PRICE $2.00

Assembling and Using your

CONAR

Tube Tester

Model 224

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.

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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.

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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.

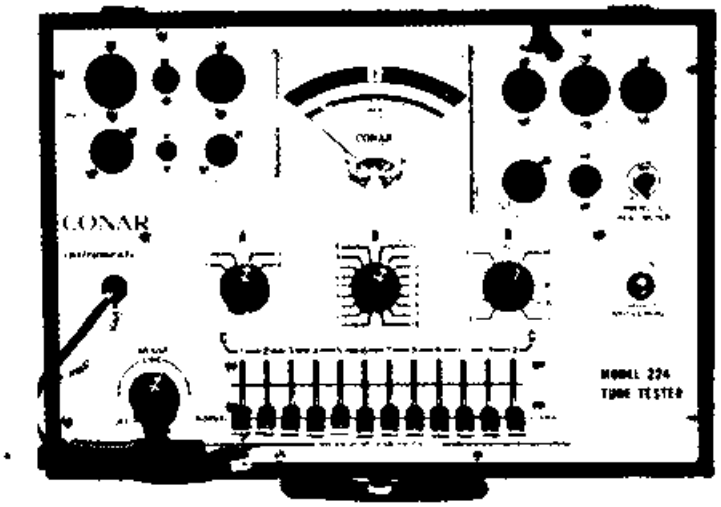
(3) A part has a defect. DEFECTIVE MATERIALS MUST BE RETURNED BEFORE A REPLACEMENT CAN BE MADE. TWO THINGS MUST BE WITH EVERY PACKAGE YOU RETURN TO US: (1) Your name and address, (2) Your reason for returning it. You may enclose a letter in the package, if you mark the package "first class letter enclosed." 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.

CONAR INSTRUMENTS DIVISION OF NATIONAL RADIO INSTITUTE, WASHINGTON, D.C. 20016

The CONAR Model 224 Tube Tester

THE MODEL 224 TUBE TESTER



SPECIFICATIONS CONAR MODEL 224 TUBE TESTER

ACCOMMODATES ALL AVAILABLE TUBE TYPES: 17 separate heater voltages from 0.75 volts to 117 volts provide *exact* operating voltages for all tube types including picture tubes. 11 sockets accommodate 4-pin, 5-pin, 6-pin, 7-pin large, 7-pin miniature, 9-pin miniature, 10-pin miniature, octal, loctal, novar, decal, nuvistor and compactron base tubes. With separate adapters, the Model 224 will also test all black-and-white and color picture tubes.

OPEN ELEMENT TEST: Special test setup allows testing for internal connections used on many tube types.

12-LEVER ELEMENT-SELECTOR-DISTRIBUTION SWITCH: This group of 3-position switches provides the Model 224 with the versatility needed to perform complete evaluation tests on all tube types – old, present, and future. These special switches provide complete flexibility and assure that the Model 224 will never become obsolete when manufacturers introduce new tube types.

INDEPENDENT HEATER TERMINAL SELECTION: This system accommodates all tube heater types – single, double or center-tapped – regardless of terminal connections. The special 12-lever switch makes this feature possible.

HEATER CONTINUITY TEST: This test quickly shows up open heaters, including open sections of tapped or multisection heaters.

SPECIAL TUBE TESTS: The Model 224 tests special purpose tubes such as "magic eye" and cold cathode rectifier tubes.

TESTS MULTISECTION TUBES: The Model 224 provides independent tests for each section of multisection tubes.

CATHODE LEAKAGE TEST: Reliable, sensitive neon lamp detects heater-cathode leakage as high as 1 megohm.

INTER-ELEMENT SHORT TEST: This test spots shorts or leakage between any elements of a tube. It also detects leakage between sections of multisection tubes.

QUALITY TESTS: The large, easy-to-read, clear-plastic cased meter gives cathode conductance (emission) on a 0 to 100 scale. The scale is also marked with multicolored "REPLACE – ? – GOOD" segments for quickly checking emission.

LINE ADJUSTMENT: The Line Adjust circuit compensates for high or low power line voltages to assure consistent, reliable tests. The correct line voltage setting is indicated directly by the panel meter.

TEST CIRCUITS TRANSFORMER OPERATED: The special fuse-protected heavy duty power transformer provides complete isolation of the test circuits from the power line. This assures utmost safety to both the operator and the instrument. Dual-tapped secondary windings provide separate circuits for the heater and test voltages.

POWER CONSUMPTION: Depends upon the tube being tested. Standby power consumption is 8 watts with 120 volt ac line voltage.

DIMENSIONS: 15-1/4" X 10-1/2" X 6-1/8" (lid in place)

WEIGHT: 10-1/2 pounds

Operating Instructions

Operating the Model 224 is as simple as "ABC". To gain familiarity with the instrument, first read the instructions in this section carefully, and then try your hand at testing a few tubes you know to be good. After you have tested one or two tubes, the steps in the test procedure will become almost automatic. Should you need an occasional reminder, there is a condensed version of the operating instructions printed on the inside front cover of your Tube Data Manual.

INSTRUMENT DESCRIPTION

The heart of the Model 224 is the 12-lever switch. With this switch, any tube pin can be connected to any of three circuits. The individual switches, numbered 1 through 12, correspond to the twelve possible tube pins. That is, switch 1 connects to pin 1 of all sockets, switch 2 connects to pin 2 of all sockets, and so on. Switch 10 connects to pin 10 of all sockets as well as to the top cap connector.

Note that all sockets do not require all twelve switches. In fact, the compactron socket is the only one having 12 pins, thus requiring all 12 switches. The other sockets will use the first 6, 7, 8, 9 or 10 switches. The five pins of the nuvistor sockets, however, do *not* connect to switches 1 through 5. The tube manufacturers have chosen to call these five pins 2, 4, 8, 10 and 12, so this socket uses switches 2, 4, 8, 10 and 12.

When any of the twelve switches is in the TEST (middle) position, an ac voltage is applied to the corresponding tube pin through the neon lamp. If there is a conductive path of 1 megohm or less between the selected tube electrode and any other electrode, the neon lamp will glow. In this way inter-element shorts and undesirable leakage between electrodes may be discovered. This same circuit can be used to check heater continuity, in which case the lamp *should* glow if the tube heater is good.

When the switch corresponding to the tube heater is placed in the C position (upper), heater voltage is applied to the tube by the B selector switch. Any of 17 separate heater voltages may be chosen by the B switch (position 18 is not used). With the proper switch set to C, the tube heater will light. All other tube elements except the cathode and the other heater connections are placed in the TEST position by setting the appropriate switches. This connects the tube as a diode. When the Press-To-Read-Meter switch is pushed, the neon lamp is disconnected and a voltage and load resistor combination selected by the A switch is connected instead. At the same time, the meter is disconnected from the Adjust Line circuit and reconnected to read the tube current. The current can be read either on the 0 to 100 scale or the REPLACE – ? – GOOD scale.

STEP-BY-STEP OPERATION

Step 1: Connect the power cord to a commercial 120-volt ac source (50-60 Hz).

Step 2: Locate the tube to be tested in the separate Tube Data Manual.

Step 3: Set the A and B switches and the D control as indicated for the tube to be tested. Place all of the lever switches in the NORMAL position.

Step 4: Insert the tube into the proper socket.

Step 5: Turn the Line Adjust control clockwise until the meter pointer is over the mark labeled "ADJUST LINE".

Step 6: Place the lever switch listed under C in the Tube Data Manual in the TEST position. The neon lamp should light if the heater of the tube is good. Reject the tube if the neon lamp does not light. If the lamp lights, move the switch on to the C position and reset the Line Adjust control as in Step 5.

Step 7: Place all lever switches listed under CATH SHORTS in the TEST position. The lamp must *not* glow. Tap the tube lightly when making this test to see if an intermittent short is present. If the lamp glows, the tube has excessive heater-cathode leakage and should be rejected without further testing. Return all switches used in this test to the NORMAL position.

Step 8: Elements which are supposed to be connected together inside the tube (if any) are listed in the tube data. Place each such switch one at a time in the TEST position. The neon lamp must glow when each switch is in the TEST position. Reject the tube without further testing if there is no glow.

Step 9: Place each of the lever switches listed in the TEST column of the Tube Data Manual in the TEST position, *one-by-one in the order listed*. The neon lamp must *not* glow unless otherwise indicated by the tube data. (Ignore momentary flashes of the lamp which are due to a series capacitor charging and discharging in the lamp circuit.) A steady glow indicates a shorted condition and the tube should be rejected without further testing. Tap the tube lightly as each switch is put in the TEST position to reveal any intermittent mechanical shorts.

Step 10: With all switches listed under TEST in the TEST position, press the Press-To-Read-Meter button and observe the quality of the tube on the meter.

If you suspect an open element in the tube being tested, you can easily test for such a condition. Return all switches that were in the TEST position to

the NORMAL position. Then, while holding the Press-To-Read-Meter button in, move each of the same switches one at a time to TEST and back to NORMAL while watching the meter. Each switch should produce *some* deflection of the meter. Some switches will produce more deflection than others; however, it is unimportant exactly how much deflection is produced. If any switch fails to cause a deflection of the meter, the element connected to that switch is open.

Step 11: If the tube you are testing is a multisection tube, return all switches to the NORMAL position and reset the A, B, and D controls to the settings indicated for the next section of the tube. Then go back and repeat Steps 1 through 10 for this section of the tube.

Letter abbreviations are used in the Tube Data Manual to identify the various tube sections. These are:

a	= amp	p	= plate
d	= diode	pe	= pentode
e	= eye	r	= rectifier
h	= heptode	s	= section
he	= hexode	t	= triode
i	= input	te	= tetrode
o	= output	to	= total

Tubes having novar and magnoval bases appear quite similar. Each type is indicated in the Tube Data Manual so that you will be able to use the correct test socket. Magnoval tubes have the symbol ▲ beside the tube number and novar tubes have the symbol ● beside the tube number.

Octal and loctal tubes are also similar in appearance. The loctal tube can be readily identified by its wire pins (small diameter). All sockets are identified by labels on the panel of the Model 224.

The CONAR stock no. 3AD picture tube adapter cable is designed to adapt the Model 224 to the emission test of all types of modern picture tubes with the exception of 110° types.

The CONAR stock no. 5AD picture tube adapter cable is designed to adapt the 3AD cable described previously to the emission test of both types of modern 110° picture tubes.

A special adapter for testing color picture tubes will soon be available for the Model 224. You will be notified when this adapter is available. Complete instructions are included with each adapter.

SPECIAL TESTS

In addition to the usual tube types, the Model 224 can also test certain gas tubes, electron ray indicator tubes ("magic eye") and several obsolete special-purpose tubes. These tubes require slightly different operating procedures which will be discussed in this section.

"EYE TESTS" (Electron ray-type indicator tubes)

> **NOTE**
> For a complete short test on "EYE" tubes, watch for neon lamp glow when the indicated switches are placed in the TEST position, the same way as is done for all other tubes.

Single Target Type. 6E5 and 6G5 tubes are typical single target electron ray indicators. For example, the data for the "EYE" section of the type 6E5 appears as follows:

TUBE		A	B	C	D	SHORTS	TEST
6E5	EYE	4	8	1	0		2-4

The following test procedure must be used:

(1) Set all switches and controls as indicated.
(2) Press the READ METER button and observe the circular fluorescent screen which should illuminate completely. Disregard meter indications.
(3) Place the first of the two switches indicated under the TEST heading (switch 2 in this example) to the NORMAL position. A good tube will now exhibit a typical angular shadow. Return the same first switch to its original TEST position and observe closure of the shadow.

Double Target Type. 6AD6 and 6AF6 tubes are typical double target electron ray indicators. For example, the data for type 6AD6 appears as follows:

TUBE		A	B	C	D	SHORTS	TEST
6AD6	EYE	4	8	2	0	8	3-4-5

The test procedure is as follows:

(1) Set A, B, C and D as indicated on supplementary chart.
(2) Perform the cathode short test by moving switch 8 to the TEST position and back to the NORMAL position, observing the neon lamp for "short" indications while the switch is in the TEST position.
(3) Set switches 3, 4, and 5 to the TEST position and observe the neon lamp for "short" indications.
(4) Press the READ METER button and observe the circular flourescent screen which should illuminate completely. Disregard meter indications.
(5) Place the first of the three switches under the TEST heading (switch 3 in this example) to the NORMAL position. A good tube will now exhibit a typical angular shadow.
(6) Place the second of the three switches under the TEST heading (switch 4 in this example) in the NORMAL position. A good tube will now exhibit another angular shadow, opposite the position occupied by the first shadow.
(7) Return switches 3 and 4 to the TEST position and note the closure of the shadows.

FM/AM Tuning Indicator Tubes. An example of this type of electron ray tube is type 6AL7, the data for which appears as follows:

TUBE		A	B	C	D	SHORTS	TEST
6AL7	EYE	1	8	*2	0	8	1-3-4-5-6

*(6AL7 – Also throw 4-5-6 to C position)

The test procedure is as follows:

(1) Set A, B, C and D as indicated on supplementary chart.
(2) Perform the cathode short test.
(3) Set switches 1, 3, 4, 5 and 6 to the TEST position and observe the neon lamp for short indications.
(4) Move switches 4, 5, and 6 to the C position.
(5) Press the READ METER button and note the two rectangular fluorescent patterns on the screen of the tube. Disregard meter indications.
(6) With the READ METER button depressed, move the first switch listed in the parenthesis note (switch 4 in this example) from its C position to the NORMAL position. One rectangular pattern should become shorter in length.
(7) With the READ METER button still depressed, move the third switch listed in the parenthesis note (switch 6 in this example) from the C position to the NORMAL position. The other rectangular pattern should then become shorter in length.
(8) Move the second switch listed in the parenthesis note (switch 5 in this example) from the C position to the NORMAL position. Both patterns should then become shorter in length from the ends opposite to those previously affected. Observe the ends closely as the movement may be slight.

SPECIAL RECTIFIER TEST (Types 70A7, 117N7, 117P7)

Because of unusual internal connections (one side of the filament connects to the plate), the rectifier sections of types 70A7, 117N7, and 117P7 require special test procedures. Caution must be exercised in performing these tests to minimize the possibility of filament burn-out.

70A7 – Rectifier Section.

(1) Set A, B, C and D as indicated on the supplementary chart.
(2) Perform the cathode short test.
(3) After the tube has heated sufficiently, move switches 2, 6, and 7 *rapidly* to the TEST position, and *quickly* depress the READ METER button. The first meter indication obtained is the significant one, since the pointer will quickly fall back as the tube filament cools. Make absolutely certain that all three switches (2, 6, and 7) are in the TEST position before the READ METER button is depressed.

117N7 and 117P7 – Rectifier Section.

(1) Set A, B, C and D as indicated on the supplementary chart.
(2) Perform the cathode short test.
(3) After the tube has heated sufficiently, move switches 2 and 7 *rapidly* to the TEST position, and *quickly* depress the READ METER button. The first meter indication obtained is the significant one, since the pointer will quickly fall back as the tube filament cools. Make absolutely certain that both switches (2 and 7) are in the TEST position before the READ METER button is depressed.

GAS TYPE RECTIFIERS

When testing rectifier types such as OY4, OZ3, and OZ4, it will be noted that the meter pointer will remain in the REPLACE sector for a brief period and then deflect quickly into the GOOD sector. This condition is normal for a good gas rectifier. Should the pointer remain in the REPLACE sector after several seconds have elapsed, the tube should be rejected.

TUBE-BRAND VARIATIONS

In determining the tube test limits for this instrument, CONAR engineers have spent considerable time checking tubes from the production runs of leading tube manufacturers. From the information gathered, the data in the Tube Data Manual accompanying this instrument has been compiled.

Due to the fact that extensive research is constantly being made in the television and radio tube industry to improve and stabilize tube characteristics, it is not uncommon for a manufacturer to make a change in the specifications of a particular tube. This change, though perhaps not readily noticeable in set performance, may become apparent when the tube is tested on your Model 224, and may necessitate a new test limit for that particular type.

Therefore, should a particular type be found to vary consistently from the assigned average Tube Data Manual limits, simply determine the new average setting for control D that will produce a reading of approximately 70 on the 0 to 100 scale directly below the three color quality scale.

Keep in mind that consistently high or low readings for any particular manufacturer's tubes of a certain type are not necessarily indicative of a poorer or better run of tubes or a defect in your tube tester.

In line with CONAR's desire to extend utmost service to builders and users of CONAR test equipment kits, new tube test data is available periodically as new tubes are introduced. You will be notified automatically as this data becomes available.

Maintenance

Your CONAR tube tester is capable of fulfilling continuous daily service requirements over a period of many years. However, in order for you, the user, to fully realize these capabilities, the same degree of care in operation and maintenance should be accorded your instrument that would be given any other fine piece of equipment.

There is always the possibility that repairs will be necessary with any piece of test equipment. Should your tube tester require servicing, just remember that the same logical processes of elimination apply as they do for any electrical circuit, and you should experience no difficulty. The checks outlined under "In Case of Trouble", will aid you considerably. Proper operating voltages are shown on the schematic on page 7. A variation of ±20% in these readings is entirely acceptable.

Should failure of the meter movement coil be suspected, the continuity may be checked with an ohmmeter if a limiting resistor of approximately 10k-ohms is first connected in series with the ohmmeter test leads. *Never* test meter coil continuity directly with an ohmmeter. Excessive current from the ohmmeter battery will invariably ruin the meter coil and will definitely result in an open condition.

Do *not* attempt repair of the meter movement coil at any time. This will automatically void our standard warranty coverage of the meter movement.

Should the clear plastic meter cover become damaged, you may obtain replacement of the cover only from CONAR Instruments. To remove the cover, insert a small screwdriver or knife blade under one of the upper corners and gently pry upward. This is a friction fit, and it should pop right off. When installing a new cover, be careful to properly engage the small plastic stud on the cover with the slotted zero adjust lever on the meter movement. Do not leave the meter movement exposed to the air for any length of time. Accumulations of dust and other foreign matter can seriously impair the operation of this delicate instrument. Should you find it necessary to have the plastic cover removed for any time, protect the movement by enclosing it in a box.

The clear plastic meter cover may occasionally, through repeated polishing or cleaning, accumulate charges of static electricity. This will cause the pointer to deflect erratically, regardless of whether the instrument is turned on or off. These static charges may easily be removed by using one of the commercially available anti-static solutions or a solution of any good liquid detergent (of the type used for washing dishes) and water. Simply dip a clean, soft cloth in the solution and wipe the surface of the meter cover. The cover need not be removed for this operation.

IN CASE OF TROUBLE

There are very few things that can go wrong with the Model 224, but in the event that you ever have difficulty with the instrument, here are a few suggestions of things to look for.

The most useful piece of test equipment would be a tvom or vom for measuring resistances and voltages. There are only 11 resistors in the tube tester, and each can easily be checked with an ohmmeter. R_4 and R_5 are 5% resistors and should measure very close to 470 ohms and 47k ohms respectively. All other resistors have a tolerance of 10%.

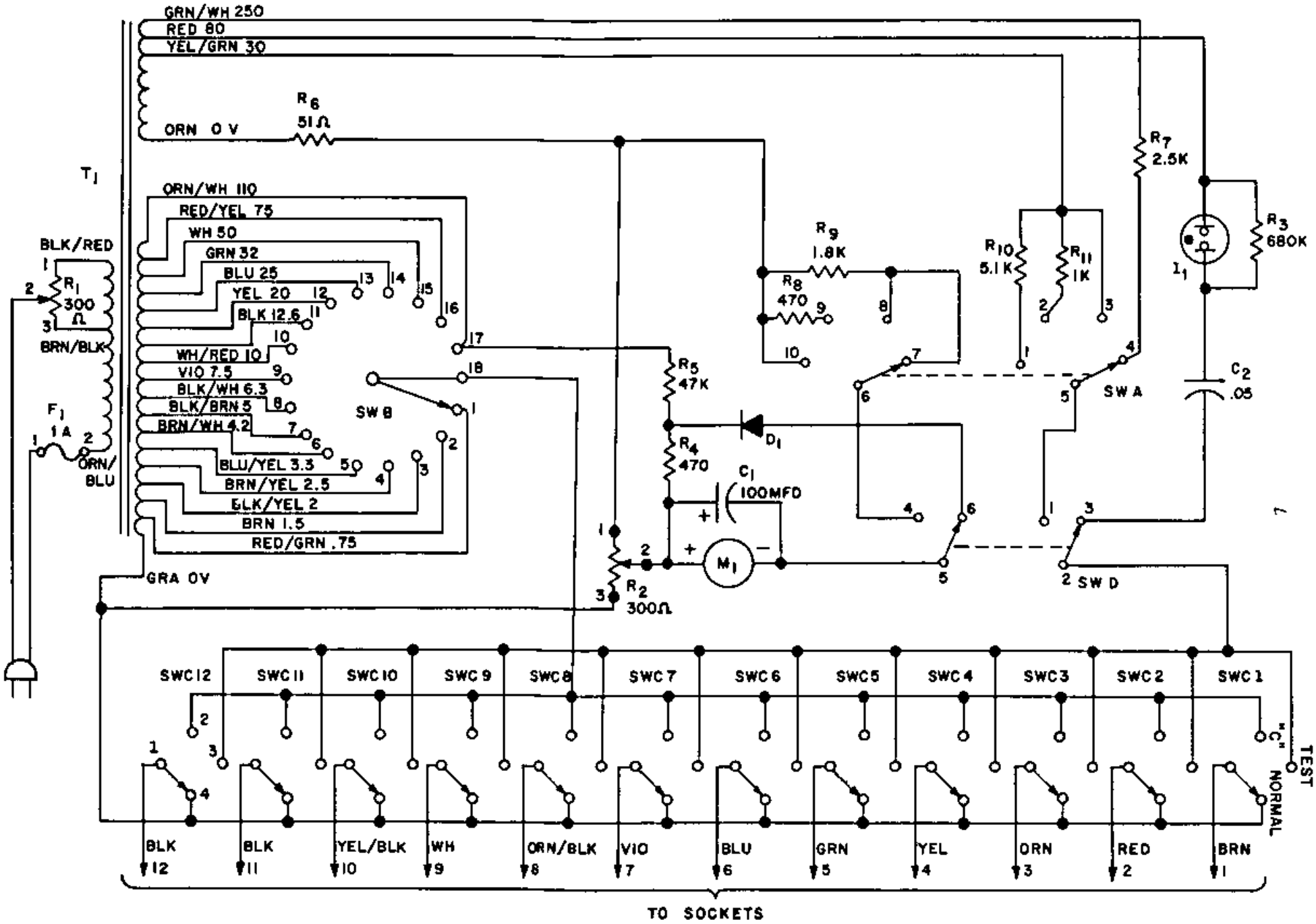
Use the ac voltmeter to measure the voltages supplied by the transformer. There are three separate circuits to measure: the primary, the test winding, and the heater winding. Measure the primary voltage from the orange/blue transformer wire connected to the fuse to the brown/black and black/red wires connected to R_1. The heater windings all connect to the 18-position switch, SWB, as indicated on the schematic diagram. The common (0 volt) gray wire for the heater voltages connects to SWC1-4.

The wiring to the sockets themselves can be checked very simply using the neon lamp short indicator. With the instrument turned on but with no tube in any of the sockets, place all of the lever switches in the NORMAL position. Next, starting with switch 1, move the lever to the TEST position and back to NORMAL. The neon lamp must *not* light. If it does, there is a short circuit between the wiring going to pin 1 of the sockets and some other socket connection. We will see in a moment how to find out which other socket connection.

Check all of the tube elements for short circuits just as you did with the first switch. If any switch causes the neon lamp to light, leave the switch in the TEST position and continue to check the rest of the switches. One of the other switches, when placed in the TEST position, should cause the neon lamp to go out. The short circuit exists, then, between the socket connections of the two switches which are in the TEST position. A close visual examination of all of the tube sockets should find the trouble.

In the unlikely event that the procedure just outlined does *not* produce results (no two switches in the TEST position cause the lamp to go out), then there is a possibility that the short circuit exists between more than two socket pins. In this event use the following procedure to find the short circuit.

As before, if any of the switches causes the neon lamp to glow, leave the switch in the TEST position and continue to test the rest of the switches. This time, however, leave the switch in the TEST position rather than moving it to TEST and back to NORMAL. Eventually the neon lamp will go out, indicating that the short exists between some of the switches that are in the TEST position. The first switch you placed in the TEST position (which caused the lamp to light) must be involved in the short circuit and the last switch placed in the TEST position (which caused the lamp to go out) must also be involved. Therefore, move the other switches one at a time from the TEST position to the NORMAL position to discover the third guilty connection. As you move one of the switches from TEST to NORMAL, the lamp will once again light.



Schematic diagram of your CONAR Model 224 Tube Tester.

As an example, let's suppose that we found the following symptoms in this order:

SWITCH	EFFECT
1-	None
2-	None
3-	Lights lamp
4-	Left in TEST
5-	Left in TEST
6-	Left in TEST
7-	Lamp goes out
STOP	

Switches 3 and 7 are involved in the short circuit, so we can forget them. Now move 4, 5, and 6 one at a time from TEST to NORMAL. When the lamp lights, say when switch 5 is moved to NORMAL, the test is complete. The short circuit must exist somewhere in the socket wiring between pins 3, 5, and 7.

If you suspect an open circuit to any of the socket connections, you can also use the neon lamp to check for this condition. Set all lever switches except No. 10 to NORMAL. Place the No. 10 switch to TEST. Now take a short length of bare wire and force it between the two halves of the top cap connector to make a "test probe".

Starting with any of the sockets, insert the other end of your "probe" into each of the holes of the socket to touch the metal pin contact of the socket. The neon lamp should light for every pin of every socket except for pin No. 10 of the nuvistor, compactron, 9-10 pin miniature and decal sockets. To check these pins, move the No. 10 switch to NORMAL and move the No. 2 switch to TEST. Insert the "probe" of the top cap connector into the pin 2 socket connection for these four sockets. The lamp should light.

This test will show you exactly which socket connection is open. Removing the panel from the cabinet and inspecting the socket connection should reveal the trouble.

Assembly Instructions

The CONAR kit you have purchased is a high quality instrument. When assembled and used as described in this manual, it will provide many years of trouble-free service. Therefore, if you work carefully and patiently, you will have more satisfaction with your new instrument and greater confidence in your ability.

Manual. We suggest that you spend a little time *now* and read the manual thoroughly before starting the actual construction of the kit. This will familiarize you with the parts used and the general procedure to be followed.

The step-by-step instructions will help you assemble the instrument with a minimum possibility of error.

Keep this manual for ready reference in the use and maintenance of your CONAR instrument.

Unpacking. Be careful as you unpack the kit. Parts could become damaged through carelessness. Do not throw away any packing materials until you account for all parts. Check the parts against those shown in Fig. 1 (page 11) and listed thereafter. In some cases we may substitute parts of slightly different physical appearance but with the specified electrical characteristics. For example, a .047-mfd capacitor may be substituted where a .05-mfd capacitor is called for in the parts list. Such a substitution has been checked carefully and will work satisfactorily. After checking the parts against the parts list, put them where they won't be lost or damaged. If any part seems to be missing, write us at once so we can supply a replacement.

Tools Required. Only standard tools are required in the construction of CONAR kits – a good quality soldering iron (25 to 40 watts) with a small tip, a pair of longnose pliers, a pair of side-cutting pliers, an assortment of screwdrivers, and an inexpensive pair of wire strippers. Nut-drivers with a screwdriver handle may be used in place of wrenches in most cases.

Assembly and Wiring. The position of wires and parts in this instrument is critical in some cases, and changes may affect the operation. Follow the diagrams closely and you should encounter little, if any, difficulty because the layout has been thoroughly checked and tested for best results.

When wiring, remove only about 1/4" of insulation from the ends of hookup wire. Removing any excessive amount of insulation may result in the exposed wire shorting to nearby terminals or wiring. Leads on parts (resistors, capacitors, etc.) should be trimmed to proper length after mounting. Do not cut leads too short! All parts should fit between mounting points without strain.

Soldering. To obtain satisfactory performance, good solder joints are essential. Read and follow the instructions on soldering which are included with this kit. Read this sheet *now*.

Service Policy. CONAR Instruments offers its full cooperation and assistance to help you obtain the specified performance from your instrument. We maintain a complete Consultation Service with which you may correspond if you experience difficulties with your completed instrument. We will inspect and repair this tube tester for a minimum service charge of $5 plus cost of parts, provided it has been constructed and completed according to instructions in this manual. This special repair service is available for one year from purchase date. Repair service for CONAR instruments that have been used longer will be available for CONAR owners at most economical charges.

Instruments that have been modified in design will not be accepted for repair. Instruments showing evidence of the use of *acid core solder* or *paste flux* will be returned not repaired.

Instruments for repair or service *must* be returned to us, transportation charges *prepaid* according to the following shipping instructions.

Shipping Instructions. When returning this instrument, be sure the power transformer is securely mounted as described in this manual. Always pack instruments carefully in a rugged, *oversized* container, using a generous supply of padding such as excelsior, shredded paper, or crumpled newspaper. You can ship in the original kit carton. Attach a tag to the instrument giving your name, address, and trouble experienced. Never return an instrument unless it is accompanied by a full explanation of difficulties encountered.

Please ship via REA Express *prepaid* and address to:

CONAR Instruments
3939 Wisconsin Avenue
Washington, D.C. 20016

A *fragile* label should appear on at least four sides of the carton.

Return shipment by CONAR will be by REA Express *collect*, including repair service charges, unless otherwise requested.

Please note that a carrier cannot be held liable for damage in transit if, in *his opinion*, packing is insufficient.

Step-by-Step Assembly. These instructions were prepared from experience in actually constructing this CONAR kit. You will find them arranged in a logical sequence, with every consideration given to the practical aspects of kit assembly. We feel the instructions offer the fastest and best method of assembling your CONAR kit. *Do not* build from the schematic even though you are thoroughly familiar with such diagrams.

Read each step thoroughly and understand the step completely before performing it. This will help you avoid errors.

Some of the instructions are given in the form of tables. These tell you which part or wire is to be connected, where it is to be connected, and if the connection is to be soldered at that time. If other connections are to be made to the same point, you will usually be told not to solder the connection until later. In that case, just crimp the lead to the terminal and proceed to the next step. This will help avoid omissions.

To aid you in placing components, we use a system of alphabetical and numerical coding. Switches are coded with a letter designation of "SW". Because there is more than one

component of this type, distinction is made by adding letters. For example, "SWA" indicates one switch, and "SWB" indicates a second switch, etc. The special 12-lever switch is SWC. All controls and resistors are coded with an "R" designation followed by a number (R_1, R_2, etc.). All capacitors are coded with a "C" designation followed by a number (C_1, etc.). These designations appear on the schematic, in the step-by-step instructions, and in the wiring diagrams.

Other items, such as ground lugs, grommets, and terminal strips, have been assigned letter designations having no particular reference to function.

We have assigned numbers to terminals on the various components. Thus, "SWA2" indicates terminal 2 of switch "SWA;" "SWB3" indicates terminal 3 of switch "SWB," etc. The terminals on the controls are referred to as R_1-1, R_2-3, etc.

Each wafer of the 12-lever switch has been given a number, and each wafer has 4 terminals. To completely describe each of the 48 terminals of SWC, we use the following scheme. Terminal No. 2 of the third wafer will be referred to as SWC3-2.

The assembly is divided into four stages. The main mechanical components are mounted first. The next stage involves wiring the tester circuits with the exception of the power transformer. In the third stage the power transformer is mounted in the case and its leads are connected. Finally, the various knobs are attached to the shafts passing through the front panel.

You are ready to build your CONAR Tube Tester.

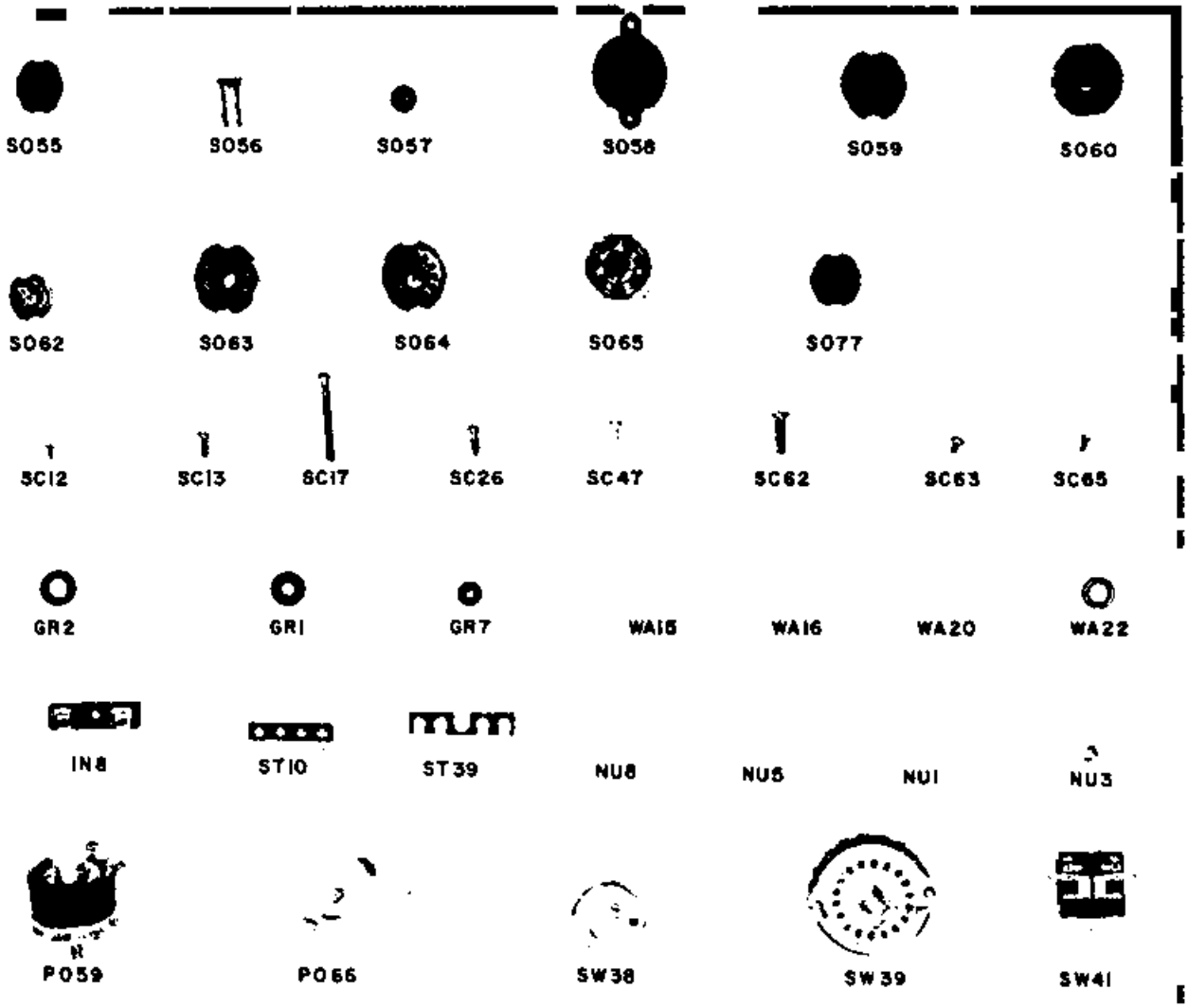


Fig. 1. Parts for CONAR Model 224 Tube Tester.

Quan.	Part No.	Description	Price Each
2	BR40	Transformer mounting bracket	.20
1	CB21	Cabinet	8.25
1	CL30	Top cap connector	.23
3	CL31	Wedge-lok band cable clamp	.08
2	CL32	Cable clamp	12/.25
1	CN8	.05-mfd capacitor	.15
1	CN112	100-mfd, 10V electrolytic	.25
1	FU6	Fuse	.22
1	GR1	3/8" grommet	12/.25
1	GR2	1/2" grommet	.05
1	GR7	5/16" grommet	.06
2	HA5	3/8" spacer	.08
1	HA13	Solder	.64
1	IN8	Fuse holder	.15
4	KN21	Pointer knob	.15
12	KN27	Push-on knob for lever switch	.08
1	KN28	Push-on knob for push-to-read switch	.08
1	LP2	Neon lamp	.35
1	ME15	Meter	9.50
19	NU1	6-32 hex nut	12/.15
4	NU3	8-32 hex nut	12/.15
6	NU5	4-40 hex nut	12/.15
2	NU8	2-56 hex nut	12/.15

Quan.	Part No.	Description	Price Each
1	PA38	Panel	3.52
1	PC1	Power cord	.40
1	PO59	300-ohm, 25W control w/nut and flat washer	3.77
1	PO66	300-ohm, 3W control w/lockwasher, nut, and flat washer	1.37
1	RE28	470-ohm, 1/2-watt resistor	.15
1	RE30	1k-ohm, 1/2-watt resistor	.15
1	RE60	680k-ohm, 1/2-watt resistor	.15
1	RE110	1.8k-ohm, 1/2-watt resistor	.15
1	RE137	5.1k-ohm, 5%, 1/2-watt resistor	.24
1	RE138	51-ohm, 5%, 1/2-watt resistor	.24
1	RE161	470-ohm, 5%, 1/2-watt resistor	.24
1	RE169	47k-ohm, 5%, 1/2-watt resistor	.24
1	RS20	2.5k-ohm, 5-watt resistor	.66
2	SC12	1/4" X 2-56 screw	12/.25
2	SC13	3/8" X 6-32 screw	12/.15
4	SC17	1-1/2" X 8-32 screw	12/.15
1	SC24	1/2" X 6-32 screw	12/.15
8	SC26	1/2" wood screw	12/.15
2	SC47	9/16" X 6-32 screw	12/.25
4	SC62	3/4" X 10-32 thread-cutting screw	6/.25
17	SC63	1/4" X 6-32 screw	12/.25
6	SC65	1/4" X 4-40 screw	12/.25
1	SO55	9-10 pin miniature socket	.26
1	SO56	Bayonet base lamp socket	.20
1	SO57	5-pin nuvistor socket	.20
1	SO58	Combination 4, 5, 6, prong socket	1.15
1	SO59	8-pin loctal socket	.51
2	SO60	9-pin novar socket	.15
1	SO62	7-pin miniature socket	.12
1	SO63	8-pin octal socket	.16
1	SO64	12-pin compactron socket	.24
1	SO65	7-pin large socket	.28
1	SO77	10-pin decal socket	.20
1	SR17	Meter rectifier	.21
1	ST10	3-lug terminal strip	.09
1	ST39	4-lug terminal strip	.09
1	SW38	2-pole, 4-position rotary switch (SWA) w/nut and flat washer	1.12
1	SW39	18-position rotary switch (SWB) w/nut and flat washer	2.10
1	SW40	12-gang lever switch (SWC)	6.24
1	SW41	DPDT push button switch (SWD)	.71
1	TR71	Power transformer	13.34
23	WA15	No. 6 lockwasher	12/.15
4	WA16	No. 8 lockwasher	12/.15
2	WA20	No. 2 lockwasher	12/.15
4	WA22	No. 10 cup washer	12/.15
1	WR46	10' red wire	.25
1	WR47	4' green wire	.20
1	WR57	4' orange wire	.20
1	WR76	3' No. 16 bus wire	.20
1	WR233	4' orange/black wire	.20
1	WR224	42" white wire	.20
1	WR238	Grid cap lead	.20
1	WR249	4' yellow wire	.20
1	WR303	5' black wire	.20
1	WR304	4' brown wire	.20
1	WR305	4' blue wire	.20
1	WR290	4' violet wire	.20
1	WR306	2' yellow/black wire	.20

MECHANICAL ASSEMBLY

The mechanical assembly of the parts on the panel is divided into two separate stages. In the first stage you will mount the 11 tube sockets. In the second stage you will mount the remaining parts on the panel.

Locate the panel and carefully remove the protective covering from the brushed aluminum front. As you will work on the panel with its front side down, you should cover your work area with a soft cloth such as a bath towel. This will protect the brushed aluminum front from accidental scratches. The other side of the panel is the "rear" of the panel, and all parts will be mounted from the rear.

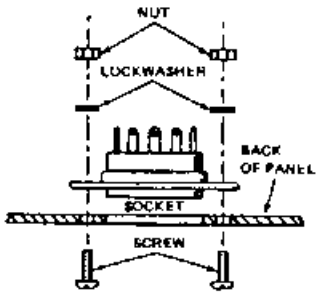


Fig. 2. Mounting a socket on the back of the panel.

Fig. 2 shows how to mount the sockets. Pass the mounting screws through the mounting holes from the front of the panel, then through the socket. Place lockwashers on the screws and secure with nuts. All sockets, except the nuvistor socket (Step 5), will fit up into the hole in the panel as shown in Fig. 2.

Be very careful not to interchange the novar socket (Step 8) and the magnoval socket (Step 4). Both sockets look very much alike. However, the magnoval socket can be identified by the fact that the mounting holes are slightly closer together than those of the novar socket. Both sockets have 9 pins.

Fig. 3 shows the locations of the 11 sockets to be mounted in this stage of the assembly. Now using Figs. 2 and 3 for reference, install all 11 sockets according to the instructions in Table I. Check off each step in the left-hand column as you come to it and check off each step in the right-hand column after you have mounted the socket. This gives you a "double-check" of your work.

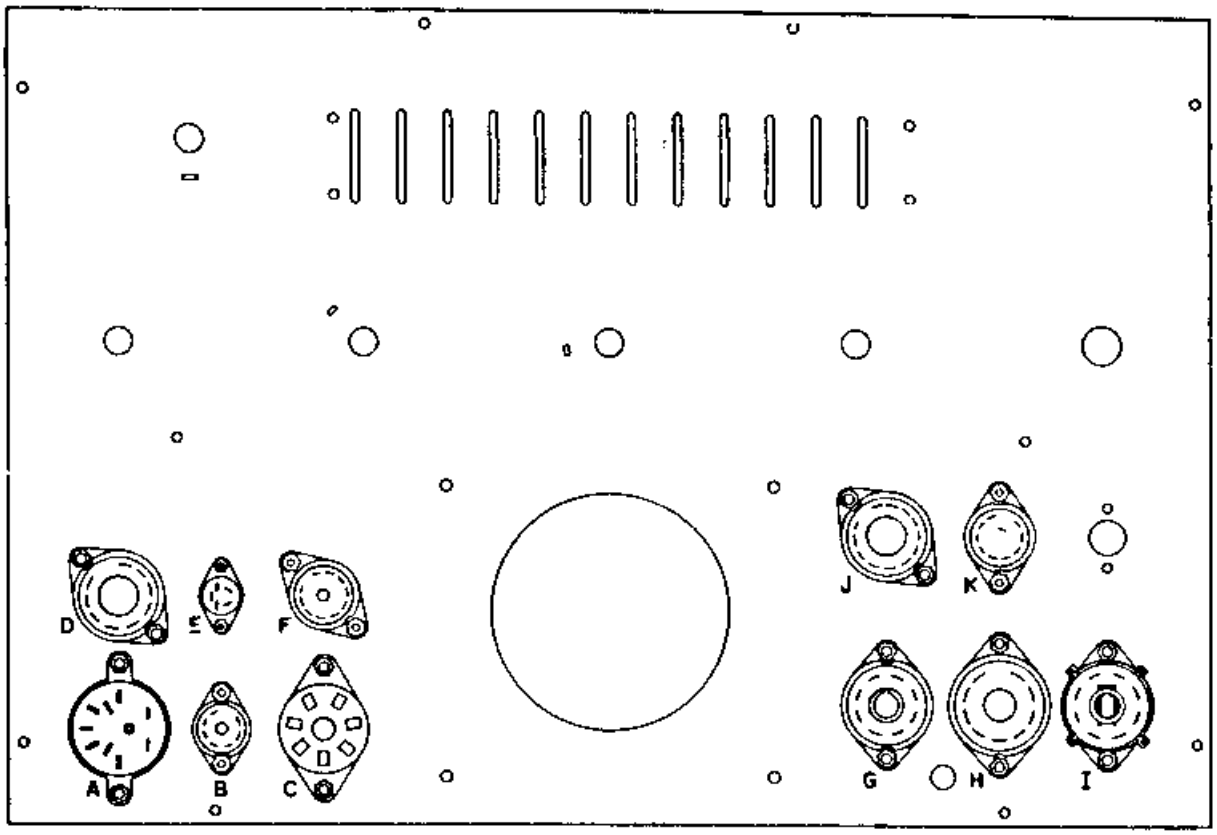


Fig. 3. Installing the sockets.

✓	STEP	SOCKET	LOCATION	HARDWARE	FIGURE	✓
	1	Combination	A	2 3/8" X 6-32 screws 2 No. 6 lockwashers 2 6-32 hex nuts	2, 3	✓
	2	7-pin min.	B	2 1/4" X 4-40 screws 2 No. 6 lockwashers 2 4-40 hex nuts	2, 3	
	3	7-pin large	C	2 1/4" X 6-32 screws 2 No. 6 lockwashers 2 6-32 hex nuts	2, 3	
	4	Novar	D	2 1/4" X 6-32 screws 2 No. 6 lockwashers 2 6-32 hex nuts	2, 3	
	5	Nuvistor	E	2 1/4" X 2-56 screws 2 No. 2 lockwashers 2 2-56 hex nuts	2, 3	
	6	Decal	F	2 1/4" X 4-40 screws 2 No. 6 lockwashers 2 4-40 hex nuts	2, 3	
	7	Octal	G	2 1/4" X 6-32 screws 2 No. 6 lockwashers 2 6-32 hex nuts	2, 3	
	8	Novar	H	2 1/4" X 6-32 screws 2 No. 6 lockwashers 2 6-32 hex nuts	2, 3	
	9	Loctal	I	2 1/4" X 6-32 screws 2 No. 6 lockwashers 2 6-32 hex nuts	2, 3	
	10	Compactron	J	2 1/4" X 6-32 screws 2 No. 6 lockwashers 2 6-32 hex nuts	2, 3	
	11	9-10 min.	K	2 1/4" X 4-40 screws 2 No. 6 lockwashers 2 4-40 hex nuts	2, 3	

TABLE I

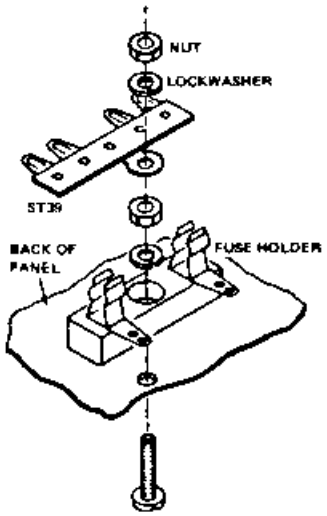


Fig. 4. Installing the fuse holder and terminal strip.

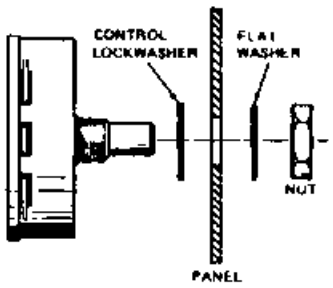


Fig. 5. Installing rotary switches and controls.

In the second stage of the mechanical assembly you will install the controls, switches, fuse holder, terminal strips, neon lamp, and meter.

The instructions are given in Table II. Use Figs. 4, 5, 6, 7 and 8 as you install the parts.

To install the grommets in Steps 1, 2 and 3, moisten the rubber and then pinch the sides of the grommet together as you work it into the hole.

Fig. 4 shows how to mount the fuse holder and the flat 4-lug terminal strip. Fig. 8 shows the position of the combination.

The switches and control mounted in Steps 5, 6, and 7 all have small locating lugs protruding from their mounting surface. These lugs must fit into the mating slot in the panel. The control mounted in Step 8 does not have a locating lug. Position this control as shown in Fig. 8 after installing the control lockwasher as shown in Fig. 5.

In Step 11, insert the neon lamp into the bayonet socket by pushing and twisting to lock the lamp in position. Insert the lamp bulb into the grommet in hole N, positioning the socket terminals as shown in Fig. 8.

The meter installed in Step 13 is packed in its own box, complete with mounting hardware. Use the hardware supplied with the meter. After you have mounted the meter, place the lid of the meter box over the face of the meter. Secure the lid to the panel with a couple of pieces of cellophane tape. This will protect the plastic meter face from damage while you work on the panel.

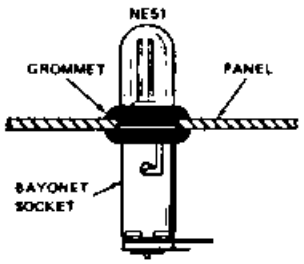


Fig. 6. Installing the neon lamp.

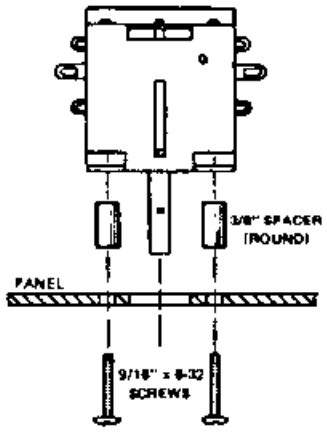


Fig. 7. Installing the push button switch.

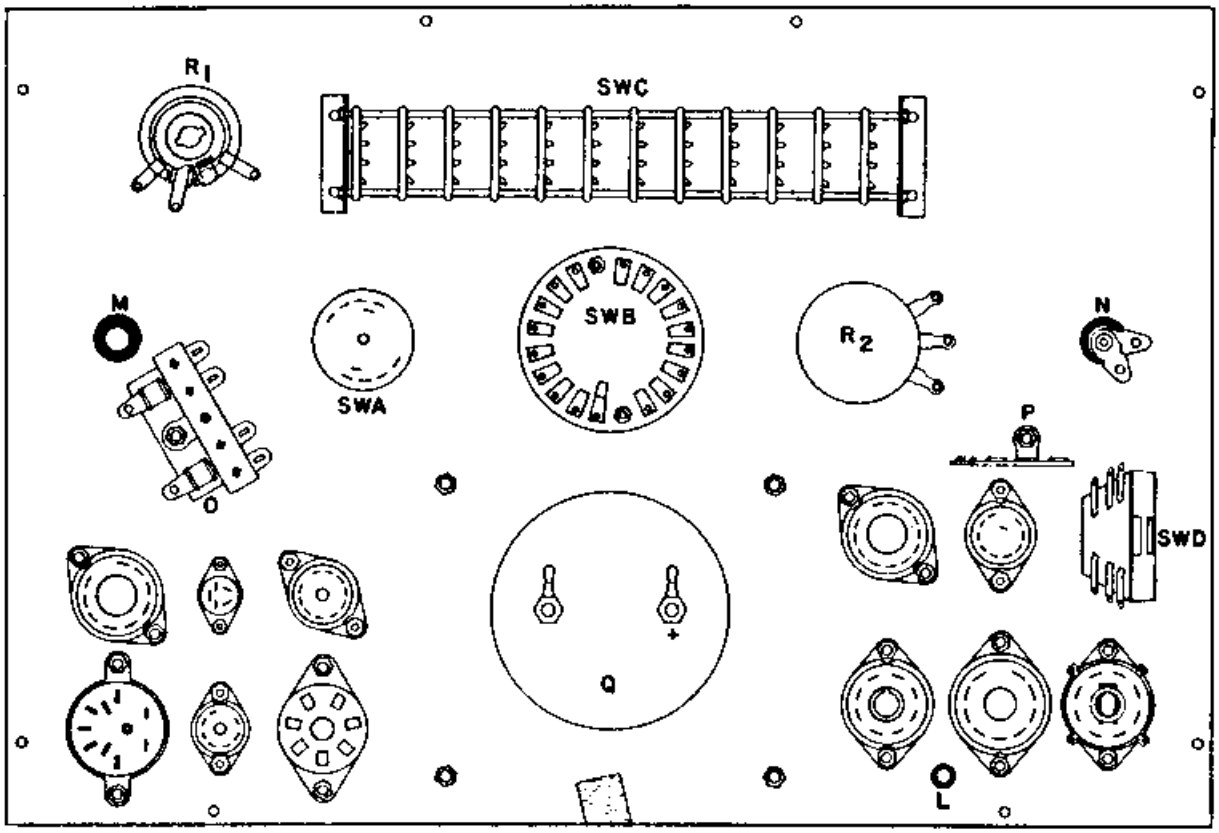


Fig. 8. Installing switches, controls, terminals strips and grommets.

✓	STEP	PART	LOCATION	HARDWARE	FIGURE	✓
	1	3/8" grommet	M		8	
	2	5/16" grommet	L		8	
	3	1/2" grommet	N		8	
	4	4-lug terminal strip and fuse holder	O	1 1/2" X 6-32 screw 2 No. 6 lockwashers 2 6-32 hex nuts	4, 8	
	5	300-ohm control (PO59)	R_1	Flat washer, nut	5, 8	
	6	2-pole, 4-position switch (SW38)	SWA	Flat washer, nut	5, 8	
	7	18-position switch (SW39)	SWB	Flat washer, nut	5, 8	
	8	300-ohm control (PO66)	R_2	Lockwasher, flat washer, nut	5, 8	
	9	3-lug terminal strip	P	1/4" X 6-32 screw No. 6 lockwasher 6-32 hex nut	8	
	10	12-gang lever switch (SW40)	SWC	4 1/4" X 6-32 screws	8	
	11	Bayonet socket and neon lamp	N		6, 8	
	12	Push button switch (SW41)	SWD	2 9/16" X 6-32 screws 2 3/8" spacers	7, 8	
	13	Meter	Q	4 6-32 hex nuts 4 No. 6 lockwashers	8	

TABLE II

PANEL WIRING

There are several stages to the panel wiring, each stage having only a few simple steps. In the first two stages you will be wiring some of the switches and controls and installing the diode, and resistors and capacitors. For these first two stages it will be easier to position the panel as shown in Fig. 9.

If there is a wire connecting terminals 1 and 2 of the meter (Q), remove it before wiring in the capacitor in Step 1. Be sure that the + end of the capacitor is connected to the terminal marked + on the meter, as shown in Fig. 9.

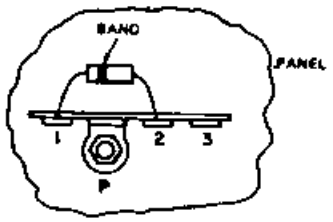


Fig. 10. Banded end (cathode) of D_1 goes to terminal P_1.

In Step 4 be sure to use the 5% resistor (gold band) and not the 10% resistor (silver band). In Step 6 also refer to Fig. 10 to properly install the diode. In steps in which hookup wire is called for, strip 1/4" of insulation from each end of the wire. In Steps 10, 11, and 12 use the bare (bus) wire and run it through all twelve terminals of SWC. Solder only those terminals indicated in Table III. Now begin the wiring called for in Table III.

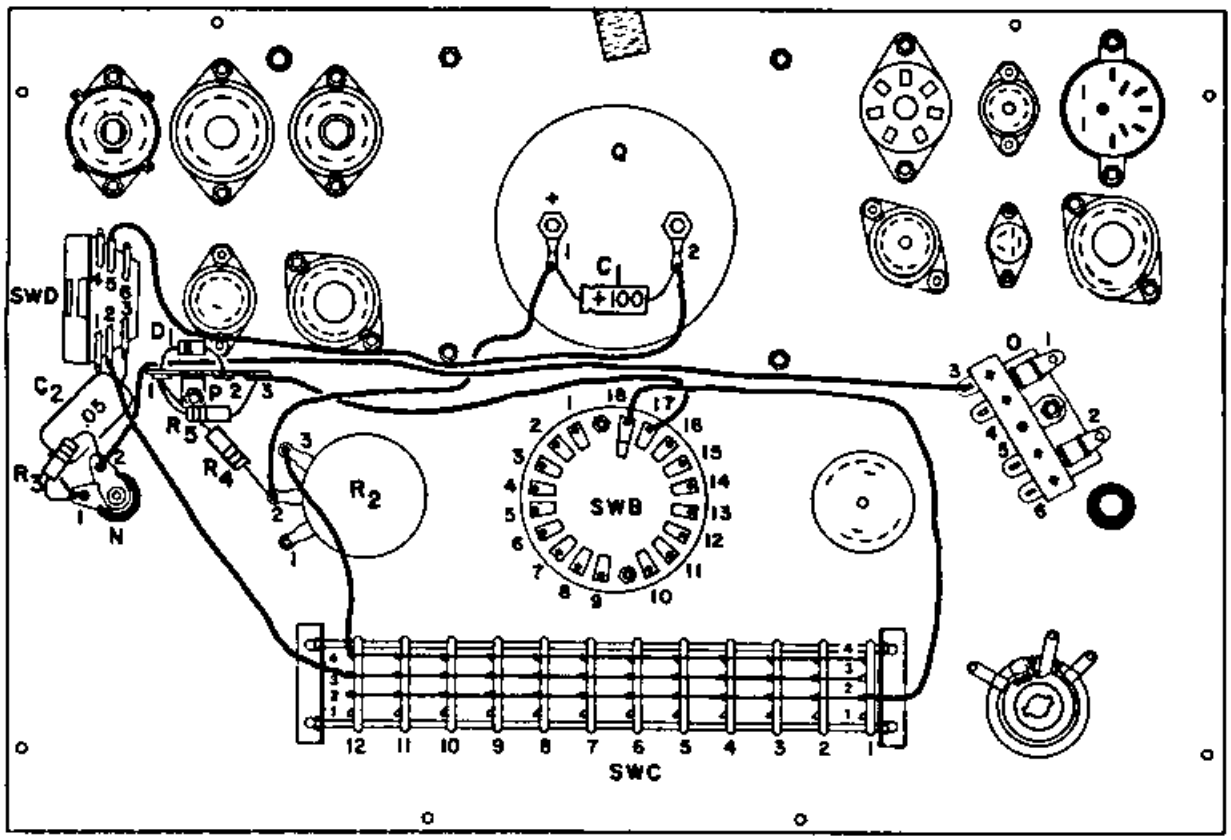


Fig. 9. General wiring, Step 1.

✓	STEP	PART/WIRE	FROM	TO	SOLDER	FIGURE	✓
	1	100-mfd capacitor, C_1	Q_1 (+)	Q_2	No	9	
	2	680k-ohm resistor, R_3 (Blue-Gray-Yellow)	N1	N2	No	9	
	3	.05-mfd capacitor, C_2	N1	SWD-3	N1, SWD-3	9	
	4	470-ohm, 5% resistor, R_4 (Yellow-Violet-Brown-Gold)	R_2-2	P1	No	9	
	5	47k-ohm, 5% resistor, R_5 (Yellow-Violet-Orange-Gold)	P1	P3	No	9	
	6	Meter rectifier, D_1 Fig 10	P1	P2	P1	9, 10	
	7	5" Red wire	R_2-2	Q_1	Both	9	
	8	9-1/2" Black wire	Q_2	SWD-5	Both	9	
	9	12" Red wire	N2	O3	N2	9	
	10	Bus wire	SWC12-4	SWC1-4 through all No. 4 lugs	All except SWC12-4 and SWC1-4	9	
	11	Bus wire	SWC12-3	SWC1-3 through all No. 3 lugs	All except SWC12-3	9	
	12	Bus wire	SWC12-2	SWC1-2 through all No. 2 lugs	All except SWC1-2	9	
	13	3-1/2" Red wire	SWC12-4	R_2-3	Both	9	
	14	6-1/2" Red wire	SWC12-3	SWD-2	Both	9	
	15	8-1/2" Red wire	SWC1-2	SWB-18	Both	9	
✓	16	5-1/2" Red wire	P3	SWB-17	P3	9	

TABLE III

The second stage of the panel wiring is given in Table IV and shown in Fig. 11.

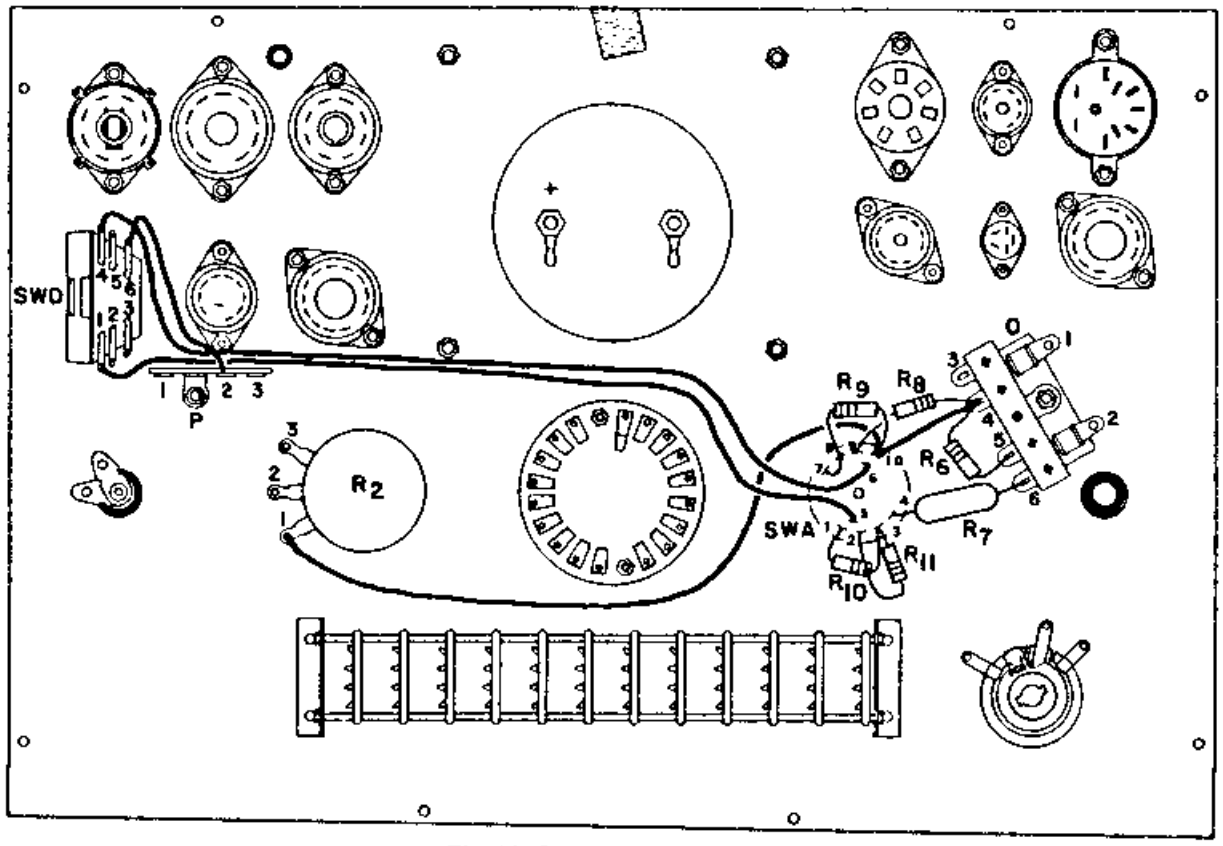


Fig. 11. General wiring, Step 2.

✓	STEP	PART/WIRE	FROM	TO	SOLDER	FIGURE	✓
✓	1	11" Red wire	SWD1	SWA5	Both	11	
	2	4" Black wire	SWD6	P2	Both	11	
	3	11-1/2" Black wire	SWD4	SWA6	Both	11	
	4	8-1/2" Red wire	R_2-1	SWA10	R_2-1	11	
	5	2" Red wire	SWA10	O4	No	11	
	6	51-ohm, 5% resistor, R_6 (Green-Brown-Black-Gold)	O4	O5	No	11	
	7	2.5k-ohm, 5W resistor, R_7	O6	SWA4	SWA4	11	
	8	470-ohm resistor, R_8 (Yellow-Violet-Brown-Silver)	O4	SWA9	Both	11	
	9	1.8k-ohm resistor, R_9 (Brown-Gray-Red-Silver)	SWA10	SWA7 SWA8	All	11	
	10	5.1k-ohm, 5% resistor, R_{10} (Green-Brown-Red-Gold)	SWA1	SWA3	SWA1	11	
✓	11	1k-ohm resistor, R_{11} (Brown-Black-Red-Silver)	SWA2	SWA3	SWA2	11	

TABLE IV

In the next wiring stages you will be connecting the 12-lever switch (SWC) to the tube sockets. For these stages, it will be more convenient to place the panel in the position shown in Fig. 12. Once again, in all of the following stages, be sure to route the wires *exactly* as shown in the accompanying figures and make the connections shown to SWC and the sockets. You will begin by wiring terminal 1 of wafer 1 of SWC (described in Table V as SWC1-1) to pin 1 of the socket in hole F, as shown in Fig. 12. Solder the connections only when instructed in the table. Now, using the brown hookup wire, complete the wiring given in Table V for SWC1-1 and pin 1 of each of the sockets.

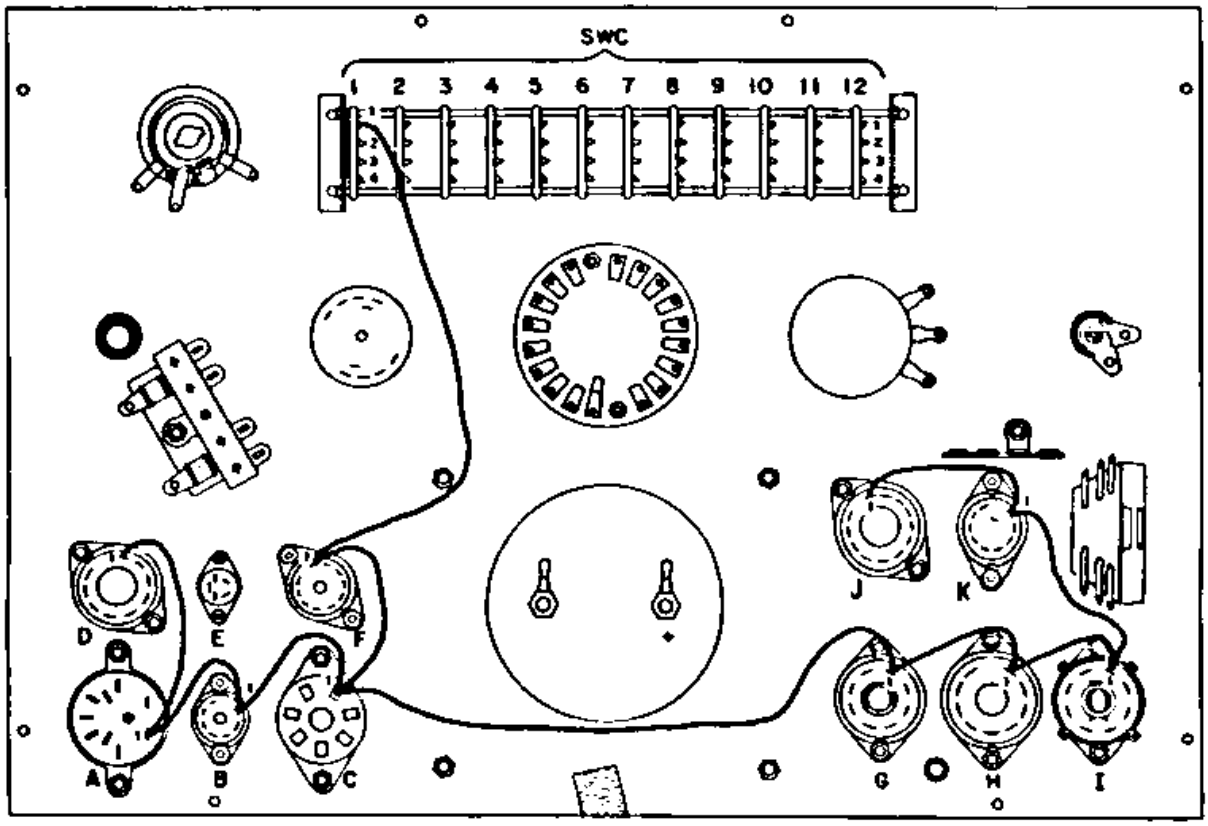


Fig. 12. Pictorial of socket wiring in Table V.

✓	STEP	WIRE	FROM	TO	SOLDER	FIGURE	✓
✓	1	7-1/2" Brown wire	SWC1-1	F1	SWC1-1	12	
	2	4" Brown wire	F1	C1	F1	12	
	3	2" Brown wire	C1	B1	No	12	
	4	2" Brown wire	B1	A1	B1	12	
	5	4" Brown wire	A1	D1	A1, D1	12	
	6	8-1/2" Brown wire	C1	G1	C1	12	
	7	2-1/2" Brown wire	G1	H1	G1	12	
	8	2-1/2" Brown wire	H1	I1	H1	12	
	9	3" Brown wire	I1	K1	I1	12	
	10	3" Brown wire	K1	J1	J1, K1	12	

TABLE V

In Step 4 of Table VI, notice that the wire from B2 goes to two terminals on socket A (A2 and A2). Strip the wire so that it will go through both terminals.

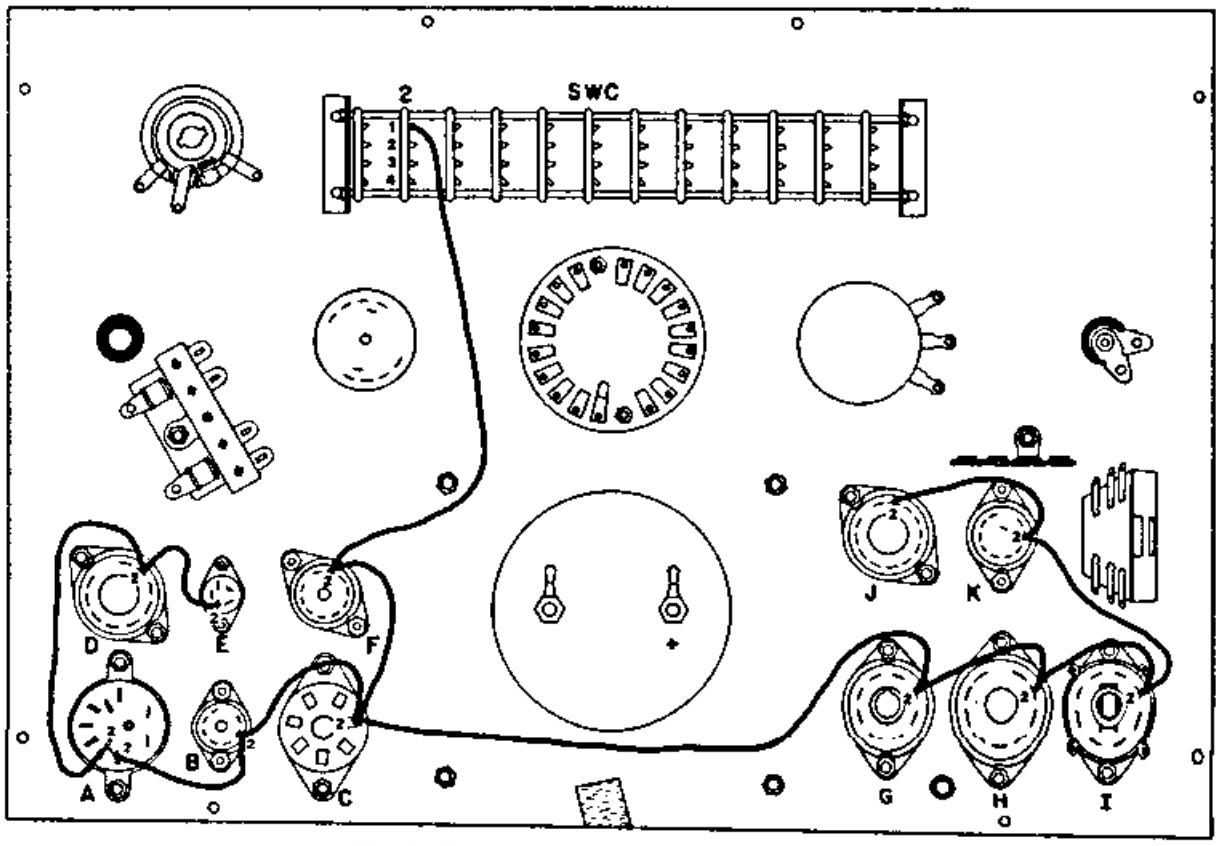


Fig. 13. Pictorial of socket wiring for Table VI.

✓	STEP	WIRE	FROM	TO	SOLDER	FIGURE	✓
	1	8" Red wire	SWC2-1	F2	SWC2-1	13	
	2	3-1/2" Red wire	F2	C2	F2	13	
	3	3" Red wire	C2	B2	No	13	
	4	3" Red wire	B2	A2, A2	B2	13	
	5	6" Red wire	A2	D2	A2	13	
	6	1-3/4" Red wire	D2	E2	Both	13	
	7	9" Red wire	C2	G2	C2	13	
	8	3-1/4" Red wire	G2	H2	G2	13	
	9	3" Red wire	H2	I2	H2	13	
	10	3" Red wire	I2	K2	I2	13	
	11	3" Red wire	K2	J2	Both	13	

TABLE VI

Notice in Step 4 of Table VII that the wire from B3 goes to three terminals A3. Strip the wire so that it will go through all three terminals. Be careful *not* to short out any of the other terminals with the bare wire.

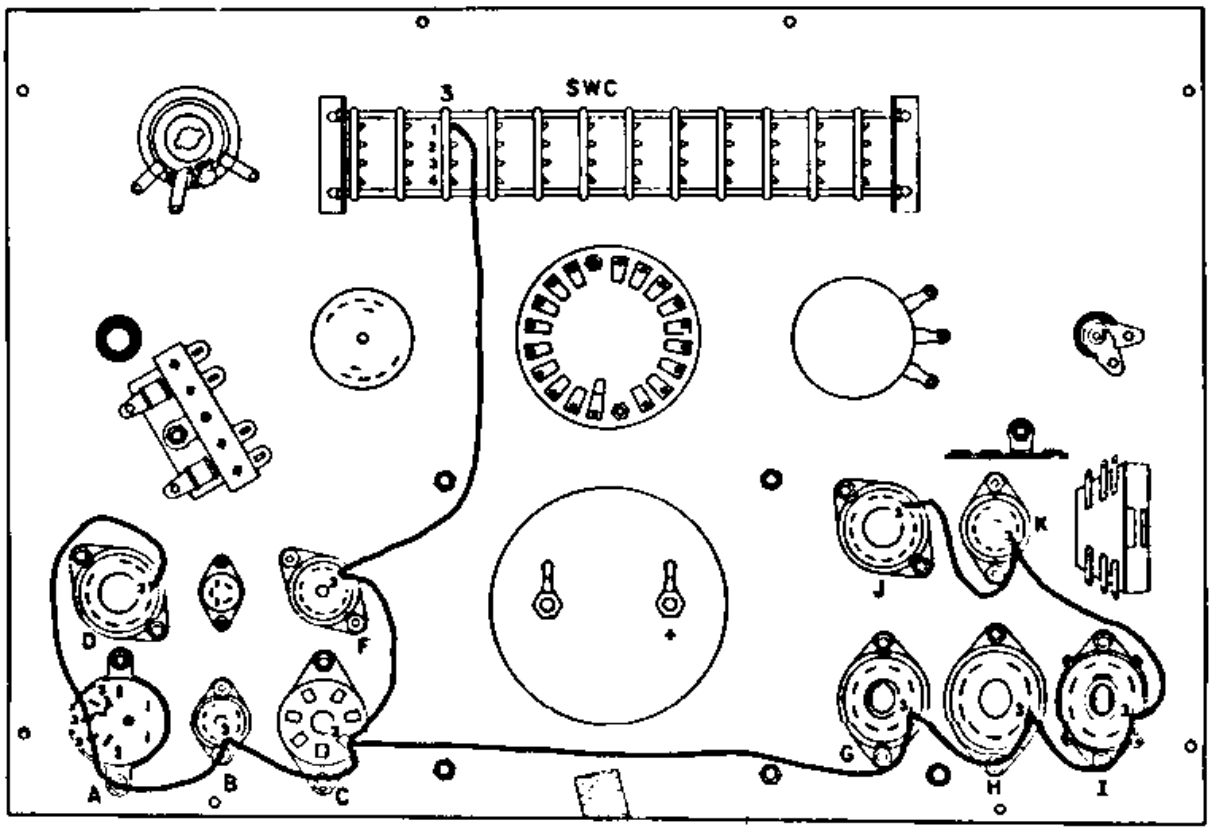


Fig. 14. Pictorial of socket wiring for Table VII.

✓	STEP	WIRE	FROM	TO	SOLDER	FIGURE	✓
	1	7-3/4" Orange wire	SWC3-1	F3	SWC3-1	14	
	2	3-3/4" Orange wire	F3	C3	F3	14	
	3	2-3/4" Orange wire	C3	B3	No	14	
	4	3-1/2" Orange wire	B3	A3 (3 pins)	B3	14	
	5	5" Orange wire	A3	D3	Both	14	
	6	8" Orange wire	C3	G3	C3	14	
	7	2-3/4" Orange wire	G3	H3	G3	14	
	8	2-1/2" Orange wire	H3	I3	H3	14	
	9	3-1/2" Orange wire	I3	K3	I3	14	
	10	2-3/4" Orange wire	K3	J3	Both	14	

TABLE VII

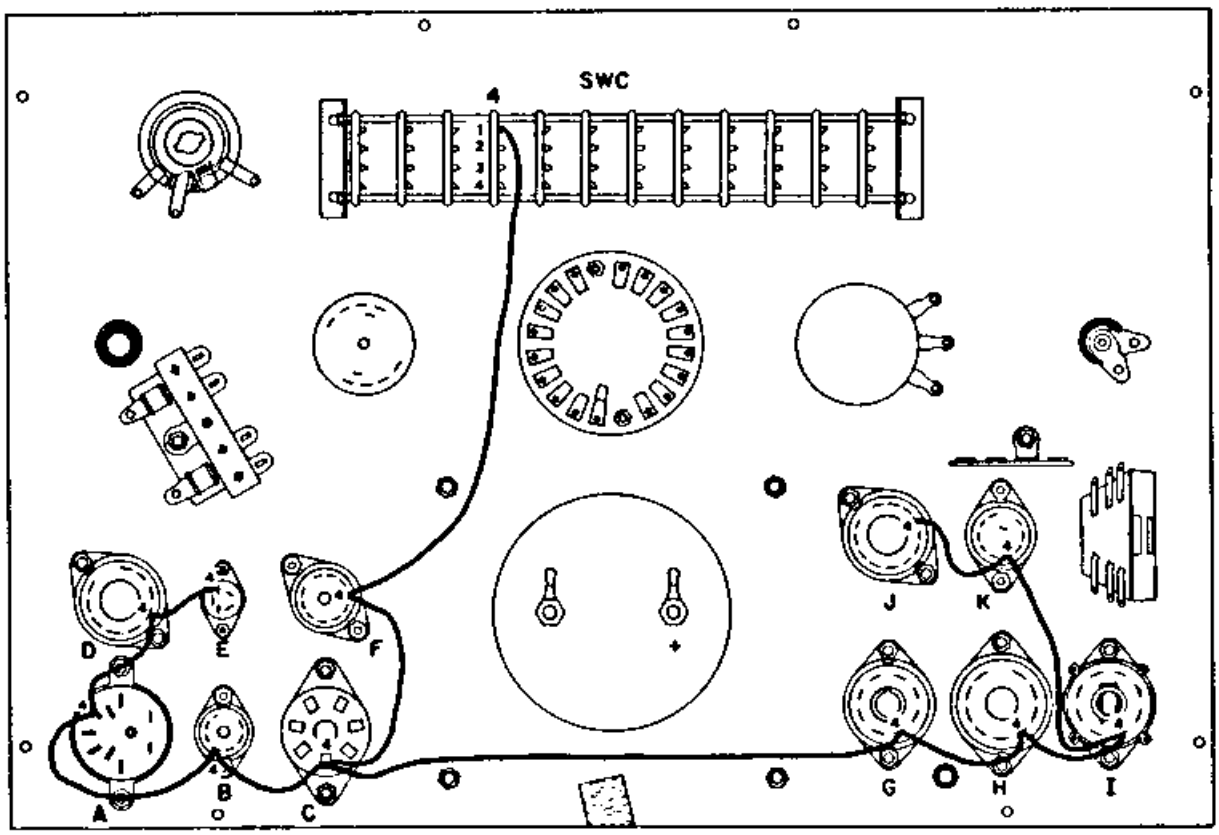


Fig. 15. Pictorial of socket wiring for Table VIII.

✓	STEP	WIRE	FROM	TO	SOLDER	FIGURE	✓
	1	8" Yellow wire	SWC4-1	F4	SWC4-1	15	
	2	3-3/4" Yellow wire	F4	C4	F4	15	
	3	2-1/2" Yellow wire	C4	B4	No	15	
	4	3-1/2" Yellow wire	B4	A4	B4	15	
	5	2-1/2" Yellow wire	A4	D4	A4	15	
	6	1-1/2" Yellow wire	D4	E4	Both	15	
	7	8" Yellow wire	C4	G4	C4	15	
	8	2-1/2" Yellow wire	G4	H4	G4	15	
	9	2-1/2" Yellow wire	H4	I4	H4	15	
	10	4" Yellow wire	I4	K4	I4	15	
	11	2-1/2" Yellow wire	K4	J4	Both	15	

TABLE VIII

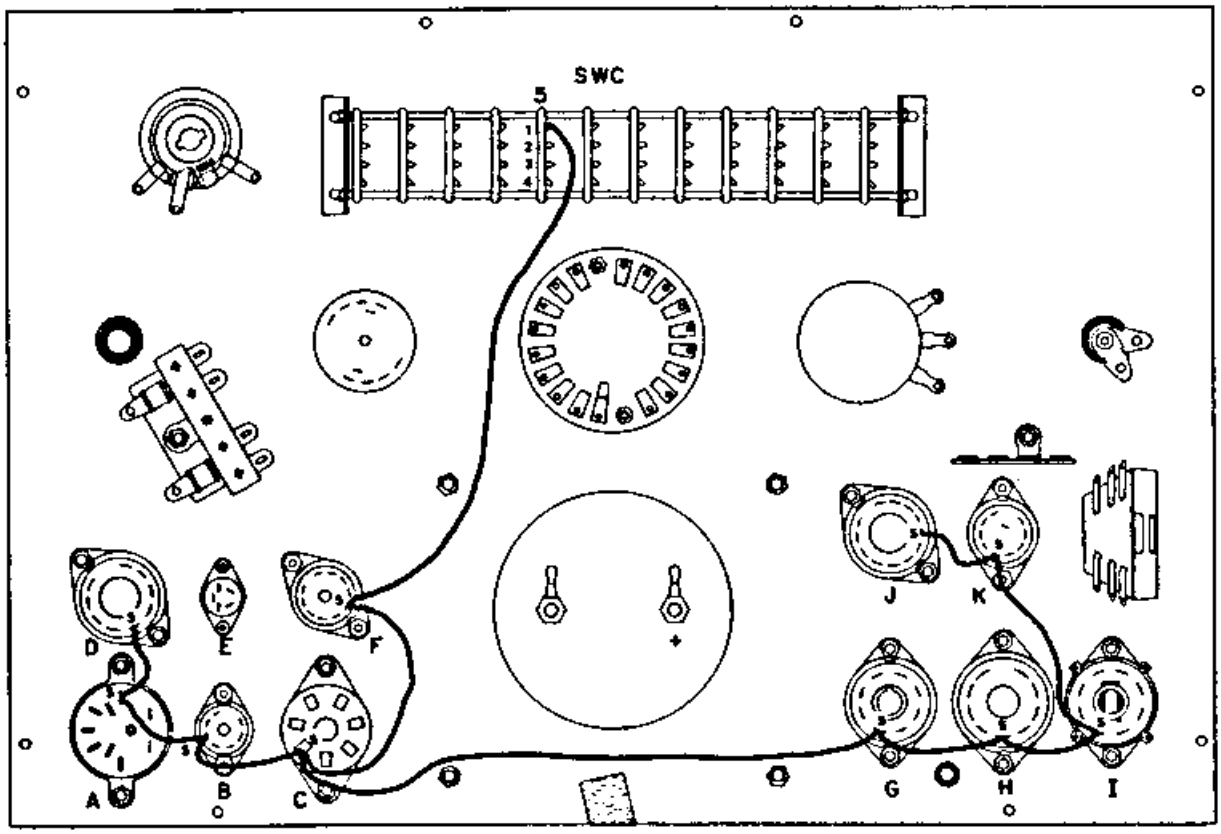


Fig. 16. Pictorial of socket wiring for Table IX.

√	STEP	WIRE	FROM	TO	SOLDER	FIGURE	√
	1	8" Green wire	SWC5-1	F5	SWC5 1	16	
	2	4-1/2" Green wire	F5	C5	F5	16	
	3	2-1/2" Green wire	C5	B5	No	16	
	4	1-3/4" Green wire	B5	A5	B5	16	
	5	1-3/4" Green wire	A5	D5	Both	16	
	6	8-1/2" Green wire	C5	G5	C5	16	
	7	2-1/2" Green wire	G5	H5	G5	16	
	8	2" Green wire	H5	I5	H5	16	
	9	3-1/2" Green wire	I5	K5	I5	16	
	10	2" Green wire	K5	J5	Both	16	

TABLE IX

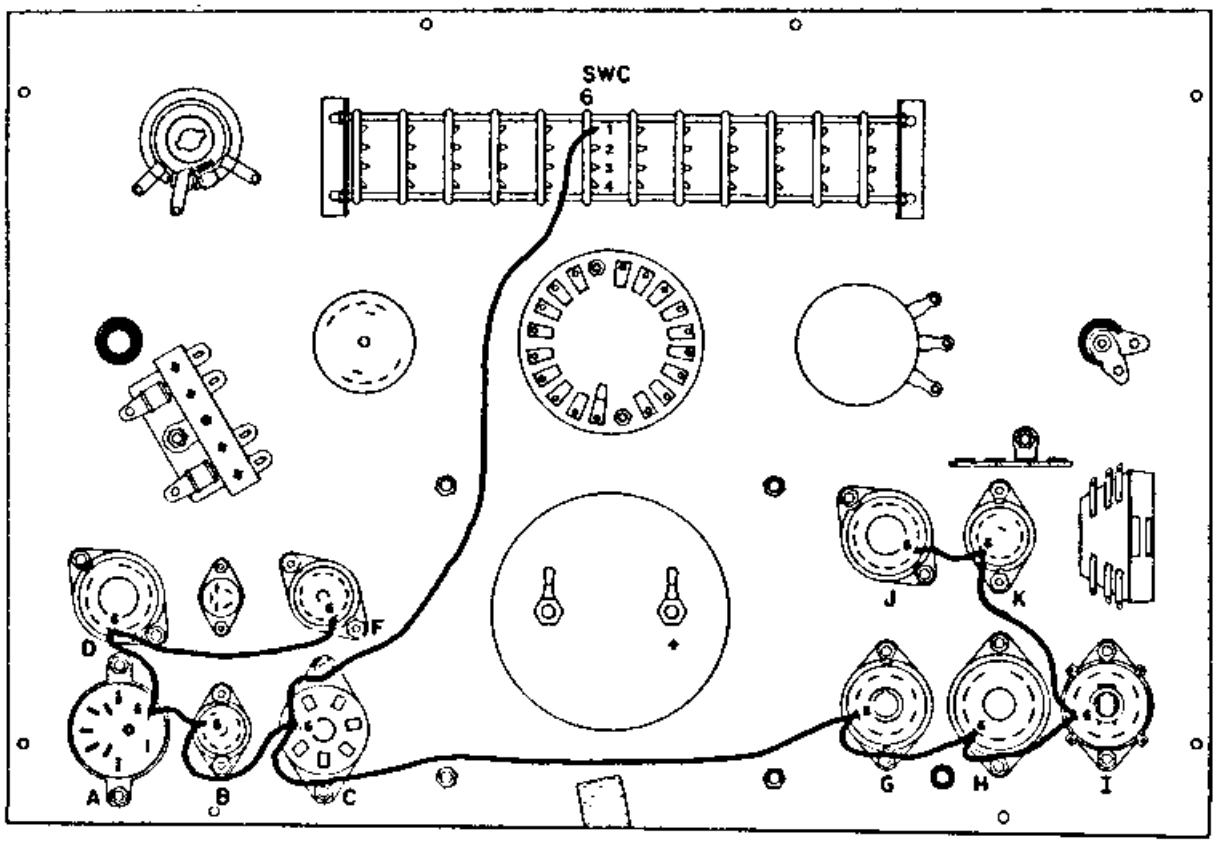


Fig. 17. Pictorial of socket wiring for Table X.

√	STEP	WIRE	FROM	TO	SOLDER	FIGURE	√
	1	9-3/4" Blue wire	SWC6-1	C6	SWC6-1	17	
	2	3" Blue wire	C6	B6	No	17	
	3	1-1/4" Blue wire	B6	A6	B6	17	
	4	1-3/4" Blue wire	A6	D6	A6	17	
	5	3-3/4" Blue wire	D6	F6	Both	17	
	6	8-3/4" Blue wire	C6	G6	C6	17	
	7	2-1/2" Blue wire	G6	H6	G6	17	
	8	2" Blue wire	H6	I6	H6	17	
	9	3-1/4" Blue wire	I6	K6	I6	17	
	10	1-3/4" Blue wire	K6	J6	Both	17	

TABLE X

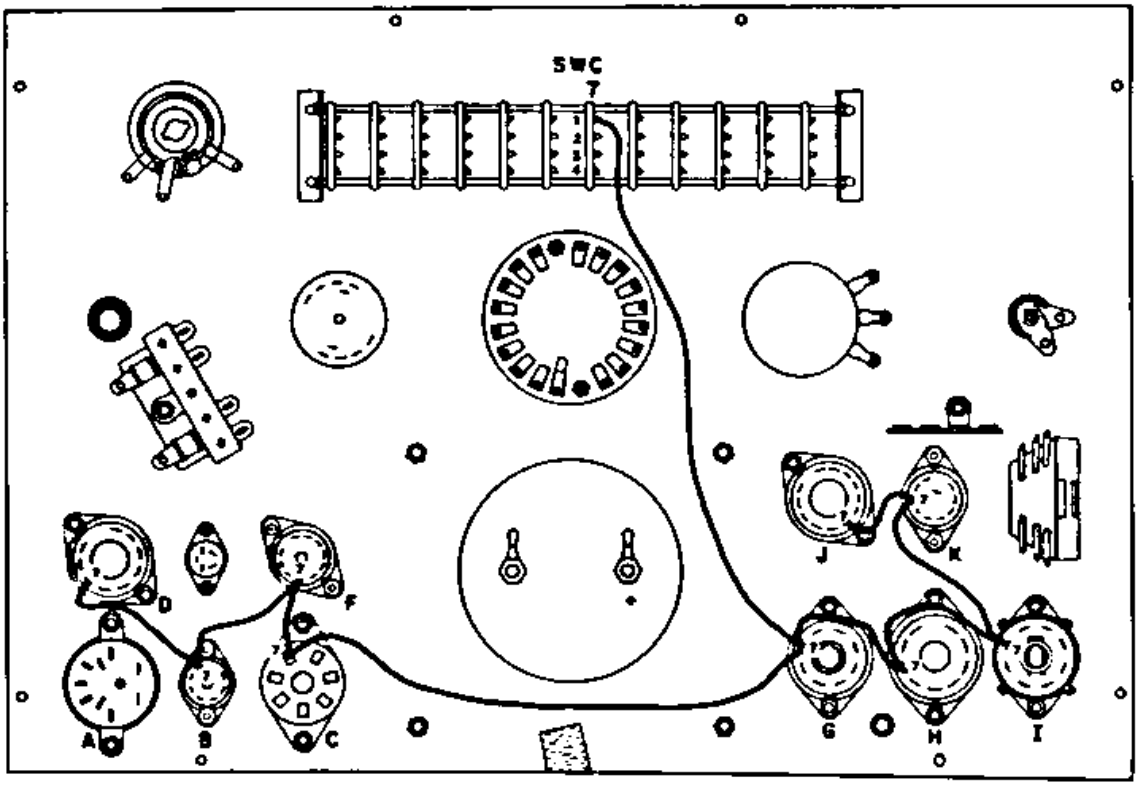


Fig. 18. Pictorial of socket wiring for Table XI.

✓	STEP	WIRE	FROM	TO	SOLDER	FIGURE	✓
	1	8-3/4" Violet wire	SWC7-1	G7	SWC7-1	18	
	2	3-1/2" Violet wire	G7	H7	No	18	
	3	3-1/4" Violet wire	H7	I7	H7	18	
	4	3-1/4" Violet wire	I7	K7	I7	18	
	5	1-3/4" Violet wire	K7	J7	Both	18	
	6	8-1/2" Violet wire	G7	C7	G7	18	
	7	1-1/2" Violet wire	C7	F7	C7	18	
	8	2-1/2" Violet wire	F7	B7	F7	18	
	9	2-3/4" Violet wire	B7	D7	Both	18	

TABLE XI

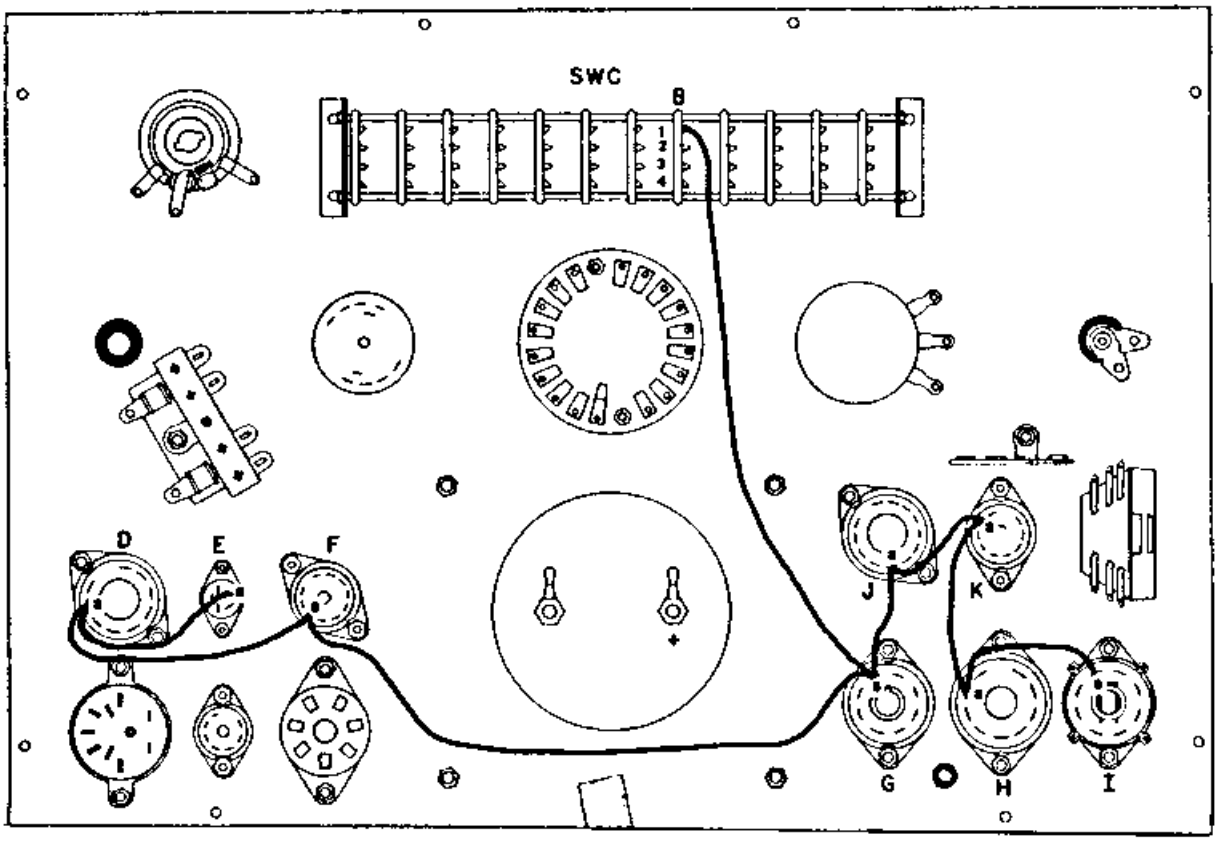


Fig. 19. Pictorial of wiring for Table XII.

√	STEP	WIRE	FROM	TO	SOLDER	FIGURE	√
	1	8-1/2" Orange/Black wire	SWC8-1	G8	SWC8-1	19	
	2	2-1/4" Orange/Black wire	G8	J8	No	19	
	3	2-1/2" Orange/Black wire	J8	K8	J8	19	
	4	3" Orange/Black wire	K8	H8	K8	19	
	5	3" Orange/Black wire	H8	I8	Both	19	
	6	8-3/4" Orange/Black wire	G8	F8	G8	19	
	7	4" Orange/Black wire	F8	D8	F8	19	
	8	3" Orange/Black wire	D8	E8	Both	19	

TABLE XII

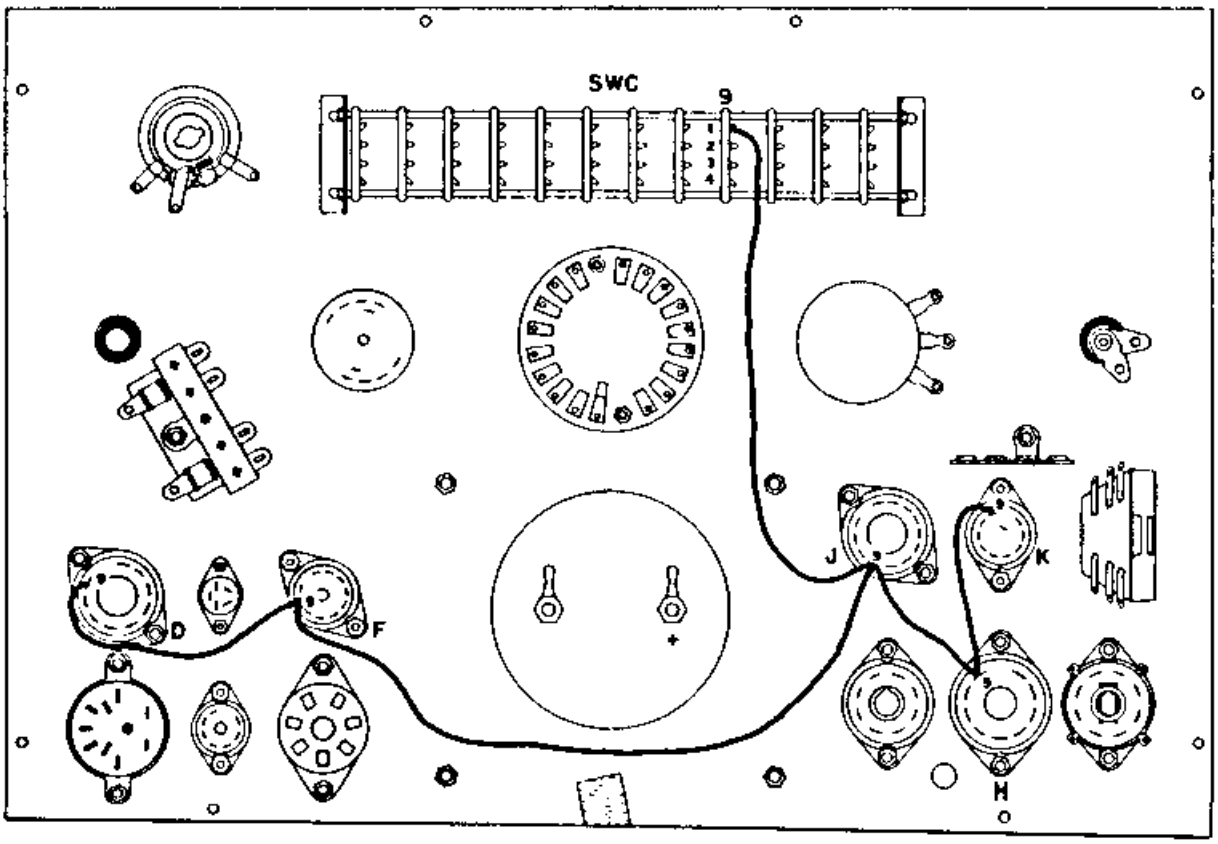


Fig. 20. Pictorial of wiring for Table XIII.

√	STEP	WIRE	FROM	TO	SOLDER	FIGURE	√
	1	8" White wire	SWC9-1	J9	SWC9-1	20	
	2	3" White wire	J9	H9	No	20	
	3	4" White wire	H9	K9	Both	20	
	4	10-1/2" White wire	J9	F9	J9	20	
	5	4-3/4" White wire	F9	D9	Both	20	

TABLE XIII

Before beginning the wiring shown in Table XIV, assemble the heavy black lead and the top cap clip as shown in Fig. 21. Pull the metal clip from the Bakelite cap so the bare end of the black lead can be pushed through the cap and soldered to the clip. The solder should lie flat on the lead and clip so the clip may be pushed back into the cap.

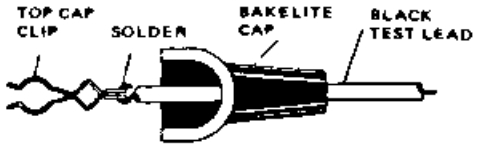


Fig. 21. Wiring the top cap clip.

Now, from the front of the panel, push the other end of the black lead through grommet L. Tie a knot in the lead so it cannot slip back through the grommet and so there will be about 5" of wire from the knot to the free end.

Now complete the socket wiring as instructed in Table XIV. When you have finished your work, carefully check all soldered connections. Make sure that no pins are shorted together and that all wires are properly soldered.

Slip two cable clamps over the bundle of wires near the meter and place the holes in the clamps over the two meter mounting studs, as shown in Fig. 22. Secure the clamps in place with two 6-32 hex nuts.

Set aside the wired panel temporarily and go on to the transformer mounting instructions.

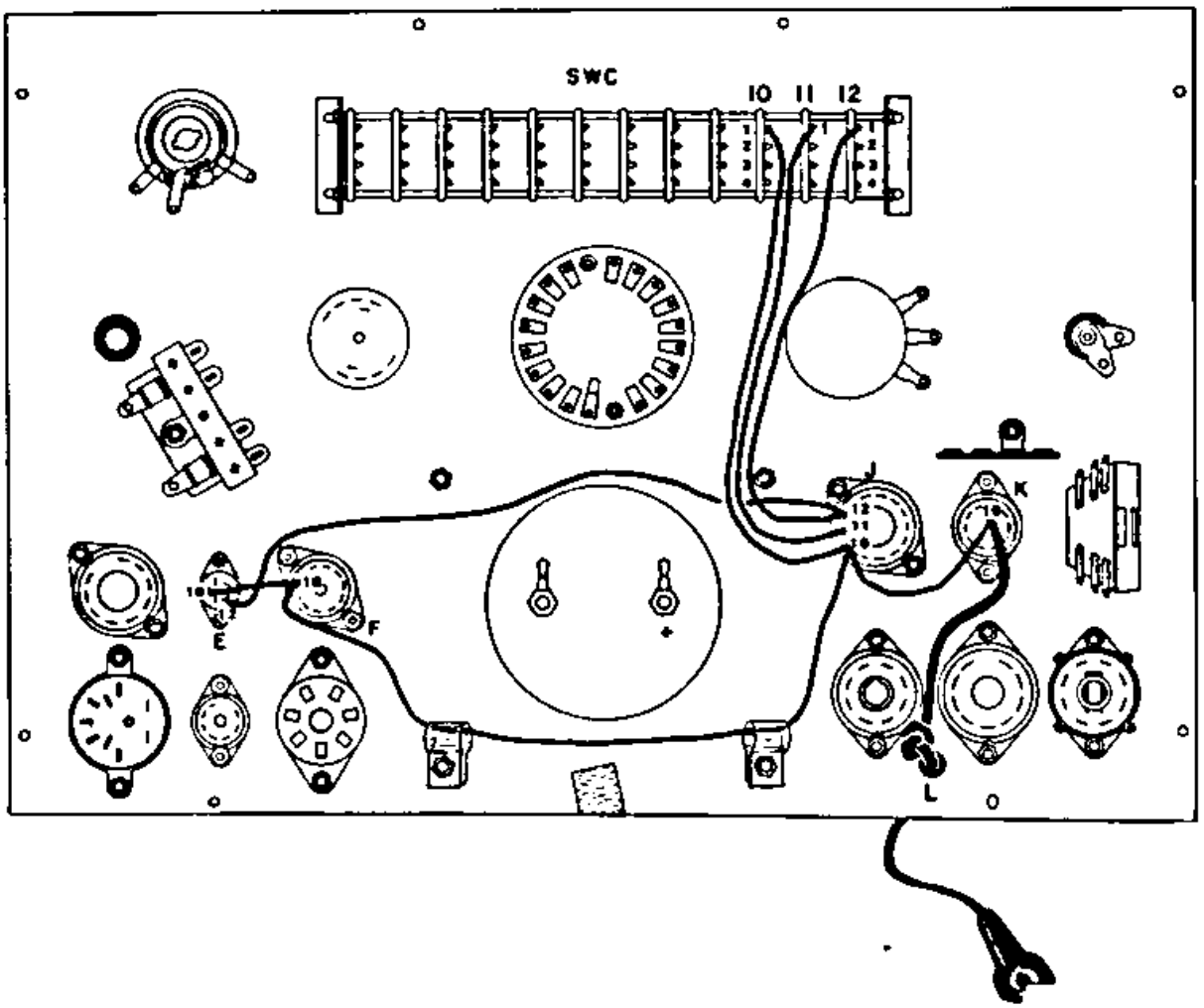


Fig. 22. Pictorial of wiring for Table XIV.

√	STEP	WIRE	FROM	TO	SOLDER	FIGURE	√
	1	6-1/2" Yellow/Black wire	SWC10-1	J10	SWC10-1	22	
	2	3-1/2" Yellow/Black wire	J10	K10	No	22	
	3	10-1/2" Yellow/Black wire	J10	F10	J10	22	
	4	2" Yellow/Black wire	F10	E10	Both	22	
	5	Top cap lead	Grommet L	K10	K10	21, 22	
	6	6-3/4" Black wire	SWC11-1	J11	Both	22	
	7	6-1/2" Black wire	SWC12-1	J12	SWC12-1	22	
	8	9-1/2" Black wire	J12	E12	Both	22	

TABLE XIV

MOUNTING AND WIRING THE POWER TRANSFORMER

The power transformer will be bolted to the inside of the cabinet so there will be no strain on the panel.

Fasten the two mounting brackets to the transformer with 1-1/2" × 8-32 screws, No. 8 lockwashers, and 8-32 nuts, as shown in Fig. 23. Bring the wires up between the mounting brackets and place the transformer in the bottom of the cabinet. Line up the four holes in the center of the back of the cabinet with four of the holes of the mounting brackets. Slip each of the four 3/4" × 10-32 thread-cutting screws through a metal cup washer, through the cabinet holes, and into the corresponding holes in the brackets. Drive the four screws home snugly with a large screwdriver. As each screw is turned into the bracket, back off a turn or two to make the going easier.

Fig. 23. Transformer and mounting brackets.

Using the technique illustrated in Fig. 24, gather all the transformer leads just above the transformer and install a wedge-lok band clamp around all the wires. First wrap the band around with the teeth against the wires and thread the band through the clamp loop as shown in Fig. 24A. Pull the band tight with your fingers, as shown in Fig. 24B, and cut off the excess length.

Fig. 24. Correct method for installing the band clamps.

Separate the transformer wires into three groups as follows:

GROUP 1:	GROUP 2:	GROUP 3:
Red/Green	Orange/White	Red/Black
Brown	Red/Yellow	Brown/Black
Black/Yellow	White	Green/White
Brown/Yellow	Green	Orange/Blue
Blue/Yellow	Blue	Green/Yellow
Brown/White	Yellow	Gray
Black/Green	Black	Orange
Black/White	Red/White	Red
Violet		

Place the partially wired panel face down over the opening in the cabinet so that the transformer wires come up over the edge of the panel near the meter, as shown in Fig. 25. Connect the wires of Group 1 to terminals 1 through 9 of SWB as instructed in Table XV and shown in Fig. 25.

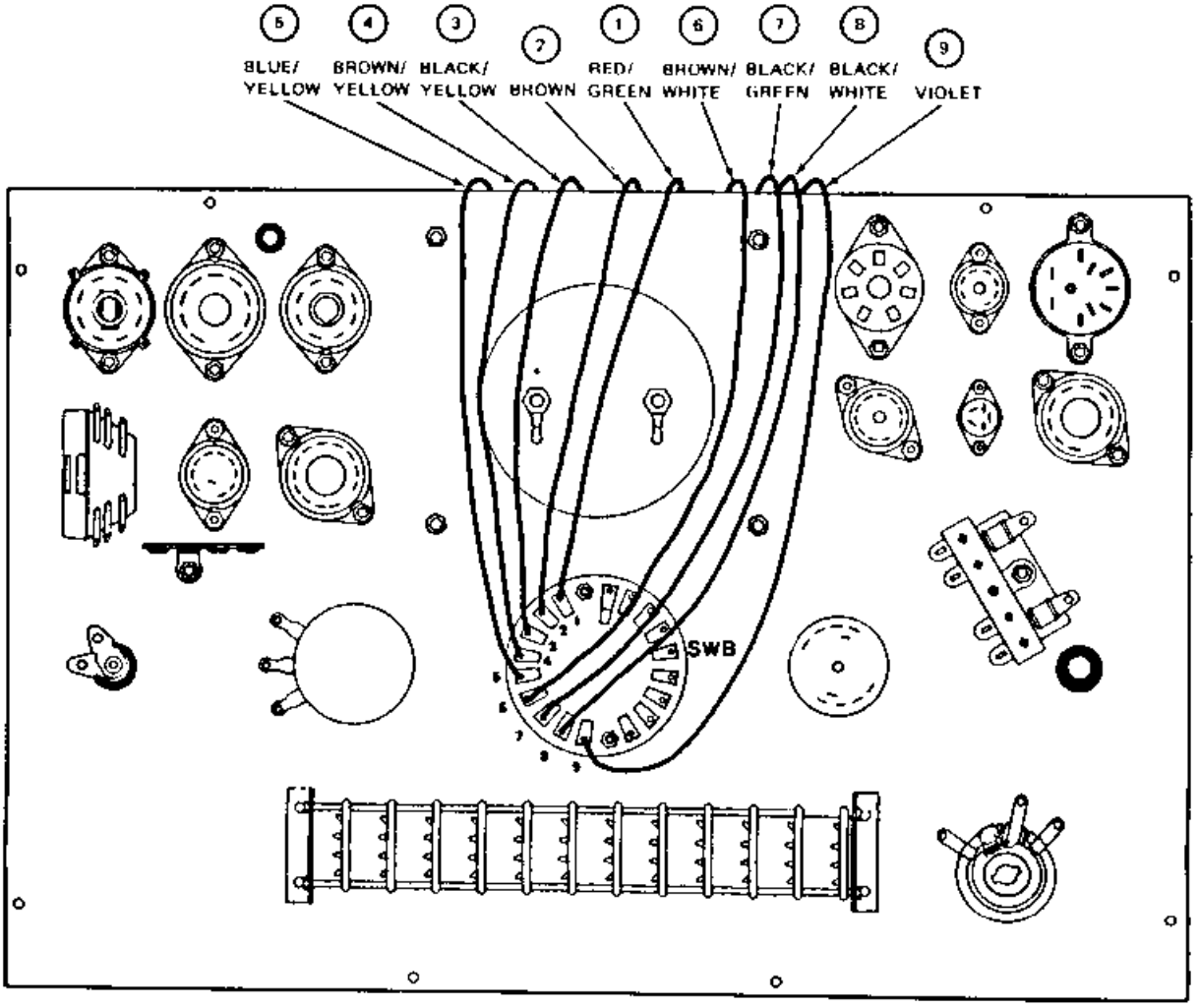


Fig. 25. First stage of final wiring.

✓	STEP	WIRE	FROM	TO	SOLDER	FIGURE	✓
	1	Red/Green wire	Transformer	SWB-1	Yes	25	
	2	Brown wire	Transformer	SWB-2	Yes	25	
	3	Black/Yellow wire	Transformer	SWB-3	Yes	25	
	4	Brown/Yellow wire	Transformer	SWB-4	Yes	25	
	5	Blue/Yellow wire	Transformer	SWB-5	Yes	25	
	6	Brown/White wire	Transformer	SWB-6	Yes	25	
	7	Black/Green wire	Transformer	SWB-7	Yes	25	
	8	Black/White wire	Transformer	SWB-8	Yes	25	
	9	Violet wire	Transformer	SWB-9	Yes	25	

TABLE XV

Connect the wires of Group 2 to terminals 10 through 17 of SWB as instructed in Table XVI and shown in Fig. 26.

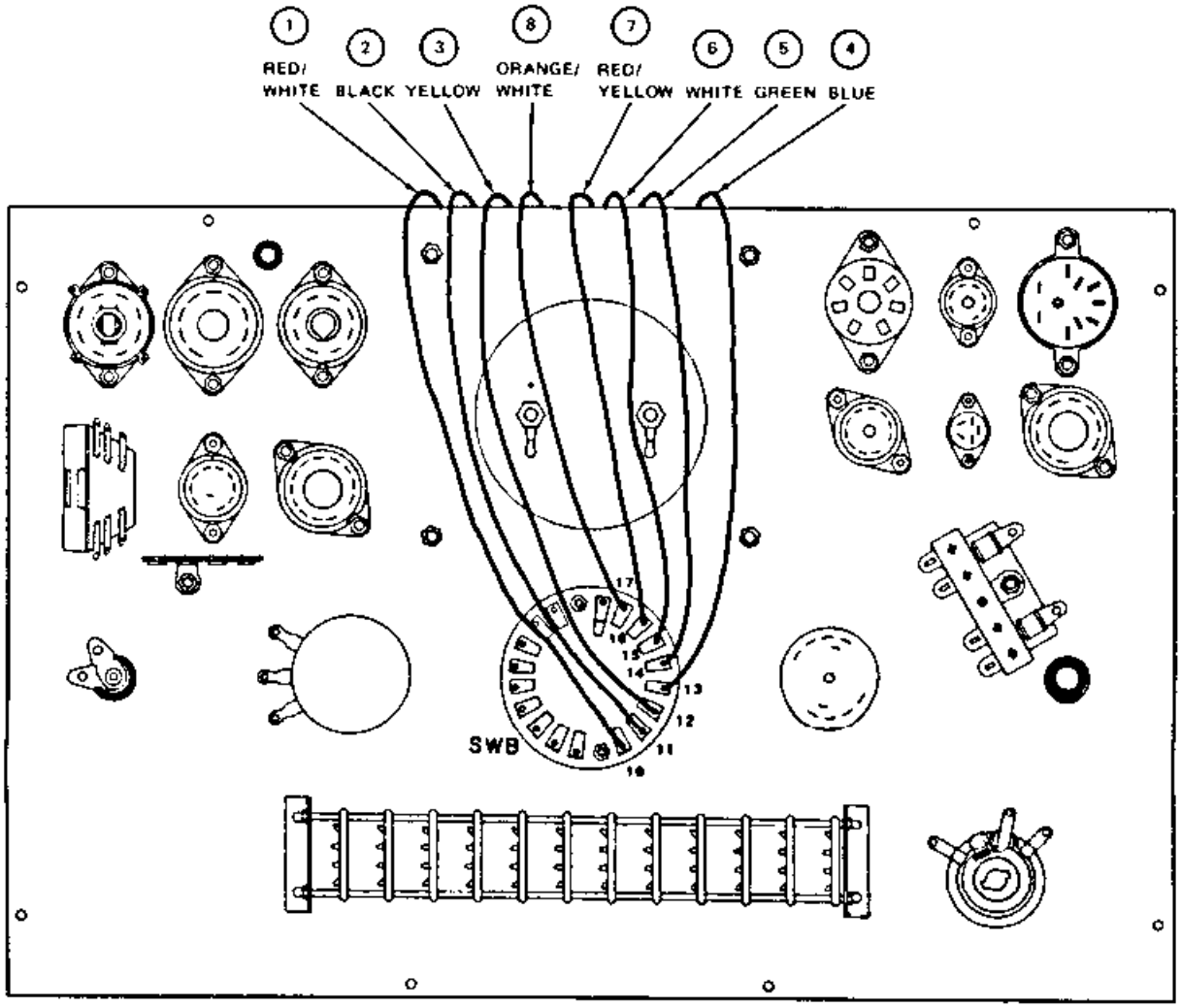


Fig. 26. Second stage of final wiring.

√	STEP	WIRE	FROM	TO	SOLDER	FIGURE	√
	1	Red/white wire	Transformer	SWB-10	Yes	26	
	2	Black wire	Transformer	SWB-11	Yes	26	
	3	Yellow wire	Transformer	SWB-12	Yes	26	
	4	Blue wire	Transformer	SWB-13	Yes	26	
	5	Green wire	Transformer	SWB-14	Yes	26	
	6	White wire	Transformer	SWB-15	Yes	26	
	7	Red/Yellow wire	Transformer	SWB-16	Yes	26	
	8	Orange/White wire	Transformer	SWB-17	Yes	26	

TABLE XVI

Connect the wires of Group 3 as instructed in Table XVII and shown in Fig. 27. After Step 8, insert the end of the power cord through the grommet in hole M and tie a knot in the wires about 5" from the end. Solder one of the power cord wires to terminal 2 of R_1. Solder the other wire to terminal 02. Finally, snap the fuse into the fuse holder at 0.

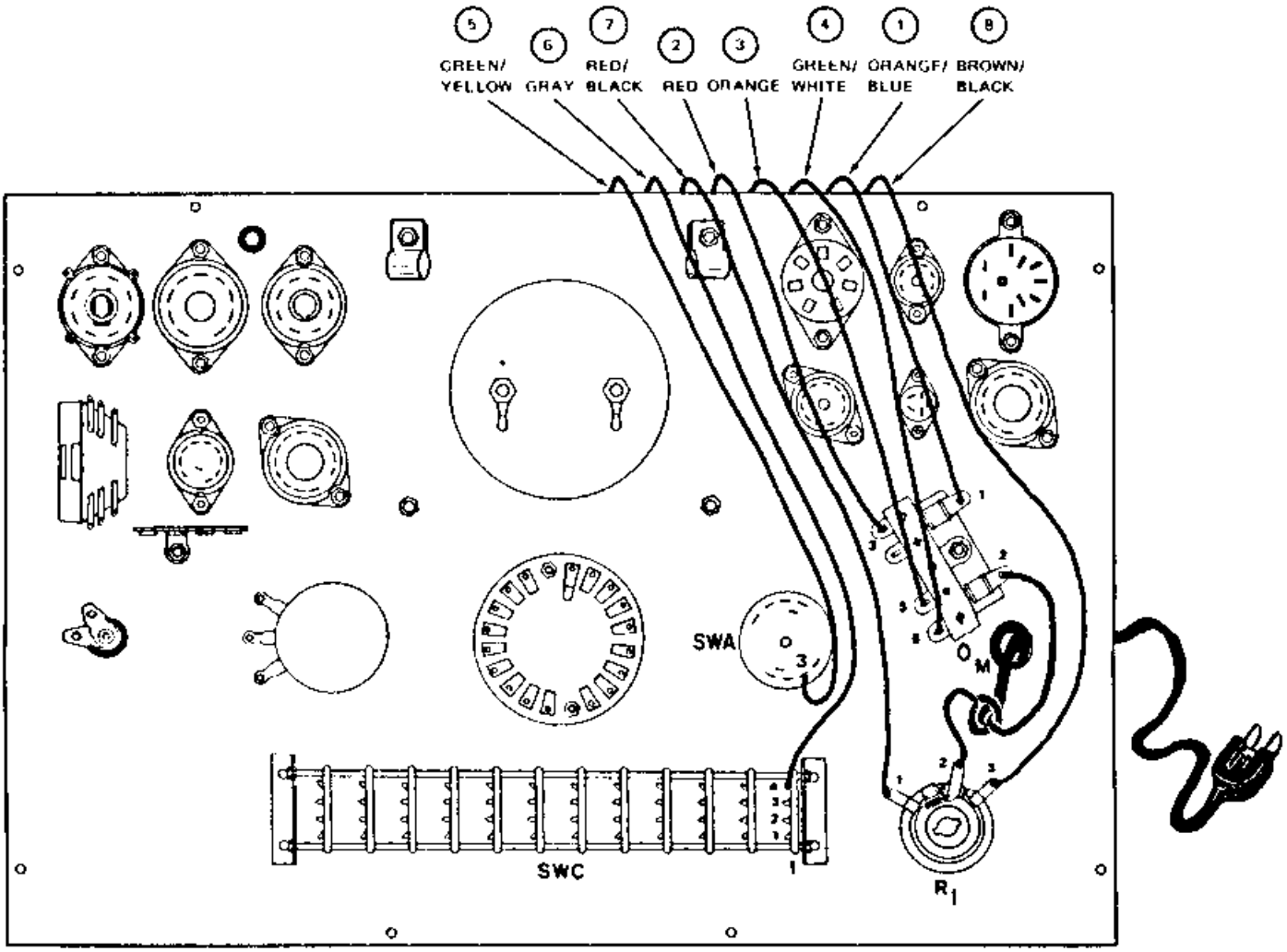


Fig. 27. Last stage of final wiring.

√	STEP	WIRE	FROM	TO	SOLDER	FIGURE	√
	1	Orange/Blue wire	Transformer	O1	Yes	27	
	2	Red wire	Transformer	O3	Yes	27	
	3	Orange wire	Transformer	O5	Yes	27	
	4	Green/White wire	Transformer	O6	Yes	27	
	5	Green/Yellow wire	Transformer	SWA-3	Yes	27	
	6	Gray wire	Transformer	SWC1-4	Yes	27	
	7	Red/Black wire	Transformer	R_1-1	Yes	27	
	8	Brown/Black wire	Transformer	R_1-3	Yes	27	

TABLE XVII

Gather the 17 wires which go to SWB and secure them with a wedge-lok band clamp near the edge of the panel. Secure the other group of 8 wires with another wedge-lok band clamp.

Lift up the panel and turn it over. Push the transformer wires down and out of the way and lay the panel into place. Remove the box lid from the meter face and secure the panel to the cabinet with 8 wood screws.

Now install the black knobs on the twelve levers of SWC and the red knob on SWD by pushing them firmly into place. Fasten pointer knobs on the shafts of SWB, SWA and R_4. Position the knobs so the small setscrew fits against the flat part of the shaft. Rotate the shaft of R_2 counterclockwise until it stops. Put the remaining pointer knob on this shaft so that the pointer rests over the last scale mark to the left (0). Tighten the setscrew.

You are now ready to test tubes, but first read the preliminary test outlined. When you have completed these tests, turn to page 3 for operating instructions.

PRELIMINARY TESTS

Examine the meter pointer; with no power applied, it should be over zero on the 0 to 100 scale. If the pointer is not zeroed, adjust it, using a small screwdriver to turn the plastic screw on the meter face.

Plug the power cord into a 120 volt, 60-Hz power outlet. Turn the Line Adjust clockwise. You should be able to adjust the meter pointer to the Adjust Line mark at the center of the scale.

Next, one at a time, move each of the lever switches to the TEST position and back to NORMAL. Without a tube in the tester the neon short lamp should not stay lighted when a lever is in the TEST position.

If the lamp does light with this test, turn to the MAINTENANCE section for further information on tracking down the problem.

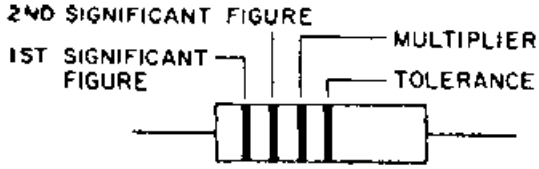
Nb
179-KM-224(912)

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

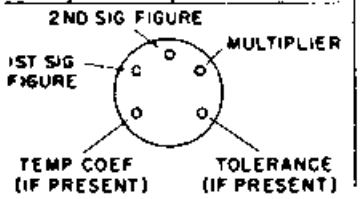


Black body = composition, non-insulated.
Colored body = composition, insulated.
Double width band for 1st sig. figure indicates wire-wound.

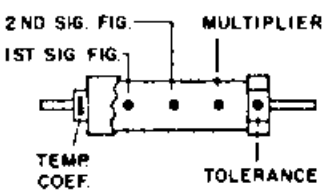
CAPACITORS — CAPACITY GIVEN IN MMF

CERAMIC

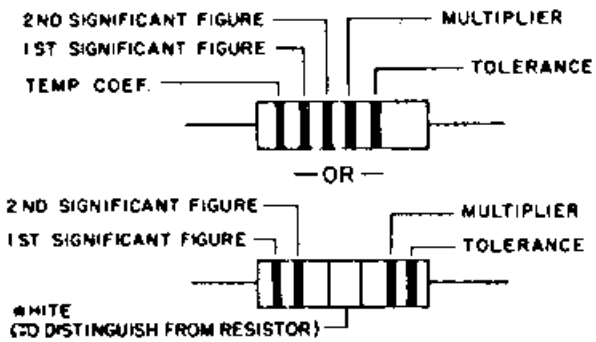
DISCS, BUTTON, OR FEED-THRU



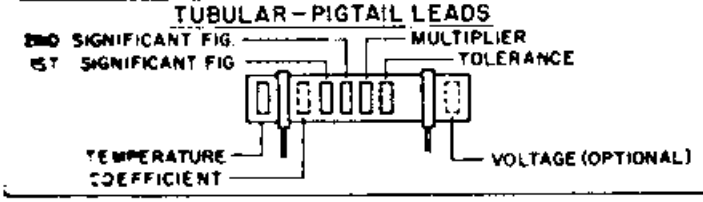
STAND-OFF



TUBULAR-AXIAL LEADS



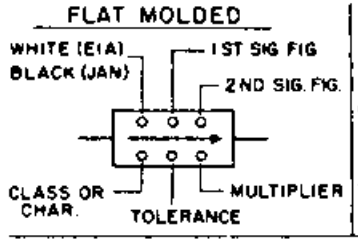
TUBULAR-PIGTAIL LEADS



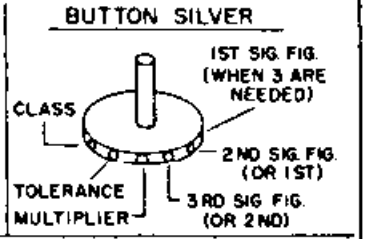
MICA

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

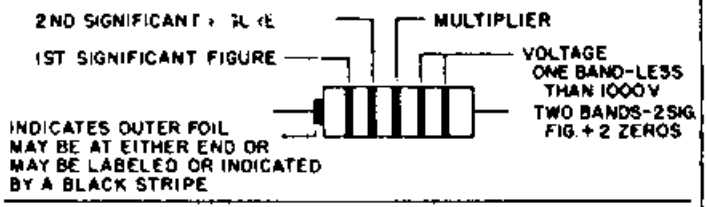
FLAT MOLDED



BUTTON SILVER

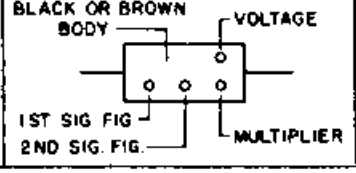


PAPER TUBULAR

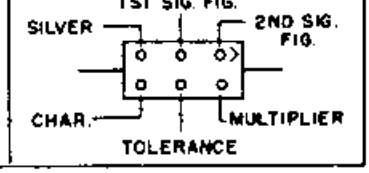


FLAT

EIA CODE



JAN CODE



USE THIS HANDY RULER FOR MEASURING LENGTHS OF WIRE