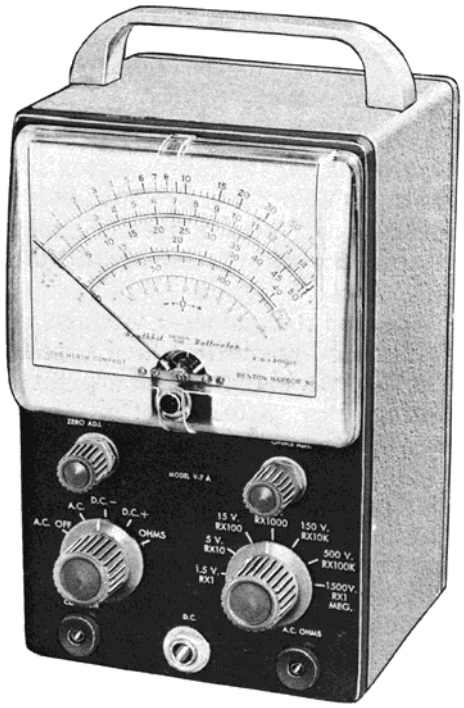
Heathkit V7A Owner's Manual

HEATHKIT VACUUM TUBE VOLTMETER

MODEL V-7A



SPECIFICATIONS

Electronic D.C. Voltmeter:	
7 Ranges:	0-1.5, 5, 15, 50, 150, 500, 1500 volts full scale, with accessory probe to 30,000 volts
Input Resistance:	11 megohms (1 megohm in probe) On all ranges, 1,100 megohms with accessory probe
Sensitivity:	7,333,333 ohms per volt on 1.5 volt range
Circuit:	Balanced bridge (push-pull) using twin triode
Accuracy:	±3% full scale
Electronic A.C. Voltmeter:	
7 R.M.S. Ranges:	0-1.5, 5, 15, 50, 150, 500, 1500 scales reading R.M.S. (.353 of peak to peak).
Frequency Response (5 v range):	±1 db 42 cps to 7.2 mc (600 Ω source).
Accuracy:	±5% full scale
7 Peak-to-Peak Ranges:	0-4, 14, 40, 140, 400, 1400, 4000
Electronic Ohmmeter:	
7 Ranges:	Scale with 10 ohms center X1, X10, X100, X1000, X10K, X100K, X1MEG. Measures .1 ohm to 1000 megohms with internal battery
Meter:	4 1/2" 200 μA movement, Polystyrene case
Multipliers:	1% precision type
Circuit board:	Printed circuit, etched metal process 3/32" XXP laminated phenolic .00135 copper foil
Tubes:	1 - 12AU7, twin triode meter bridge 1 - 6AL5, twin diode full wave AC rectifier
Battery:	1 1/2 volt flashlight cell
Cabinet Size:	7 3/8" high x 4 11/16" wide x 4 1/8" deep charcoal grey panel, feather grey cabinet
Kit Shipping Weight	7 lbs.
Power Requirements	105-125 volt 50-60 cycle AC 10 watts

11/6/59

INTRODUCTION

This Heathkit model V-7A VTVM represents the first kit instrument using a prewired, prefabricated printed circuit board in its design. The advantages of this circuit board use are numerous and it might be helpful to discuss them briefly before actually entering into kit construction. The printed circuit process itself is very interesting and an outline of the basic method involved will provide a much better understanding of the entire project.

The printed circuit board is actually nothing more than an insulating material on which a metal conductor pattern has been prepared. This metal conductor pattern replaces virtually all of the wiring usually associated with conventional chassis construction. The labor saving thus attained represents one of the principal advantages of printed circuit use. Other advantages are exact duplication of engineering development model, elimination of construction variations due to individual assembly techniques, more compact efficient construction and reduced margin of error.

There are many methods by which the metal conductor pattern is obtained and at the present time, the etching of a copper clad laminated phenolic board appears to be the most logical and flexible one. Usually a copper clad surface is subjected to a printing process such as is used in photography, silk screen, offset printing, etc. After printing, the unwanted metal not protected by the printing pattern is etched away leaving the desired pattern.

Generally speaking, the same soldering techniques with which you are already familiar will apply. It is recommended that a smaller soldering iron with a small tip be used. Irons in the range of 25 or 50 watts are entirely adequate. Soldering pencils are ideal for this work. Quick heating solder guns can be used but some precaution should be observed regarding the possibility of overheating. Overheating will damage the copper foil or the board and the practice itself should be discouraged in this assembly technique. Should the circuit board become overheated through soldering, the condition will be immediately evident by a distinctly audible "frying" or "crackling."

You will note that on the reverse side of the circuit board, a silk screening process actually designates the placement of components and identifies them by electrical value. To install a condenser or resistor, it is merely necessary to hold the component in one hand and bend both leads downward with the other hand forming a U-shaped unit. Then it is merely necessary to insert the leads through the openings provided and place the resistor or condenser directly over the designated area on the board. Spread the leads slightly so as to keep the units in place and prevent shifting. Usually many components can be mounted and then a number of soldered connections can be made without requiring frequent handling or turning of the board. After making the solder connection, the remaining leads should be trimmed off close to the board.

Tube sockets are mounted in a similar manner by inserting the socket pins in the circuit board cutout provided and properly aligning the socket. The pins can then be quickly soldered to the corresponding terminals for good electrical connection and at the same time provide adequate mechanical construction.

A properly prepared circuit board will provide many years of trouble-free service. There will be no deterioration of electrical connections or continuity of circuits and of course no separation of the copper and laminate. Your Heathkit represents the most widely accepted VTVM in the electronics industry. Properly constructed and intelligently used, it will provide many years of accurate trouble-free measurement service.

PRELIMINARY NOTES AND INSTRUCTIONS

The Heathkit model V-7A Peak-to-Peak Vacuum Tube Voltmeter is an excellent instrument and care used during construction will be well repaid. The construction is open and easily accomplished but it should not be rushed, as poor workmanship can result in poor operation.

UNPACK THE KIT CAREFULLY, EXAMINE EACH PART AND CHECK IT AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. If a shortage is found, attach the inspection slip to your claim and notify us promptly. Hardware items are counted mechanically and if a few are missing, please secure them locally if at all possible. Use the charts on the inside covers of this manual to identify the parts.

Read the manual completely through before starting actual construction. In this way, you will become familiar with the general procedure used. Study the pictorials and diagrams to get acquainted with the circuit layout and location of parts. When actually assembling and wiring, read the entire step through so that no suggestions will be missed.

To facilitate describing the location of parts, tube sockets, controls, terminal strips, etc. have all been lettered and are coded. All such numbering and lettering is clearly shown in the figures and when instructions say, for example, "wire to G3" refer to the proper figure and connect a wire to pin 3 of socket G.

It is recommended that O, Z, P, etc. be actually labeled as such on the panel with a pencil. Lettering on the inside of the panel where wiring is done will reduce the possibility of making wrong connections.

Tube socket pins are numbered as shown in Figure 5. Always read clockwise when the socket is viewed from the bottom.

A circuit description is included in the later section of this manual so that those with some knowledge of electronics will be able to obtain a clearer picture of the actual functioning of this instrument. It is not expected that those with little experience will understand the description completely, but it should be of help in the event that they desire to become more familiar with the circuit operation and thus learn more from building the kit than just the placing of parts and wiring.

Small changes in parts may be made by the Heath Company. Any part supplied will work just as well as the part for which it was substituted. By reading the color code on resistors for instance, it will be readily understood that a value of 51 KΩ is a substitute for the specified 47 KΩ provided the specified value is not supplied. Such changes will be made only if the specified parts are unobtainable at the time and are made to insure a minimum delay in filling your order.

Resistors and controls have a tolerance rating of ±20% unless otherwise stated. Therefore a 100 KΩ resistor may test anywhere between 80 KΩ and 120 KΩ. Frequently condensers show an even greater variation such as -50% to +100%. This Heathkit is designed to accomodate such variations.

PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

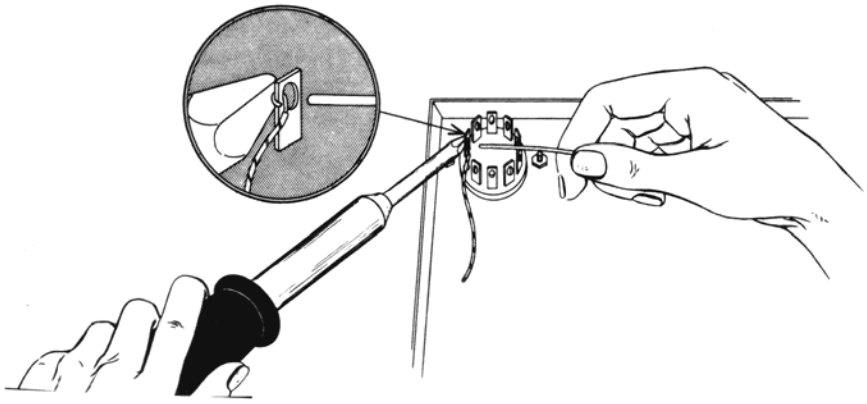
Correct soldering technique is extremely important. Good solder joints are essential if the performance engineered into the kit is to be fully realized. If you are a beginner with no experience in soldering, a half-hour's practice with odd lengths of wire and a tube socket will be a worthwhile investment.

High quality solder of the proper grade is most important. There are several different brands of solder on the market, each clearly marked "Rosin Core Radio Solder." Such solders consist of an alloy of tin and lead, usually in the proportion of 50:50. Minor variations exist in the mixture such as 40:60, 45:55, etc. with the first figure indicating the tin content. Radio solders are formed with one or more tubular holes through the center. These holes are filled with a rosin compound which acts as a flux or cleaning agent during the soldering operation.

NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes. Such compounds, although not corrosive at room temperatures, will form residues when heated. The residue is deposited on surrounding surfaces and attracts moisture. The resulting compound is not only corrosive but actually destroys the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will create erratic or degraded performance of the instrument.

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

If terminals are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good joint is made without relying on solder for physical strength. To make a good solder joint, the clean tip of the soldering iron should be placed against the joint to be soldered so that the terminal is heated sufficiently to melt solder. The solder is then placed against both the terminal and the tip of the iron and will immediately flow out over the joint. Refer to the sketch below. Use only enough solder to cover wires at the junction; it is not necessary to fill the entire hole in the terminal with solder. Excess solder may flow into tube socket contacts, ruining the socket, or it may creep into switch contacts and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.



A poor solder joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface, caused by movement of the joint before it solidified is another evidence of a "cold" connection. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance. Photographs in the adjoining picture clearly indicate these two characteristics.

A good, clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 60 or 100 watt iron, or the equivalent in a soldering gun, is very satisfactory. Smaller irons generally will not heat the connections enough to flow the solder smoothly over the joint and are recommended only for light work, such as on etched circuit boards, etc. Keep the iron tip clean and bright. A pad of steel wool may be used to wipe the tip occasionally during use.

Take these precautions and use reasonable care during assembly of the kit. This will insure the wonderful satisfaction of having the instrument operate perfectly the first time it is turned on.

RANGE SWITCH ASSEMBLY

The range switch is the very heart of the VTVM multiplier circuit and careful workmanship here will reward the kit builder with trouble-free performance. This switch has been especially designed for the Heathkit VTVM. It is important that solder connections be well made with a clean, hot, well tinned iron, small tip preferred. Avoid excessive use of solder or flux. Do not overheat or burn the switch wafers. Complete absence of any potential leakage path is desirable. The switch assembly is entirely logical and the step-by-step procedure should be carefully followed. Take your time, be sure of each step and do a good job.

The range switch is the long, 3-deck rotary switch, part #63-79. Inspect the switch for alignment by holding it vertically and sighting from one side to determine if the switch shaft and stacked tubular wafer separators are all parallel to each other. If the assembly is misaligned, probably due to handling or shipping, alignment should be restored before proceeding with the work. This can be accomplished by holding the metal detent wafer at the shaft end in one hand and firmly twisting the SPACERS on the switch deck with the other hand. After aligning, check the tightness of the mounting nuts on the last wafer. They should be snug without excessive strain.

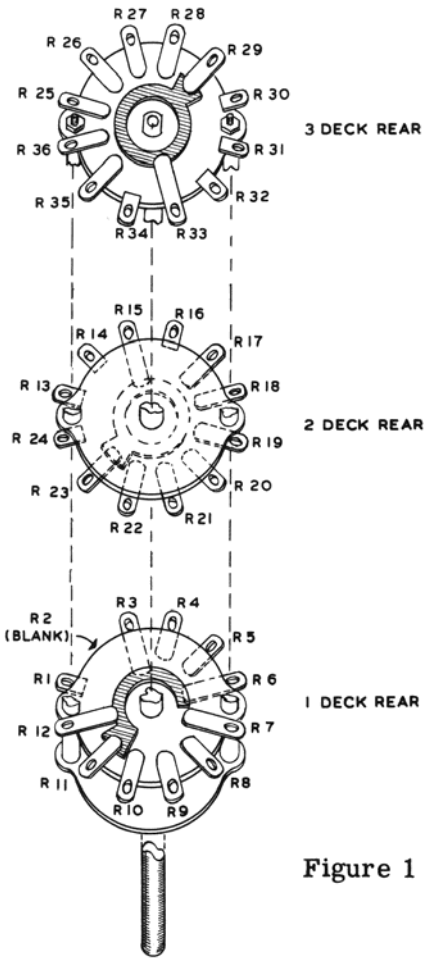


Figure 1

RANGE SWITCH NUMBERING SYSTEM

RANGE SWITCH WIRING

The range switch can be conveniently wired before panel mounting. Study Figure 1 for proper orientation and switch lug designation. Switch lug marking follows a definite pattern. The three decks, front (deck #1), center (deck #2), and rear (deck #3) are all 12-position wafers and terminals will be designated as follows: Front deck, #1 numbered from 1 to 12; Center deck, #2 from 13 to 24; Rear deck, #3 from 25 to 36. NOTE: Before wiring, be sure your switch agrees with the terminal arrangement shown in Figure 1 and described below.

Lug numbering will be called out in clockwise rotation commencing with the front deck. Therefore, R1 will be the front deck lug as identified in Figure 1. The next position, normally R2, is blank followed in continuous succession by R3, R4, etc. Note that on the first deck #1 contact surfaces appear on both sides of the deck. Whereas the remaining decks #2 and #3, the contacts are all on one side of the wafer.

During assembly procedure, mount resistors so that the printed values are visible. This is good practice and will be helpful in the event trouble shooting is required. Trim excess resistor lead length and crimp the lead ends aroung the switch lug for good mechanical connection. Avoid undue strain on the switch lug itself so that the rivet mounting will not become loosened. Use insulated sleeving whenever bare wire is adjacent to the switch frame or the possibility of shorting to adjacent wiring exists.

Check off each step in the space provided (✓) as it is completed.

(S) means solder the connection. (NS) means do not solder yet.

USE ROSIN CORE SOLDER ONLY. SEE SOLDER NOTE ON PAGE 4.

Successful instrument construction requires close observance of the step-by-step procedure outlined in this manual. For your convenience, many illustrations are repeated in large size fold-in sheets. It is suggested that these sheets be fastened to the wall over your work area for reference purposes during instrument construction.

Arrange the supply of precision resistors and begin range switch assembly in the following manner. Be sure of each step before soldering as correction can be annoying.

( ) Connect 320 KΩ resistor between R1 (NS) and R4 (NS). Physical placement is between the wafer and detent plate. See Figure 2.

( ) Connect 900 KΩ 1 watt (large) resistor between R1 (NS) and R6 (NS). Place resistor between deck #1 and deck #2. See Figure 2.

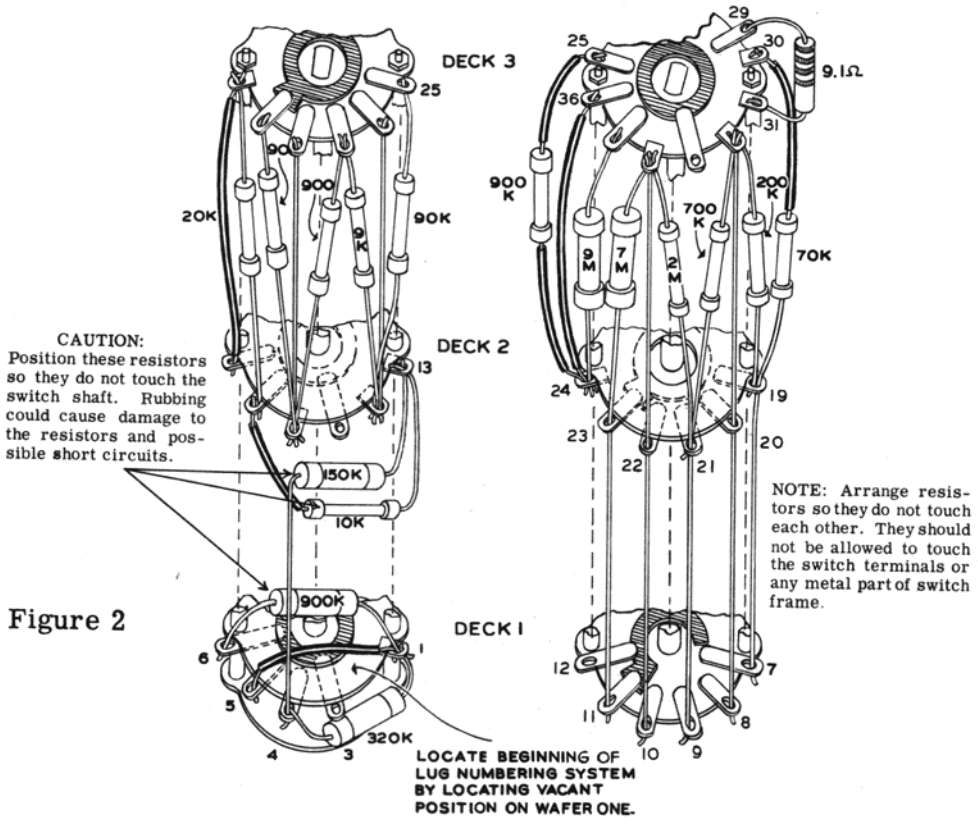


Figure 2

RANGE SWITCH DETAIL

( ) Connect 150 KΩ resistor between R13 (NS) and R4 (S). See Figure 2 for placement.

( ) Connect 10 KΩ resistor between R13 (NS) and R17 (NS). Use insulated sleeving on R17 connection.

( ) Connect a length of bare wire between R1 (S) and R5 (S). (Use sleeving.)

( ) Connect 20 KΩ resistor between R17 (S) and R30 (NS).

( ) Connect a length of bare wire between R30 (NS) and R18 (S). (Use sleeving.)

( ) Connect one lead of the 70 KΩ resistor through R19 (NS) to R7 (S). Use sleeving and connect the remaining lead to R30 (S).

( ) Connect 200 KΩ resistor from R19 (S) to R32 (NS).

( ) Connect a bare wire through R32 (NS) and again through R20 (S) and to R8 (S).

( ) Connect one lead of the 700 KΩ resistor through R21 (NS) to R9 (S). Connect the other lead to R32 (S).

( ) Connect 2 megohm resistor from R21 (S) to R34 (NS). (Note that R33 is left unconnected during this progressive sequence.)

( ) Connect a bare wire through R34 (NS) and on through R22 (S) and to R10 (S).

( ) Connect one lead of 7 megohm resistor through R23 (S) and to R11 (NS). Connect the other lead to R34 (S).

( ) Connect 9 megohm resistor between R35 (S) to R24 (NS).

( ) Connect a bare wire from R36 (S) to R24 (NS). (Use sleeving.)

( ) Connect 900 KΩ resistor from R25 (NS) to R24 (S). (Use sleeving.)

( ) Connect 90 KΩ resistor from R25 (S) to R14 (NS).

( ) Connect a bare wire from R26 (S) to R14 (NS).

( ) Connect 9 KΩ resistor from R27 (NS) to R14 (S).

( ) Connect 900 Ω resistor from R27 (S) to R16 (NS). Note that R15 has been skipped at this time.

( ) Connect a bare wire from R28 (S) to R16 (NS)

( ) Connect a 90 Ω resistor from R29 (NS) to R16 (S).

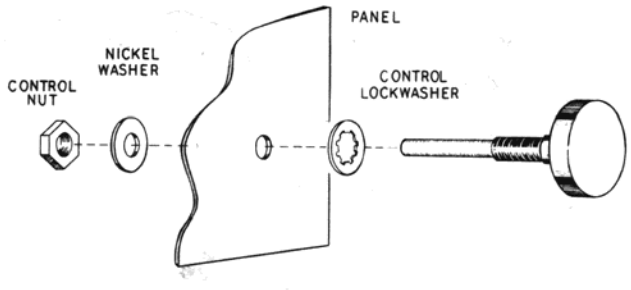
( ) Connect 9.1 Ω resistor (colored white and brown) from R29 (S) to R31 (NS). See Figure 2 for resistor placement.

This completes the resistor range switch assembly. Before temporarily setting it aside, recheck the entire procedure to insure accuracy. Check all resistor leads and bare wires for possible shorting. Visually inspect all solder connections from every angle to make sure that a poor solder connection is not present. Check for the possibility of excess solder used on connections shorting to adjacent connections. Shake out all loose pieces of solder and wire trimmings.

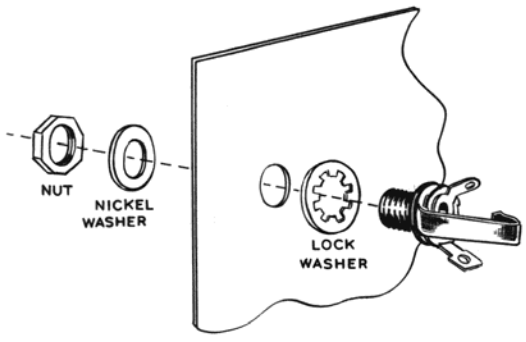
PANEL

In all operations involving panel assembly and wiring, a soft cloth or pad should be placed on the working surface so that the panel will not become marred or damaged by handling.

Refer to Figure 3 for explanation of parts mounting on panel. Note the placement of controls in respect to lug positioning. On all controls and switches be sure to use a control lockwasher between the panel and the control or switch. Use a flat nickel washer under the control mounting nut to prevent marring the panel.



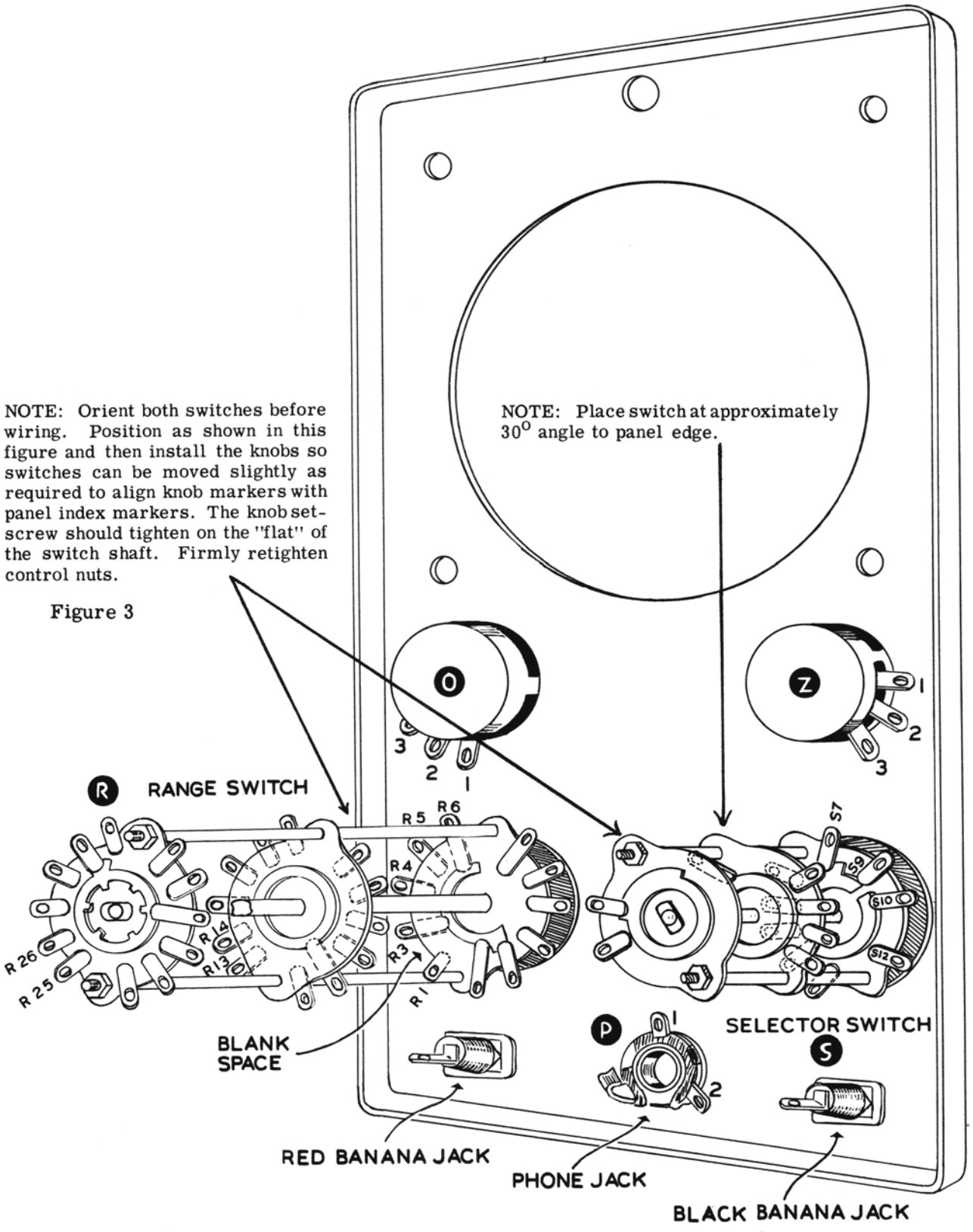
HOW TO MOUNT CONTROLS & SWITCHES

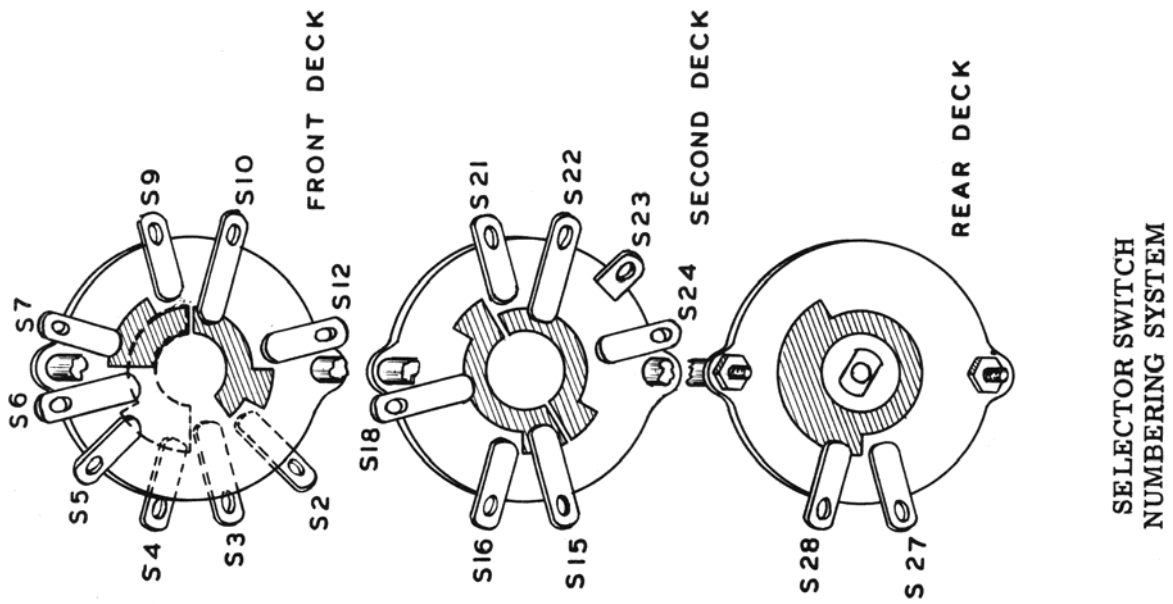


PHONE JACK ASSEMBLY

NOTE: Orient both switches before wiring. Position as shown in this figure and then install the knobs so switches can be moved slightly as required to align knob markers with panel index markers. The knob set-screw should tighten on the "flat" of the switch shaft. Firmly retighten control nuts.

Figure 3





Banana jacks are mounted in the positions shown. Observe the correct color placement. After inserting banana jack inserts, be sure to bend slightly as shown in Figure 4.

Please note alphabetical designations of controls, switches and other points of connection. For example, OHMS ADJUST will be designated as "O" and the lugs numbered O1, O2, O3. ZERO ADJUST as "Z" and lugs Z1, Z2, Z3, etc.

PANEL WIRING

Note that the use of insulated sleeving is specified in some of the following wiring procedure. This sleeving is used to cover the whole length of the hookup wire involved in the step, and its purpose is to insure adequate clearance between that particular section of wire and adjacent wiring and parts. Use of sleeving is specified only in circuits carrying high AC test voltage and the purpose of the sleeving is to prevent arcing or flashover due to wiring dress.

( ) Install a .01 μfd 1600 volt condenser between R6 (S) and S12 (S). (Use sleeving.) Observe condenser placement as shown in Pictorial 1 on the following page.

( ) Connect a wire from O3 (S) to S16 (S).

( ) Connect a wire from O2 (S) to Z1 (NS).

( ) Connect a wire from Z3 (S) to S18 (NS).

( ) Connect a wire from S2 (S) to P2 (S).

( ) Connect a wire from S3 (S) to R11 (S).

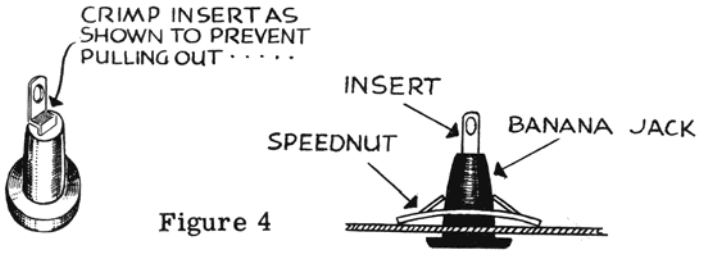


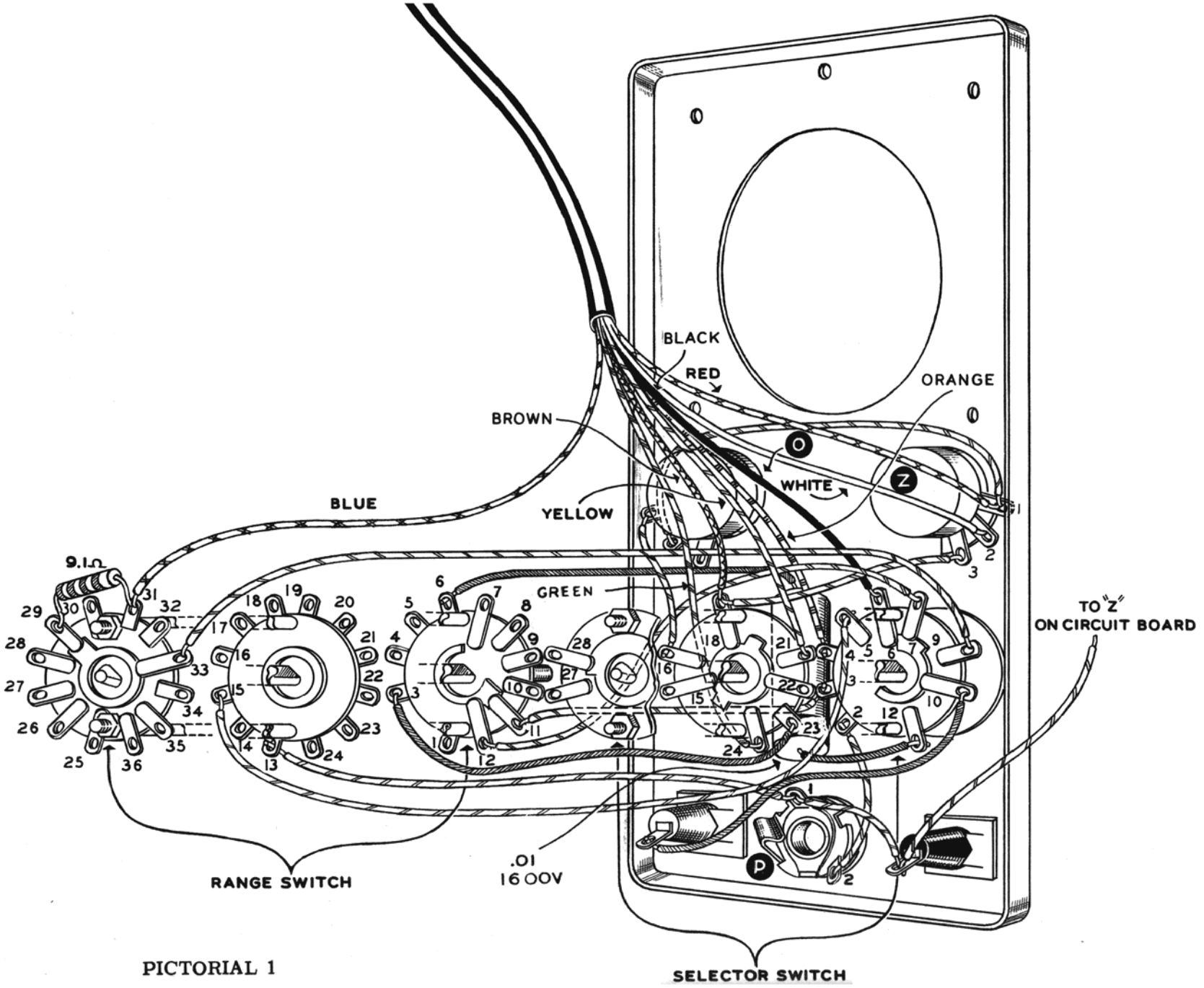
Figure 4

( ) Connect a wire from S5 (S) to R15 (S). Note that S4 is skipped at this time.

( ) Connect a wire from S7 (S) to R12 (S). Note that S6 is skipped at this time.

( ) Connect a wire from S9 (S) to R33 (S).

( ) Connect a wire from S10 (S) to the red banana jack (S). Use insulated sleeving over the entire length of this wire.


BLACK
RED
ORANGE
BROWN
WHITE
BLUE
YELLOW
GREEN
9.1Ω
TO "Z" ON CIRCUIT BOARD
.01
1600V
RANGE SWITCH
SELECTOR SWITCH

PICTORIAL 1

( ) Connect a wire from S23 (NS) to R3 (S). Use insulated sleeving over the entire length of this wire.

( ) Connect a wire from R13 (S) to P1 (NS).

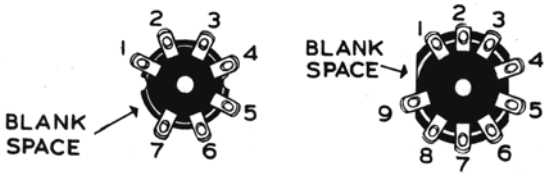
( ) Connect a wire from P1 (S) to the black banana jack (NS).

( ) Connect a 4" length of wire to the black banana jack (S). Leave the other end disconnected for the time being.

CIRCUIT BOARD ASSEMBLY AND WIRING

The V-7 VTVM printed circuit board is virtually self-explanatory regarding assembly procedure. The reverse or silk screen side of the board clearly indicates the location of components and cable wiring. However, to minimize the possibility of error and thereby utilize to the fullest extent the advantages offered by printed circuits, the step-by-step procedure as outlined below should be followed.

NOTE: Inspect the circuit board carefully for any obvious defects (broken foil, foil inside of punched holes, etc.) before mounting parts to it.



TUBE SOCKET NUMBERING SYSTEM VIEWED FROM BOTTOM

Figure 5

( ) Install 7-pin socket through lettered side of the board in the smaller of the two socket locations.

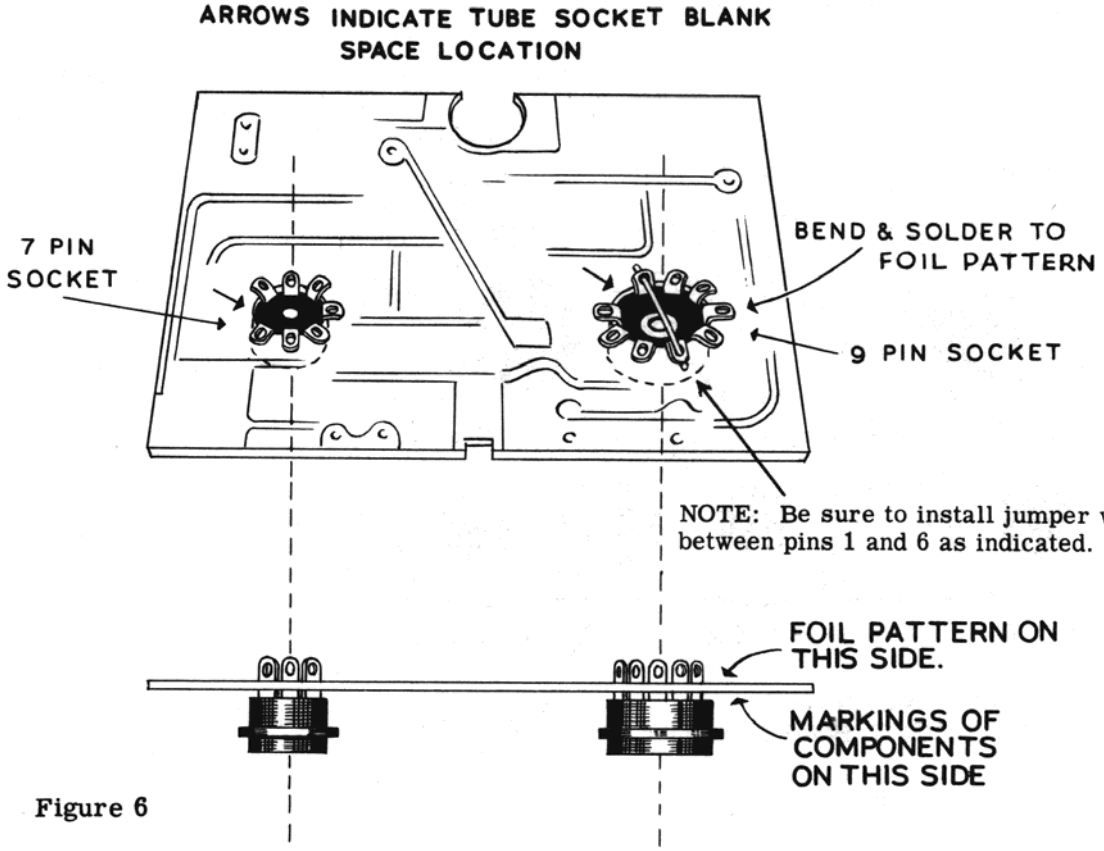


Figure 6

( ) Orient the spacing between socket pins 1 and 7 so that it corresponds with the placement shown in Figure 6. With a low wattage small tipped soldering iron, using only rosin core type solder, begin soldering the socket pins to the copper foil terminals. See notes on printed circuit soldering in the INTRODUCTION on Page 3. Note that pin 6 of the 7-pin socket has no circuit connection and soldering only serves to increase mechanical mounting strength.

Please read "Special Note" on Page 31 before proceeding with next step.

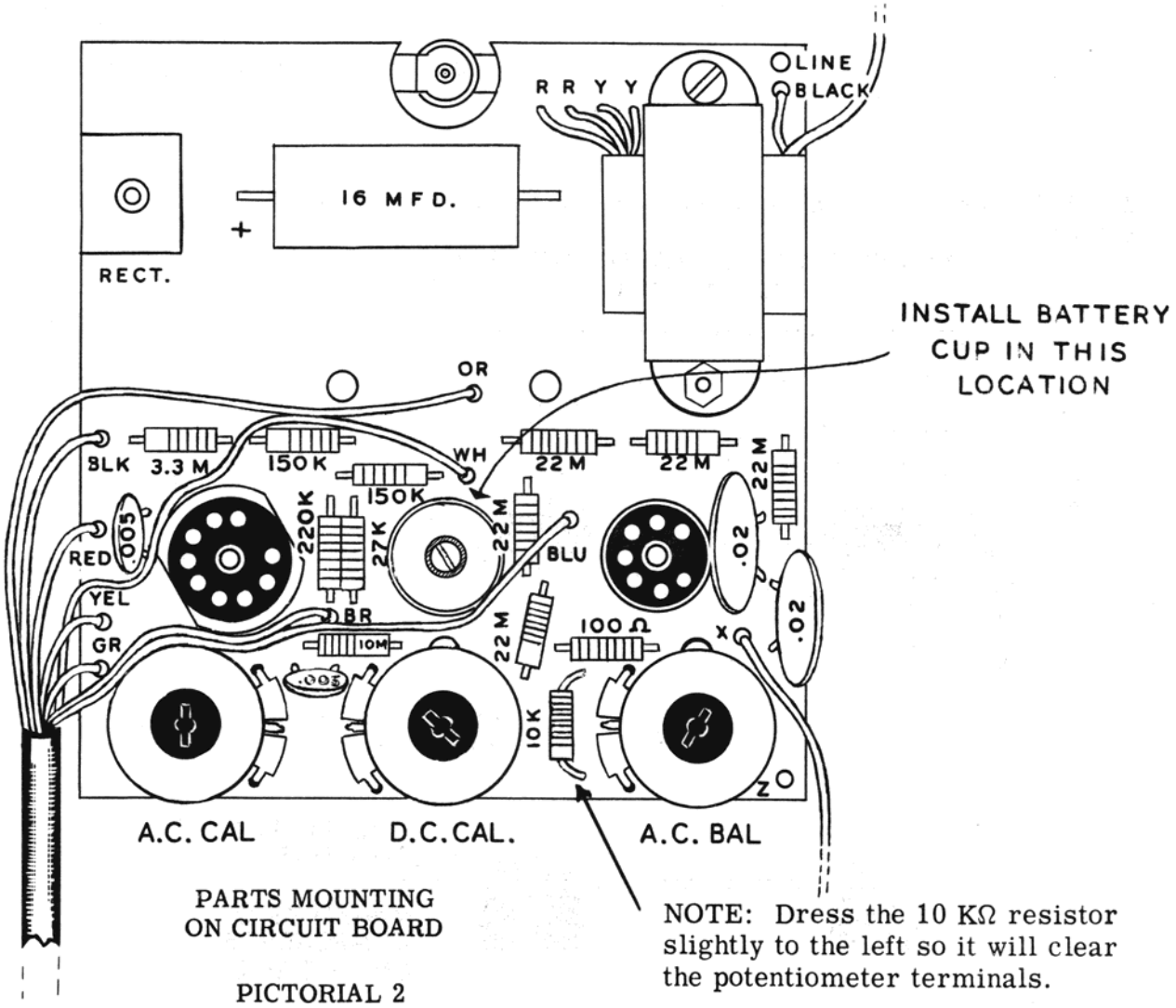
( ) Install 9-pin socket through lettered side of board. Before soldering socket pins to foil pattern, be sure to connect a wire jumper between pins 1 and 6. Then solder all socket pins to the foil pattern.

RESISTORS

( ) Install a 3.3 megohm resistor (orange-orange-green) in position designated on the back of the circuit board. Bend the leads at right angles to the resistor body, insert leads in the correct holes and spread leads slightly so the resistor will not drop out of position. Do not solder yet. All of the remaining carbon resistors will be mounted in a similar manner.

( ) Install a 220 KΩ resistor (red-red-yellow) in the position shown on board. Refer to Pictorial 2 for all resistor placement.

( ) Install a 150 KΩ resistor (brown-green-yellow).



PARTS MOUNTING ON CIRCUIT BOARD

NOTE: Dress the 10 KΩ resistor slightly to the left so it will clear the potentiometer terminals.

PICTORIAL 2

( ) Install 27 KΩ resistor (red-violet-orange).

( ) Install 10 megohm resistor (brown-black-blue).

( ) Install 150 KΩ resistor (brown-green-yellow).

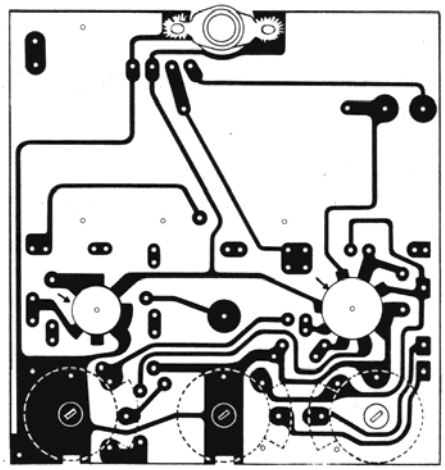
( ) Install five 22 megohm resistors (red-red-blue) in the five positions shown.

( ) Install a 100 Ω resistor (brown-black-brown).

( ) Install a 10 KΩ resistor (brown-black-orange). Position as shown in Pictorial 2.

Now that the resistors are mounted, check for snug positioning against the circuit board. Then spot solder each lead and trim off close to board surface. Carefully check each connection after clipping to eliminate the presence of a rosin or cold solder joint.

CONTROLS



PLACEMENT OF CONTROLS

Figure 7

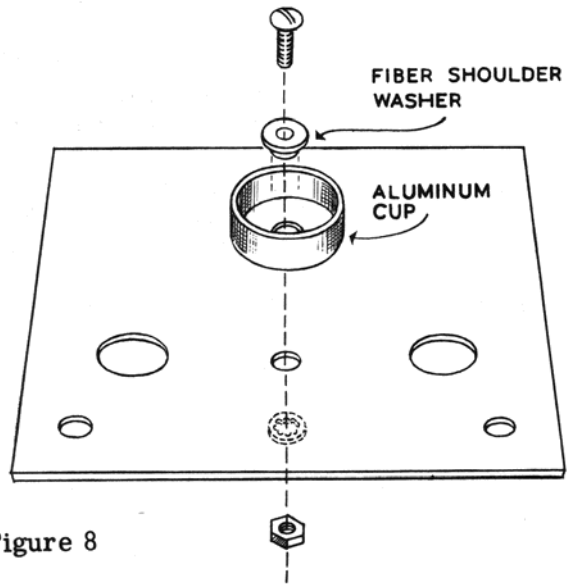


Figure 8

BATTERY CUP MOUNTING ON REVERSE SIDE OF CIRCUIT BOARD

( ) Mount the three special type 10 KΩ controls from the screened side of the board so the mounting lugs and terminals protrude through to the foil side. See Pictorial 2 and Figure 7. Press the controls firmly against the board and solder the mounting lugs and terminals to the foil pattern. One mounting lug of the A.C. CAL. control cannot be soldered to the foil, so bend the lugs slightly inward in order to hold the control securely.

RECTIFIER - TRANSFORMER - CONDENSERS

( ) Mount the selenium rectifier on the reverse side of the circuit board with the terminal lugs protruding through the opening provided. Be sure to note the position of the positive terminals. Bend the lugs over and solder to the circuit board. This will cause one of the lugs to protrude beyond the edge of the circuit board. Clip off the excess portion of this lug so it will be flush with the circuit board edge. This is important, since a short can occur if the lug touches the VTVM case.

( ) Mount the power transformer as shown in Pictorial 2. Use 6-32 mounting hardware and note that the 6-32 screw closest to the 6AL5 tube socket is inserted from the etched metal side of the board. This is done to insure adequate clearance for the plastic meter housing when the board is assembled to the instrument.

( ) Transformer leads are pre-cut to proper length. Insert leads in their respective, color-coded places and solder leads to the circuit board.

( ) Mount the .005 μfd condensers in their places as shown in Pictorial 2. Solder leads and trim excess length.

( ) Mount both .02 μfd condensers in their places as shown in Pictorial 2. Solder leads and trim excess length.

( ) Mount the 16 μfd filter condenser in the space provided. Be sure to observe polarity with the positive terminal adjacent to the rectifier positive terminal. Solder leads and trim off excess lead length.

( ) Mount the pilot light socket in location shown in Pictorial 2. Solder the lugs directly to the circuit. (Bend one lug to an offset position.)

CONNECTING CABLE

An 8-wire color-coded cable is used to connect the circuit board to the remaining VTVM circuitry. This cable should be prepared in the following manner.

( ) Measure 5" from one end of the cable and carefully remove the cable sheathing by making a circular cut with a small sharp knife and then slipping off the end of the cable sheath. Be careful not to cut into the internal wires.

( ) Next cut wires to the following lengths:

Green - 1/2"	Brown - 2"
Yellow - 3/4"	White - 3"
Red - 1 1/4"	Blue - 3 1/2"
Black - 1 3/4"	Orange - 4 1/4"

( ) Carefully remove about 3/16 insulation from the end of each wire. Twist the fine wire strands tightly and insert the color-coded wires in the openings as shown in Pictorial 2. Solder each wire as it is inserted and clip excess length.

( ) Using 6-32 x 3/8" screw and fiber shoulder washer, install battery holder in position shown in Figure 8.

( ) Connect one end of a 4" length of hookup wire to point X on board.

The circuit board is now completely assembled and ready for installation in the VTVM.

WIRING CIRCUIT BOARD TO PANEL

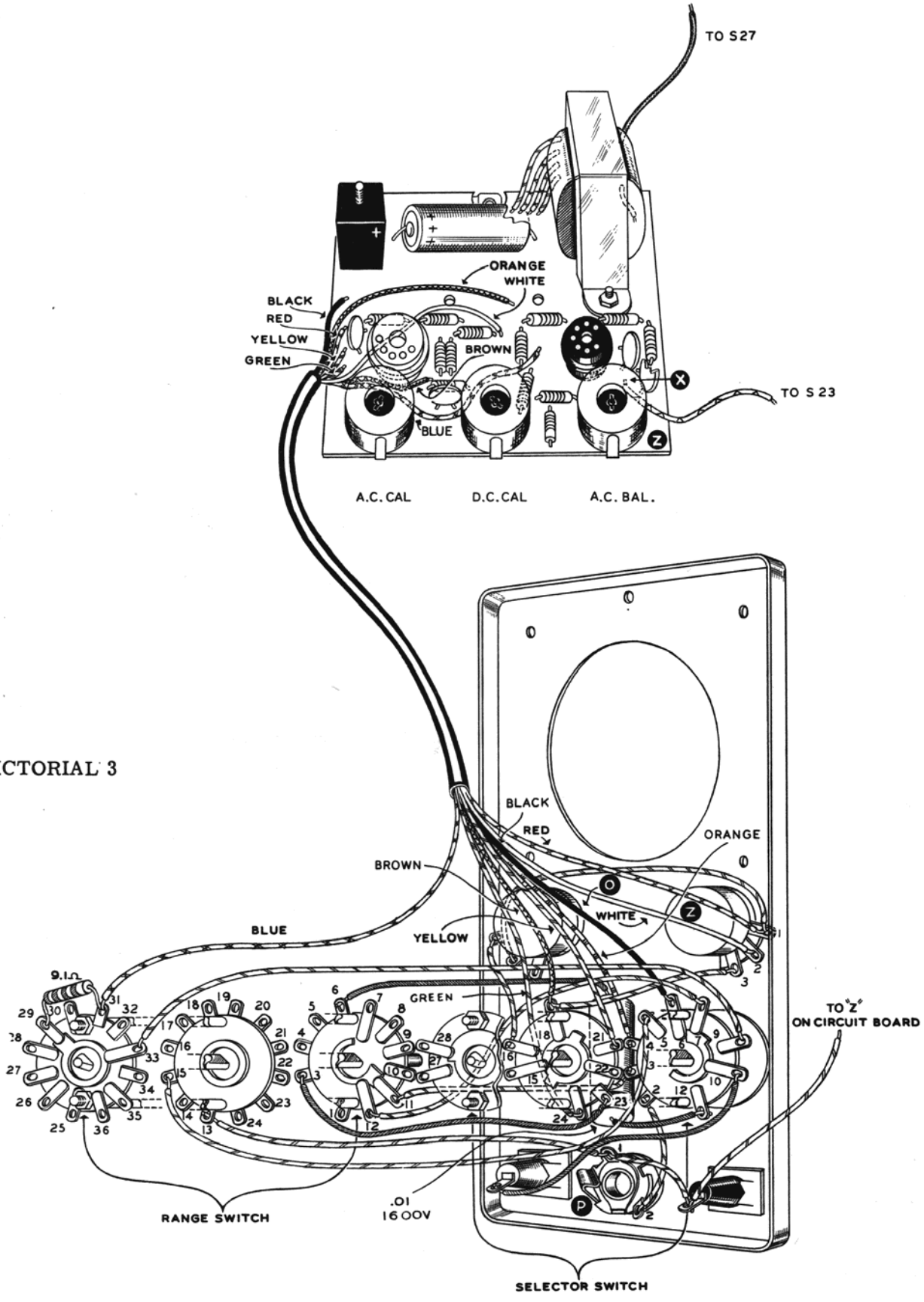
( ) Prepare the 8-wire cable by removing 4" of sheath at the free end. Do not cut the green and blue wires but shorten all others to a length of 3" from the end of the sheath. Again remove about 3/16" of insulation. As a matter of convenience, all wires will be connected to the panel assembly before actually mounting the circuit board.

( ) Connect orange wire to S4 (S).

( ) Connect black wire to S6 (S).

( ) Connect white wire to Z2 (S).

( ) Connect red wire to Z1 (S).


TO S27
ORANGE
WHITE
BLACK
RED
YELLOW
GREEN
BROWN
BLUE
TO S 23
A.C. CAL
D.C. CAL
A.C. BAL.
BLACK
RED
ORANGE
BROWN
WHITE
BLUE
YELLOW
GREEN
9.1Ω
TO "Z" ON CIRCUIT BOARD
RANGE SWITCH
.01
1600V
SELECTOR SWITCH

PICTORIAL 3