PRICE $2.00

HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT by Daystrom

HEATH COMPANY • BENTON HARBOR, MICHIGAN

CAPACITOR CHECKER
MODEL IT-11

RESISTOR AND CAPACITOR COLOR CODES

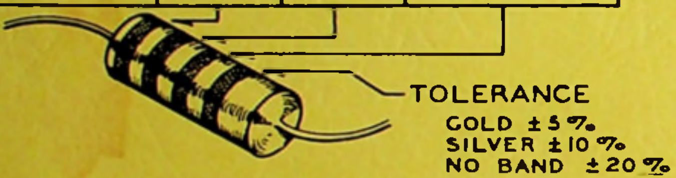
RESISTORS

The colored bands around the body of a color coded resistor represent its value in ohms. These colored bands are grouped toward one end of the resistor body. Starting with this end of the resistor, the first band represents the first digit of the resistance value; the second band represents the second digit; the third band represents the number by which the first two digits are multiplied. A fourth band of gold or silver represents a tolerance of ±5% or ±10% respectively. The absence of a fourth band indicates a tolerance of ±20%.

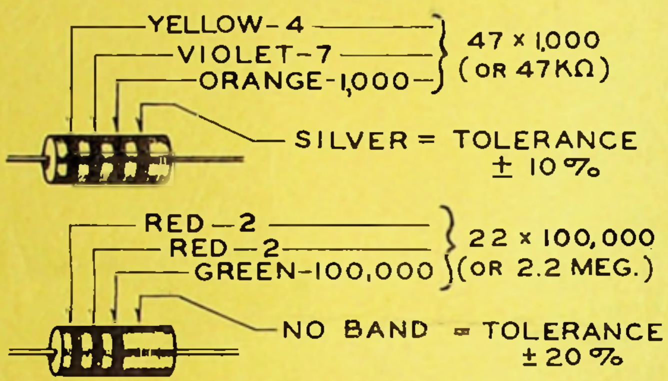
The physical size of a composition resistor is related to its wattage rating. Size increases progressively as the wattage rating is increased. The diameters of 1/2 watt, 1 watt and 2 watt resistors are approximately 1/8", 1/4" and 5/16", respectively.

The color code chart and examples which follow provide the information required to identify color coded resistors.

COLOR	CODE 1ST DIGIT	2ND DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD	-	-	.1
SILVER	-	-	.01



EXAMPLES

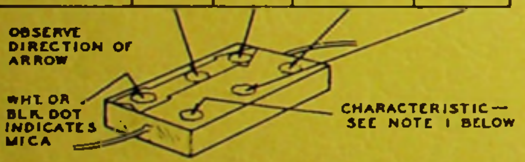


CAPACITORS

Generally, only mica and tubular ceramic capacitors, used in modern equipment, are color coded. The color codes differ somewhat among capacitor manufacturers, however the codes shown below apply to practically all of the mica and tubular ceramic capacitors that are in common use. These codes comply with EIA (Electronics Industries Association) Standards.

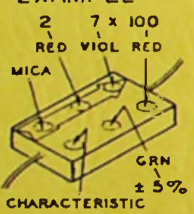
MICA

COLOR	CODE 1ST DIGIT	2ND DIGIT	MULTIPLIER	TOLER. %
BLACK	0	0	1	±20
BROWN	1	1	10	—
RED	2	2	100	± 2
ORANGE	3	3	1000	± 3
YELLOW	4	4	10,000	—
GREEN	5	5	—	± 5
BLUE	6	6	—	—
VIOLET	7	7	—	—
GRAY	8	8	—	—
WHITE	9	9	—	—
GOLD	-	-	.1	—
SILVER	-	-	.01	± 10



(VALUE IN μμf—SEE NOTE 3 BELOW)

EXAMPLE



2,700μμf ± 5%
OR .0027μfd

TUBULAR CERAMIC

Place the group of rings or dots to the left and read from left to right.

COLOR	CODE 1ST DIGIT	2ND DIGIT	MULTIPLIER	TOLER % 10 OR LESS	TOLER % OVER 10
BLACK	0	0	1	± 20	± 20
BROWN	1	1	10	± 0.1	± 1
RED	2	2	100	—	± 2
ORANGE	3	3	1,000	—	± 2.5
YELLOW	4	4	10,000	—	—
GREEN	5	5	—	± 0.5	± 5
BLUE	6	6	—	—	—
VIOLET	7	7	—	—	—
GRAY	8	8	—	± 0.25	—
WHITE	9	9	—	± 1.0	± 10

(VALUE IN μμf—SEE NOTE 3 BELOW)

EXAMPLE

33μμf ±5%

NOTES:

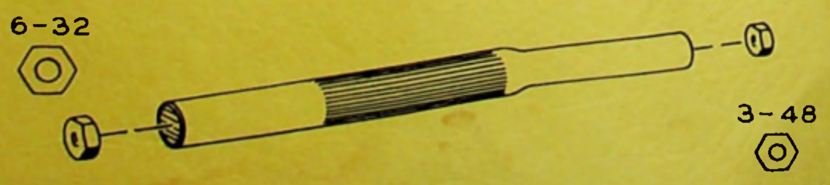
1. The characteristic of a mica capacitor is the temperature coefficient, drift capacitance and insulation resistance. This information is not usually needed to identify a capacitor but, if desired, it can be obtained by referring to EIA Standard, RS-153 (a Standard of Electronic Industries Association.)

2. The temperature coefficient of a capacitor is the predictable change in capacitance with temperature change and is expressed in parts per million per degree centigrade. Refer to EIA Standard, RS-198 (a Standard of Electronic Industries Association.)

3. The farad is the basic unit of capacitance, however capacitor values are generally expressed in terms of μfd (microfarad, .000001 farad) and μμf (micro-micro-farad, .000001 μfd); therefore, 1,000 μμf = .001 μfd, 1,000,000 μμf = 1μfd.

USING A PLASTIC NUT STARTER

A plastic nut starter offers a convenient method of starting the most used sizes: 3/16" and 1/4" (3-48 and 6-32). When the correct end is pushed down over a nut, the pliable tool conforms to the shape of the nut and the nut is gently held while it is being picked up and started on the screw. The tool should only be used to start the nut.



Assembly and Operation of the HEATHKIT by Daystrom

CAPACITOR CHECKER

MODEL IT-11

HEATH COMPANY,
BENTON HARBOR,
MICHIGAN

a subsidiary of DAYSTROM, INCORPORATED

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All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

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SPECIFICATIONS

Test Circuit	AC bridge, powered by an internal 60 cycle supply or by an external audio generator with 10 volts output. Upper frequency limit: 10 kc.
Capacitance, 5 Ranges	10 $\mu\mu$f to .005 μfd. .001 μfd to .5 μfd. .1 μfd to 50 μfd. 20 μfd to 1000 μfd. External standard (comparison bridge; maximum ratio 25:1).
Capacitor Leakage	DC test voltages from 3 to 600 volts in 16 steps.
Resistance, 4 Ranges	5 Ω to 5000 Ω. 500 Ω to 500 KΩ. 50 KΩ to 50 megohms. External standard (comparison bridge; maximum ratio 25:1).
Inductance Check	External standard only.
Power Supply	Transformer-operated, half-wave rectifier.
Power Requirements	105-125 volts AC, 50/60 cycles, 30 watts.
Dimensions	9-5/8" high x 6-5/8" wide x 5" deep.
Net Weight	5 lbs.
Shipping Weight	7 lbs.

INTRODUCTION

The HEATHKIT Model IT-11 Capacitor Checker is a general-purpose instrument designed for use by servicemen, engineers, and technicians in checking capacitors for value, leakage, shorts, and opens. The Checker may also be used to check resistance, inductance, and transformer turns ratios.

A bridge circuit and eye tube indicator are used in making quick, accurate tests. Precision resistors and capacitors in the bridge circuit provide a high degree of accuracy and stability.

Terminals are provided on the front panel for the component under test (TEST), an external generator (EXT. GEN.), and external standard (EXT. STD.).

CIRCUIT DESCRIPTION

Frequent reference to the small schematic diagrams in this description will prove helpful in fully understanding how the circuit functions.

The heart of the Capacitor Checker is the AC-powered bridge. Balance control R13 is used to vary the resistance of two arms of the bridge. The third arm is the standard (internal or external) and the fourth arm is the component being tested.

BRIDGE RATIO CALCULATIONS

Referring to Figure 1, assume that Rx = Rs (any value) and that Balance control R13 is in the center of its range so that R13A = R13B (500 Ω each). Under this condition, with the bridge balanced and with Rx equal to Rs, the ratio of R13A to R13B = 1:1.

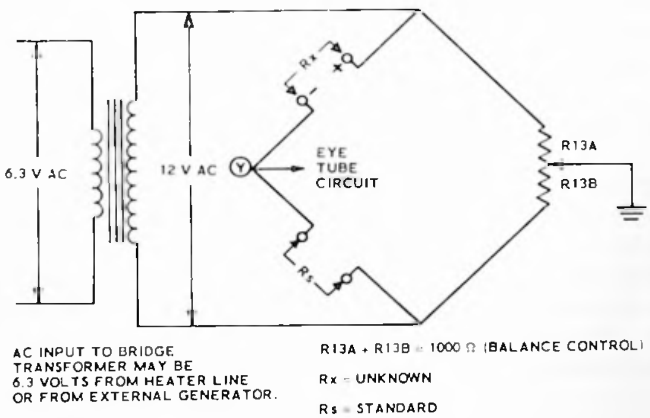


Figure 1

If Rx did not equal Rs, balance of the bridge would occur with the Balance control at some point other than the center of its range. When balance occurs with R13A = 600 Ω, then R13B = 400 Ω. The ratio is now 600/400, or 1.5:1.

When balance occurs with R13A = 800 Ω, then R13B = 200 Ω. The ratio is 800/200, or 4:1.

Turning the Balance control changes the values of R13A and R13B. When the bridge is balanced, R13A times Rs = R13B times Rx. Then the voltage at Y (see Figure 1) is minimum and the eye tube opens. The bridge circuit is basically the same for all types of measurements; only the standards and the unknown values change.

MEASURING RESISTANCE

When checking resistance, Rs becomes the resistance standard and Rx is the unknown resistance. The value of Rx is indicated on the front panel by the Balance control pointer when the bridge is balanced.

MEASURING CAPACITANCE

LOWER RANGES - C x .0001 and C x .01

Referring to Figure 2, the standard, Cs, is a capacitor (internal or external), and Cx is the unknown capacitance being measured. As in measuring resistance, the Balance control is adjusted for balance of the bridge. At balance R13A times XCs = R13B times XCx. In this case, XCs is the capacitive reactance of Cs and XCx is the capacitive reactance of Cx.

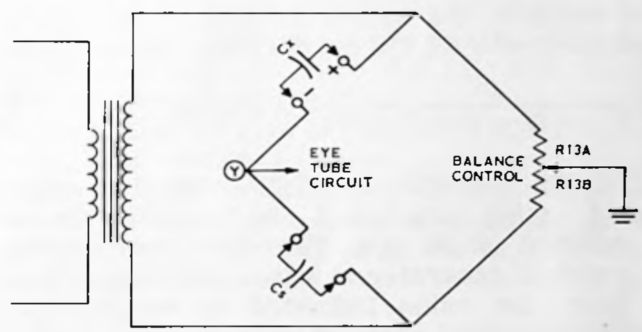


Figure 2

HIGHER RANGES - C x 1 and C EXT Scale

Capacitors are measured on the higher ranges just as described for the two lower ranges, except for electrolytics.

Since electrolytic capacitors have a certain amount of internal series resistance, it is necessary to use POWER FACTOR control R14 along with Balance control R13 to properly balance the bridge. See Figures 3 and 3A. The POWER FACTOR control is used to cancel the effect of series resistance in electrolytic capacitor Cx, and is used only on the two higher ranges. The formula for finding the series resistance of an electrolytic capacitor is:

$$\text{Series Resistance} = \frac{\%\,PF}{2\pi FC}$$

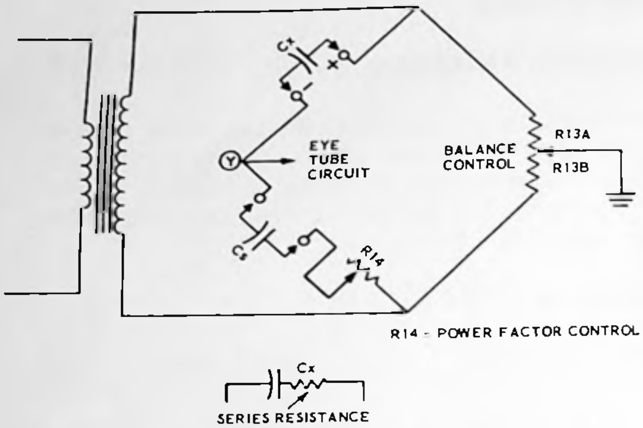


Figure 3

% PF = percent power factor
π = 3.14
F = frequency of applied voltage
C = capacity in farads

For example, the series resistance of a 2 μfd capacitor with 5% PF at 60 cycles would equal:

$$\frac{.05}{2\pi \times 60 \times 2 \times .000001} = 66.3\ \Omega$$

NOTE: The POWER FACTOR control is calibrated, using internal 2 μfd capacitor C6 as a standard, at 60 cps. Therefore, when using an external generator at a frequency other than 60 cps, the value indicated by the POWER FACTOR control must be corrected by a factor of $\frac{FT}{60}$. FT is the external applied frequency.

EXAMPLE: Determine the % PF of a capacitor which measures 5% PF at 120 cps.

$$\% \text{ PF} = \text{measured } \% \text{ PF} \times \frac{FT}{60}$$

$$\% \text{ PF} = .05 \times \frac{120}{60}$$

$$\% \text{ PF} = 10\%$$

USING THE EXTENDED SCALE

The capacitance scale is extended by adding 9000 Ω resistor R34 in series with Balance control R13. The bridge is balanced as before, using the Balance control, plus the POWER FACTOR control for electrolytics. However,

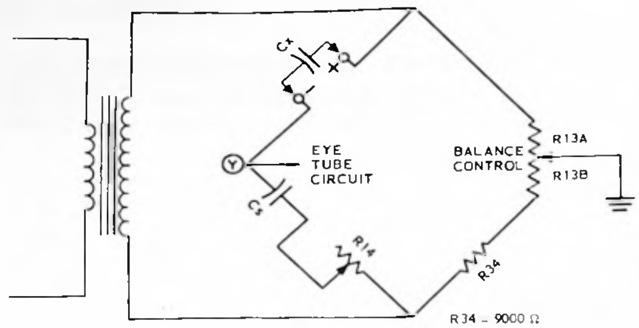


Figure 4

the ratio has now been changed due to the addition of R34. With the Balance control in the center of its range, R13A = 500 Ω and R13B = 500 Ω. Therefore, the ratio is:

$$\frac{9000 \text{ plus } 500}{500} = 19{:}1$$

The standard internal capacitance value is 2 μfd, which makes the center scale reading equal to 19 times 2 μfd, or 38 μfd. The remainder of the "C" EXTENDED SCALE is calculated in the same way.

MEASURING INDUCTANCE

Again, the bridge is balanced using Balance control R13. At balance, R13A times XLs = R13B times XLx. Here XLs = the inductive reactance of the standard, and XLx = the inductive reactance of the component being tested. An external standard must be used when measuring inductance.

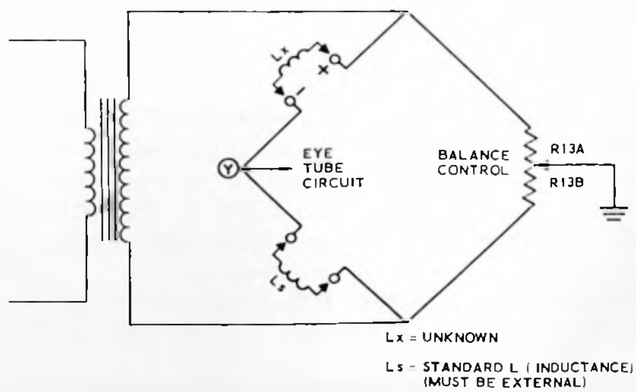


Figure 5

The AC series resistance (characteristic) of the external component should be similar to that of the test component to permit balancing, as the POWER FACTOR control is not used in the external standard circuit.

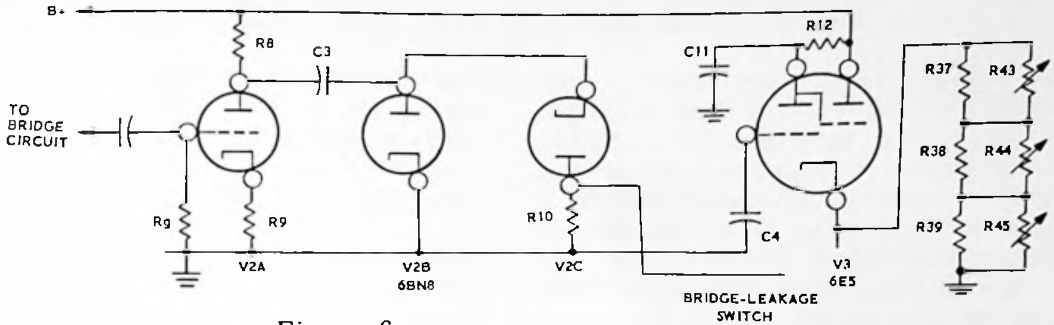


Figure 6

EYE TUBE CIRCUIT

When the bridge circuit is not balanced, an AC signal voltage is applied from point Y of the bridge to the grid of amplifier stage V2A. The amplified signal from V2A is then applied to the voltage-doubler rectifier circuit, consisting of V2B, V2C, C3, and C4. The resulting negative DC voltage is applied to the grid of eye tube V3, closing the eye.

When the bridge is balanced, no signal is applied from the bridge to V2A. Therefore, no negative DC voltage is present at the grid of the eye tube, and the eye stays open.

CAPACITOR LEAKAGE

CHECKING LEAKAGE

When checking a capacitor for leakage, V2A is connected as a DC amplifier. When voltage is applied to the capacitor under test, through 10 KΩ limiting resistor R40, the capacitor charges, drawing current through grid resistor Rg of V2A. The voltage drop across this resistor causes V2A to conduct due to a positive voltage developed on its grid. This changes the voltage at the plate of V2A and at the grid of the eye tube, causing the eye to close. When the capacitor is fully charged, current ceases to flow through grid resistor Rg, and the grid voltage of V2A returns to its original value. The plate voltage of V2A also returns to its original value and the eye tube opens. This indicates a good capacitor.

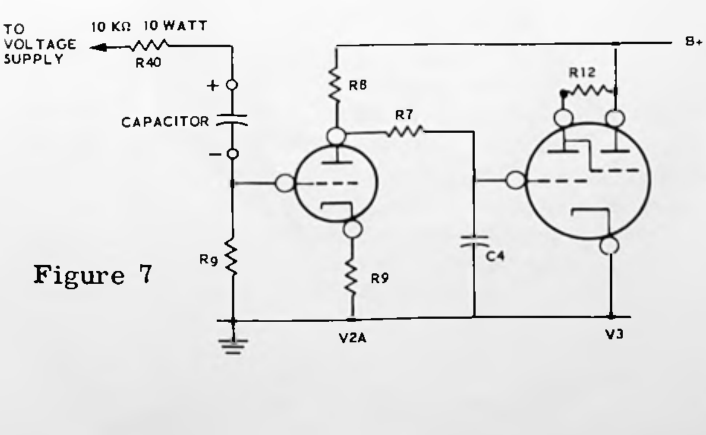


Figure 7

If the capacitor being checked is leaky or shorted, current continues to flow through grid resistor Rg, preventing the eye tube from opening.

Calibrate controls R43, 44, and 45, connected in parallel with Type switch resistors R37, 38 and 39, are adjusted for proper grid current through Rg for different types of capacitors.

LEAKAGE DISCHARGE

When the BRIDGE-LEAKAGE switch is moved from the LEAKAGE position to the DISCHARGE position, the capacitor under test is shunted to ground through resistors R40 and R36. During the resulting discharge time, a voltage is again developed at the grid of amplifier stage V2A. In turn, V2A causes a change in the grid voltage of eye tube V3, causing the eye to close. After the capacitor has discharged, the voltage on the grid of tube V2A returns to its original value and the eye tube opens.

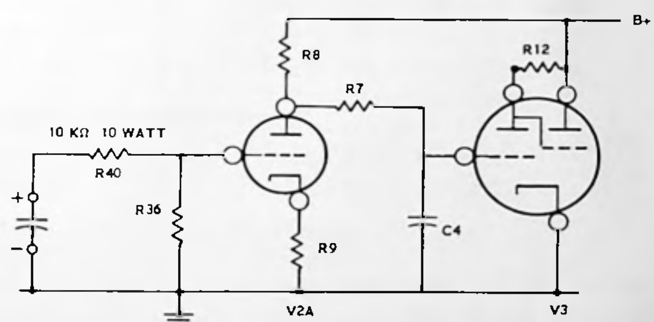


Figure 8

POWER SUPPLY

The transformer-operated power supply uses V1 in a half-wave rectifier circuit. The fused primary circuit of the transformer is symmetrically bypassed with C9 and C10 for increased accuracy when measuring low capacitance at 60 cps. The filament circuit is effectively center tapped with R41 and R42. Capacitors C1 and C2, with resistors R1, R2, R3, R4, and R5 make up a filter-voltage divider network to provide proper DC voltages to the circuit.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacement section and supply the information called for therein. Include all inspection slips in your letter to us.

In order to expedite delivery to you, we are occasionally forced to make a minor substitution of parts. Such substitutions are carefully checked before they are approved and parts supplied will work satisfactorily. In checking the Parts List for resistors, for example, you may find that a resistor with a 5% tolerance has been substituted for a resistor with a 10% tolerance, as shown in the Parts List. These changes are self-evident and are mentioned here only to prevent confusion in checking the contents of your kit.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started:

1. Lay out all parts so that they are readily available.

2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-3	4	100 Ω 1/2 watt (brown-black-brown)
1-119	2	560 Ω 1/2 watt (green-blue-brown)
1-7	2	680 Ω 1/2 watt (blue-gray-brown)
1-8	1	820 Ω 1/2 watt (gray-red-brown)
1-9	1	1000 Ω 1/2 watt (brown-black-red)
1-44	1	2200 Ω 1/2 watt (red-red-red)
1-16	1	4700 Ω 1/2 watt (yellow-violet-red)
1-20	9	10 KΩ 1/2 watt (brown-black-orange)
1-25	4	47 KΩ 1/2 watt (yellow-violet-orange)
1-26	1	100 KΩ 1/2 watt (brown-black-yellow)
1-29	2	220 KΩ 1/2 watt (red-red-yellow)
1-35	1	1 megohm 1/2 watt (brown-black-green)
1-36	2	1.5 megohm 1/2 watt (brown-green-green)
2-83	2	200 Ω 1/2 watt 1% precision
2-35	1	9000 Ω 1/2 watt 1% precision
2-38	1	20 KΩ 1/2 watt 1% precision
2-55	1	2 megohm 1/2 watt 1% precision
1A-5	1	22 KΩ 1 watt (red-red-orange)
1B-18	1	33 KΩ 2 watt (orange-orange-orange)
1B-10	4	47 KΩ 2 watt (yellow-violet-orange)
3J-7	1	10 KΩ 10 watt wire-wound
Capacitors		
20-2	1	200 μμf molded mica (red-black-brown)
21-71	2	.001 μfd disc ceramic 1400 V
21-81	1	.1 μfd disc ceramic
23-70	1	.02 μfd tubular 2% (two matched .01 μfd capacitors connected in parallel)
23-59	1	.05 μfd tubular
23-28	1	.1 μfd tubular
Capacitors (Cont'd.)		
23-56	1	.5 μfd tubular
23-16	1	2 μfd tubular
25-41	2	40 μfd 350 V electrolytic
Controls-Switches		
10-58	3	100 KΩ tab-mount control
11-40	2	1000 Ω control, wire-wound
60-1	1	SPST slide switch
60-2	1	DPDT slide switch
62-15	1	3-position lever switch
62-16	1	3-position lever switch
63-277	1	16-position rotary switch
63-278	1	8-position rotary switch
Tubes-Transformers		
411-128	1	6BN8 tube
411-120	1	6E5 tube
411-156	1	6AX4 tube
51-80	1	Bridge transformer
54-34	1	Power transformer
Connectors-Terminal Strips-Sockets		
100-M16B	3	Binding post cap, black
100-M16R	3	Binding post cap, red
427-3	6	Binding post base
431-1	1	Dual-lug terminal strip
431-10	1	3-lug terminal strip
431-11	2	5-lug terminal strip
431-16	1	2-lug terminal strip
434-31	1	Octal socket
434-12	1	6-pin tube socket
434-77	1	9-pin tube socket
Metal Parts-Knobs-Pointers		
90-175	1	Cabinet
200-M302	1	Chassis
203-250F511-512-513	1	Front panel
462-97	2	Knob, lever switch
462-139	3	Knob, control
462-140	1	Knob, large control
463-27	3	Small pointer
463-28	1	Dial pointer
Hardware		
250-2	2	3-48 x 5/16" screw
250-18	2	8-32 x 3/8" screw
250-26	4	6-32 x 5/8" screw
250-48	4	6-32 x 1/2" screw

PART No.	PARTS Per Kit	DESCRIPTION
Hardware (Cont'd.)		
250-89	17	6-32 x 3/8" screw
250-83	2	#10 sheet metal screw
252-1	2	3-48 nut
252-3	21	6-32 nut
252-4	2	8-32 nut
252-7	4	Control nut
252-22	2	Speednut
253-9	4	#8 flat washer
253-10	4	Control flat washer
254-7	2	#3 lockwasher
254-1	20	#6 lockwasher
254-2	1	#8 lockwasher
254-5	2	Small control lockwasher
254-4	2	Control lockwasher
255-1	1	1/8" spacer
255-13	4	1/4" spacer
259-1	6	#6 solder lug

PART No.	PARTS Per Kit	DESCRIPTION
Hardware (Cont'd.)		
259-2	1	#8 solder lug
208-2	2	Mounting clip
Insulators-Wire		
73-1	4	Grommet
75-17	12	Binding post insulator
75-24	1	Line cord strain relief
89-1	1	Line cord
134-38	1	Wire harness
344-1	1	Length hookup wire
Miscellaneous		
211-15	1	Handle
261-9	4	Rubber feet
421-20	1	1/2 ampere slow-blow fuse
422-1	1	Fuse holder
595-445	1	Manual

PROPER SOLDERING TECHNIQUES

Only a small percentage of HEATHKIT equipment purchasers find it necessary to return an instrument for factory service. Of these instruments, by far the largest portion of malfunctions are due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 30 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron than this may not heat the connection enough to flow the solder smoothly over the joint. Keep the iron tip clean and bright by wiping it from time to time with a cloth.

CHASSIS WIRING AND SOLDERING

1. Unless otherwise indicated, all wire used is the type with colored insulation (hookup wire); the size of the conductor is the same for all colors of hookup wires furnished with this kit. In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the construction step.

2. To avoid breaking internal connections when stripping insulation from the leads of transformers or similar components, care should be taken not to pull directly on the lead. Instead, hold the lead with pliers while it is being stripped.

3. Leads on resistors, capacitors and similar components are generally much longer than they need to be to make the required connections. In these cases, the leads should be

cut to proper length before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points.

4. Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the wire is too large to allow bending or if the step states that the wire is not to be crimped, position the wire so that a good solder connection can still be made.

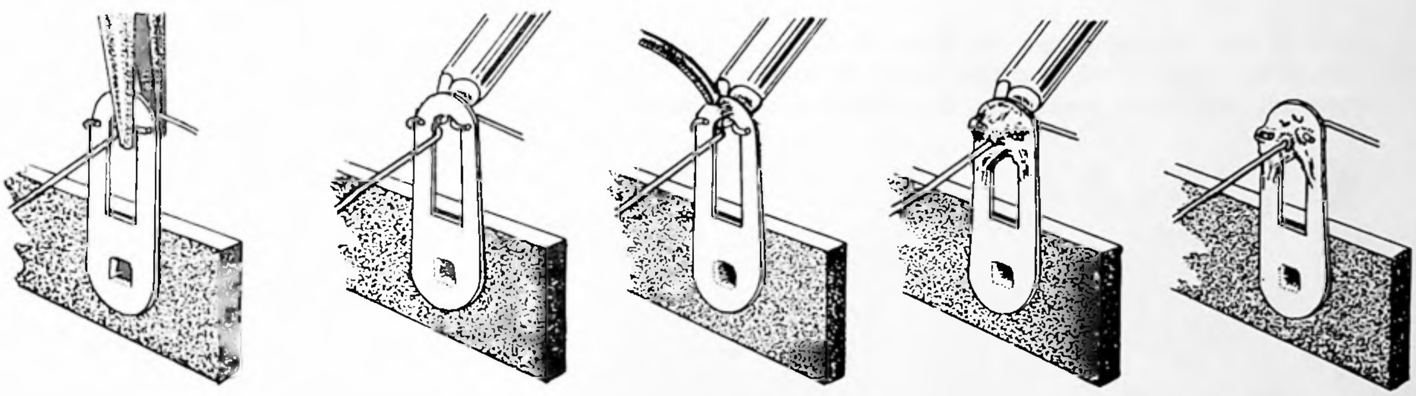
5. Position the work, if possible, so that gravity will help to keep the solder where you want it.

6. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.

7. Then place the solder against the heated terminal and it will immediately flow over the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.

8. Remove the solder and then the iron from the completed junction. Use care not to move the leads until the solder is solidified.

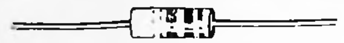
A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly over the entire junction. In some cases, it may be necessary to add a little more solder to achieve a smooth bright appearance.

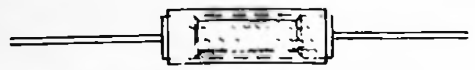


CRIMP WIRES | HEAT CONNECTION | APPLY SOLDER | ALLOW SOLDER TO FLOW | PROPER SOLDER CONNECTION

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.

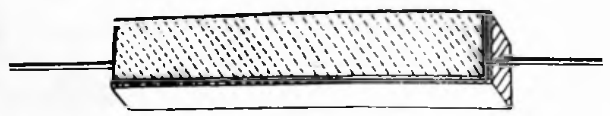
RESISTORS–CAPACITORS

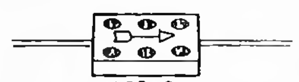

1/2 WATT RESISTOR


1/2 WATT 1% PRECISION RESISTOR


1 WATT RESISTOR

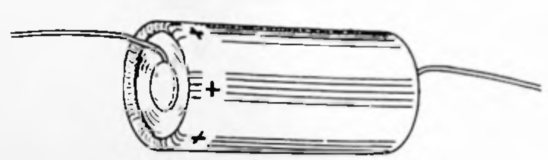

2 WATT RESISTOR


#3J-7
10 KΩ 10 WATT WIRE-WOUND RESISTOR

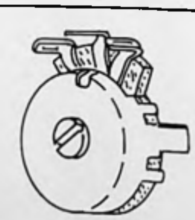

#20-2
200 μμf MOLDED MICA CAPACITOR

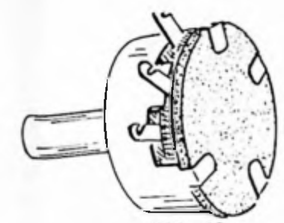

#21-81
.1 μfd DISC CERAMIC CAPACITOR

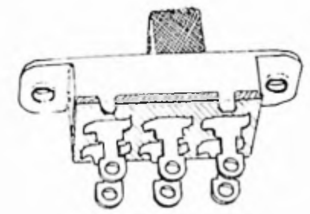

TUBULAR CAPACITOR


#25-41
40 μfd, 350 VOLT ELECTROLYTIC CAPACITOR

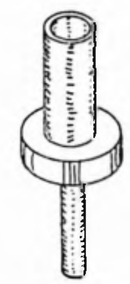
CONTROLS–SWITCHES

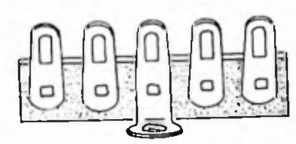

#10-58
100 K TAB-MOUNT CONTROL


#11-40
1000 Ω CONTROL, WIRE-WOUND


DPDT SLIDE SWITCH

CONNECTORS TERMINAL STRIPS


#427-3
BINDING POST BASE

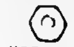

#431-11
5-LUG TERMINAL STRIP

HARDWARE–INSULATOR


#250-2
3-48 x 5/16" SCREW


#250-18
8-32 x 3/8" SCREW


#250-26
6-32 x 5/8" SCREW


#252-1
3-48 NUT


#252-3
6-32 NUT


#252-4
8-32 NUT


#252-7
CONTROL NUT

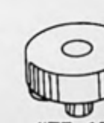

#252-22
SPEEDNUT

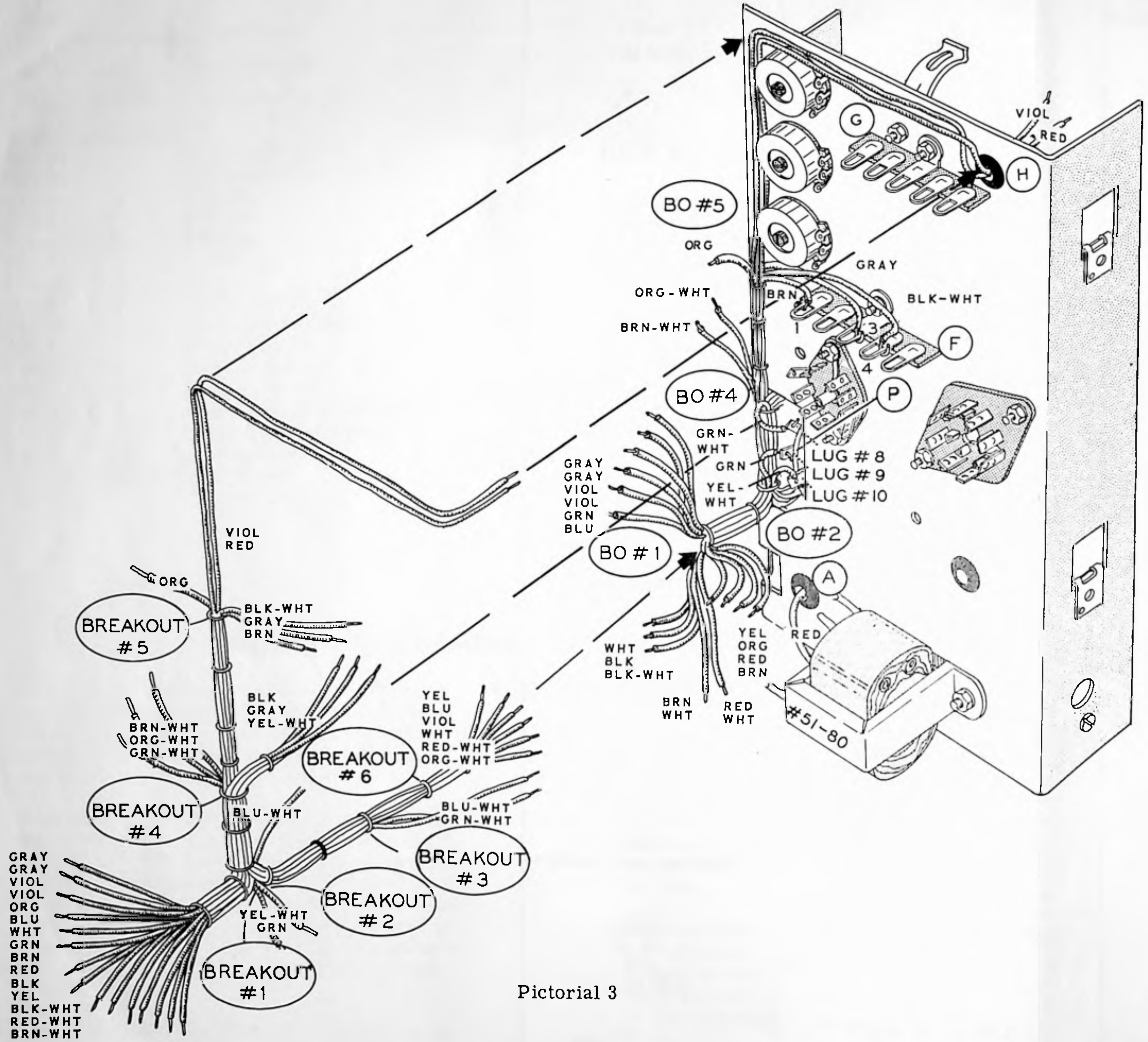

#254-7
#3 LOCKWASHER


#254-4
CONTROL LOCKWASHER

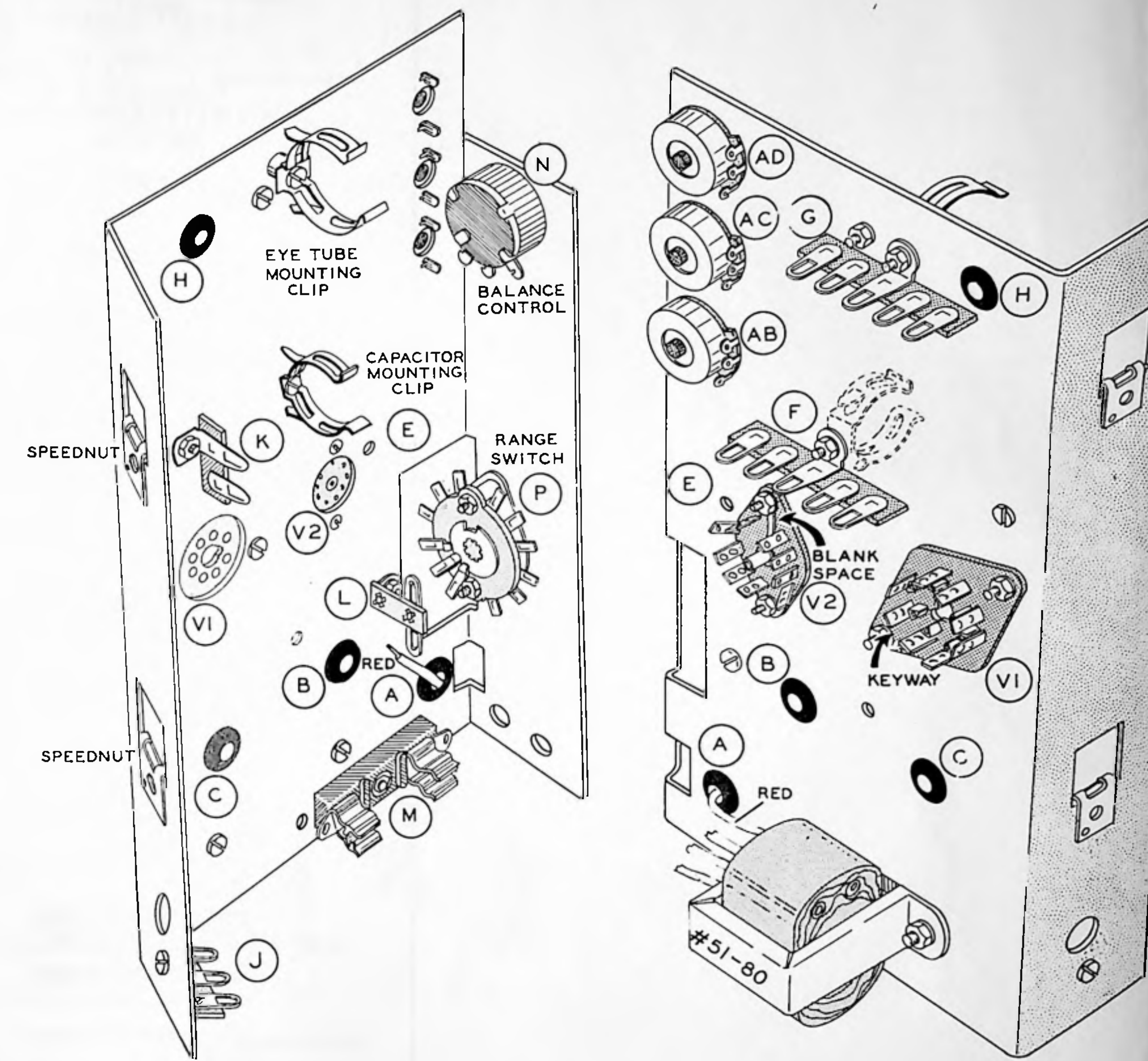

#255-1
1/8" SPACER


#259-1
#6 SOLDER LUG


#75-17
BINDING POST INSULATOR



Pictorial 3



Pictorial 2

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the Pictorial as it is added.

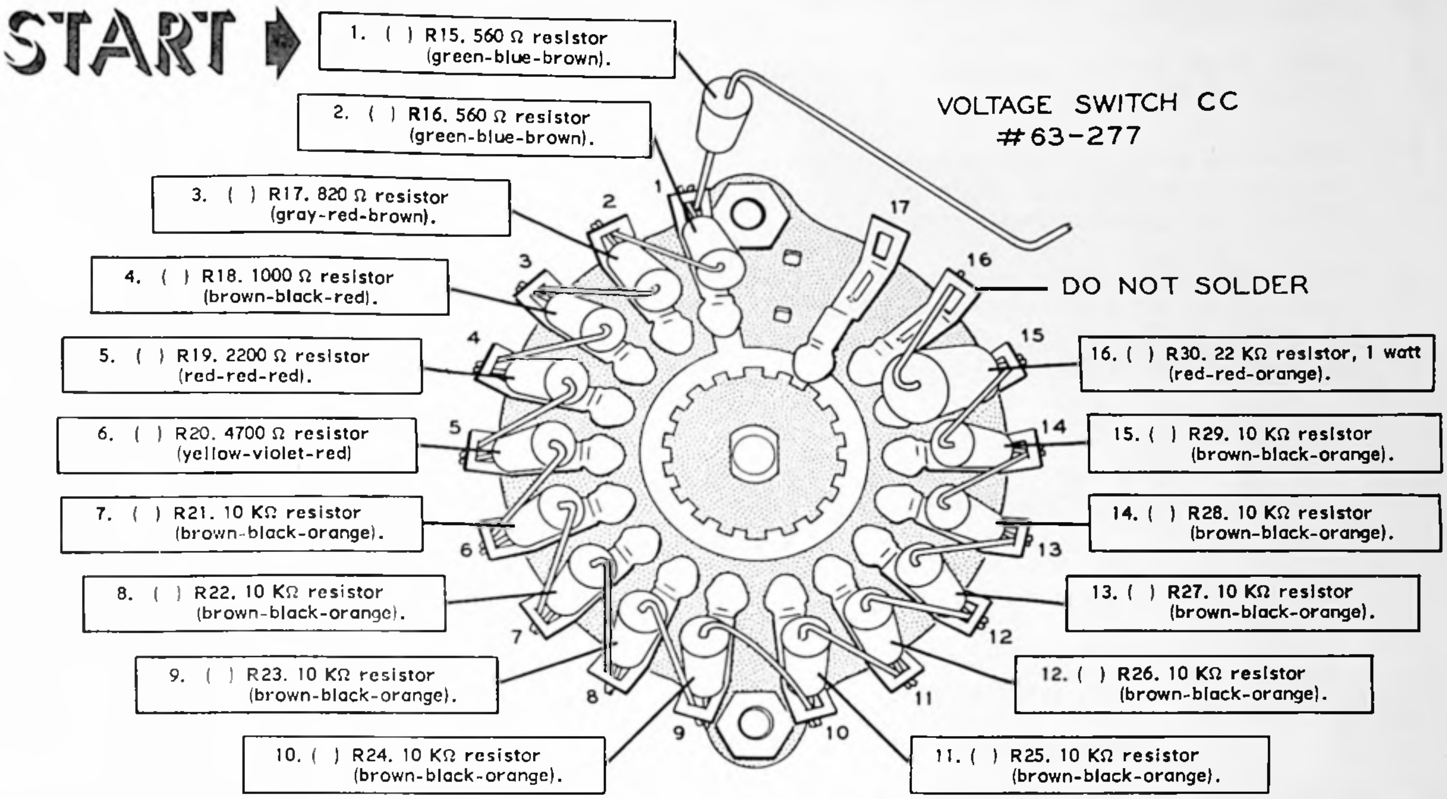
The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but, because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustrations may be slightly distorted to facilitate clearly showing all of the parts.

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a lead to lug 1 (S-2)," it will be understood that there will be two leads connected to the terminal at the time it is soldered. (In cases where a lead passes through a terminal or lug and then connects to another point, it will count as two leads, one entering and one leaving the terminal.)

The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation on the Schematic, its designation will appear in the construction step which directs its installation.

STEP-BY-STEP ASSEMBLY



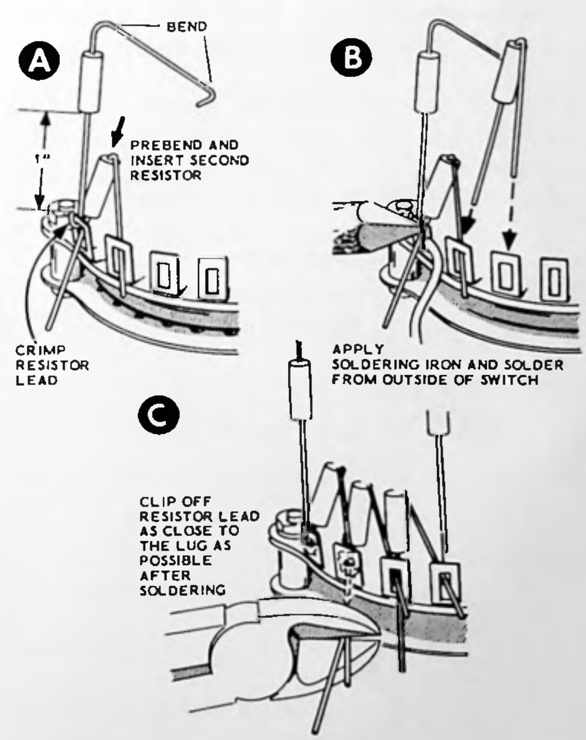
Pictorial 1

VOLTAGE SWITCH CC WIRING

To install a resistor on VOLTAGE switch CC, bend one lead against the resistor body before making the connection. Cut off the excess lead after the connection has been soldered. See Detail 1A.

Perform the steps on Pictorial 1. All resistors are 1/2 watt except R30, which is a 1 watt resistor.

After completing the steps on Pictorial 1, check to be sure all connections except lugs 16 and 17 are soldered. Set this switch aside to be installed later.



Detail 1A

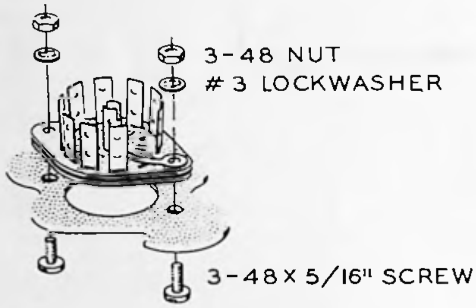
CHASSIS PARTS MOUNTING

Refer to Pictorial 2 (fold-out from Page 10) for the following steps.

( ) Install four rubber grommets in chassis holes A, B, C, and H.

( ) Install a speednut at each square cut-out on the rear of the chassis. Make sure the flat side of each speednut faces outward.

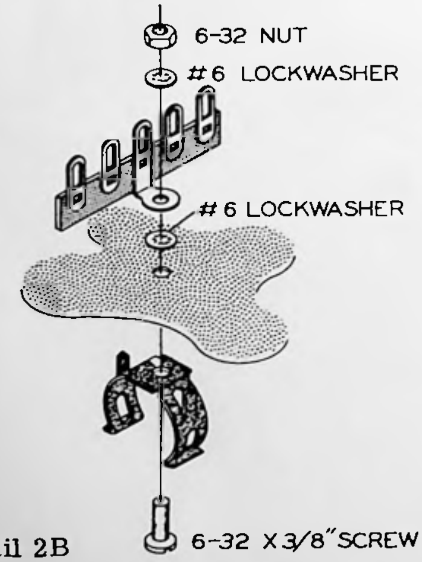
( ) Mount the 9-pin tube socket at V2. Use 3-48 screws, #3 lockwashers, and 3-48 nuts as shown in Detail 2A. Orient the blank space as shown in Pictorial 2.



Detail 2A

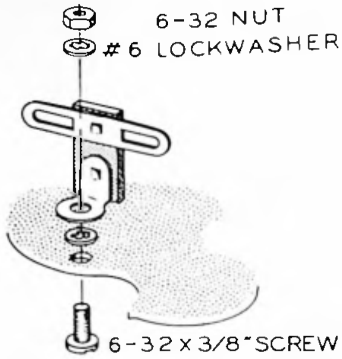
( ) In the same manner, mount the octal tube socket at V1. Use 6-32 x 3/8" screws, #6 lockwashers, and 6-32 nuts. Position the socket with its keyway as shown.

( ) Referring to Detail 2B, mount the capacitor mounting clip and a 5-lug terminal strip at location F. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut.



Detail 2B

( ) Mount a dual-lug terminal strip at L. Use a 6-32 x 3/8" screw, #6 lockwashers, and 6-32 nut as shown in Detail 2C.



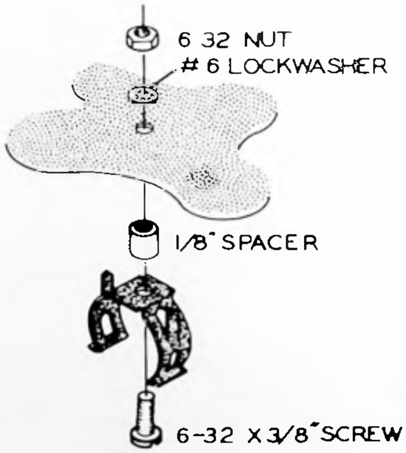
Detail 2C

( ) Similarly, mount a 2-lug terminal strip at K.

( ) Mount 3-lug terminal strip J on the rear flange of the chassis. Use a 6-32 x 3/8" screw, two #6 lockwashers and a 6-32 nut.

( ) Mount fuse holder M, using a 6-32 x 3/8" screw, #6 lockwasher, and 6-32 nut.

( ) Mount the eye tube mounting clip as shown in Detail 2D. Use a 6-32 x 3/8" screw, 1/8" spacer, #6 lockwasher, and 6-32 nut.



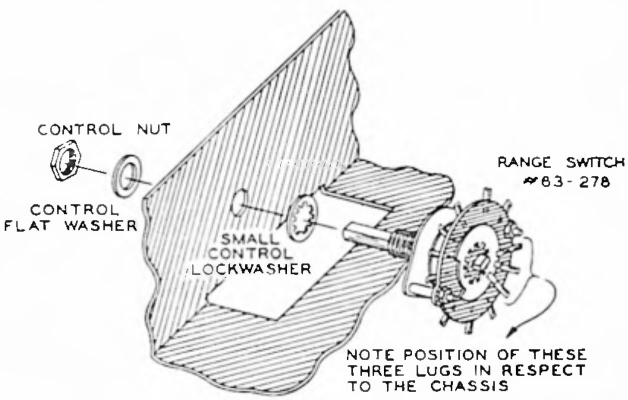
Detail 2D

( ) Mount 5-lug terminal strip G, using a 6-32 x 3/8" screw, #6 lockwashers, and 6-32 nut. Make sure the terminal strip is mounted on the screw nearest grommet H as shown in Pictorial 2.

Cut the leads of the bridge transformer (#51-80) to the following lengths:

	COLOR	LENGTH
( )	Red	5-1/4"
( )	Red-yellow	3-1/4"
( )	Black	2-1/2"
( )	Black-yellow	2-1/2"

( ) Strip 1/4" of insulation from the end of each lead and tin. ("Tin" means to melt a small amount of solder on the exposed lead end.)

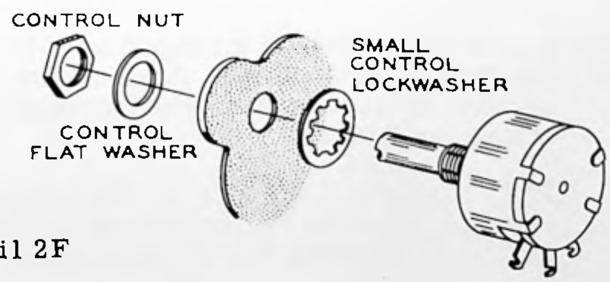


Detail 2E

( ) Mount the bridge transformer (#51-80), using 6-32 x 3/8" screws, #6 lockwashers, and 6-32 nuts. Insert the red lead through grommet A to be connected later.

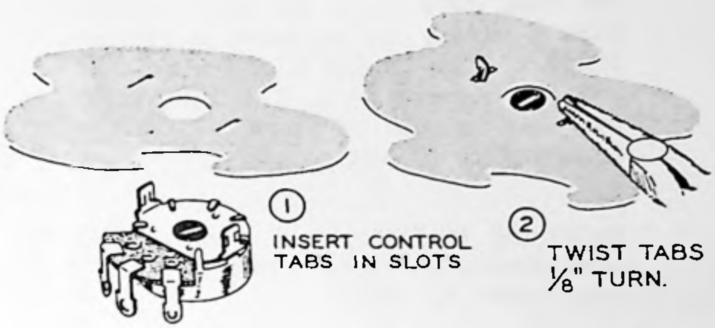
( ) Mount the RANGE switch (#63-278) at P. Use a small control lockwasher, a flat washer, and control nut as shown in Detail 2E. Position this switch with its lugs as shown in Pictorial 2.

( ) Similarly, mount the Balance control (#11-40) at N. Use a small control lockwasher, a flat washer, and control nut. Position as shown in Pictorial 2.



Detail 2F

( ) R43. Refer to Detail 2G and mount a 100 KΩ tab-mount control at AB. Position the control as shown and twist the tabs 1/8 turn to secure the control.



Detail 2G

( ) R44, 45. In a like manner, mount 100 KΩ tab-mount controls at AC and AD.

HARNESS AND RANGE SWITCH P WIRING

Refer to Pictorials 3 (fold-out from Page 10) and 4 for the following steps.

( ) Locate the wire harness and form it as shown in Pictorial 3.

( ) Install the harness on the chassis as shown. Except for the green-white, brown-white, and orange-white wires from breakout #4, and the yellow-white and green wires from breakout #2, all the wires from these two breakouts go through the chassis as shown, on either side of the RANGE switch.

( ) Connect the green-white wire from breakout #4 to lug 8 of switch P (S-1).

( ) Connect the green wire from breakout #2 to lug 9 of switch P (S-1).

( ) Connect the yellow-white wire from breakout #2 to lug 10 of switch P (S-1).

Connect the following three wires from breakout #5 to terminal strip F.

( ) Brown wire to lug 1 (NS).

( ) Gray wire to lug 3 (NS).

( ) Black-white wire to lug 4 (NS).

( ) Position the violet and red wires as shown in Pictorial 3 and insert their ends through grommet H.

( ) Install the 6-pin tube socket on the 6E5 eye tube. Now place the tube into the eye tube mounting clip as shown in Pictorial 4. Position lugs 1 and 6 of the tube socket just above grommet H. The front end of the eye tube should be flush with the front flange of the chassis.

( ) Referring to Pictorial 4, connect the red wire coming through grommet H to lug 3 of tube socket V3 (NS).

( ) Connect the violet wire coming through grommet H to lug 5 of tube socket V3 (NS).

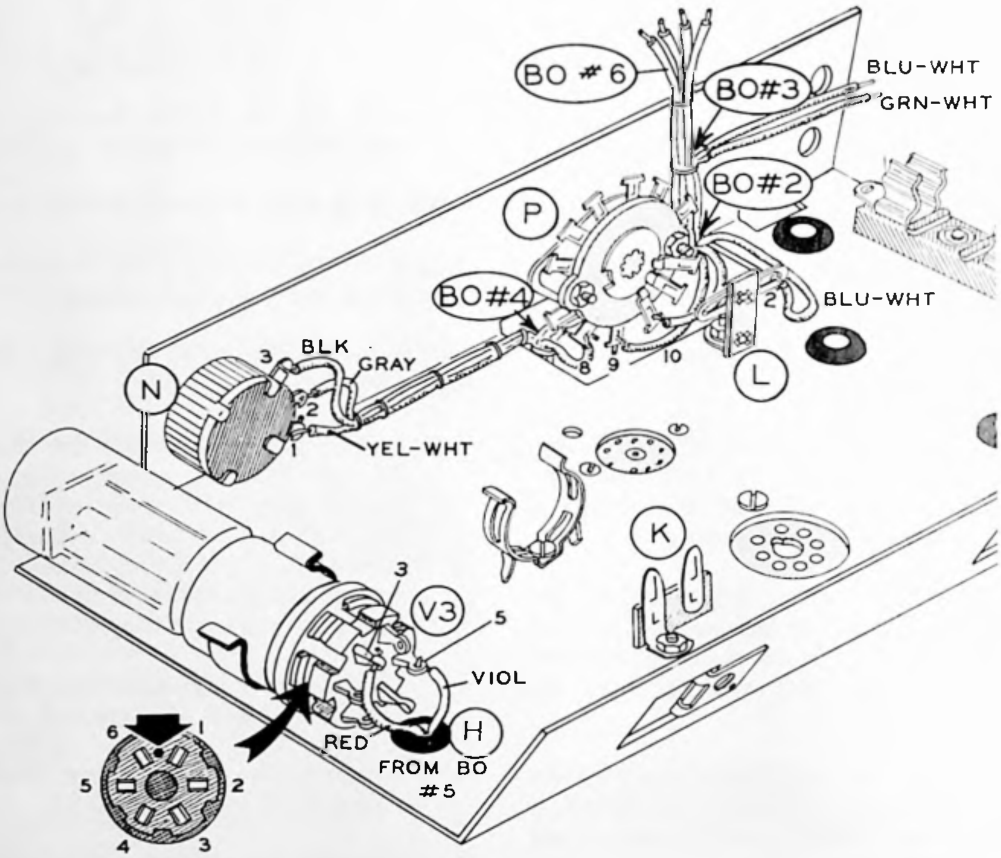
Referring to Pictorial 4, connect the following three wires from breakout #4 to control N:

( ) Yellow-white wire to lug 1 (S-1).

( ) Gray wire to lug 2 (S-1).

( ) Black wire to lug 3 (S-1).

( ) Position the blue-white wire from breakout #2 as shown and connect it to lug 2 of terminal strip L (NS).



Pictorial 4

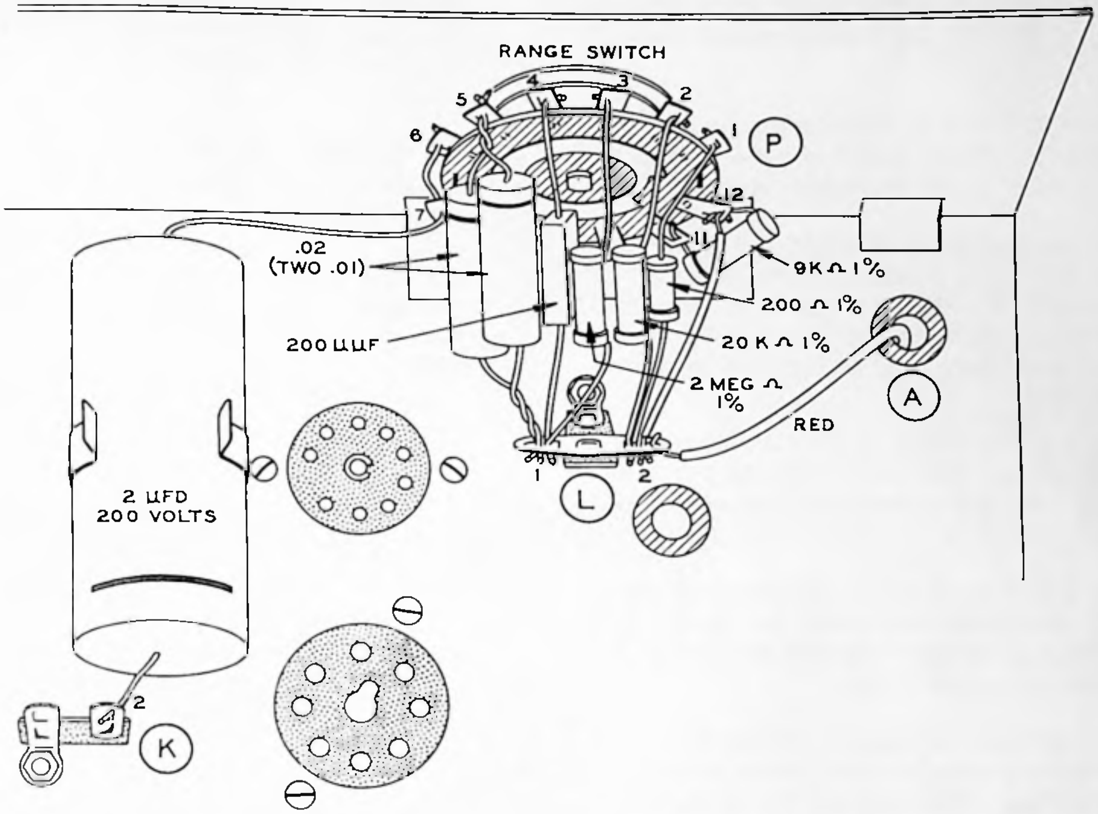
RANGE SWITCH P WIRING

Refer to Pictorial 5 for the following steps.

( ) C6. Insert the 2 μfd 200 V capacitor into the capacitor clip as shown. Connect the lead from the banded end to lug 2 of terminal strip K (NS).

( ) Insert the free lead through lug 7 (NS) to lug 6 (S-1) of switch P. Position this lead so that it clears the switch frame. Now solder lug 7 (S-2).

( ) R34. Connect a 9000 Ω (9 KΩ) precision resistor from lug 11 (S-1) to lug 12 (NS) of switch P. Position the resistor as shown.



Pictorial 5

( ) Connect a 1-1/2" wire from lug 12 of switch P (S-2) to lug 2 of terminal strip L (NS).

( ) R31. Connect a 200 Ω precision resistor from lug 1 of switch P (S-1) to lug 2 of terminal strip L (NS).

( ) R32. Connect a 20 KΩ precision resistor from lug 2 of switch P (S-1) to lug 2 of terminal strip L (NS).

( ) Connect the red lead from the bridge transformer coming through grommet A, to lug 2 of terminal strip L (S-5).

( ) R33. Connect a 2 megohm precision resistor from lug 3 of switch P (S-1) to lug 1 of terminal strip L (NS).

( ) C7. Connect a 200 μμf (red-black-brown) molded mica capacitor from lug 4 of switch P (S-1) to lug 1 of terminal strip L (NS).

( ) C8. Connect the .02 μfd tubular capacitor from lug 5 of switch P (S-1) to lug 1 of terminal strip L (S-3). (C8 is actually two .01 μfd capacitors connected in parallel.)

CHASSIS WIRING

Refer to Pictorial 6 (fold-out from Page 19) for the following steps.

( ) Connect a 6-1/2" wire to lug 2 of terminal strip F (NS). Insert the other end of this wire through hole E (near lug 8 of tube socket V2). It will be connected later.

( ) C3. Connect a .05 μfd capacitor from lug 2 (NS) to lug 7 (NS) of tube socket V2.

( ) Connect a 1-1/2" wire from lug 2 (S-2) to lug 6 (S-1) of tube socket V2.

( ) R7. Connect a 100 Ω (brown-black-brown) 1/2 watt resistor from lug 7 of tube socket V2 (NS) to lug 1 of terminal strip F (S-2). Position as shown.

( ) R6. Connect a 1.5 megohm (brown-green-green) 1/2 watt resistor from lug 8 of tube socket V2 (NS) to lug 2 of terminal strip F (S-2).

( ) R9. Connect a 680 Ω (blue-gray-brown) 1/2 watt resistor from lug 9 of tube socket V2 (S-1) to lug 3 of terminal strip F (NS).

( ) R10. Pass one lead of a 220 KΩ (red-red-yellow) 1/2 watt resistor through lug 1 of tube socket V2 (NS) to lug 4 of terminal strip F (S-2). Now solder lug 1 of V2 (S-2). Connect the other lead to lug 3 of terminal strip F (NS).

( ) Connect a 5" wire to lug 3 of tube socket V1 (NS). Position this wire beside terminal strip F. The other end will be connected later.

( ) Connect a 7" wire to lug 5 of terminal strip F (NS). Position this wire as shown and insert the other end through grommet H. It will be connected later.

NOTE: The purpose of using twisted pairs of hookup wire is to provide cancellation of hum in the filament wiring. Best results will be obtained if the wires are twisted approximately two full turns per inch.

( ) Twist together two 3-1/2" lengths of hookup wire. At one end of this twisted pair, connect either wire to lug 4 (NS) and the other wire to lug 5 (NS) of tube socket V2.

( ) At the other end of this twisted pair, connect either wire to lug 7 (NS) and the other wire to lug 8 of tube socket V1 (NS).

( ) Twist together two 10" lengths of hookup wire. At one end of this twisted pair, connect either wire to lug 7 (NS) and the other wire to lug 8 (NS) of tube socket V1.

( ) Position this pair as shown in Pictorial 6 and insert the other end through grommet H to be connected later.

( ) C1. Connect a 40 μfd, 350 V electrolytic capacitor from lug 3 of tube socket V1 (NS) to lug 5 of terminal strip G (NS). The positive (+) lead goes to tube socket V1.

( ) R1. Connect a 47 KΩ (yellow-violet-orange) 2 watt resistor from lug 4 of terminal strip G (NS) to lug 3 of tube socket V1 (NS).

( ) R2. Connect another 47 KΩ (yellow-violet-orange) 2 watt resistor between the same two lugs, lug 4 of terminal strip G (NS) and lug 3 of tube socket V1 (S-4). Position as shown.

( ) R3. Connect a 47 KΩ (yellow-violet-orange) 2 watt resistor from lug 5 of terminal strip F (NS) to lug 4 of terminal strip G (NS).

( ) R4. Connect another 47 KΩ (yellow-violet-orange) 2 watt resistor between the same two lugs, lug 5 of terminal strip F (NS) and lug 4 of terminal strip G (S-4).

( ) R5. Connect a 33 KΩ (orange-orange-orange) 2 watt resistor from lug 5 of terminal strip F (NS) to lug 3 of terminal strip G (NS). Position as shown.

( ) C2. Connect a 40 μfd, 350 V electrolytic capacitor from lug 3 of terminal strip F (NS) to lug 1 of terminal strip G (NS). The positive (+) lead goes to terminal strip G.

( ) Connect a 3" wire between lug 1 (S-2) and lug 5 (S-2) of terminal strip G. Position as shown.

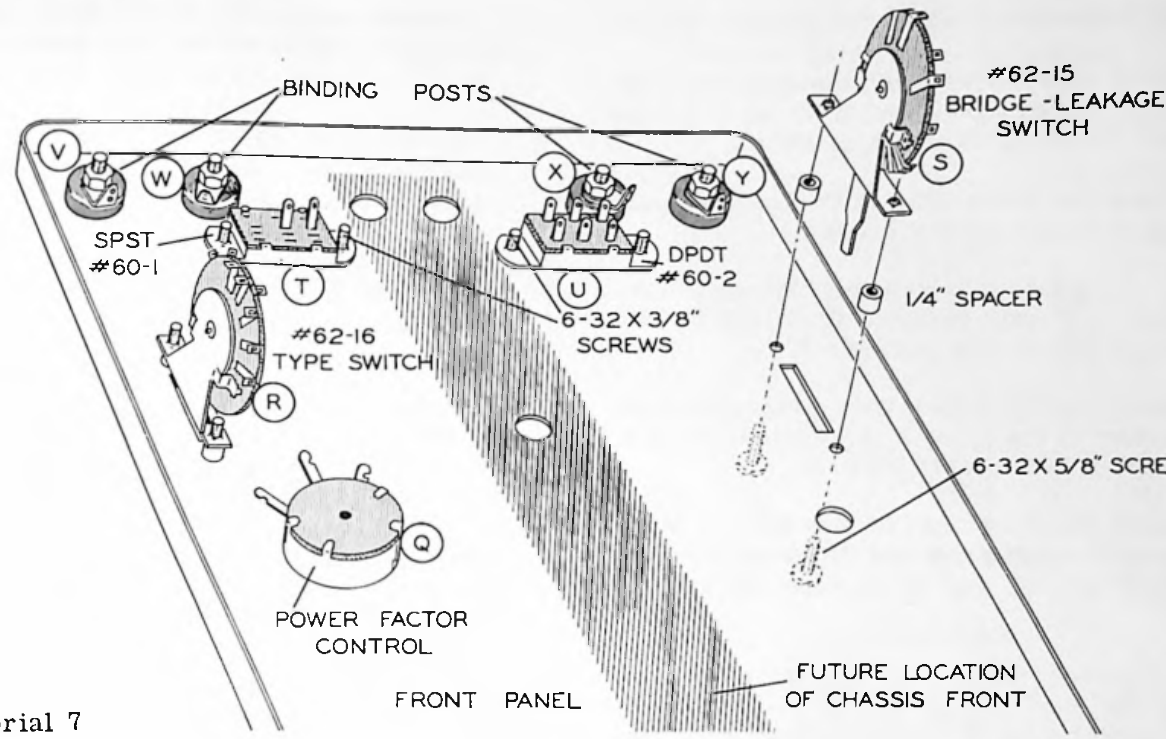
( ) R37. Cut both leads of a 47 KΩ (yellow-violet-orange) 1/2 watt resistor to 1". Pass one lead through lug 1 (NS) to lug 2 (S-1) of control AB. Pass the other lead through lug 3 of control AB (NS) to lug 1 of control AC (NS).

( ) R38. Cut both leads of a 47 KΩ (yellow-violet-orange) 1/2 watt resistor to 1". Pass one lead through lug 1 (NS) to lug 2 (S-1) of control AC. Pass the other lead through lug 3 of control AC (NS) to lug 1 of control AD (NS). Now solder lug 1 of control AB (S-3).

( ) R39. Cut one lead of a 47 KΩ (yellow-violet-orange) 1/2 watt resistor to 1". Pass this lead through lug 1 (NS) to lug 2 (S-1) of control AD. Connect the other lead to lug 3 of control AD (NS). Now solder lug 1 of control AD (S-3).

( ) Connect a 4" hookup wire from lug 3 of control AD (S-2) to lug 3 of terminal strip G (S-2).

( ) Connect one end of a 7-1/2" wire to lug 1 of control AB (S-3). Dress the wire as shown and pass the free end down through grommet H for connection later.



Pictorial 7

( ) Connect one end of an 11" wire to lug 3 of control AB (S-3). Position the free end of the wire down through the chassis cutout above switch P for connection later.

( ) Connect one end of a 12" wire to lug 3 of control AC (S-3). Position the free end of the wire down through the chassis cutout as before, for connection later.

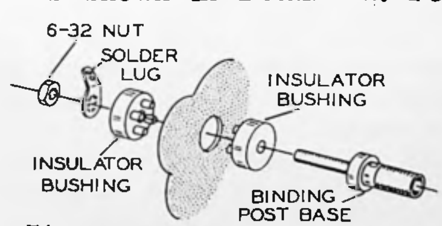
FRONT PANEL ASSEMBLY

Refer to Pictorial 7 for the following steps.

( ) Mount the SPST slide switch (#60-1) at T, using 6-32 x 3/8" screws. Position this switch as shown.

( ) In the same manner, mount the DPDT slide switch (#60-2) at U.

( ) Mount binding post bases at V, W, X and Y as shown in Detail 7A. Position each solder lug as shown in Pictorial 7. The hole in each binding post base should be parallel with the bottom of the panel. Do not install binding post bases in the EXT. GEN. locations at this time.



Detail 7A

( ) Mount the BRIDGE-LEAKAGE switch (#62-15) at S. Use 6-32 x 5/8" screws, 1/4" spacers, and position as shown.

( ) Similarly, mount the Type switch (#62-16) at R. Position as shown.

( ) Mount the POWER FACTOR control (#11-40) at Q. Use a control lockwasher, flat washer, and control nut as shown in Detail 2F. Position as shown in Pictorial 7.

( ) Remove the control nut and flat washer from control N and switch P. Mount the front panel on the chassis. Do not pinch any of the harness wires. Now reinstall the flat washer and control nut on control N and switch P. Do not tighten yet.

( ) Mount the two remaining binding post bases at AA and BB. Position the hole in each binding post base parallel with the bottom of the front panel. Position the solder lugs as shown in Pictorial 8.

( ) Now tighten the control nut on control N and switch P.

Refer to Pictorial 8 for the following steps.

( ) Connect either wire of the twisted pair coming through grommet H to lug 1 of tube socket V3 (S-1). Position as shown.

( ) Connect the other wire of this twisted pair to lug 6 of tube socket V3 (S-1).

( ) R12. Connect a 1 megohm (brown-black-green) 1/2 watt resistor from lug 2 (NS) to lug 4 (NS) of tube socket V3.

( ) Connect the free hookup wire coming through grommet H from lug 5 of terminal strip F to lug 4 of tube socket V3 (S-2).

( ) Connect the free end of the hookup wire coming through grommet H, from lug 1 of control AB, to lug 5 of tube socket V3 (S-2).

( ) C4. Connect the .5 μfd tubular capacitor from lug 3 of tube socket V3 (S-2) to lug 1 of terminal strip K (NS). The lead from the banded end of this capacitor goes to terminal strip K.

( ) C11. Connect a .1 μfd tubular capacitor from lug 2 of socket V3 (S-2) to lug 1 of terminal strip K (S-2). The banded end should connect to the terminal strip.

( ) Connect an 8-3/4" wire from lug 2 of control Q (S-1) to lug 2 of terminal strip K (S-2). Position this wire under the harness wires going to switch P and around the 2 μfd capacitor. See Pictorial 8.

( ) Connect a 4-1/2" wire from lug 3 of control Q (S-1) to solder lug V (NS). Position as shown.

( ) Insert one end of a 1-1/2" wire through grommet A. Connect the other end to solder lug BB (S-1).

( ) Insert one end of a 2-1/4" wire through grommet A. Connect the other end to solder lug AA (S-1). The other ends of the two wires just installed will be connected later.

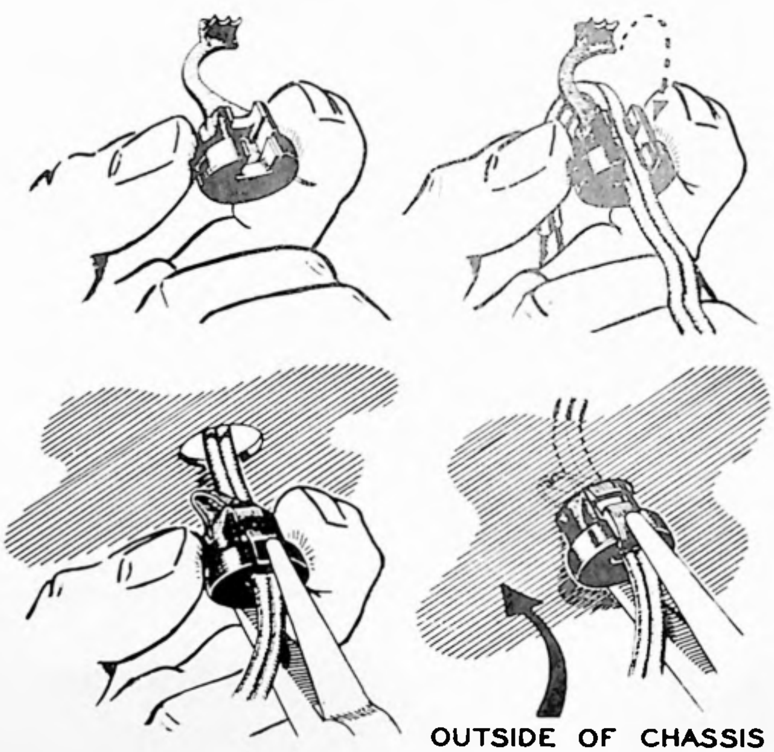
( ) Connect a 2-1/2" wire from lug 1 of switch T (S-1) to lug 1 of fuse holder M (S-1).

( ) Connect a 2-1/4" wire from lug 2 of fuse holder M (S-1) to lug 1 of terminal strip J (NS).

( ) C10. Connect a .001 μfd disc capacitor from lug 3 (NS) to lug 2 (NS) of terminal strip J.

( ) C9. In the same manner, connect the remaining .001 μfd disc capacitor from lug 1 (NS) to lug 2 (S-2) of terminal strip J.

( ) Install the line cord and line cord strain relief in chassis hole Z. See Detail 8A. The line cord leads should extend about 1" inside the chassis.



Detail 8A

( ) Connect either line cord lead to lug 1 (S-3) and the other lead to lug 3 (NS) of terminal strip J.

Referring to Pictorial 8, connect the following harness wires from breakout #6 to Type switch R. Position the wires as shown:

WIRE COLOR	LUG NUMBER
( ) Violet	1 (S-1).
( ) Red-white	4 (NS).
( ) Orange-white	3 (NS).
( ) White	5 (NS).
( ) Yellow	6 (NS).
( ) Blue	8 (S-1).

( ) Now position the harness away from the movable contact of switch R.

( ) Connect the hookup wire coming from hole E to lug 7 of switch R (NS).

( ) R35. Connect a 47 KΩ (yellow-violet-orange) 1/2 watt resistor from lug 6 (S-2) to lug 7 (S-2) of switch R.

( ) R11. Connect a 100 Ω (brown-black-brown) 1/2 watt resistor from lug 3 (S-2) to lug 4 (S-2) of switch R.

( ) Connect the free end of the hookup wire coming through the cutout from lug 3 of control AB to lug 2 of switch R (S-1).

( ) Connect the free end of the other hookup wire coming through the cutout from lug 3 of control AC to lug 5 of switch R (S-2).

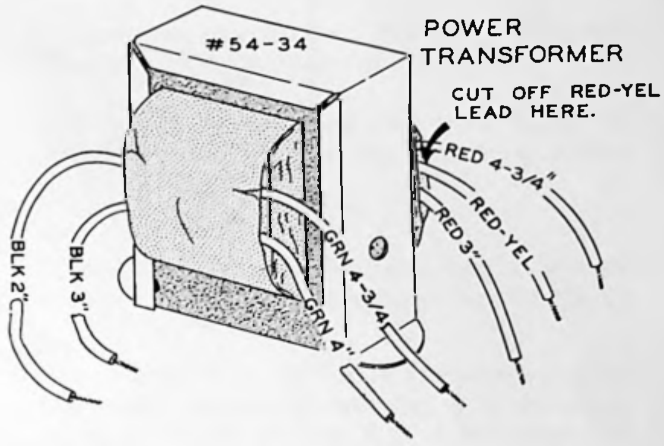
( ) Connect the green-white wire from breakout #3 to solder lug W (S-1).

( ) Connect the blue-white wire from breakout #3 to solder lug V (S-2).

( ) Cut the power transformer (#54-34) leads to the lengths shown in Detail 8B. Strip 1/4" insulation from each lead end and tin.

( ) Mount the power transformer in the position shown in Pictorial 8. Use two 8-32 screws, a #8 lockwasher, a #8 solder lug, and 8-32 nuts as shown in Detail 8C. The solder lug should be mounted at SS, on the mounting screw nearest tube socket V1. See Pictorial

10. Both green leads go into grommet B and both red leads go into grommet C. They will be connected later.

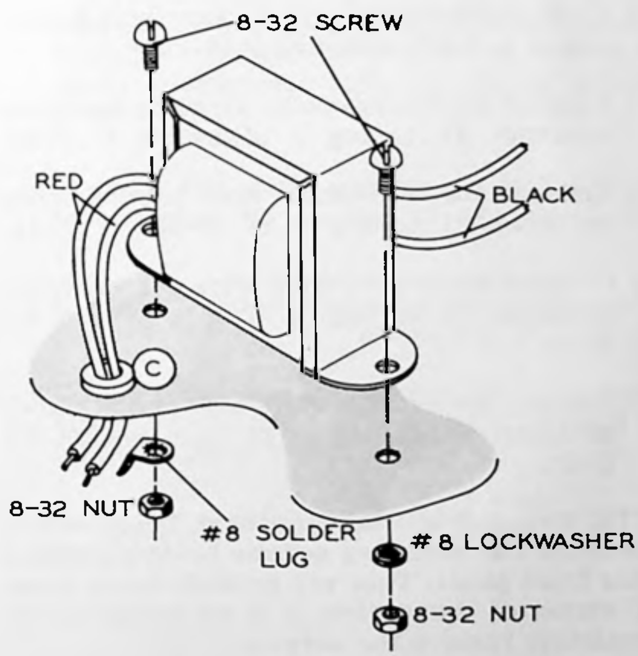


Detail 8B

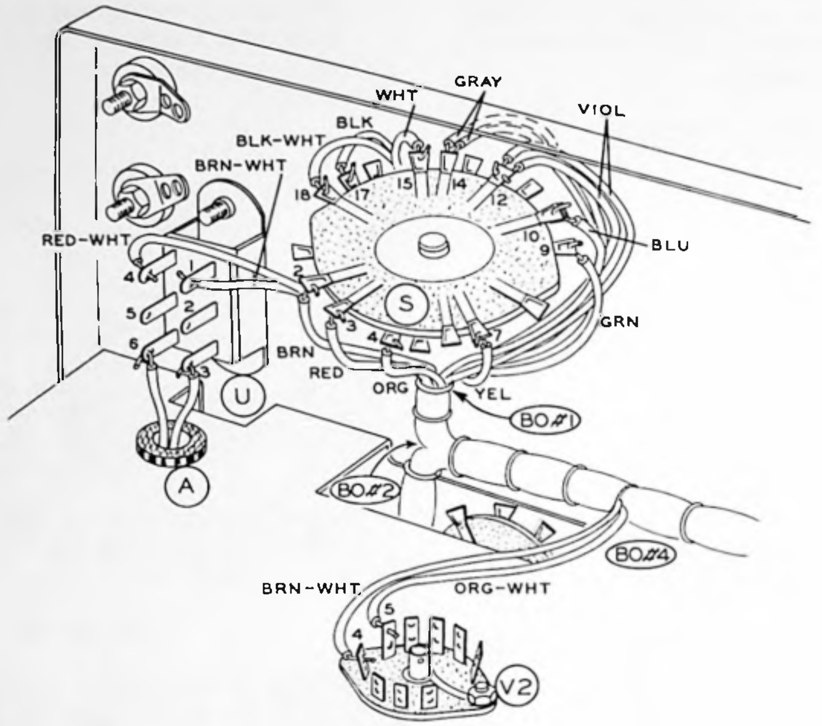
CAUTION: If necessary, bend lug 2 of fuse holder M away from the transformer frame to prevent shorting the AC line voltage to the chassis.

( ) Connect the shorter black lead to lug 2 of switch T (S-1).

( ) Connect the remaining black lead to lug 3 of terminal strip J (S-3).



Detail 8C



Pictorial 9

Refer to Pictorial 9 for the following steps.

( ) Connect either wire in grommet A to lug 3 of switch U (S-1).

( ) Connect the remaining free wire from grommet A to lug 6 of switch U (S-1).

( ) Connect the brown-white wire coming from breakout #1 to lug 1 of switch U (S-1).

( ) Connect the red-white wire coming from breakout #1 to lug 4 of switch U (S-1).

( ) Connect the brown-white wire coming from breakout #4 to lug 4 of tube socket V2 (S-2).

( ) Connect the orange-white wire coming from breakout #4 to lug 5 of tube socket V2 (S-2).

NOTE: Switch S will be wired next. Temporarily loosen the two mounting screws holding switch S to the front panel. This will provide more room for wiring of the switch. It is not necessary to completely remove the screws.

( ) Before making connections, route the harness wires from breakout #1 to their terminating points on switch S. See Pictorial 9.

Connect the following harness wires from breakout #1 to BRIDGE-LEAKAGE switch S. Position the wires as shown in Pictorial 9.

WIRE COLOR	LUG NUMBER
( ) Brown	2 (S-1).
( ) Red	3 (S-1).
( ) Orange	4 (S-1).
( ) Yellow	7 (NS).
( ) Green	9 (S-1).
( ) Blue	10 (S-1) solder both lugs.
( ) Both violet	12 (S-2).
( ) Both gray	14 (NS).
( ) White	15 (S-1).
( ) Black	17 (NS).
( ) Black-white	18 (S-1).

Refer to Pictorial 10 for the following steps.

( ) Connect a 3-1/2" wire from solder lug X (S-1) to lug 11 of switch S (S-1). Position as shown.

( ) Connect a 1-1/2" wire from solder lug Y (S-1) to lug 16 of switch S (S-1).

( ) R36. Connect a 680 Ω (blue-gray-brown) 1/2 watt resistor from lug 14 (S-3) to lug 7 (S-2) of switch S. Solder both lugs. Make sure the resistor leads do not touch any metal part of the switch.

( ) C5. Connect a .1 μfd disc capacitor from lug 13 (S-1) to lug 8 (S-1) of switch S. Make sure the capacitor leads do not touch any other switch contacts.

NOTE: The mounting screws for switch S may now be retightened. Do not pinch any of the wires when tightening the screws.

( ) Connect the black-yellow lead from the bridge transformer to lug 2 of switch U (S-1).

( ) Connect the black lead from the bridge transformer to lug 5 of switch U (S-1).

( ) Connect the red-yellow lead from the bridge transformer to lug 17 of switch S (S-2).

( ) Twist together the two green power transformer leads, coming from grommet B, and connect either lead to lug 7 of tube socket V1 (NS).

( ) Connect the other green lead to lug 8 of tube socket V1 (NS).

( ) R41. Connect a 100 Ω (brown-black-brown) 1/2 watt resistor from lug 7 of tube socket V1 (S-4) to solder lug SS (NS).

( ) R42. Connect the remaining 100 Ω (brown-black-brown) 1/2 watt resistor from lug 8 of tube socket V1 (S-4) to solder lug SS (NS).

( ) Connect the shorter red lead from the power transformer to solder lug SS (NS).

( ) Connect the remaining red lead from the power transformer to lug 5 of tube socket V1 (S-1).

( ) Connect a 2" wire between lug 3 of tube socket V2 (S-1) and solder lug SS (S-4).

( ) R8. Connect a 220 KΩ (red-red-yellow) 1/2 watt resistor from lug 5 of terminal strip F (S-5) to lug 7 of tube socket V2 (S-3). Position as shown in Pictorial 10.

( ) Connect a 4" wire from lug 8 of tube socket V2 (S-2) to lug 6 of switch S (S-1).

( ) R40. Connect a 10 KΩ 10 watt wire-wound resistor from lug 1 (S-1) to lug 5 (S-1) of switch S. Position as shown in Pictorial 10.

( ) Locate VOLTAGE switch CC (#63-277) and, using a control lockwasher, flat washer and control nut, mount it with its lugs in the position shown in Pictorial 10. If necessary, bend the resistors of this switch inward to avoid interference with the wiring of tube socket V2.

( ) Connect the wire coming from lug 3 of tube socket V1 to lug 16 of switch CC (S-2).

( ) Connect the orange wire coming from break-out #5 to lug 17 of switch CC (S-1).

( ) Connect the free lead of the 560 Ω resistor coming from lug 1 of switch CC to lug 3 of terminal strip F (S-5).

This completes all wiring of the Capacitor Checker. Recheck all connections to see that they are securely soldered. Also, make sure that all wires and components are placed and connected as shown in the illustrations.

FINAL ASSEMBLY

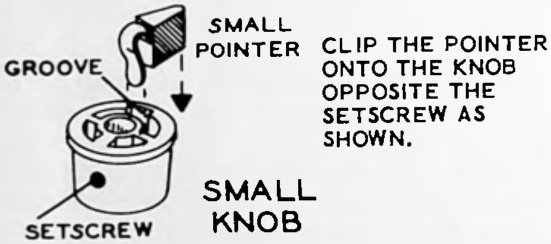
( ) Install the 6BN8 and 6AX4 tubes in their proper sockets as shown in Pictorial 11.

( ) Slide the eye tube forward until the end of the tube touches the front panel.

( ) Install the 1/2 ampere slow-blow fuse in the fuse holder.

Refer to Pictorial 12 and Details 12A and 12B for the following steps.

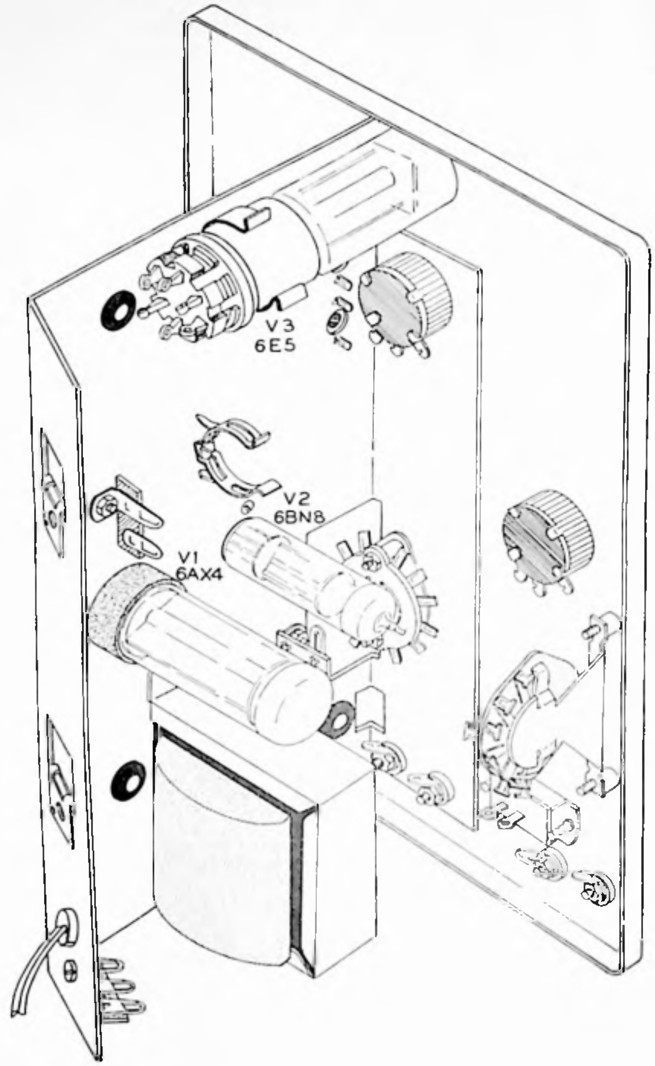
( ) Prepare each of the three small control knobs by snapping a small pointer onto the knob as shown in Detail 12A.



Detail 12A

( ) Install two of these knobs, one on the VOLTAGE switch and one on the RANGE switch. Tighten the setscrew of each knob against the flat side of the switch shaft. It may be necessary to loosen the mounting nut and rotate the switch slightly so the knob pointer will line up with the front panel markings when the knob is rotated.

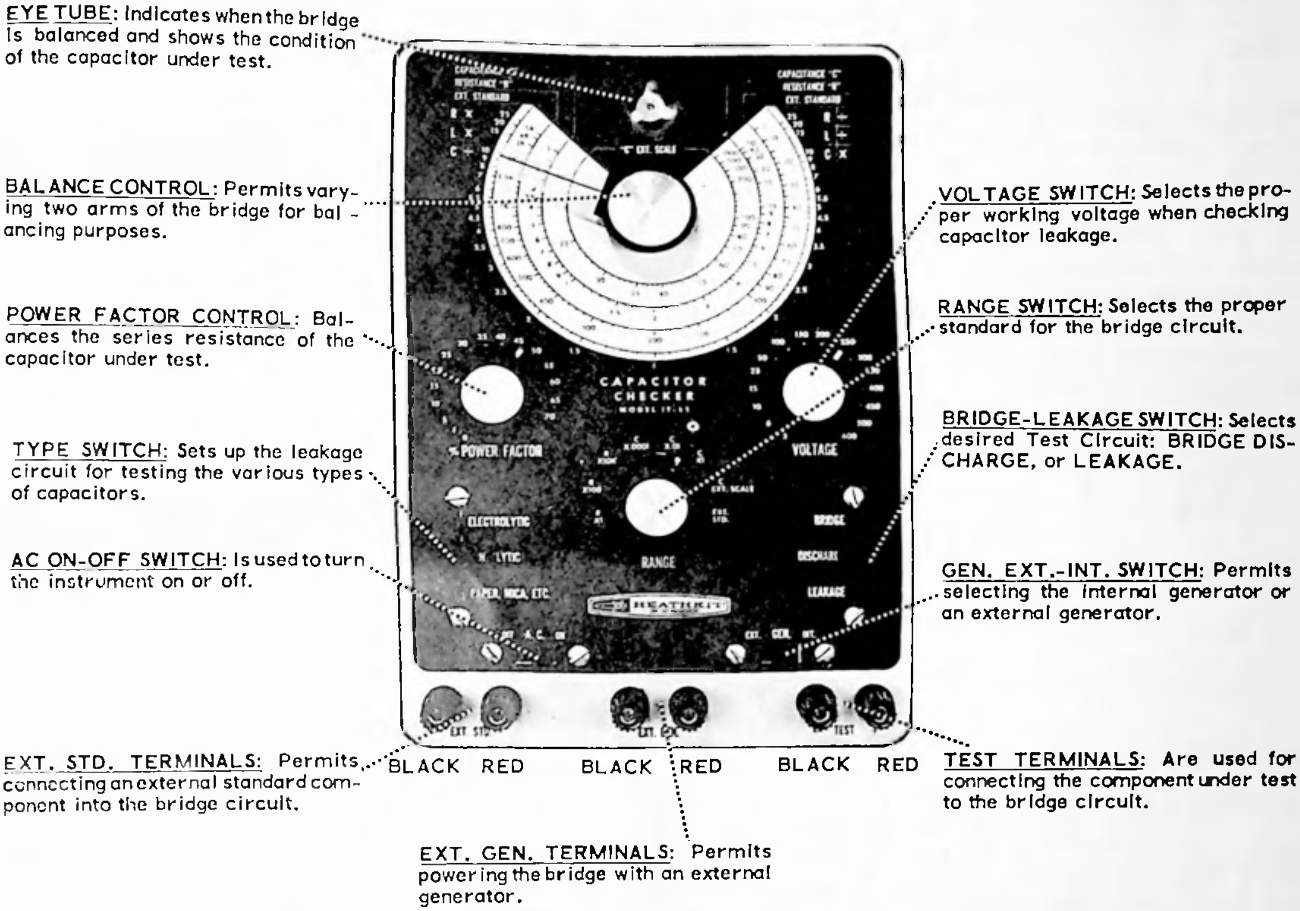
( ) Install the remaining small control knob on the POWER FACTOR control. Position this knob on the control shaft so that the pointer lines up with the front panel markings when the knob is rotated. Now tighten the setscrew.



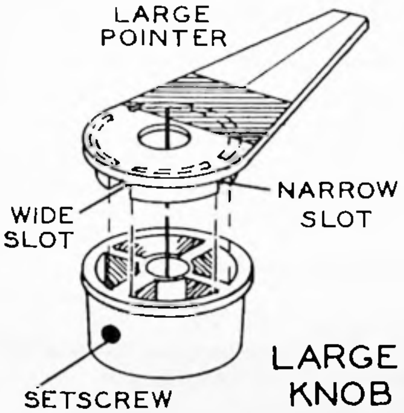
Pictorial 11

( ) Snap the large pointer into the large control knob as shown in Detail 12B. Then install the knob on the Balance control. Turn the control shaft to the center of its range and position the control with the pointer straight down. Now tighten the setscrew in the knob. The pointer should travel an equal distance beyond each end of the scale when the knob is rotated.

( ) If the knob pointers tend to spring away from the panel after the knobs are installed, the pointers may be removed and bent gently to correct this condition.



Pictorial 12



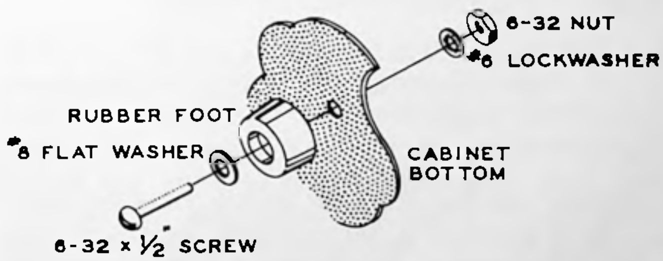
Detail 12B

( ) Install a knob on each of the two lever switches.

( ) Install the six binding post caps in the positions shown in Pictorial 12.

( ) Fasten the handle to the cabinet, using two #10 x 1/2" sheet metal screws.

( ) Referring to Detail 12C, fasten the rubber feet to the cabinet using four 6-32 x 1/2" screws, #8 flat washers, #6 lockwashers, and 6-32 nuts.



Detail 12C

Set the cabinet aside to be installed later. The only remaining parts should be a 200 Ω 1% precision resistor, a 1.5 megohm resistor, and a 100 KΩ resistor which will be used in calibration.

TEST AND CALIBRATION

TESTING

If any of the following steps do not produce the desired results, turn the instrument OFF and refer to the In Case Of Difficulty section.

Make sure the line cord is plugged into a standard 117 volt outlet. Turn the instrument on by moving the AC slide switch to the ON position. After a few seconds for warmup, the eye tube should have a green glow and the filaments of the 3 tubes should be lit.

Set the controls to the following positions.

CONTROL	POSITION
( ) BRIDGE-LEAKAGE	BRIDGE
( ) GEN.	INT.
( ) Type switch	Any
( ) VOLTAGE	3
( ) POWER FACTOR	0
( ) RANGE	*

*For positions R X1 through C X1, the eye tube should be closed with the Balance control in any position except maximum clockwise. The tube should be open when the Balance control is maximum clockwise. Position the Balance control maximum clockwise and with your finger touch the negative TEST terminal. The eye tube should tend to close when the RANGE switch is in positions R X100 through C X.01.

( ) Set the RANGE switch to C EXT. SCALE. In this position, the eye tube should be closed regardless of the Balance control position.

( ) Now set the RANGE switch to EXT. STD. In this position, the eye tube should be open regardless of the Balance control position. As before, touching the negative TEST terminal or the red EXT. STD. terminal should close the eye tube.

( ) Switch the GEN. switch to EXT. position. The eye tube should remain open regardless of the RANGE switch or Balance control positions.

VOLTAGE TEST

( ) Connect a voltmeter (VTVM or 1000 Ω/volt) to the TEST terminals. Set the voltmeter to read high DC+. Set the BRIDGE-LEAKAGE switch in LEAKAGE position and the TYPE switch to ELECTROLYTIC. Now turn the VOLTAGE switch through its 16 positions. The voltmeter reading should be essentially the same as the VOLTAGE switch indications.

BRIDGE CALIBRATION

Connect the 200 Ω 1% precision resistor to the TEST terminals. Set the RANGE switch to R X1 and the BRIDGE-LEAKAGE switch to the BRIDGE position. Set the GEN. switch to INT. Adjust the Balance control very carefully for maximum opening of the eye tube. Loosen the setscrew in the Balance knob and position the Balance pointer straight down, over the "1" at the center of the EXTERNAL STANDARD scale. Now retighten the setscrew. Remove the 200 Ω resistor and save it for occasional calibration checks.

LEAKAGE CALIBRATION

There are two calibration procedures which can be used: the first without and the second with a milliammeter. The first is quite satisfactory, however, the second procedure will provide greater accuracy.

CALIBRATION WITH NO MILLIAMMETER

1. Turn the instrument on, and allow it to warm up.
2. Connect a 100 KΩ (brown-black-yellow) resistor across the TEST terminals.
3. Set the controls as follows:
   VOLTAGE -- 300 volts.
   Type -- ELECTROLYTIC.
   BRIDGE-LEAKAGE -- LEAKAGE.

4. Adjust the eye tube to "just closed" with the top (AD) calibrate control.

5. Move the BRIDGE-LEAKAGE switch to DISCHARGE and remove the 100 KΩ resistor.

6. Connect a 1.5 megohm (brown-green-green) resistor across the TEST terminals.

7. Set the controls as follows:
   VOLTAGE -- 25 volts.
   Type -- MIN.'LYTIC.
   BRIDGE-LEAKAGE -- LEAKAGE.

8. Adjust the eye tube to the "just closed" position with the bottom (AB) calibrate control.

9. Set the controls as follows:
   VOLTAGE --3 volts.
   Type -- PAPER.
   BRIDGE-LEAKAGE -- LEAKAGE.

10. Adjust the eye tube to "just closed" position with the center (AC) calibrate control.

11. Return the BRIDGE-LEAKAGE switch to DISCHARGE and remove the 1.5 megohm resistor from the Test terminals.

CALIBRATION WITH A MILLIAMMETER

1. Connect the meter in series with a 2 megohm control across the TEST terminals.

2. Turn the instrument on and allow it to warm up.

3. Set the controls as follows:
   VOLTAGE -- 50 volts.
   Type -- ELECTROLYTIC.
   BRIDGE-LEAKAGE -- LEAKAGE.

4. Adjust the 2 megohm control until the meter reads 2 ma.

5. Adjust the eye tube to the "just closed" position with the top (AD) calibrate control.

6. Set the controls as follows:
   TYPE -- MIN.'LYTIC.
   BRIDGE-LEAKAGE -- LEAKAGE

7. Reduce the VOLTAGE switch setting and increase the 2 megohm control until the meter reads 15 μa.

8. Adjust the eye tube to the "just closed" position with the bottom (AB) calibrate control.

9. Set the controls as follows
   Type -- PAPER.
   BRIDGE-LEAKAGE -- LEAKAGE.

10. If necessary, reduce the VOLTAGE switch setting, and increase the 2 megohm control until the meter reads 2 μa.

11. Set the eye tube to the "just closed" position with the center (AC) calibrate control.

LEAKAGE REFERENCE CHECK

Due to component tolerances and line voltage variations, it is usually not possible to draw 2 ma from the power supply on the 25 volt setting of the VOLTAGE switch. To determine the degree of closure of the eye tube under short conditions, set the VOLTAGE switch to 25, BRIDGE-LEAKAGE switch to LEAKAGE, and the Type switch to ELECTROLYTIC. Momentarily short the TEST terminals with a screwdriver and observe the eye tube. The size of the opening remaining should be mentally retained as an indication of short conditions on the 25 volt setting only. The 50 volt position should completely close the eye. NOTE: A completely shorted capacitor will be detected during the value test (Bridge Circuit). It is not recommended that the leakage test be performed on a capacitor known to be shorted since possible damage to the power supply could occur.

CHECKING FOR MINIMUM HUM

Set the RANGE switch to EXT. STD. position. Check the width of the eye tube indication. Now reverse the line cord plug and again check the width of the eye tube indication. The line cord plug should be left in the position that gives the widest eye tube opening.

With the BRIDGE-LEAKAGE switch in the BRIDGE position, rotate the Balance control for a very narrow opening of the eye tube. Next rotate the eye tube in its mounting clip until the eye tube opening is vertical.

Install the cabinet using two 6-32 x 3/8" screws. The screws are placed through the rear of the cabinet and into the speednuts in the rear chassis flange.

OPERATION

FRONT PANEL

Pictorial 12 (on Page 23) explains the eye tube, and front panel controls and terminals.

NOTE: It is always best to connect the component under test directly to the TEST terminals. Long test leads may pick up stray AC fields and give inaccurate readings. If test leads must be used, keep them as short as possible.

RESISTANCE MEASUREMENT

Connect the unknown resistance to the TEST terminals. Set the RANGE switch to one of the "R" multipliers. The GEN. switch should always be in INT. position on all tests unless an external generator is used. The Type, VOLTAGE, and POWER FACTOR controls are not used in this test. Set the BRIDGE-LEAKAGE switch to the BRIDGE position. Adjust the Balance control for maximum eye tube opening. Read the resistance indicated by the Balance control pointer on the "R" scale and multiply by the RANGE switch setting.

CAPACITANCE MEASUREMENT (lower ranges-X .0001 and X .01).

Connect the unknown capacity to the TEST terminals. The VOLTAGE switch is not used in this test.

Set the Type switch to its lower position, this position is for paper, mica, ceramic, glass, and any other small value capacitors. The RANGE switch should be in either the C X .0001 or C X.01 position, depending on the size of the capacitance under test. Set the BRIDGE-LEAKAGE switch to the BRIDGE position and adjust the Balance control for eye tube opening. Read the value of the capacitance on the "C" scale and multiply by the RANGE switch setting.

NOTE: To obtain sharper eye tube indications when measuring small capacitance values, connect an external generator to the EXT. GEN. terminals and set the GEN. switch to EXT. position. Set the generator to 1000 cps.

CAPACITANCE MEASUREMENT (high range-X1, Extended Scale).

WHEN CHECKING ELECTROLYTIC CAPACITORS IT IS ESSENTIAL THAT POLARITY BE OBSERVED. The positive (+) lead of the capacitor should be connected to the positive (red) binding post, and the negative (-) lead to the negative (black) binding post of the TEST terminals. The VOLTAGE switch is not used in this test.

Set the Type switch to either the MIN. 'LYTIC or ELECTROLYTIC position, depending on the capacitor under test. NOTE: A MIN. 'LYTIC (miniature electrolytic) can be distinguished from an electrolytic by its high capacitance, low working voltage and small physical size. Miniature electrolytics are usually encased in ceramic or plastic and are completely sealed. Adjust the Balance control and the *POWER FACTOR control for the widest opening of the eye tube. Read the capacitance on the "C" scale or EXTENDED scale, depending on the RANGE switch setting. The capacitance is read at so much (%) power factor. For example: 40 μfd at 6% power factor.

*POWER FACTOR is the measure of the energy loss in an imperfect capacitor. In filter applications, a higher power factor decreases the effective capacity so that the effective capacity at 20 PF (POWER FACTOR) is 98% of the measured capacity. At 30% PF, the effective capacity is decreased to 95%. While at 50% PF, the effective capacity is decreased to 87% of the measured capacity.

A significant point of the capacitor test, well worth remembering, is that a capacitor which will not balance on any of the ranges but allows the eye tube to open on the low end of the low range, is an open capacitor. A capacitor which allows the eye to open on the high end of the high range is a shorted capacitor. In either case, there is no reason to carry the test any further.

LEAKAGE TEST

After the capacitor value has been determined, a leakage test for quality can be made. Set the VOLTAGE switch to the voltage rating of the capacitor (the four voltage positions below 25 volts are to be used for miniature electrolytics only), which is usually printed on the capacitor itself. Push the BRIDGE-LEAKAGE switch to the LEAKAGE position and observe the action of the eye tube. A sudden closing and then return to normal shadow angle indicates a satisfactory capacitor. A partially closed eye or fluttering condition would indicate an intermittent condition. If the eye stays closed the capacitor is leaky.

NOTE: The eye may not open on some electrolytics, especially large electrolytics. This does not always mean the capacitor is shorted. Refer to the Capacitor Current section which follows.

After the leakage test, return the BRIDGE-LEAKAGE switch to the DISCHARGE position. When the eye tube opens, the capacitor under test is discharged and safe to handle.

CAPACITOR CURRENT

The eye will close when approximately 2 milliamperes of direct current are drawn through the test circuit when checking electrolytic capacitors. Approximately 15 microamperes of current are required to close the eye when checking miniature electrolytics, and approximately 2 microamperes are required when checking paper, mica, etc., capacitors.

Some electrolytic capacitors may allow 2 milliamperes of current to go through them and still be satisfactory. In this case, the eye will not open, showing the capacitor to be leaky or shorted. Leakage current is calculated with the following formula: $I = K \times C + .3$

I = milliamperes of maximum current through the capacitor.

C = capacitance in μfd.
K = constant relative to the voltage rating of the capacitor, as follows:

3 to 100 volts	K = .01
101 to 250 volts	K = .02
251 to 350 volts	K = .025
351 to 450 volts	K = .04

EXAMPLE: 40 μfd capacitor rated at 450 volts.

$I = K \times C + .3$
$I = .04 \times 40 + .3$

$I = 1.6 + .3$

I = 1.9 milliamperes.

EXTERNAL STANDARD SCALES

Connect a component of known value to the EXT. STD. terminals. If the component to be tested is a resistor, then the EXT. STD. component must be a resistor; for checking capacitors, the EXT. STD. component must be a capacitor, etc; for checking inductance, use a coil of known value as the external standard. Set the RANGE switch to EXT. STD. and the BRIDGE-LEAKAGE switch to BRIDGE. Adjust the Balance control for eye tube opening. When measuring resistance or inductance and the pointer is on the left side of the scale, multiply the value of the EXT. STD. component by the pointer reading on the EXT. STD. scale. If the pointer is on the right side of the scale, divide the EXT. STD. component by the pointer reading.

When measuring capacitance, divide the value of the EXT. STD. component by the pointer reading when the pointer is on the left side; multiply the value of the EXT. STD. component by the dial reading when the pointer is on the right side.

To improve accuracy when checking small capacitance values, connect a generator to the EXT. GEN. terminals and push the GEN. switch to the EXT. position. Set the generator at 1000 cps and set the RANGE switch to EXT. STD. Balance the bridge for eye tube opening indication. If the pointer does not read "1" (center of scale), add capacitance to the appropriate terminals (TEST or EXT. STD.) until the pointer is at center scale with the bridge balanced. This capacitance should be left on the terminals when checking small value capacitances on the EXT. STD. scale.

NOTE: When measuring inductance, an external standard must be used as no internal inductance is provided. The external standard inductance should have characteristics similar to those of the inductance being measured. Multiply for pointer readings on the left side of the scale and divide for readings on the right side of the scale.

MEASURING TRANSFORMER TURNS RATIO

Connect either pair of leads (primary or secondary) to the TEST terminals and the other pair to the EXT. STD. terminals. (Interchanging the primary and secondary leads only results in reading the ratio on the other side of the scale.) Set the RANGE switch to EXT. STD. and adjust the Balance control for eye tube opening. Read the TURNS RATIO directly on the EXTERNAL STANDARD scale.

Polarity is important when measuring turns ratio, due to transformer action. That is, a signal appearing in one winding will also appear in the other winding. If eye tube opening cannot be obtained, reverse the leads of one winding.

In some cases, the ratio may be misleading. This is due to the non-loaded condition of the transformer under test. For example, the filament winding of a transformer might show up as something other than 18:1. Assuming the primary winding is 117 volts and the filament winding is 6.3 volts, the turns ratio is equal to the primary voltage (117 volts) divided by the secondary filament winding voltage (6.3 volts), which is approximately equal to 18:1.

EXT. GEN.

An external generator may be used for checking components at frequencies other than internal 60 cps. Any audio generator capable of delivering 2 volts or more to the EXT. GEN. terminals at the desired frequency may be used. A larger signal voltage will give a sharper null indication on the eye tube.

The maximum voltage that should be applied to the EXT. GEN. terminals is 6 volts. The frequency limit of this circuit is 10,000 cps.

A point to remember, when using this instrument, is that the greatest error will occur at the ends of the scales. Therefore, for greatest accuracy, use the range that will give a null indication on the eye tube nearest center scale.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of this manual.

3. Make sure that all tubes light up properly.

4. Check the tubes with a tube tester or by substitution of tubes of the same types and known to be good.

5. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the chassis.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with an 11 megohm vacuum tube voltmeter. Voltages may vary as much as 10% due to line voltage variations.

8. A review of the Circuit Description will prove helpful in indicating where to look for trouble.

SERVICE INFORMATION

SERVICE

If, after applying the information contained in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case Of Difficulty. Possibly it will not be necessary to write.

2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.

3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case Of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.

4. Identify the kit model number and date of purchase, if available. Also mention the date of the kit assembly manual. (Date at bottom of Page 1.)

5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed instrument to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a minimal service fee, plus the price of any additional parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service for your HEATHKIT equipment. Although you may find charges for local service somewhat higher than for factory service, the amount of increase is usually offset by the transportation charge you would pay if you elected to return your kit to the Heath Company.

HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company; however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if the Service Center assists you in locating a defective part (or parts) in your kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipment will be returned NOT repaired.

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.

B. Identify the type and model number of kit in which it is used.

C. Mention date of purchase.

D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your instrument must be returned for service, these instructions should be carefully followed.

Before packing the kit, remove the tubes and pack them carefully in a separate carton. Then pack and ship both the kit and the tubes as described below.

ATTACH A TAG TO THE EQUIPMENT BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan

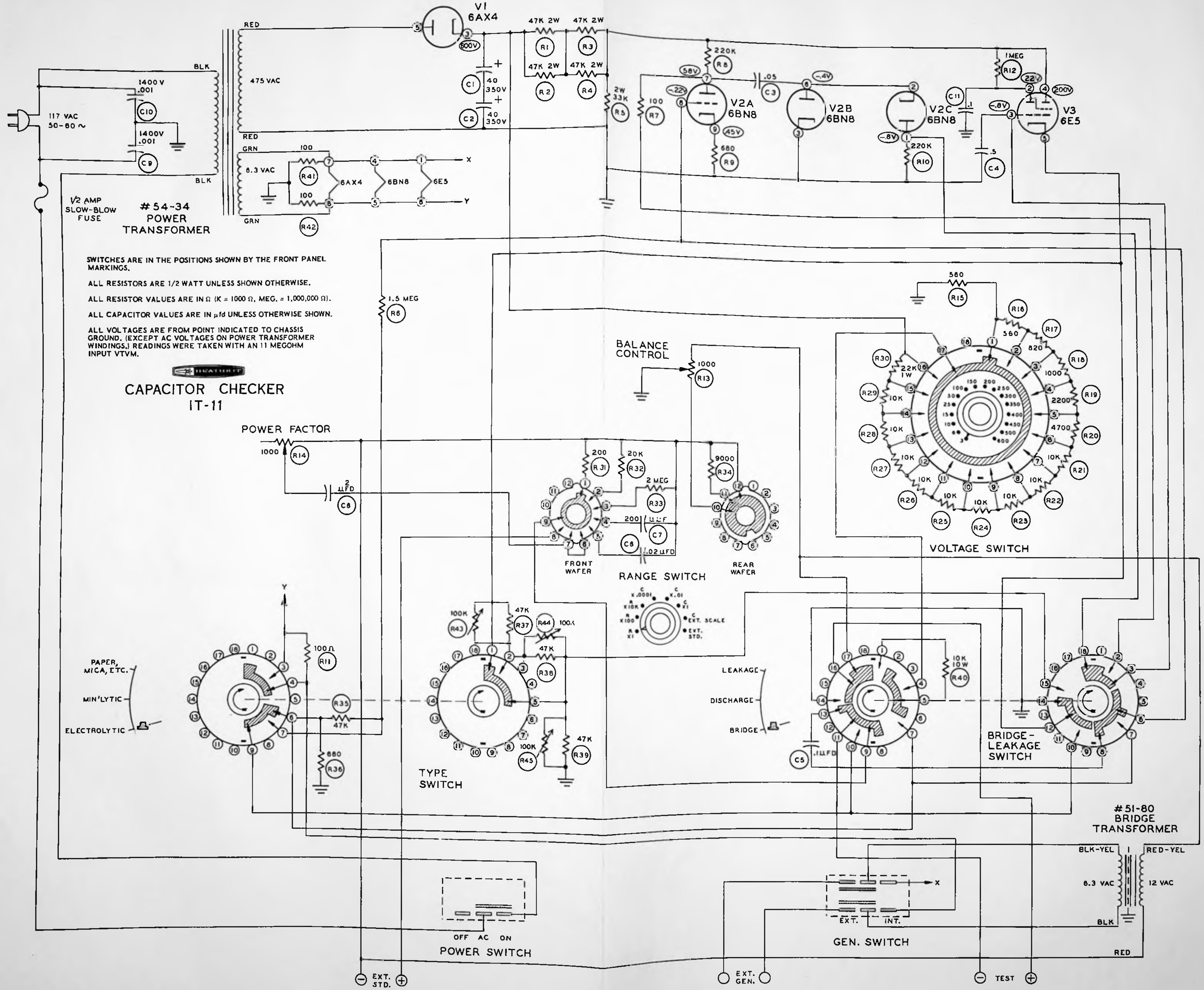
Include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.

WARRANTY

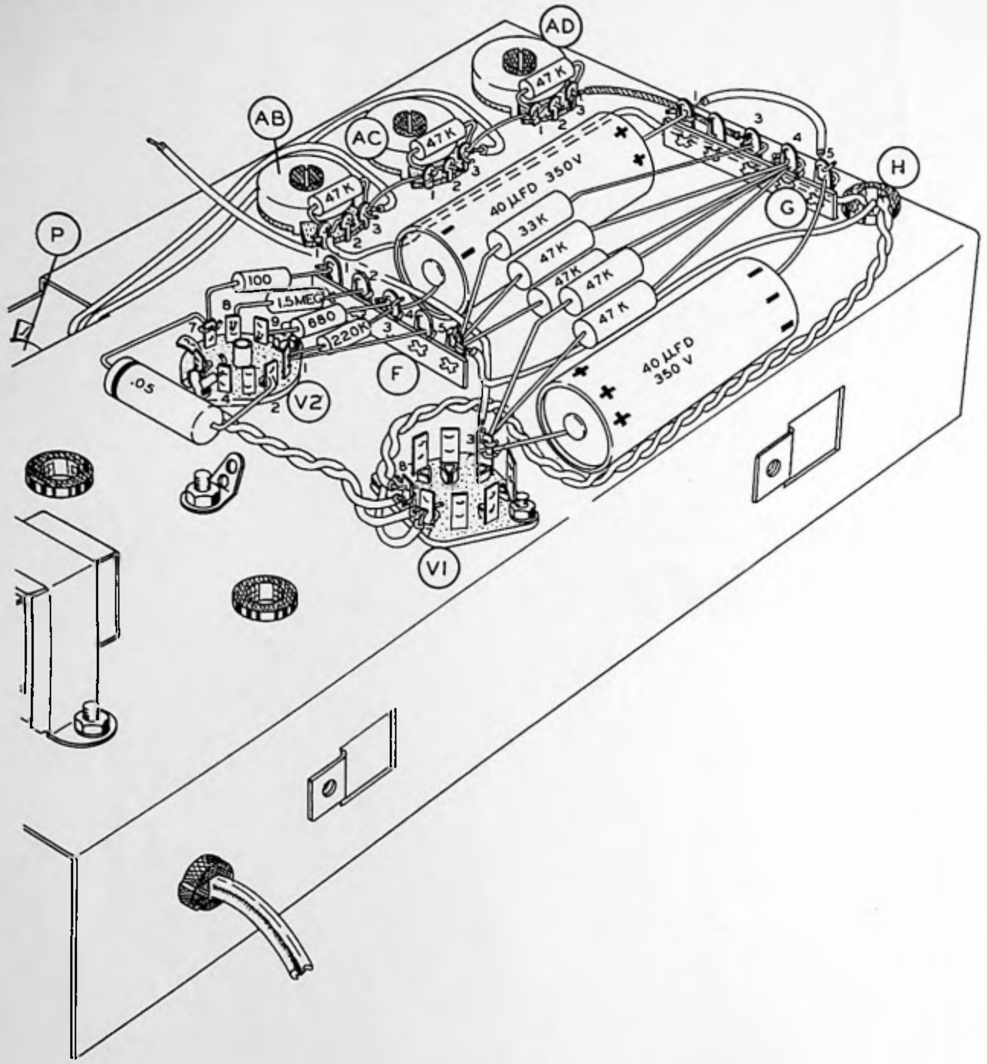
Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

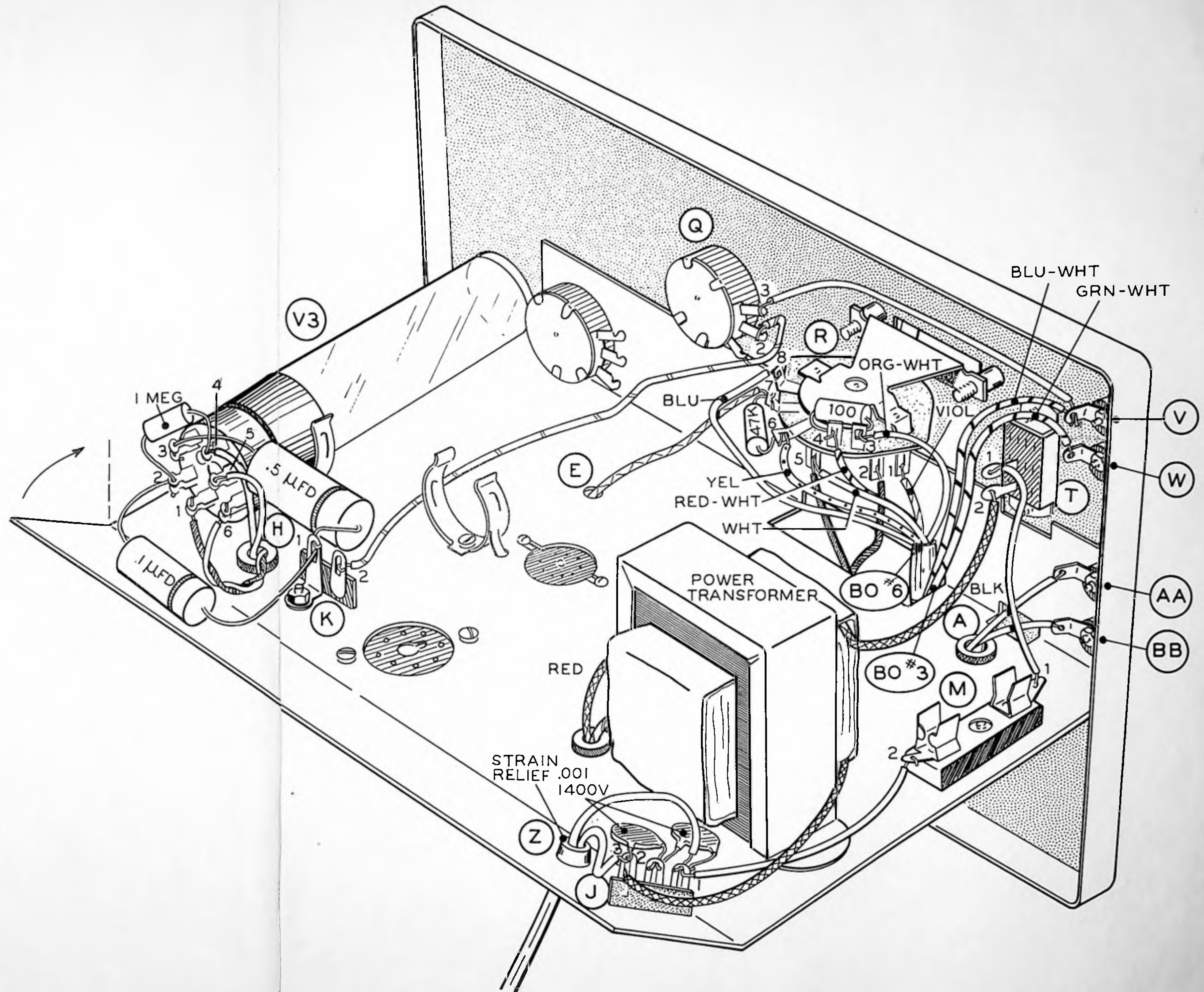
HEATH COMPANY



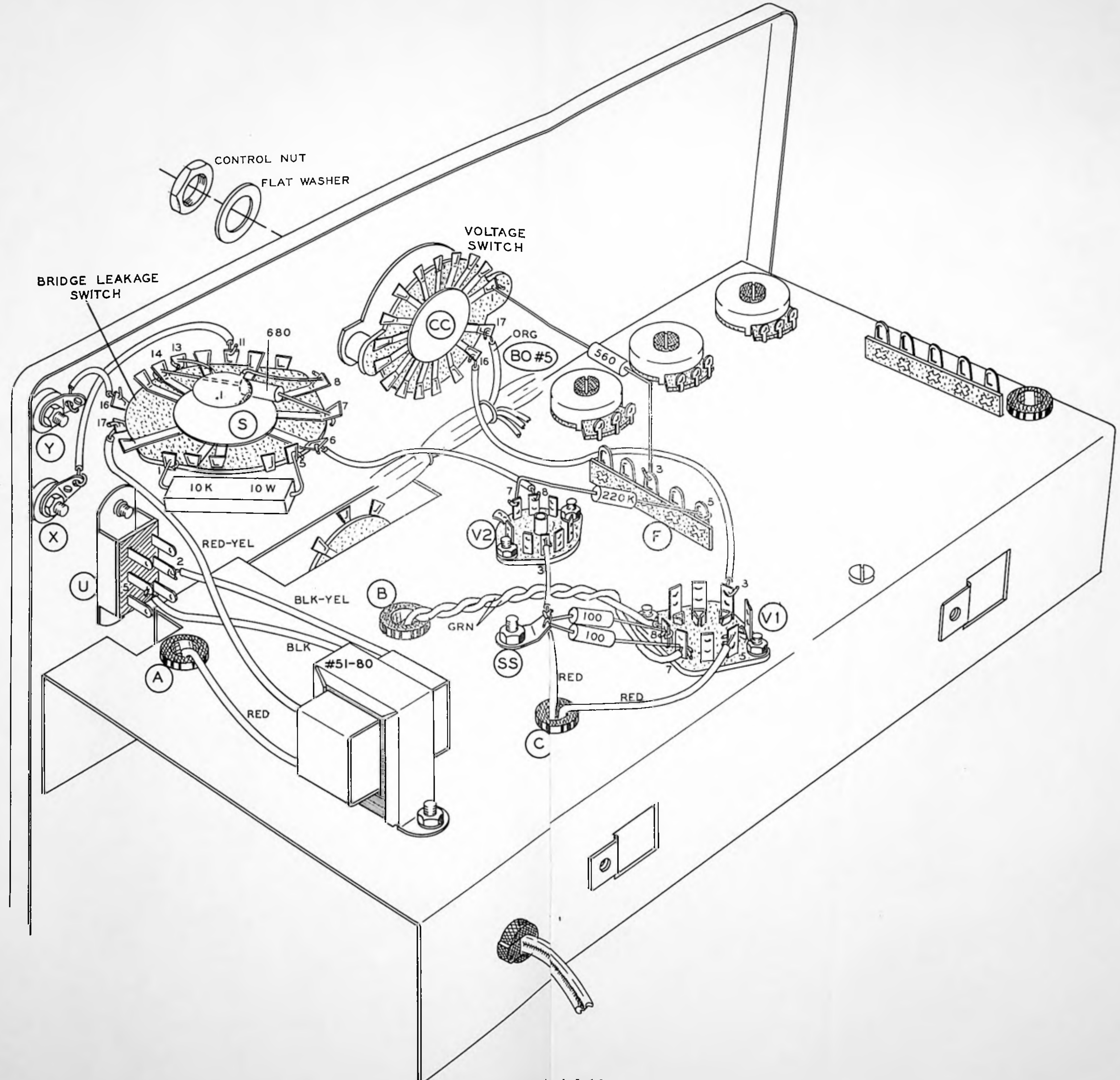
V1 6AX4
RED
BLK
475 VAC
117 VAC 50-60 ~
1400V .001
C10
C9
1/2 AMP SLOW-BLOW FUSE
#54-34 POWER TRANSFORMER
6.3 VAC
GRN
R41
R42
6AX4
6BN8
6E5
500V
C1
C2
40 350V
47K 2W
R1
R2
R3
R4
2W 33K
R5
100
R7
220K
R8
58V
-22V
45V
680
R9
V2A 6BN8
.05
C3
-.4V
V2B 6BN8
C11
V2C 6BN8
-.8V
220K
R10
.5
C4
1MEG
R12
22V
200V
V3 6E5
SWITCHES ARE IN THE POSITIONS SHOWN BY THE FRONT PANEL MARKINGS.
ALL RESISTORS ARE 1/2 WATT UNLESS SHOWN OTHERWISE.
ALL RESISTOR VALUES ARE IN Ω (K = 1000 Ω, MEG. = 1,000,000 Ω).
ALL CAPACITOR VALUES ARE IN µfd UNLESS OTHERWISE SHOWN.
ALL VOLTAGES ARE FROM POINT INDICATED TO CHASSIS GROUND. (EXCEPT AC VOLTAGES ON POWER TRANSFORMER WINDINGS.) READINGS WERE TAKEN WITH AN 11 MEGOHM INPUT VTVM.
CAPACITOR CHECKER
IT-11
1.5 MEG
R6
BALANCE CONTROL
1000
R13
560
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
22K 1W
VOLTAGE SWITCH
POWER FACTOR
1000
R14
2 µFD
C6
200
R31
20K
R32
2 MEG
R33
200 µµF
C7
C8
.02 µFD
9000
R34
FRONT WAFER
REAR WAFER
RANGE SWITCH
X.0001
X.01
X10K
X1
X100
EXT. SCALE
EXT. STD.
PAPER, MICA, ETC.
MIN'LYTIC
ELECTROLYTIC
100Ω
R11
R35
47K
680
R36
100K
R43
47K
R37
R44
100K
R38
100K
R45
R39
TYPE SWITCH
LEAKAGE
DISCHARGE
BRIDGE
10K 10W
R40
.1 µFD
C5
BRIDGE-LEAKAGE SWITCH
#51-80 BRIDGE TRANSFORMER
BLK-YEL
RED-YEL
6.3 VAC
12 VAC
BLK
RED
OFF AC ON
POWER SWITCH
EXT. INT.
GEN. SWITCH
EXT. STD.
EXT. GEN.
TEST



Pictorial 6



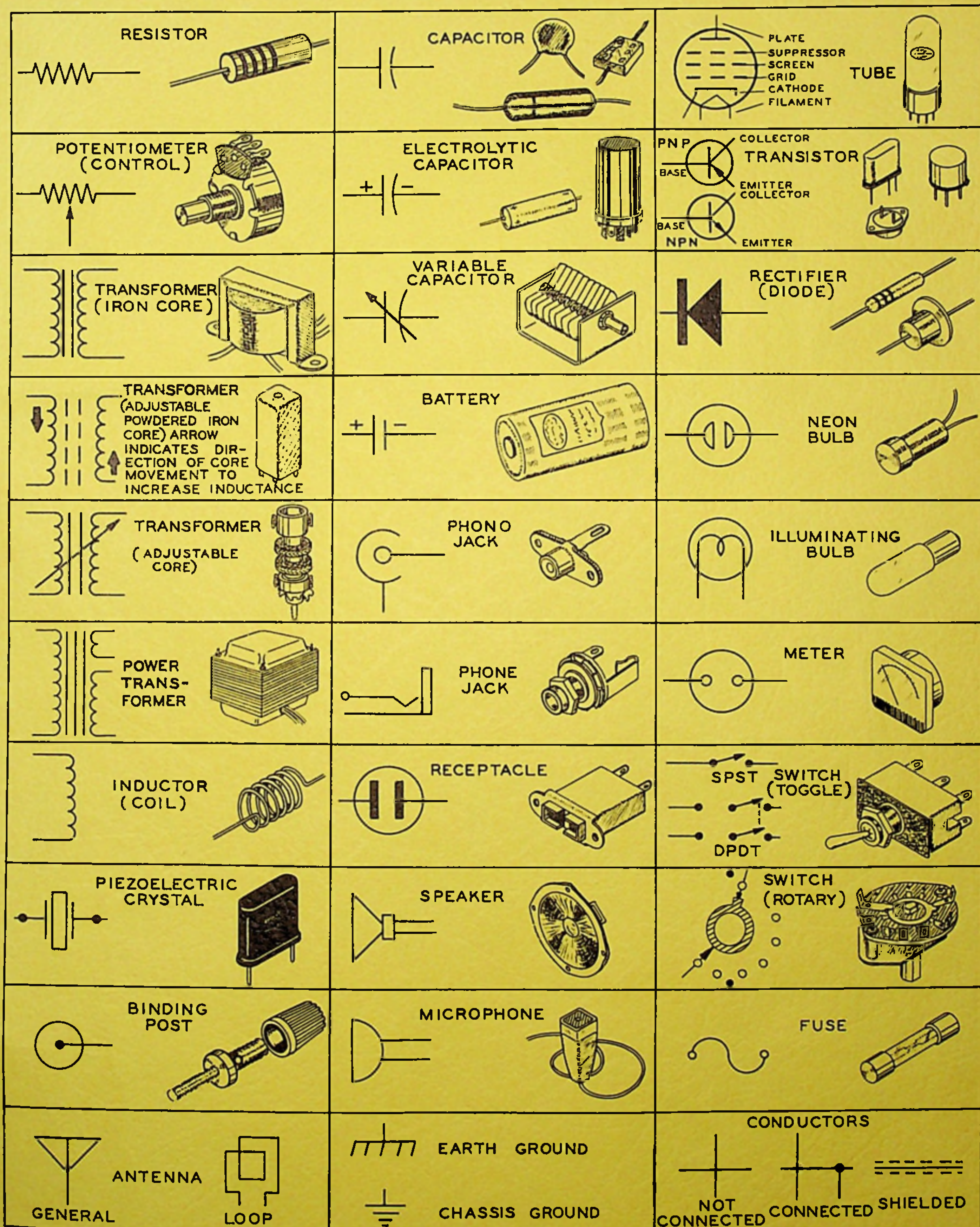
Pictorial 8



Pictorial 10

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



HEATH COMPANY

BENTON HARBOR, MICHIGAN

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