2A (2 wires). Route the other end as shown; it will be connected later.
- Green wire. Solder one end to terminal 5 of S-2A. Connect the other end to terminal 4 of S-1B.
- White/green wire. Solder one end to terminal 6 of S-2A (2 wires). Connect the other end to terminal 5 of S-1B.
- Orange wire. Solder one end to terminal 4 of S-1B (2 wires). Route the other end as shown; it will be connected later.

CONNECT THE FREE WIRE ENDS OF THE WHITE CABLE AS FOLLOWS:

- Brown wire. Solder to terminal 8 of S-2B. Be sure you pick up the brown wire — **not the black one.**
- Gray wire. Solder to terminal 5 of S-2B.
- Black wire. Solder to terminal 5 of S-1A.
- Red wire. Solder to terminal 1 of S-1A.
- White wire. Solder to terminal 2 of S-1B.
- White/red wire. Connect one end to terminal 3 of TS-4. Route the other end as shown; it will be connected later.

- I-1 neon lamp. Press one lead of the lamp close to the body of the lamp and insert the lamp and the lead into the clear plastic clamp mounted under TS-5. Place $\frac{1}{2}$ " of small tubing over the remaining lead and connect it to terminal 2 of TS-5. Connect the other lead to terminal 1 of TS-5. **Be sure to keep both of these leads short.**
- Blue wire. Connect one end to terminal 1 of TS-4. Solder the other end to terminal 1 of TS-5 (2 wires).
- Blue wire. Connect one end to terminal ~~2~~ of TS-4. Solder the other end to terminal 2 of TS-5 (2 wires). ~~4~~
- R-33, 33K resistor (orange, orange, orange). Connect one lead to terminal 3 of TS-4. Solder the other lead to terminal ~~2~~ of TS-4 (2 wires). ~~4~~

NOW SEE FIGURE 15.

Figure 15 shows the remainder of the wiring on this side of S-1.

- White/orange wire. Solder one end to terminal 2 of S-1A. Route the other end as shown; it will be connected later.
- $\frac{1}{2}$ " bare wire. Connect one end to terminal 3 of S-1A. Solder the other end to terminal 4 of S-1A.
- Free end of the blue wire from grommet C. Solder to terminal 3 of S-1A (2 wires).
- White/violet wire. Solder one end to terminal 1 of S-1B. Route the other end as shown; it will be connected later.
- White/blue wire. Solder one end to terminal 1 of S-1C. Route the other end as shown; it will be connected later.
- Violet wire. Solder one end to terminal 2 of S-1C. Route the other end as shown; it will be connected later.
- Free end of the violet wire from grommet B. Solder to terminal 3 of S-1C.
- C-1, .02 μ f disc capacitor; this is the capacitor marked 1 KV. Clip one lead to $\frac{1}{4}$ " and solder it to terminal 5 of S-1B (2 wires). The other lead will be connected later.
- This completes the wiring of this side of the switches. All connections on this side of the switches should now be soldered. Go back and check all the wiring to the switches and terminal strips TS-4 and TS-5.
- When you are sure all is correct, go on to the next page.

FIGURE 14

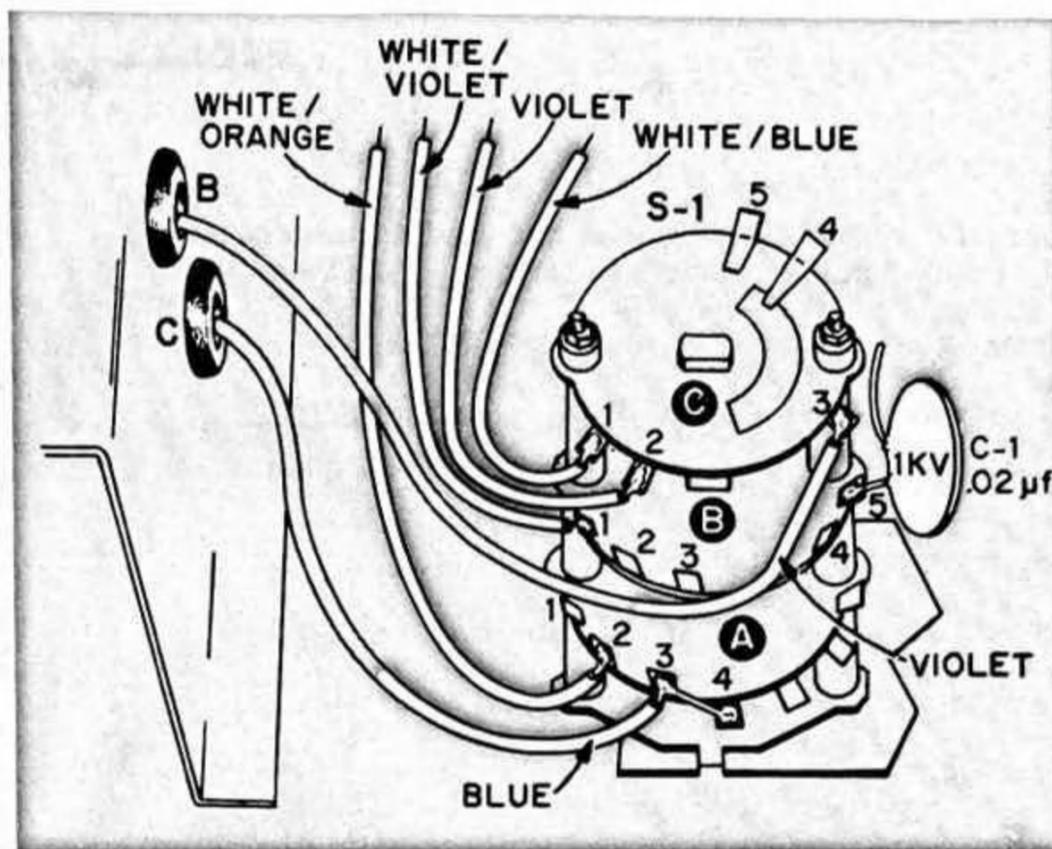
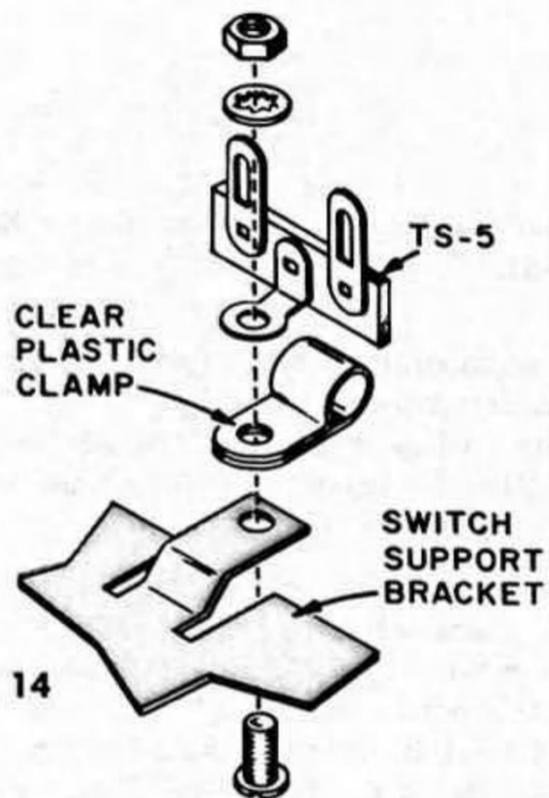


FIGURE 15

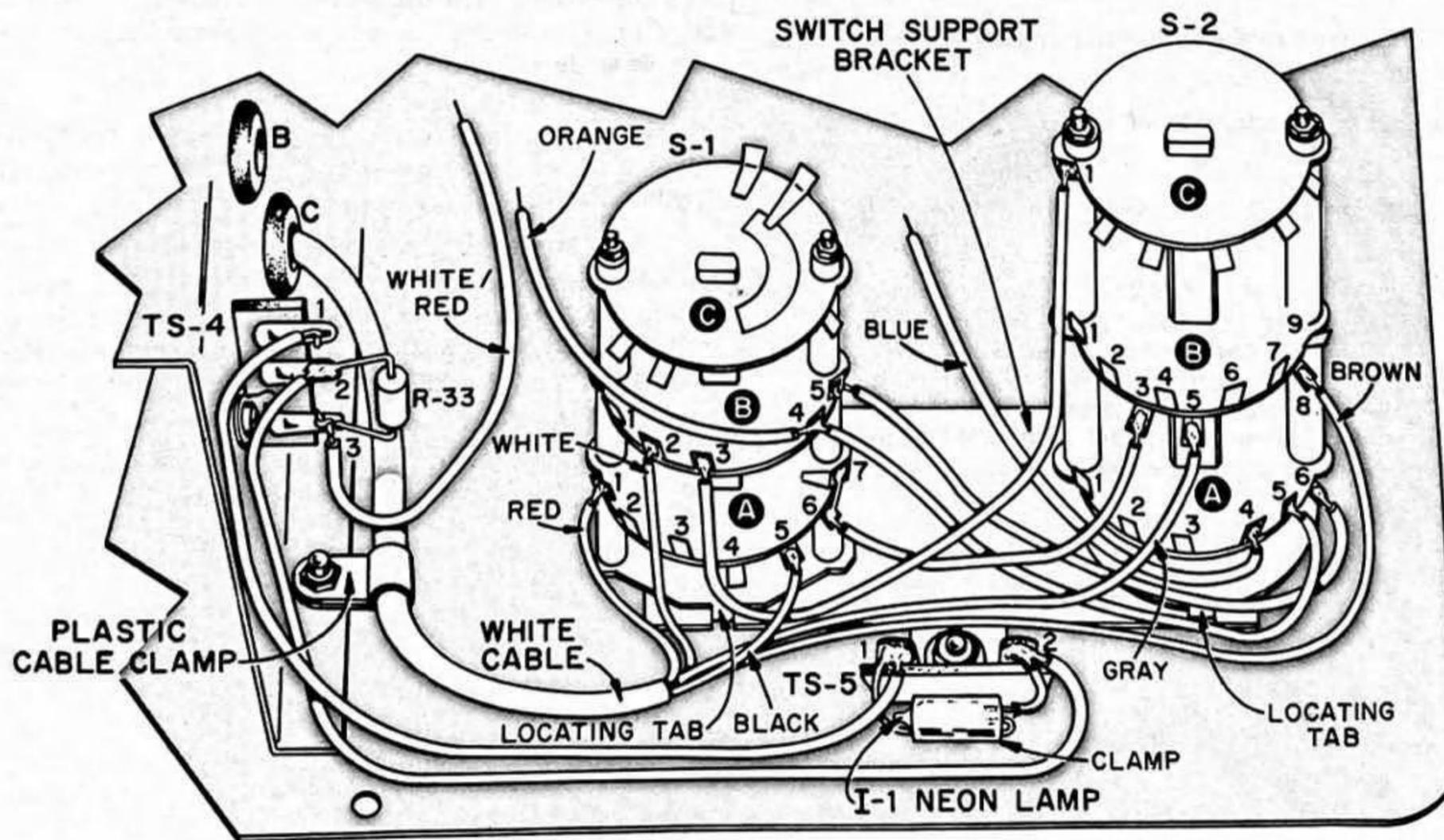


FIGURE 13. MOUNTING AND FIRST INTERWIRING OF SWITCHES

FINAL WIRING

SEE FIGURE 16.

- Black leads from T-1 transformer. Solder one lead to terminal 3 of TS-4 (3 wires). Connect the other lead to terminal 1 of TS-4.
 - Orange wire from S-1B. Solder to terminal 9 of S-1B.
 - White/orange wire from S-1A. Connect to terminal 8 of S-1B.
 - White/red wire from TS-4. Solder to terminal 4 of S-1C.
 - Gray wire from grommet C. Solder to terminal 9 of S-1A.
 - Free lead of C-1. Clip to $\frac{1}{4}$ " and solder to terminal 6 of S-1B.
 - White/violet wire from S-1B. Solder to terminal 16 of S-2B.
 - Violet wire from S-1C. Solder to terminal 14 of S-2B (3 wires).
 - White/brown wire from grommet C. Solder to terminal 11 of S-2A.
 - Blue wire from S-2A. Solder to terminal 8 of S-1B (2 wires).
 - White/blue wire from S-1C. Connect to the solder lug under the front panel connector.
 - $\frac{3}{4}$ " bare wire. Solder one end to terminal 11 of S-1A. Connect the other end to terminal 10 of S-1A.
 - Free end of the red wire from the gray cable. Solder to terminal 10 of S-1A (2 wires).
 - Orange wire. Solder one end to terminal 9 of S-2A (3 wires). Solder the other end to the solder lug under the front panel connector (3 wires). **Be sure solder flows over all three wires in each of these connections.** In order to heat this connection sufficiently to melt solder properly, you may find it necessary to remove the nut and temporarily lift the solder lug away from the panel while soldering. When you remount the solder lug, be sure it is tightly secured with the nut.
 - Green wire. Solder one end to terminal 8 of S-1A. Solder the other end to terminal 1 of R-31.
 - Yellow wire and $3\frac{1}{2}$ " of medium tubing. From the rear of the panel, insert the end of the yellow wire into the hole on the front panel connector. Solder this wire to the front panel connector (be sure to fill the hole with solder). Slip the tubing down over the wire. Solder the other end of the wire to terminal 7 of S-1B.
 - Line cord. Press a $\frac{3}{8}$ " grommet into the hole in the rear of the cabinet and thread the line cord through this grommet (from the rear of the cabinet). Thread the cord on through the cable clamp next to T-1 transformer. Tie a knot 5" from this end of the cord and separate the ends of the cord down to this knot. Solder one lead to terminal 5 of S-1C. Solder the other lead to terminal 1 of TS-4 (3 wires).
 - You have completed all wiring and soldering on your VTVM. Very carefully check each connection. All terminals on the switches should now be soldered.
- The following terminals on the chassis should be blank: terminal 8 of TS-2, terminal 8 of TS-3, pin 6 of V-1, and terminals 3 of R-28, R-29 and R-30. All other terminals should be soldered.
- Do all solder connections have a shiny, metallic finish? If not, reheat them with your soldering iron, adding a little solder if necessary. A dull, flaky solder connection will not conduct electricity efficiently; it may even prevent an electrical contact.
 - As a last check, try to move wires in a connection; if a wire can be moved, that connection must be resoldered.

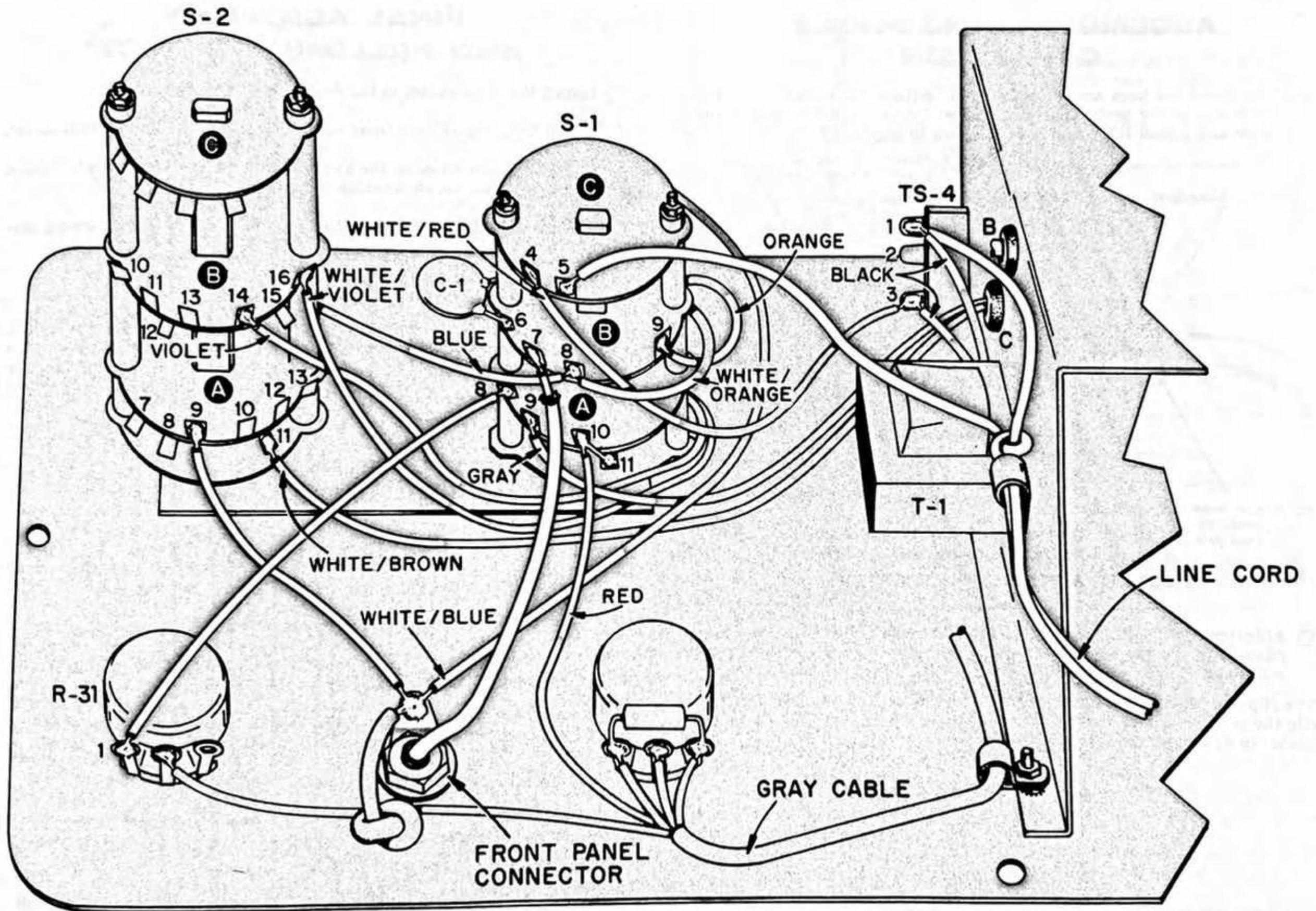


FIGURE 16. FINAL WIRING

ASSEMBLING THE PROBE CONNECTOR

- The probe has been assembled for you. Attach the connector to the other end of the probe cable as follows: Prepare the free end of the cable and install the connector as shown in Figure 17.

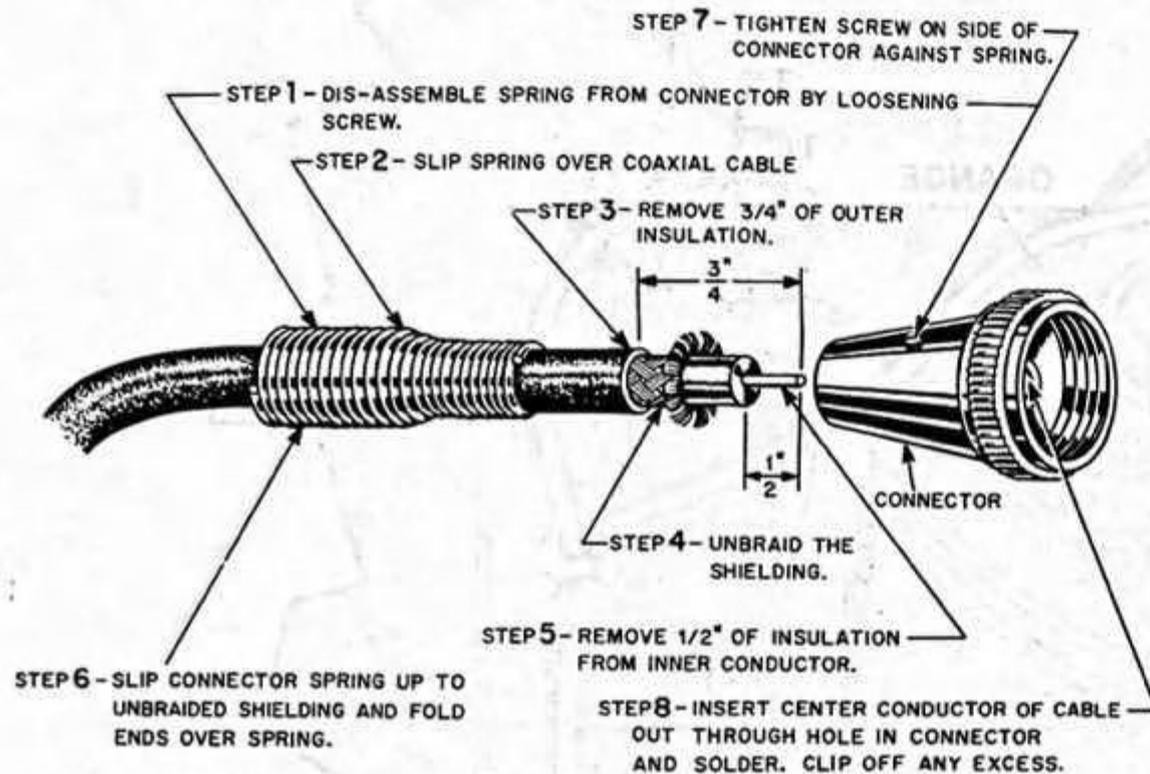


FIGURE 17. ATTACHING THE CONNECTOR

- Alligator clip for the probe tip. With the tip of your screwdriver, push down the dimple in the shank of the clip — see Figure 18. This will allow the clip to fit over the probe tip.

The clip may now be inserted over the tip of the probe. It can be used to clip the probe to a test point. When the clip is left off, you have a small probe tip to reach into tight corners, etc.

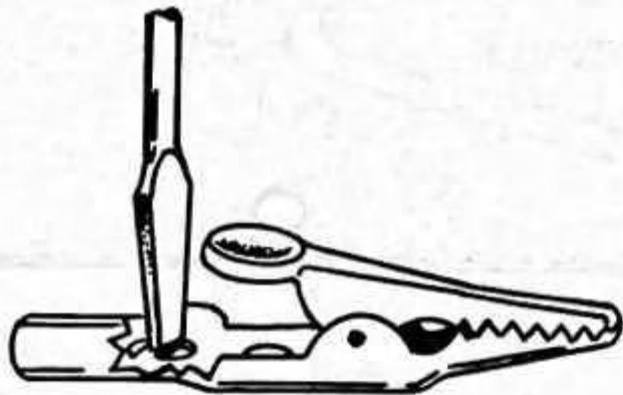


FIGURE 18. PREPARING THE PROBE CLIP

FINAL ASSEMBLY AND PRELIMINARY TEST

- Install V-1, 6AL5 tube, in the 7-pin socket.
- Install V-2, 12AU7 tube (may be marked 12AU7A), in the 9-pin socket.
- Knobs. Place a knob on the shaft of each of the front panel controls. Tighten the set screw against the flat side of the shaft.

Before you install the VTVM in the cabinet, perform the following preliminary test:

- Set the FUNCTION SWITCH TO OFF.

CAUTION! Before you connect your instrument to the AC power line, remember: Never touch any of the exposed wiring while the VTVM is plugged in. Do not place the unit on a grounded metal table or radiator during this test.

- Plug the line cord into an AC power outlet (110-130 volt, 60 cycle).
- Turn the FUNCTION SWITCH to AC. The pilot lamp should light and the tube filaments should glow. If they do not light, turn the instrument OFF and follow the suggestions listed at the end of this section.
- If the tube filaments glow and the pilot lamp lights, let the instrument warm up for a minute.
- The needle should move to the right or left. Adjust the front panel ZERO control to set the needle to zero at the left side of the meter scale. If you are unable to adjust the meter needle with the ZERO control, turn to the next section in this manual.
- If the ZERO control will adjust the meter needle, you may turn the instrument OFF and disconnect the line cord from the AC outlet.
- This completes the preliminary test.
- Battery. Snap the battery into the battery clip. BE SURE THE POSITIVE END OF THE BATTERY FACES THE TERMINAL MARKED +.
- Push all leads away from the edge of the panel. Now install the unit in the cabinet so the side with the alignment holes is next to the meter. Fasten with four #4 black, self-tapping screws.
- Press the pilot lamp jewel into the hole in the front panel above the switches.

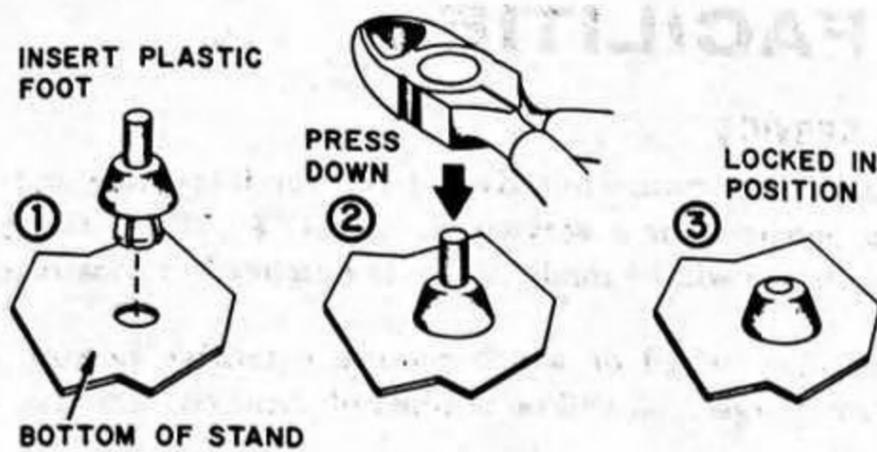


FIGURE 19. INSTALLING THE FEET

Your VTVM is now ready for calibration. Before you place the unit on the swivel stand, turn to the CALIBRATION section in your OPERATOR'S MANUAL and calibrate your instrument.

Battery cover. Mount over the rectangular hole in the bottom of the cabinet. Fasten with two #4 black, self-tapping screws.

Swivel stand and four plastic feet. From the bottom of the stand, install the feet in the holes near the corners. Fasten as shown in Figure 19.

Place the cabinet between the uprights of the swivel stand. Thread the thumb screws through the holes in the stand and into the threaded holes in the sides of the cabinet. See Figure 20.

Attach the probe lead to the front panel connector.

The instrument can be positioned to any angle by loosening the thumb screws and retightening them when you have positioned the instrument as you desire.

Three holes have been provided in the bottom of the swivel stand for screws to mount the instrument on a wall or under a shelf.

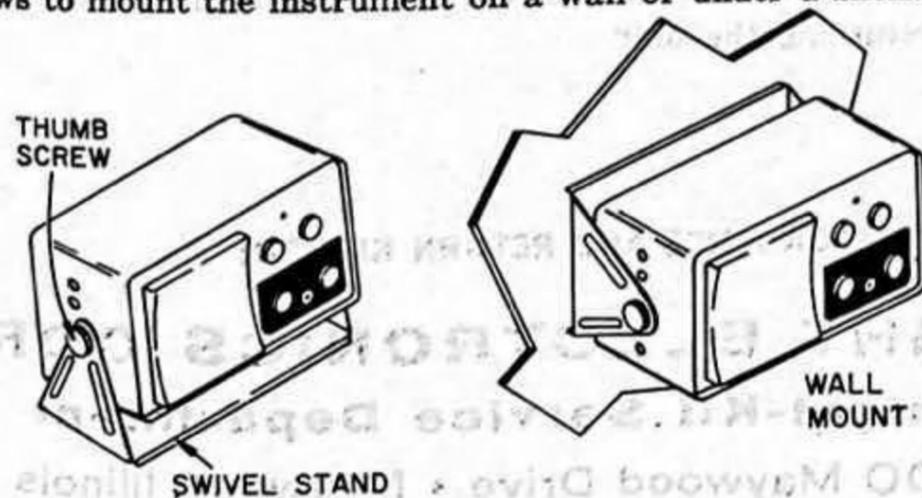


FIGURE 20

WIRING CHECK POINTS

If your VTVM does not function properly after you complete the wiring, we have listed a few general suggestions below to help you double-check your work.

PROBLEM	CHECK
Pilot light and tube filaments do not light.	Wiring and soldering of line cord and transformer leads.
Meter needle does not deflect.	Wiring of V-2 socket, especially pins 1 and 6.
ZERO control does not move needle.	Wiring to S-1B and S-2C. Wiring and soldering of resistors R-4 through R-10.
1.5V DC CAL does not control needle movement.	Wiring and soldering to R-28. Check wiring and soldering from pins 10 and 11 of S-1A to pin 1 of V-2 socket.
.5V DC CAL does not control needle movement.	Wiring and soldering of R-29 and terminal 5 of S-2B.
AC ZERO does not control needle movement.	Wiring and soldering of R-14, R-15, R-16 and R-21.
AC CAL does not control needle movement.	Wiring and soldering to S-2A. Check wiring and soldering of C-1 and V-1 socket.
OHMS control does not work.	Wiring and soldering to R-31 and S-1A.
If the AC function does not work at all.	Wiring and soldering to S-1B, S-2A, S-2B and S-1A.
If DC function does not work at all.	Wiring and soldering to S-1B, S-2C, S-2B and S-1A.
If OHMS function does not work at all.	Wiring and soldering to S-1B, S-2A, S-1C and S-1A.
If no function will work.	Wiring and soldering of probe and probe lead. Wiring on the chassis.

The MAINTENANCE section in your OPERATOR'S MANUAL has additional troubleshooting information which may be helpful.

KNIGHT-KIT SERVICE FACILITIES

TECHNICAL CONSULTING SERVICE

If, after following the instructions and suggestions given in this manual you are still unable to obtain proper performance from your kit, we invite you to contact our Technical Consulting Service for further assistance. Please be as accurate and thorough as possible because the effectiveness of our advice depends entirely on the information you supply.

Use the following as a guide for your correspondence:

1. Have you checked all the suggestions under Service Hints? Careful consideration of these points may solve your problem without writing.
2. Be sure to give the kit model number, the date of purchase and the serial numbers on the label pasted on the chassis and the back cover of the manual.
3. Have you made a thorough check of all wiring and soldering? Each solder connection should have a shiny metallic finish. Reheat any connection that appears doubtful and add a little solder if needed. Be sure there are no parts accidentally touching each other, the chassis or nearby terminals.
4. If the kit is of the type that requires calibration or alignment, double check these procedures. Be as specific as possible in your report. Outline adjustments made and the alignment procedure employed.
5. When you write be sure to describe all associated equipment. Specifically note the switch positions. Define as clearly as possible the symptoms as noted and mention any particular circumstance under which the problem occurs (after unit has been on for some time, only when jarred or moved, only when used for a particular purpose, etc.).
6. If you have completed the recommended service hints, be sure to outline the results and note any measurements taken which are out of tolerance.

KNIGHT-KIT PARTS WARRANTY

Knight Electronics guarantees that only premium-quality parts are selected for use in Knight-Kits. Every Knight-Kit part is fully warranted for a period of one year from date of purchase against defects in material and workmanship. Prompt No-Charge replacements of defective parts will be made.

INSPECTION SERVICE

You may return your completed Knight-Kit for inspection and repair within one year from purchase for a service charge of \$6.50 for this particular kit. An additional charge will be made for parts damaged in construction.

Kits not completely wired or which require extensive re-work will incur an additional labor charge. You will be notified of these charges prior to our repairing your kit.

No service charge will be made for a period of 90 days from date of purchase, if malfunctioning of the completed kit is due to a defective part. Service charges for kits returned after the one year period will be on a time and materials basis.

PACKING INSTRUCTIONS

Should you find it necessary to return your Knight-Kit be sure to pack it carefully. The original carton is too large; use a smaller carton, but one large enough so that ample cushioning material can be placed around the unit. **TO PREVENT COSTLY DAMAGE IN TRANSIT**, cushion your Knight-Kit tightly using plenty of packing materials. Mark: **FRAGILE—DELICATE ELECTRONIC EQUIPMENT**.

SHIPPING INSTRUCTIONS

For safety, your unit should be shipped by REA Express Prepaid and Insured. Please include remittance to cover repair costs. This will save you costly COD fees; any excess remittance will be refunded. Your repaired unit will be returned to you REA Express collect.

When you return a kit please enclose your order papers and a letter explaining why you are returning the unit.

ADDRESS CORRESPONDENCE AND RETURN KITS TO:

KNIGHT ELECTRONICS CORP.

Knight-Kit Service Department

2100 Maywood Drive • Maywood, Illinois



This is the ultra-modern Knight Electronics plant in Maywood, Illinois, a nearby suburb of Chicago. This extensive facility is devoted completely to the research, engineering, and manufacturing of quality electronic equipment in kit form. Knight pioneers in creating better electronic products at lower cost for hobbyists, experimenters, laboratories, schools, and industry.

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KNIGHT-KITS ARE THE FIRST CHOICE of exacting builders of electronic equipment . . . this has been true since the early 20's. There is an outstanding KNIGHT-KIT for every requirement. Each is a rewarding experience in kit construction. You will be proud to build and own a KNIGHT-KIT.

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Fig. 8-3. Knight-Kit KG-625 VTVM schematic.

