ASSEMBLING AND USING YOUR . . . . . Heathkit

"WILLIAMSON TYPE" AMPLIFIER

MODEL W-3M

595-106

HEATH COMPANY
BENTON HARBOR,
MICHIGAN

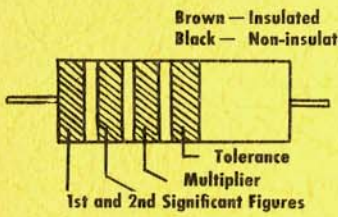
PRICE $1.00

THE WORLD'S *Finest* TEST EQUIPMENT IN KIT FORM

STANDARD COLOR CODE — RESISTORS AND CAPACITORS

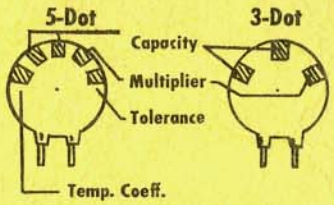
INSULATED UNINSULATED Color	FIRST RING BODY COLOR First Figure	SECOND RING END COLOR Second Figure	THIRD RING DOT COLOR Multiplier
BLACK	0	0	None
BROWN	1	1	0
RED	2	2	00
ORANGE	3	3	,000
YELLOW	4	4	0,000
GREEN	5	5	00,000
BLUE	6	6	000,000
VIOLET	7	7	0,000,000
GRAY	8	8	00,000,000
WHITE	9	9	000,000,000

AXIAL LEAD RESISTOR

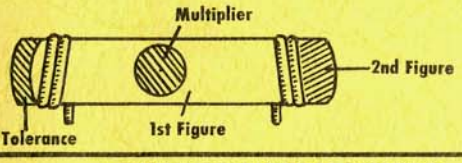


Wire wound resistors have 1st digit band double width

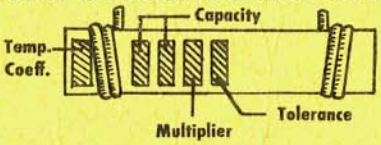
DISC CERAMIC RMA CODE



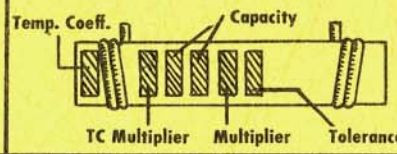
RADIAL LEAD DOT RESISTOR



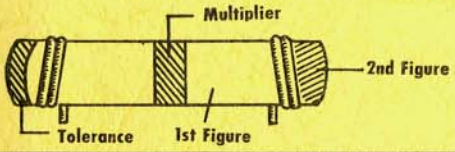
5-DOT RADIAL LEAD CERAMIC CAPACITOR



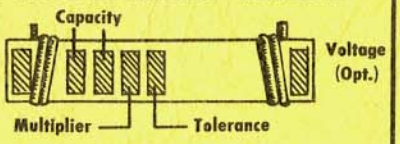
EXTENDED RANGE TC CERAMIC HICAP



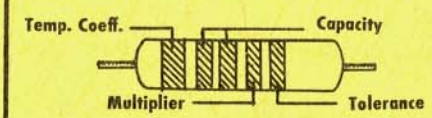
RADIAL LEAD (BAND) RESISTOR



BY-PASS COUPLING CERAMIC CAPACITOR



AXIAL LEAD CERAMIC CAPACITOR

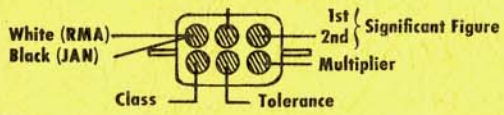


The standard color code provides all necessary information required to properly identify color coded resistors and capacitors. Refer to the color code for numerical values and the zeroes or multipliers assigned to the colors used. A fourth color band on resistors determines tolerance rating as follows: Gold = 5%, silver = 10%. Absence of the fourth band indicates a 20% tolerance rating.

The physical size of carbon resistors is determined by their wattage rating. Carbon resistors most commonly used in Heathkits are ½ watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors ½ watt, 1 or 2 watt may be color coded but the first band will be double width.

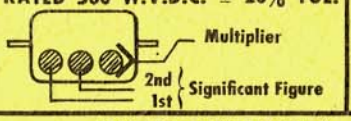
MOLDED MICA TYPE CAPACITORS

CURRENT STANDARD CODE



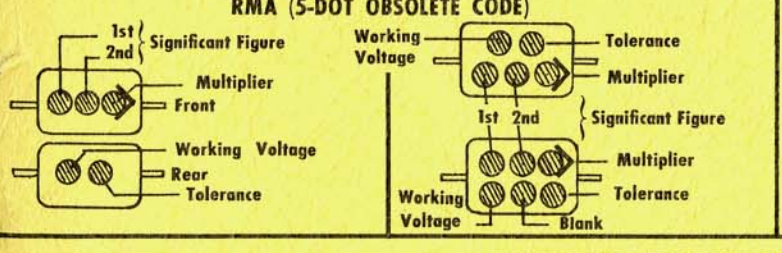
JAN & 1948 RMA CODE

RMA 3-DOT (OBSOLETE) RATED 500 W.V.D.C. ± 20% TOL.

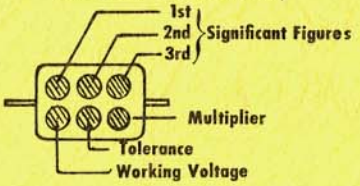


BUTTON SILVER MICA CAPACITOR

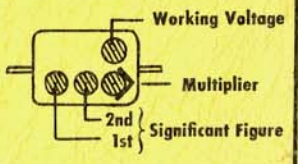
RMA (5-DOT OBSOLETE CODE)



RMA 6-DOT (OBSOLETE)

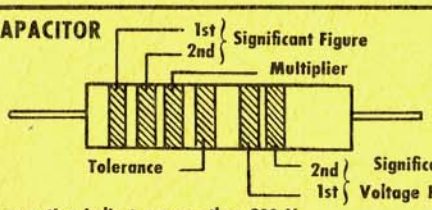


RMA 4-DOT (OBSOLETE)



MOLDED PAPER TYPE CAPACITORS

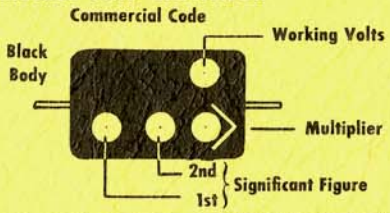
TUBULAR CAPACITOR



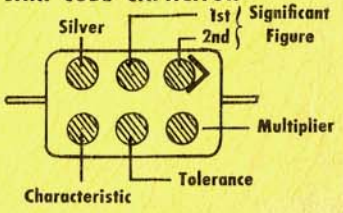
Normally stamped for value

A 2 digit voltage rating indicates more than 900 V. Add 2 zeros to end of 2 digit number.

MOLDED FLAT CAPACITOR



JAN. CODE CAPACITOR



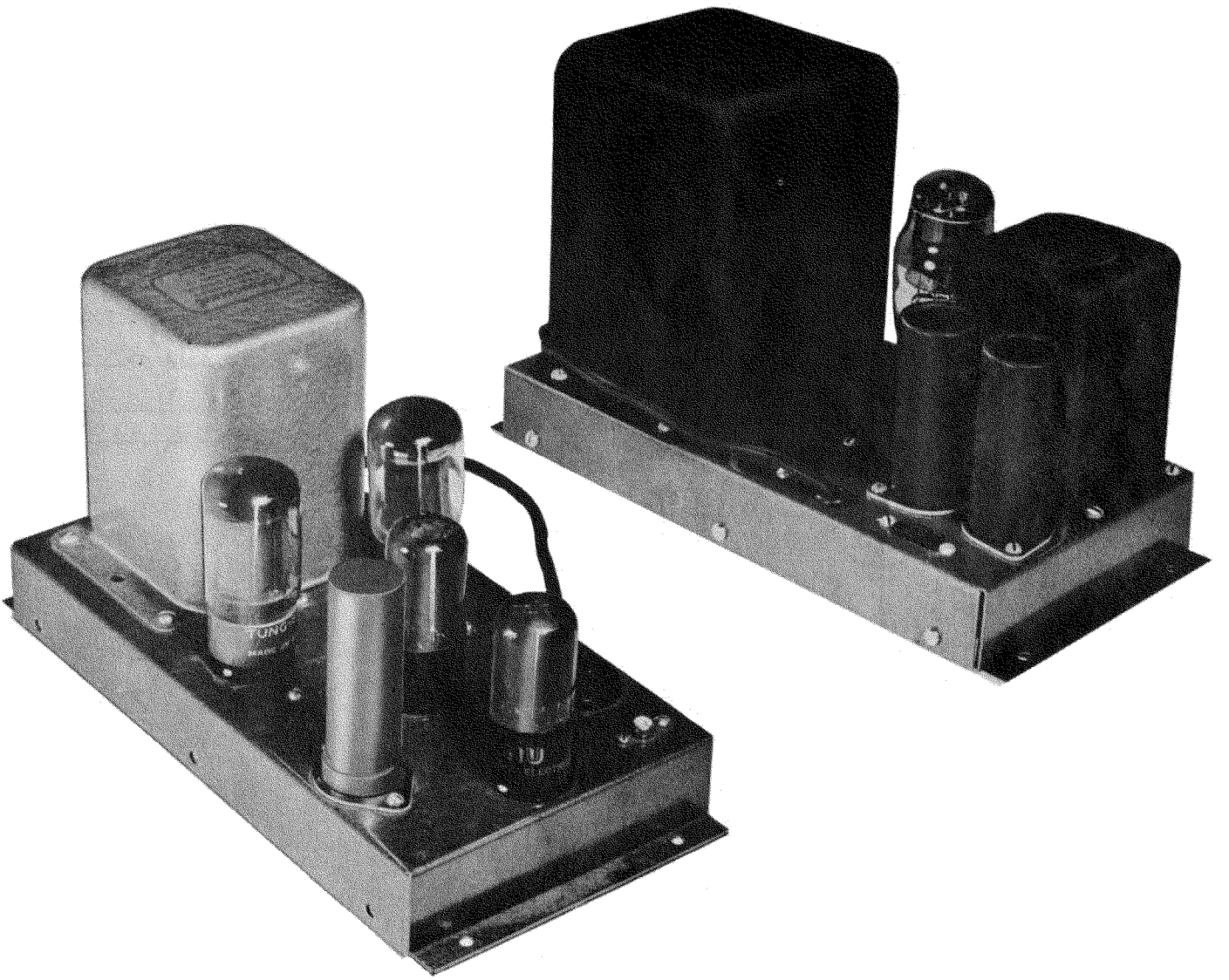
The tolerance rating of capacitors is determined by the color code. For example: red = 2%, green = 5%, etc. The voltage rating of capacitors is obtained by multiplying the color value by 100. For example: orange = 3 × 100 or 300 volts. Blue = 6 × 100 or 600 volts.

In the design of Heathkits, the temperature coefficient of c or mica capacitors is not generally a critical factor and fore Heathkit manuals avoid reference to temperature cc cient specifications.

Courtesy of Centralab

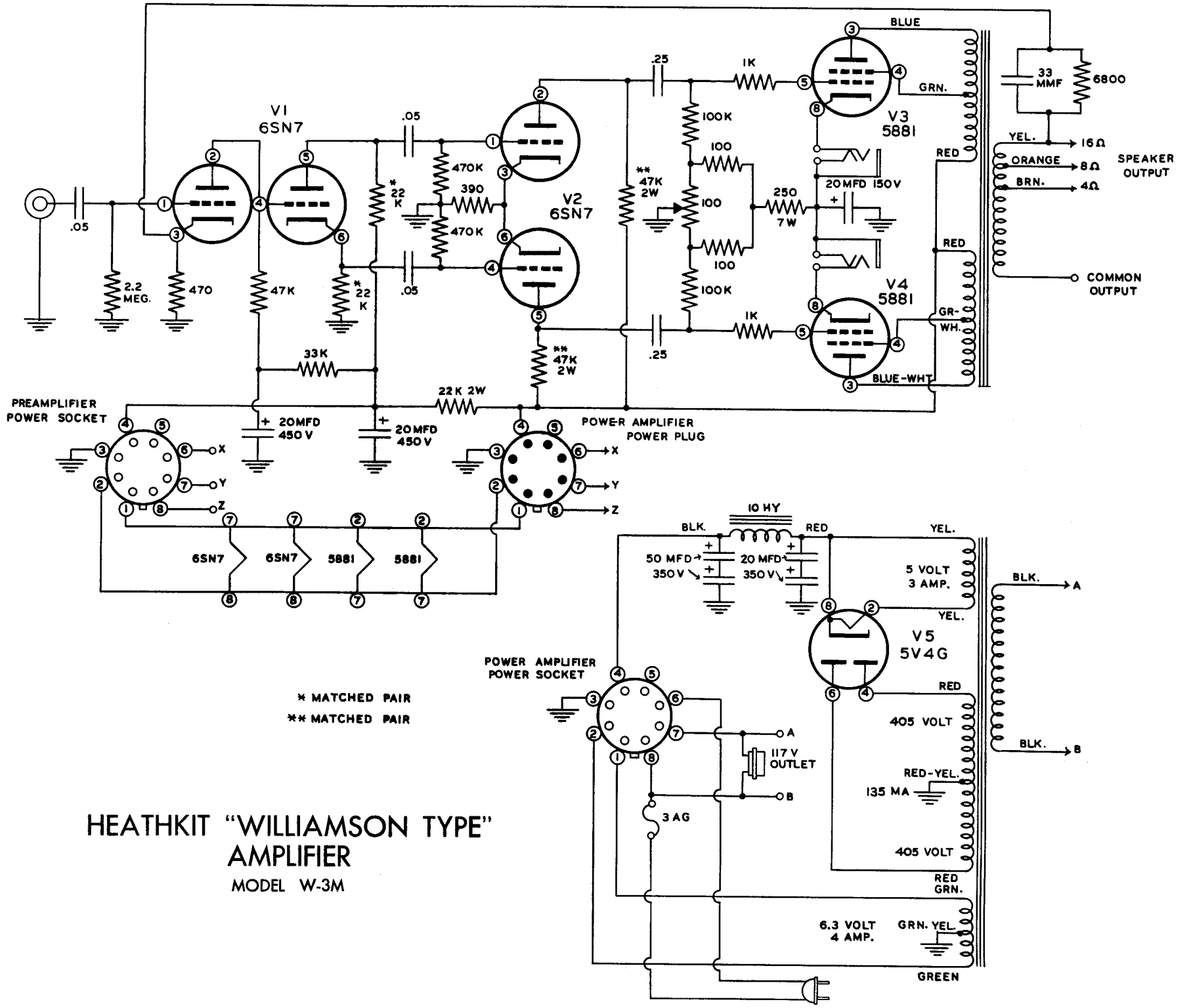
HEATHKIT "WILLIAMSON TYPE" AMPLIFIER

MODEL W-3M



TECHNICAL SPECIFICATIONS

Tube Complement	2 - 6SN7GT, 2 - 5881, 1 - 5V4G
Frequency Response	within 1 db from 10 cycles to 100 KC
Harmonic Distortion at 5 watt output	less than 0.5% between 20 cycles and 20 KC
IM Distortion at 5 watt equivalent output	0.5% using 60 and 3000 cycles
Output Impedance	4, 8 or 16 ohms
Input Voltage for 5 watt output	0.75 volts across 2.2 megohms
Power Requirements	105-125 volts 50/60 cycles 120 watts
Overall Dimensions (each unit)	7" high x 5 1/2" wide x 11" long



HEATHKIT "WILLIAMSON TYPE" AMPLIFIER

MODEL W-3M

INTRODUCTION

The art and science of the reproduction of sound has steadily made advances with improvements of major importance occuring occasionally. Among these major advances, we count the LP type recordings, the modern magnetic phono pickups, FM broadcasting and the Williamson amplifier circuit.

These advances in different links in the chain of devices needed for reproduction of sound were made when each link appeared to become the weakest one.

In the summer of 1947, Mr. D. T. N. Williamson had the results of his search for a perfect amplifier published in the British periodical "Wireless World." Further notes on this amplifier appeared in the same publication in 1949.

The comparative simplicity of the circuit tempted many skilled home constructors and the remarkable results soon became well known the world over. Several articles appeared in American publications, referring specifically to the original Williamson circuit. The artical in the November, 1949 issue of Audio Engineering described a "Musician's Amplifier" patterned after the Williamson.

Not all attempts to duplicate the original performance with other components and different layouts were successful. Thus there developed a thriving trade of importing the components used in the original design, largely to replace parts in existing amplifiers that were lacking in performance.

The Heathkit amplifier closely follows the very successful Musician's Amplifier and is considered by many to surpass the original Williamson.

The original article by Mr. Williamson outlined the six basic requirements for a perfect amplifier as follows: (1) Negligible non-linear distortion. (2) Linear frequency response and power handling capacity over the range of 10 cycles to 20 kc. (3) Negligible phase shift over the same range. (4) Good transient response. (5) Low output resistance. (6) Adequate power reserve.

All six requirements are properly fulfilled in the Heathkit amplifier through the careful choice of component parts and selection of optimum operating conditions.

The operational qualities were of primary concern and thus electrical efficiency has been sacrificed wherever needed. The first requirement of Mr. Williamson calls for the use of only the most linear portion of the tube characteristics. Although that portion has been extended by higher than normal plate supply voltages, it is only a fraction of the curve normally used in amplifiers. Thus a comparatively low output power level is obtained with tubes capable of much more efficient operation under less stringent requirements.

A recent modification of this circuit has been described by David Sarser and Melvin C. Sprinkle in Audio Engineering for July, 1952. This article, entitled "Gilding the Lily," points out several changes which increase the efficiency of the circuit without perceptible degradation of its performance. The instructions in this manual incorporate these changes. However, instructions are given on Page 19 for building the amplifier in accordance with the original design.

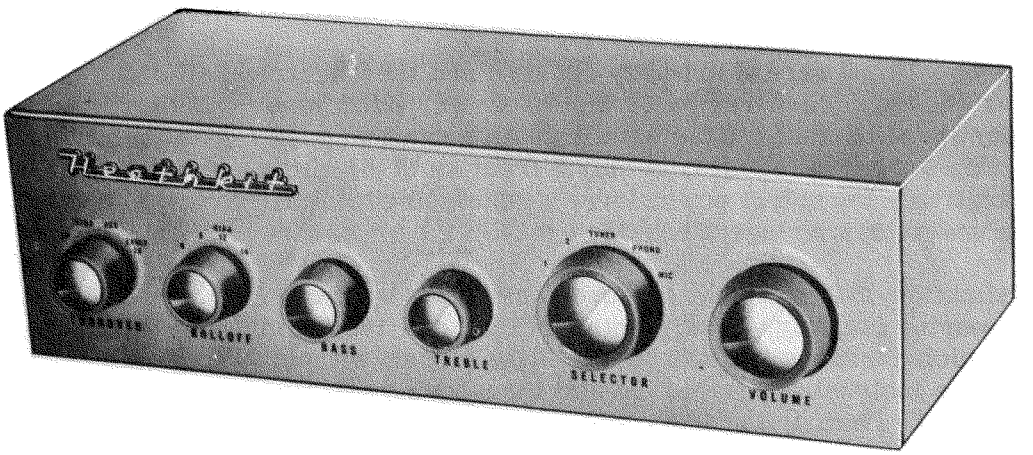
Either circuit, at levels up to 5 watts output, affords performance far beyond the finest speaker systems available today. Average power output for home listening rarely exceeds 1 watt. The circuit as described in the assembly instructions will provide a power output of 12 to 15 watts before intermodulation distortion becomes noticeable, even to the trained ear. The circuit described on Page 19, as originally used by Williamson, displays similar characteristics at levels of 8 to 10 watts.

While the frequency limits of this amplifier are quite outside the audible range of single frequencies, the results are definitely noticeable. The extended range insures exact reproduction of the transients generated at the start of each note, such as the sharp crash of the symbal, the brief scratching of the bow as it starts to move across the strings of the violin or the deep thud of the kettle drum. The individual instruments of the orchestra are thus quite readily distinguished.

Mr. Williamson's second requirement of both linear frequency response and power handling capability and the third requirement of negligible phase shift call for an output transformer with quite extraordinary characteristics. An incorrectly designed transformer may produce distortion that is easily mistaken for faulty operating conditions of the tubes. The transformer used in the Heathkit amplifier has the characteristics required and may well be considered the heart of the amplifier.

Considering your substantial investment in this kit, it is readily understood that it warrants the greatest care in assembly to reap the performance of which this amplifier is capable.

The model W-3M is free running with no controls. It is designed to be used with a signal source having its own controls or with a preamplifier. The Heathkit model WA-P2 Preamplifier is highly recommended.



HEATHKIT PREAMPLIFIER MODEL WA-P2

ASSEMBLY AND OPERATION INSTRUCTIONS

This Heathkit amplifier was developed to provide an excellent link in the chain of devices that are required for the highest quality reproduction of sound in the home. To obtain maximum enjoyment from such a chain, the other links (record, stylus, pickup, turntable, speaker and enclosure) should also be of the highest quality.

To realize the full capabilities of this amplifier, the construction should be carried out with the utmost care. Hurried and careless construction may readily lead to difficulties, either initially or after some period of satisfactory operation. Therefore, take the time to do a good job.

This manual has been prepared to help you construct the amplifier with the least possible chance of error. Please read it all the way through before starting any of the work.

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 on the inside covers of the manual to help identify any doubtful components. If you find a part missing and you are certain it has not been discarded with the packing material, attach the inspection slip to your claim and notify us promptly of the shortage. Hardware items are counted by weight and if a few are missing, please secure them locally if at all possible.

Read the note on soldering on the inside of the back cover. Make a good mechanical connection with clean metal to clean metal. Use only good quality rosin core radio type solder. Pastes or acids are difficult to remove and even minute quantities left combine with moisture from the air to form a corrosive product. Weeks or months later, corrosion may result in untimely failure.

> 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.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are carefully checked before they are approved and the parts supplied will work satisfactorily. By checking the parts list for resistors, for example, you may find that a 51 KΩ resistor has been supplied in place of a 47 KΩ as shown in the parts list. These changes are self-evident and are mentioned here only to prevent confusion to you in checking the contents of your kit.

Resistors and controls generally have a tolerance rating of ±20% unless otherwise stated in the parts list. Therefore a 100 KΩ resistor may test anywhere between 80 KΩ and 120 KΩ. (The letter K is commonly used to designate a multiplier of 1000.) Tolerances on condensers are generally even greater. Limits of +100% and -50% are common for electrolytic condensers. The parts furnished with your Heathkit have been specified so as to not adversely affect the operation of the finished instrument.

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

Attach the large fold-in pictorials to the wall above your work space. The small reproduction in the manual is intended for reference later on after the large copy has become mutilated or lost.

Leads on condensers and resistors are usually much longer than they need to be. These leads should be cut to the proper length as the parts are wired into place. This will result in both superior operation and neater appearance. Use insulated sleeving on bare wires of condensers and resistors where necessary to prevent the leads from accidentally touching bare wires or metal parts. Use lockwashers under all nuts unless otherwise specified.

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

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

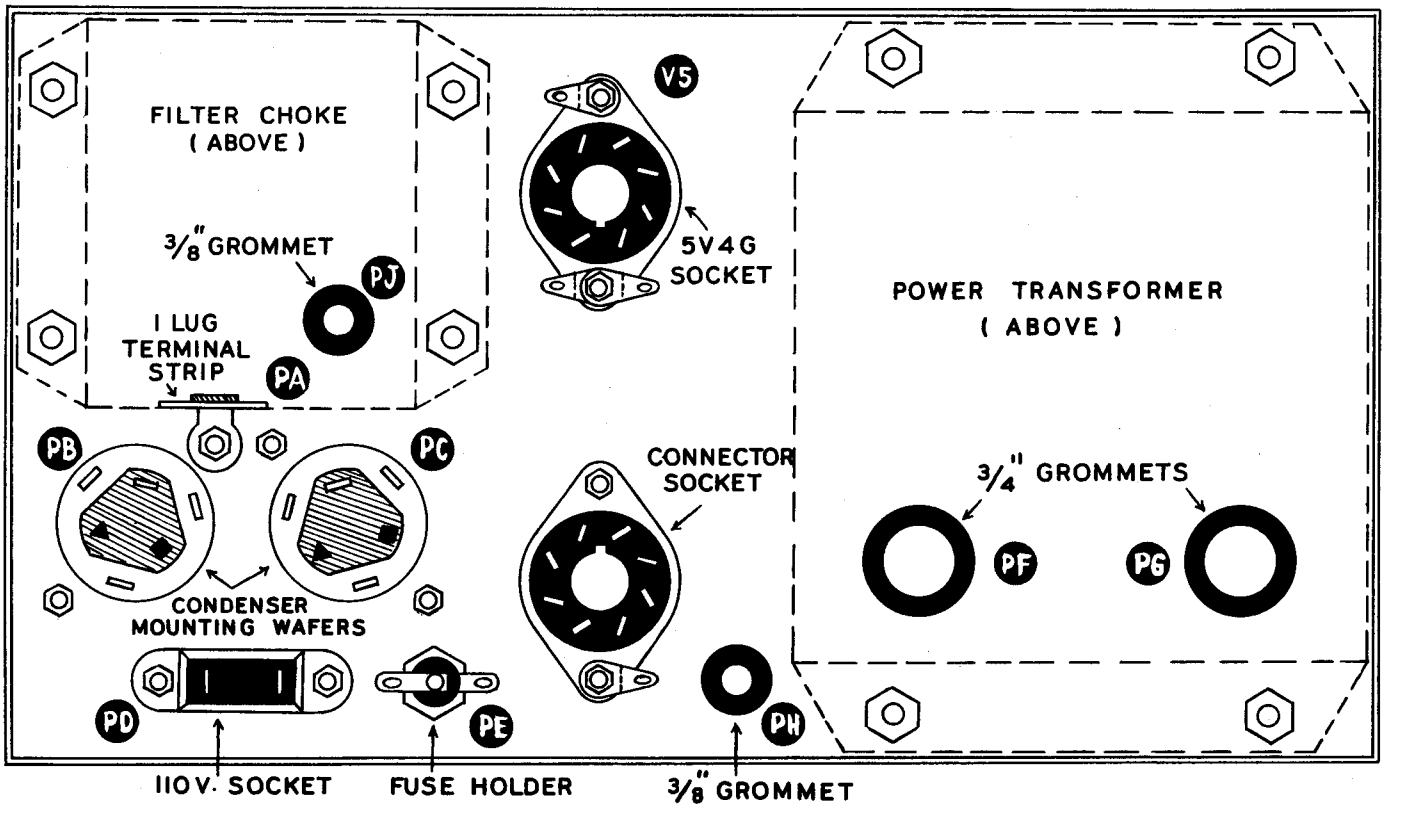
POWER SUPPLY

Mount the two condenser mounting wafers PB and PC on top of the chassis as shown in Pictorial 1, with 6-32 screws and nuts. Note the position of the triangular cutout. Under the chassis, include a 1-lug terminal strip PA under the nut indicated.

Mount the V5 octal tube socket and the similar connector socket from below the chassis with 6-32 screws and nuts. Observe that the keyways in the sockets are pointed inward toward each other. Place one solder lug under the top nut and two under the bottom nut. Position as shown in Pictorial 1.

Mount the 110 volt socket PD from below the chassis with 6-32 screws and nuts. Place a solder lug under the bottom nut, pointing to the right as shown.

Mount the fuse holder PE with the nut and lockwasher supplied and install the fuse. When necessary, replace with a type 3AG rated at not more than 3 amperes.



POWER SUPPLY CHASSIS LAYOUT — BOTTOM VIEW

PICTORIAL 1

Install the two 3/8" grommets PH and PJ for the line cord and the filter choke and the two 3/4" grommets PF and PG for the transformer leads.

Mount the power transformer on top of the chassis with the leads through the 3/4" grommets. Use 8-32 screws and nuts.

Mount the filter choke on top of the chassis with the leads through the 3/8" grommet. Use 8-32 screws and nuts.

Install the two 50 μfd 350 volt electrolytic condensers at PB and PC. Observe the position of the lugs in the sketch and install from the top of the chassis by passing the mounting prongs through the slots in the wafer. After making sure that the condenser is snugly seated against the wafer, twist each of the mounting prongs 1/8 of a turn with a pair of pliers.

( ) Twist together the transformer leads that come from grommet PG and place to tube socket V5. After cutting each wire to length and stripping the insulation off the ends, connect the red-yellow lead to the ground lug (S) on the V5 socket. See Pictorial 2.

( ) Connect one red lead to pin 6 (S) on V5.

( ) Connect the other red lead to pin 4 (S) of V5.

( ) Connect the one yellow lead to pin 2 (S) of V5.

( ) Connect the other yellow lead to pin 8 (NS) of V5.

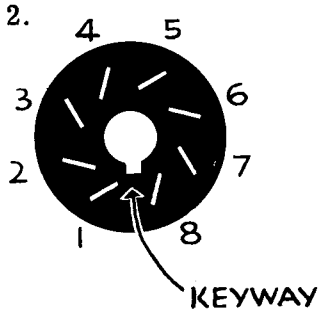


Figure 1

( ) Twist together the black transformer leads from grommet PF and place to the 110 volt socket PD.

( ) After cutting the leads to length and stripping the insulation off the ends, connect one black lead to one socket lug (NS) and the other black lead to the other socket lug (NS).

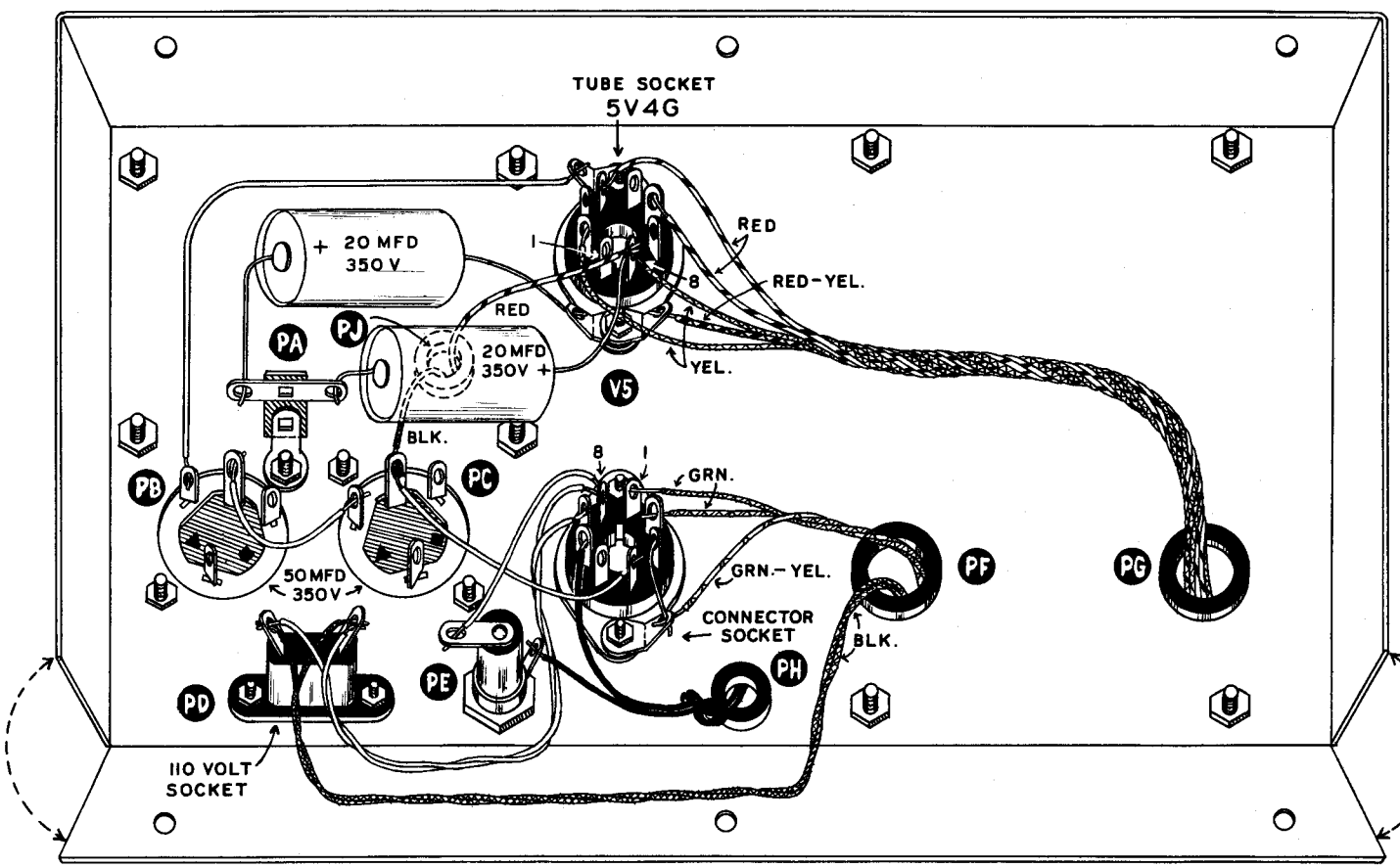
( ) Twist together the remaining transformer leads that come from grommet PF and place them to the connector socket.

( ) After cutting the leads to length and stripping the insulation from the ends, connect one green lead to pin 1 (S) on the connector socket.

( ) Connect the other green lead to pin 2 (S) on the connector socket.

( ) Connect the green-yellow lead to the ground lug (NS) at the connector socket.

( ) Connect a piece of bare wire between pin 3 (S) and the ground lug (S) at the connector socket.



POWER SUPPLY PICTORIAL

PICTORIAL 2

( ) Twist two wires together and connect one pair of ends to socket PD with one wire to one lug (S) and the other wire to the other lug (S).

( ) Connect the other ends to the connector socket pin 7 (S) and pin 8 (NS).

( ) Connect a wire from pin 8 (S) on the connector socket to the end lug (S) on the fuse holder.

( ) Connect a wire from pin 4 (S) on the connector socket to the center lug on condenser PC (NS).

( ) Connect the black lead from the filter choke to the center lug on condenser PC (S).

( ) Connect the red lead from the filter choke to pin 8 (NS) on V5.

( ) Connect the positive (+) lead of a 20 μfd 350 volt electrolytic condenser to pin 8 (S) of V5 and the other lead to terminal strip PA (S).

( ) Connect the positive lead of another 20 μfd 350 volt electrolytic condenser to terminal strip PA (S) and the other lead to the ground lug (S) at V5.

( ) Connect a wire between a twisted mounting prong (S) on condenser PC and the center lug (S) on condenser PB.

( ) Connect a wire between a twisted mounting prong (S) on condenser PB and a ground lug (S) at socket V5.

( ) Place the end of the line cord through grommet PH from the top of the chassis and tie a knot for strain relief so it cannot be pulled out.

( ) Connect one wire of the line cord to the side lug (S) of fuse holder PE and the other wire to pin 6 (S) on the connector socket.

( ) Check the wiring very carefully against the pictorial and make sure each connection is properly soldered. Shake out any excess solder and loose short pieces of wire.

( ) Install the four rubber feet in one of the bottom plates as shown in Figure 2. Attach this plate to the bottom of the chassis with six #6 sheet metal screws.

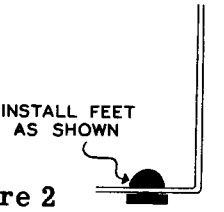


Figure 2

( ) Install the 5V4G tube in socket V5 between the power transformer and the filter choke.

AMPLIFIER

( ) Mount the five octal sockets on the chassis at V1, V2, V3, V4 and for the connector socket. Be sure that the keyways are positioned as shown in Pictorial 3. The sockets are secured in place with the wavy retaining ring. Start one end of the ring in the groove in the socket and then work the rest of the ring around the socket and into the groove with a screwdriver. See Figure 4.

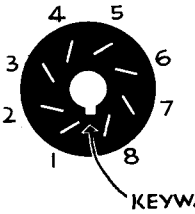


Figure 3

( ) Mount the phono input socket at K from below the chassis with 6-32 screws and nuts.

( ) Mount the condenser mounting wafer at H on top of the chassis with 6-32 screws and nuts. Note the position of the three mounting slots.

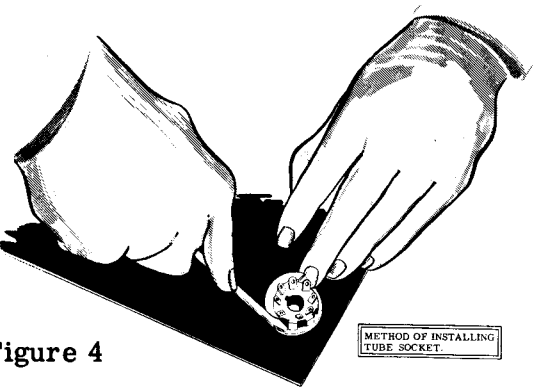
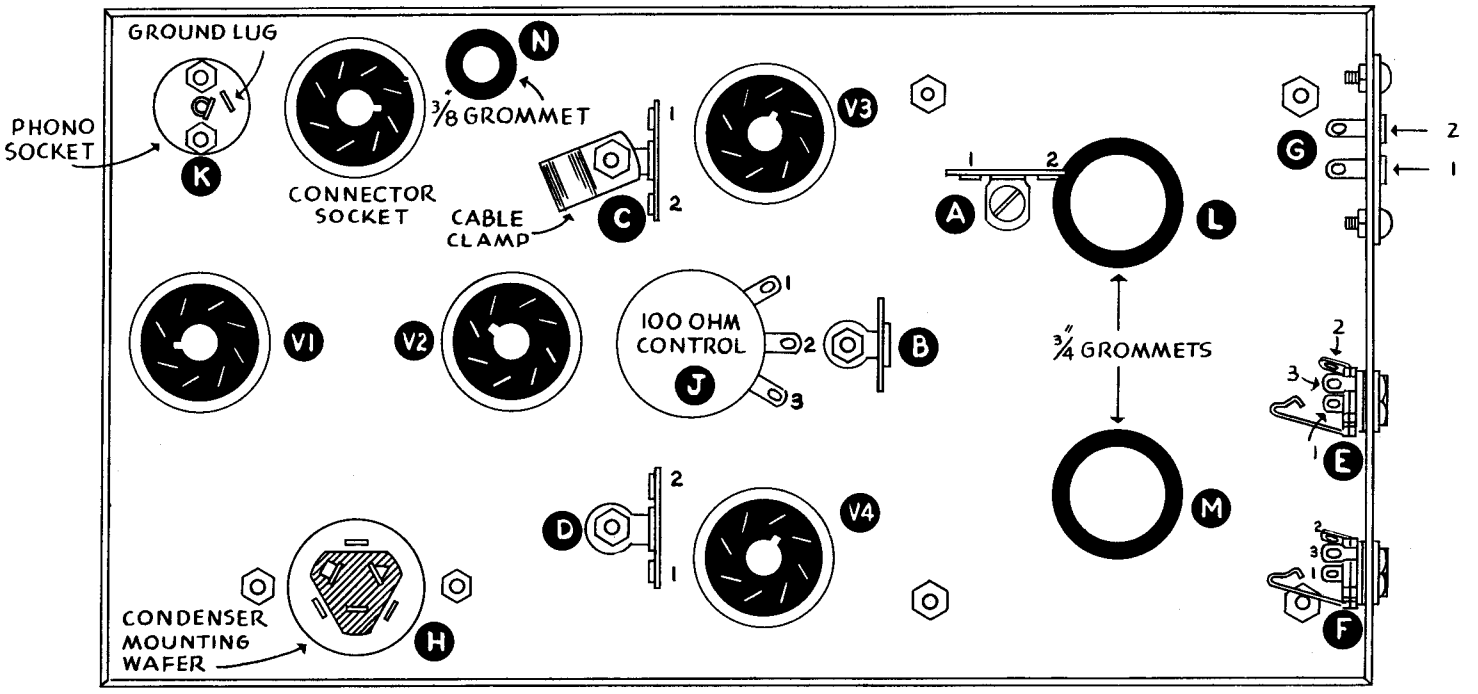


Figure 4



AMPLIFIER CHASSIS LAYOUT··*Bottom View*

PICTORIAL 3

( ) Mount the 2-screw speaker terminal strip at G on the end of the chassis using 6-32 hardware.

( ) Mount a 2-lug terminal strip under the chassis at A, using a #6 sheet metal screw. Insert the two 3/4" grommets in the large holes L and M.

( ) Mount a 1-lug terminal strip under the chassis at B, using 6-32 hardware.

( ) Mount a 2-lug terminal strip D near socket V4 under the chassis, with a 6-32 screw and nut.

( ) Mount the output transformer on top of the chassis, using 8-32 screws, lockwashers and nuts. Be sure the group of four leads comes through the grommet L.

( ) Mount the 100 Ω control from below the chassis at position J. Use a control lockwasher between the control bushing and the underside of the chassis.

( ) Install the 3/8" grommet at position N.

( ) Use a length of 8-wire cable (not longer than three feet) for connection between amplifier and power supply. Note that if the installation requires a longer cable between these two units, other cable should be obtained locally. For a distance not exceeding three feet, the cable supplied with the kit (all wires #22 gauge) is suitable. For a distance not exceeding four feet, an 8-wire cable with at least two #20 gauge wires may be used. For a distance not exceeding six feet, a cable with two #18 gauge wires (such as Belden #8448) may be used. For distances up to nine feet, two conductors in the cable should be #16 gauge.

( ) Remove the overall insulation (plastic or braid) on one end for a distance of a good 6" and place this end through grommet N. Bend open the 3/16" plastic cable clamp and slip it around the cable at the point where the overall insulation ends.

( ) Install the 2-lug terminal strip C together with the cable clamp, using the long 6-32 screw and nut.

( ) Mount the jacks E and F on the end of the chassis. Use an insulated shoulder washer between jack bushing and chassis and an insulated flat washer under the nut.

( ) Mount the 20-20 μfd 450 volt, 20 μfd 25 volt electrolytic condenser on top of the chassis by passing the mounting prongs through the slots in the mounting wafer. Make sure the unmarked lug is toward the edge of the chassis and while holding the condenser snugly against the wafer, twist each of the mounting prongs 1/8 turn with pliers.

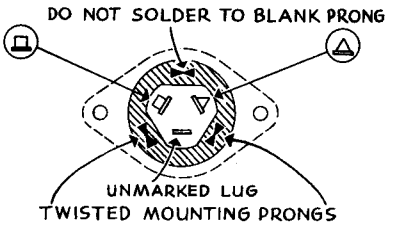


Figure 5

( ) Cut the wires from the cable to length required and strip the insulation off the ends. With the cable supplied with this kit, no special attention need be paid to which wire goes where at this point, but if a cable with two larger conductors is used, these larger wires should be numbers 1 and 2. Connect wire ① to pin 2 (NS) on socket V3. See Pictorial 4.

( ) Connect wire ② to pin 7 (NS) on V3.

( ) Connect wire ③ to lug G1 (NS) on the 2-screw terminal strip.

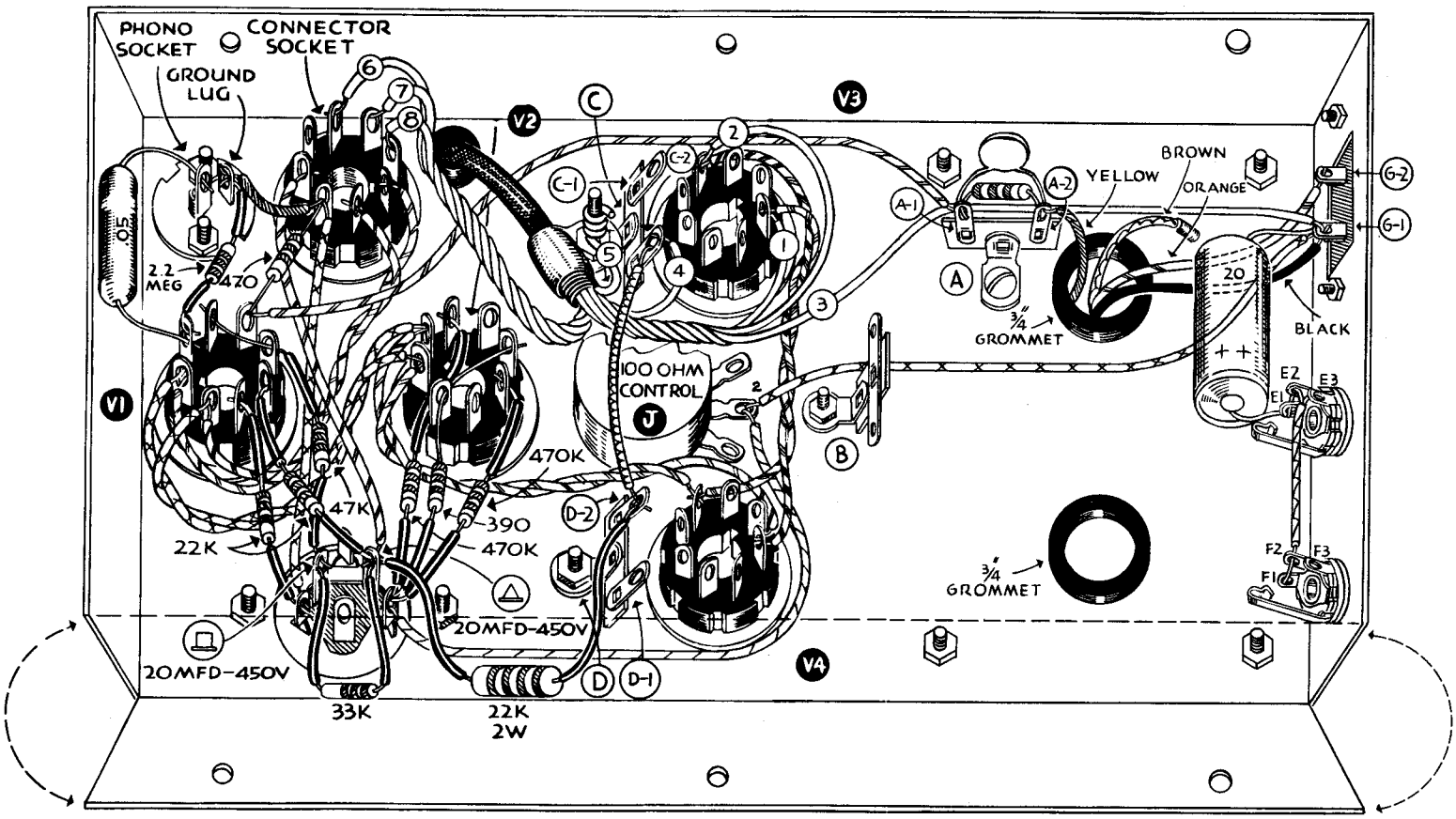
( ) Connect wire ④ to terminal strip C2 (NS).

( ) Wrap wire ⑤ which is not used, around the long screw that holds the cable clamp. This wire may be considered a spare.

( ) Connect wire ⑥ to pin 6 (S) on the connector socket.

( ) Connect wire ⑦ to pin 7 (S) on the connector socket.

( ) Connect wire ⑧ to pin 8 (S) on the connector socket.



PICTORIAL 4

( ) Twist two wires together and at one end connect one wire to pin 2 (S) and the other to pin 7 (S) on socket V3.

( ) At the other end of the twisted pair, connect one wire to pin 2 (NS) and the other wire to pin 7 (NS) on socket V4.

( ) Twist another pair of wires together and on one end connect one wire to pin 2 (S) and the other to pin 7 (S) on socket V4.

( ) At the other end of this twisted pair, connect one wire to pin 7 (NS) and the other to pin 8 (NS) on socket V2.

( ) In the same manner, connect pins 7 (S) and 8 (S) on socket V2 to pins 7 (NS) and 8 (NS) on socket V1.

( ) In the same manner, connect pins 7 (S) and 8 (S) on socket V1 to pins 1 (S) and 2 (S) on the connector socket.

( ) Connect the black lead from the output transformer to terminal strip G1 (NS).

( ) Connect a wire from terminal strip G1 (NS) to the center lug (NS) on control J.

( ) Connect a wire between the center lug (S) on control J and the nearest twisted mounting prong (NS) on condenser H.

( ) Connect a wire between the other twisted mounting prong (NS) on condenser H and pin 3 (NS) on the connector socket.

( ) Connect a short wire between pin 3 (NS) on the connector socket and the ground lug (NS) on phono socket K.

( ) Connect a 2.2 megohm resistor (red-red-green) between the ground lug (S) on phono socket K and pin 1 (NS) on socket V1 (use sleeving).

( ) Connect a 470 Ω resistor (yellow-purple-brown) between pin 3 (S) on the connector socket and pin 3 (NS) on socket V1.

( ) Connect a 470 KΩ resistor (yellow-purple-yellow) between pin 1 (NS) on socket V2 and the nearest twisted mounting prong (NS) on condenser H (use sleeving).

NOTE: One of the twisted mounting prongs has not been pierced and should not be used as a terminal. This prong should be disregarded.

( ) Connect a 390 Ω resistor (orange-white-brown) with one lead through pin 6 (NS) to pin 3 (S) on socket V2 and the other lead to the nearest twisted mounting prong (NS) on condenser H (use sleeving). Now solder pin 6.

( ) Connect a 470 KΩ resistor (yellow-purple-yellow) between pin 4 (NS) on socket V2 and the twisted mounting prong (S) on condenser H (use sleeving).

NOTE: In the following instructions, the term "matched pair" refers to the two pair of resistors separately packed and so marked in your kit. These consist of one pair of 22 KΩ 1/2 watt resistors (red-red-orange) and one pair of 47 KΩ 2 watt resistors (yellow-purple-orange). These pairs are carefully matched to each other for equal resistance and should be used only where indicated to obtain maximum performance from the amplifier.

( ) Connect one of the matched pair of 22 KΩ resistors (red-red-orange) between pin 6 (NS) on socket V1 and the nearest twisted mounting prong (S) on condenser H (use sleeving).

( ) Connect a wire to pin 4 (S) on the connector socket and to the ▲ marked lug (NS) on condenser H.

( ) Connect a 47 KΩ 1/2 watt resistor (yellow-purple-orange) (do NOT use one of the large 2 watt matched pair) with one lead through pin 4 (S) to pin 2 (S) on socket V1 and the other lead to the ■ marked lug (NS) on condenser H. Make sure there is adequate clearance around pin 3 on the socket (use sleeving).

( ) Connect a 33 KΩ resistor (orange-orange-orange) between the ■ marked lug (S) and the ▲ marked lug (NS) on condenser H (use sleeving).

( ) Connect the other 22 KΩ resistor (red-red-orange) of the marched pair between pin 5 (NS) on socket V1 and the ▲ marked lug (NS) on condenser H (use sleeving).

( ) Connect a 22 KΩ 2 watt resistor (large red-red-orange) between the ▲ marked lug (S) on the condenser and lug D2 (NS) on the terminal strip (use sleeving).

( ) Connect a wire between lug D2 (NS) and lug C2 (NS).

( ) Connect a wire from pin 3 (S) on socket V1 to lug A1 (NS).

( ) Connect a 6800 Ω resistor (blue-gray-red) between terminal A1 (NS) and A2 (NS). Then connect a 33 μμf condenser between A1 (S) and A2 (NS).

( ) Connect the yellow wire from the output transformer to A2 (S).

( ) Make one of the following connections, depending upon the impedance of your speaker system:

For 4 Ω output, connect the brown lead from the transformer to G2 (S).
For 8 Ω output, connect the orange lead from the transformer to G2 (S).
For 16 Ω output, connect a lead from A2 (already soldered) to G2 (S).

Lead not used should be taped at the end and wrapped around bracket of terminal strip A.

( ) Connect a wire with one end through lug F2 (S) to lug F1 (S) and with the other end through lug E2 (S) to lug E1 (NS) on the phone jacks.

( ) Connect a .05 μfd tubular condenser from pin 1 (S) on socket V1 to center lug (S) on phono socket K. See Pictorial 4. NOTE: Tubular paper capacitors may or may not be marked by a band indicating "outside foil." Marked or not however, the capacitors may be connected either way in this circuit since the "polarity" is not critical.

( ) Connect the blue lead from the output transformer to pin 3 (S) on socket V3.

*( ) Connect the green lead from the transformer to pin 4 (S) on socket V3.

( ) Connect the blue-white lead from the output transformer to pin 3 (S) on socket V4.

*( ) Connect the green-white lead from the output transformer to pin 4 (S) on socket V4.

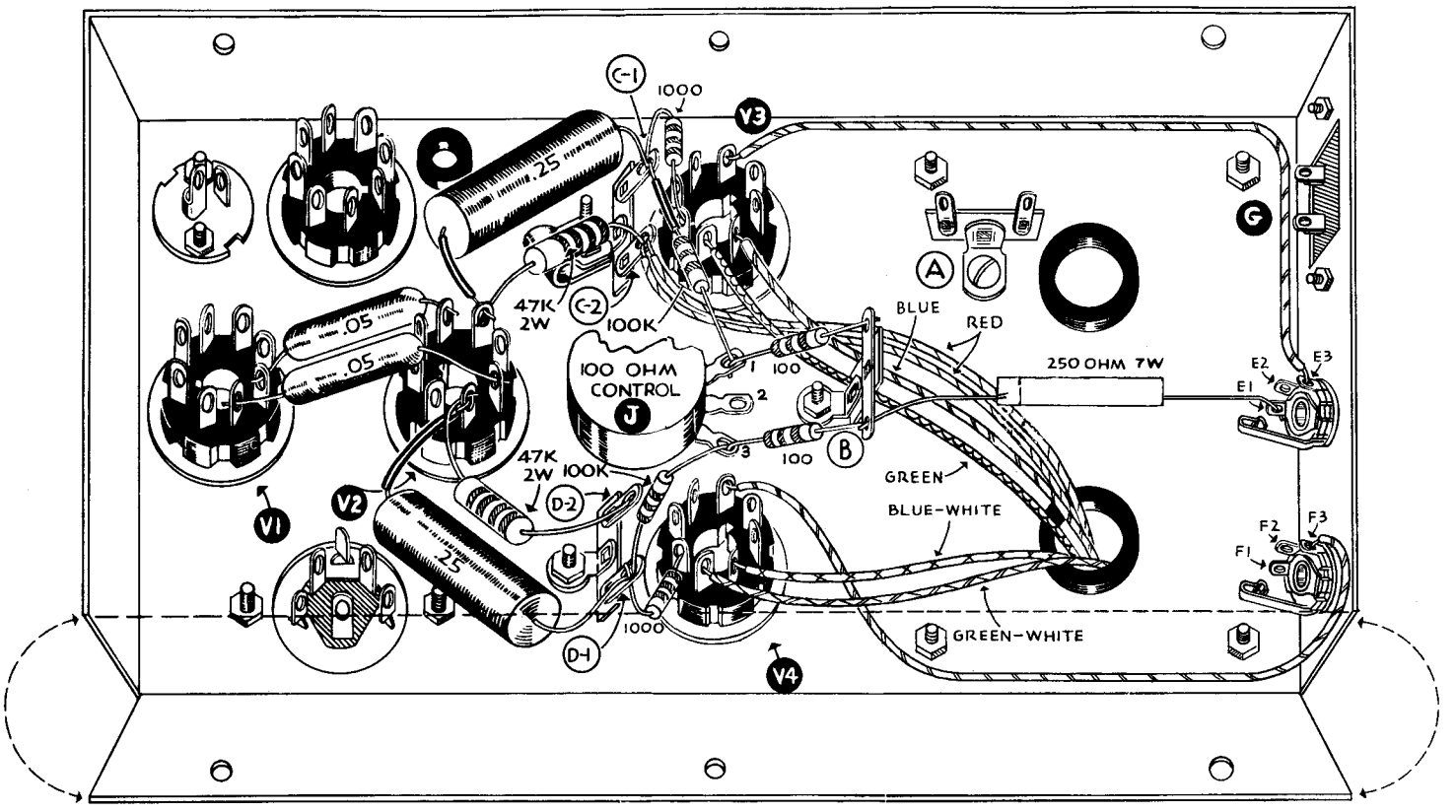
( ) Connect the TWO red leads from the output transformer to C2 (NS).

( ) Connect a wire between pin 8 (S) on socket V4 and lug F3 (S).

( ) Connect a wire between pin 8 (S) on socket V3 and lug E3 (S).

( ) Connect the 250 Ω 7 watt resistor between lug E1 (NS) and the 1-lug terminal strip B (NS).

*Read NOTE on Page 19 for Optional Circuit.



PICTORIAL 5

1) Connect the positive end of a 20 μfd condenser to E1 (S). Connect the other lead of this condenser to G1 (S).

2) Connect a 100 Ω resistor (brown-black-brown) between terminal strip B (S) and lug 3 on control J (NS).

3) Connect a 100 KΩ resistor (brown-black-yellow) between lug 3 (S) on control J and lug D1 (NS) (use sleeving).

4) Connect a 1 KΩ resistor (brown-black-red) between lug D1 (NS) and pin 5 (S) on socket V4.

5) Connect a 100 Ω resistor (brown-black-brown) between terminal strip B (S) and control lug J1 (NS).

6) Connect a 100 KΩ resistor (brown-black-yellow) between control lug J1 (S) and lug C1 (NS) (use sleeving).

7) Connect a 1 KΩ resistor (brown-black-red) between lug C1 (NS) and pin 5 (S) on socket V3.

8) Connect one of the matched pair of 47 KΩ 2 watt resistors (large yellow-purple-orange) between lug C2 (S) and pin 2 (NS) on socket V2.

9) Connect a .25 μfd (large tubular) condenser between pin 2 (S) on socket V2 and lug C1 (S) (use sleeving). Again note that "outside foil," if marked, may be disregarded.

10) Connect the other 47 KΩ 2 watt resistor (large yellow-purple-orange) of the matched pair between lug D2 (S) and pin 5 (NS) on socket V2.

11) Connect a .25 μfd condenser between pin 5 (S) on socket V2 and lug D1 (S) (use sleeving).

12) Connect a .05 μfd condenser between pin 5 (S) on socket V1 and pin 1 (S) on socket V2.

( ) Connect another .05 μfd condenser between pin 6 (S) on socket V1 and pin 4 (S) on socket V2.

( ) Install the octal plug on the end of the cable. Remove the overall insulation for about 1 1/2". Remove the insulation from each wire for about 3/4". Slip the plug cap on the cable with the grommet toward the chassis end. Arrange the wires in a circle and slip wire ① in the hole marked 1, wire ② in the hole marked 2, etc. Make sure the wire sticks out beyond the pin. Bend the wire over to keep it from slipping out. See Figure 6.

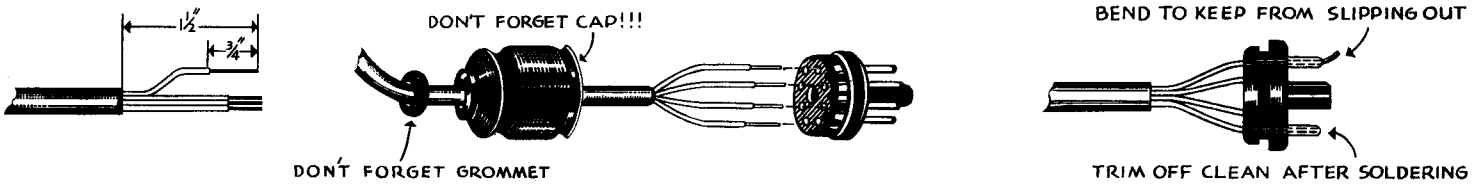


Figure 6

( ) Solder the wire in each pin by heating the pin with the soldering iron and letting the solder flow up into the pin. See that no excess solder sticks to the outside of the pin. If necessary reheat the pin and wipe off excess solder with a cloth.

( ) Cut off the bent over portions of wire leaving a clean pin.

( ) Press the cap over the plug so it snaps into place. When removing this plug from the power supply, never pull on the cable. Always use the plug cap for a handle.

( ) Check the wiring very carefully against both pictorials and make sure each connection is properly soldered. Shake out any excess solder and loose short pieces of wire.

( ) Install the four rubber feet in the bottom plate and attach to the bottom of the chassis with six #6 sheet metal screws.

( ) Install the two 6SN7 GT tubes in sockets V1 and V2 and the two 5881 tubes in sockets V3 and V4.

TESTING THE COMPLETED AMPLIFIER

This amplifier is designed for operation from signal sources that are equipped with volume and tone controls such as some AM and FM tuners, tape reproducers or record players have.

For signal sources without volume and tone controls, the use of a preamplifier is recommended.

If the Heathkit WA-P2 Preamplifier was not purchased with the unit, procure a standard octal connector plug and cap, similar to Amphenol's 86-PM8, from a local source. This connector is used to make the following voltages and control circuits available for use with auxiliary equipment.

Pins 1 and 2	6.3 volts 1.0 amperes AC
Pin 3	Negative plate supply
Pin 4	Positive plate supply (200 volts 10 ma DC)
Pin 5	Not used
Pins 6 and 7	115 volts AC from power line
Pins 6 and 7	Line switch, to control amplifier and AC outlet on amplifier chassis

Before the amplifier can be tested, connections should be made to the auxiliary equipment as shown above or a jumper must be connected between pins 6 and 7 on the connector plug.

The output stage should now be adjusted for equal currents in the 5881 tubes.

Connect the loudspeaker leads to the speaker terminals on the amplifier chassis.

If the following testing components are not on hand, they can probably be borrowed from a friend or a local radio service man can make the adjustment in a few minutes. If desired, the essential parts can be obtained locally or from one of the large mail-order radio parts companies for less than $2.00. Their possession in case of tube replacement or balance checks after prolonged use may be well worth the small outlay. A pocket tester, such as the Heathkit Handitester would be more convenient for a multitude of tests in case of operating difficulties and should prove of value to the technically inclined constructor.

Connect a DC milliammeter with a range of not less than 60 milliamperes full scale (preferably 0-100 milliamperes) to a phone plug. Connect the positive (+) terminal of the meter to the center connection of the phone plug (tip) and the other meter terminal to the outer connection of the phone plug (sleeve).

Plug the line cord from the amplifier into a 105-125 volt 50/60 cycle AC (alternating current) outlet. CAUTION: DO NOT PLUG INTO A DC (DIRECT CURRENT) OUTLET, such as is found in some of the older districts of the bigger cities. DC will cause the fuse to break the circuit and prevent damage. This amplifier will not operate on DC or 25 cycle AC and replacing the fuse will be to no avail.

Turn the amplifier on. Observe the filaments in the tubes. If they light up, the filament circuits are functioning correctly. The speaker should now produce some background noise. This indicates that the amplifier appears to be functioning normally.

Insert the phone plug that is connected to the meter into one of the phone jacks on the amplifier. The meter should indicate between 40 and 60 milliamperes. Note the reading and insert the plug into the other jack. Adjust the control between the 5881 tubes with a screwdriver until both readings are alike.

If the signal source (record player or tuner) is not already equipped with a phono plug of the type supplied with this kit, install a phono plug on the output lead of the signal source as shown.

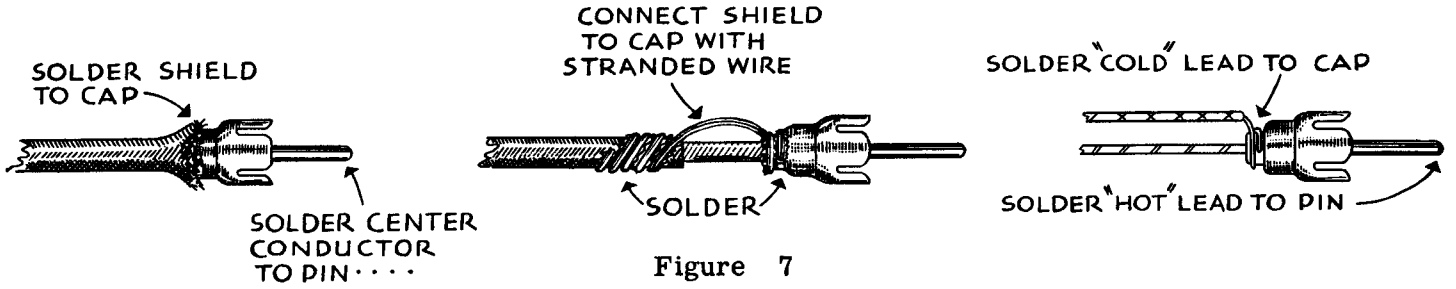


Figure 7

IN CASE OF DIFFICULTY

If the initial test does not produce the desired results, proceed as follows:

1. Make sure that all the tubes light up properly. Make sure the tubes are in their proper sockets. Test the tubes.
2. Have a friend check the wiring against the pictorials. Mistakes in wiring are much more easily located by another person.
3. Check the operating voltages with a meter. All measurements are made between tube pins and chassis. The voltages should check within 20% of the values listed below, if a vacuum tube voltmeter (VTVM) with 11 megohms input resistance is used. With a voltohmmeter (VOM) of 1000 or 20,000 Ω per volt sensitivity, some readings may be considerably less. If a reading is found to differ appreciably from the tabulated value, check into that part of the circuit to locate the source of difficulty. This can be done, for instance, by checking the resistance of the resistors and testing the condensers for opens or shorts. All measurements made without preamplifier.

VOLTAGE CHART

SOCKET TUBE TYPE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
V1 6SN7	0	50	1	50	200	60	3 VAC	3 VAC
V2 6SN7	0	140	3.5	0	140	3.5	3 VAC	3 VAC
V3 - V4 5881	0	3 VAC	415	420	0 to 10	0	3 VAC	36
V5 5V4G		440		405 VAC		405 VAC		440

4. If the amplifier oscillates and produces a loud squeal or motor-boats and makes a putt-putt sound, check for improper positioning of parts and wiring (known as lead dress) and poor solder connections to ground (chassis) or filter condensers. (NOTE: Speaker leads placed close to the unshielded portions of the input leads will readily provide oscillation and acoustic feedback from the speaker back to the turntable and pickup may result in a roar or howl at maximum settings of the volume control.)
5. If a part is believed to be or actually found to be faulty, please write us promptly and we will advise you.
6. Should the procedure as outlined fail to bring the desired results, write to the Heath Company describing the difficulties by giving all possible information, such as sound produced, meter readings obtained and all other pertinent data available. We will attempt to analyze your trouble and advise you accordingly.

IN ALL CORRESPONDENCE, REFER TO THIS KIT AS THE MODEL W-3M AMPLIFIER. Failure to mention this model number will make it difficult to determine which of the many models produced, both at present and in the past, you are referring to.

OPERATION

Since the W-3M has no controls, it is operated by the controls on the preamplifier or signal source. Follow the operating instructions for the specific equipment which is used with the amplifier.

APPLICATION AND INSTALLATION

The W-3M amplifier is designed for high quality sound applications. Such applications require additional components, as a suitable reproducer system and one or more sources of signal. In order to make the fullest use of the quality obtainable from the amplifier, the other components should also be of as high a quality as possible, as the weakest link in the chain will determine the ultimate performance level.

The choice of reproducer depends primarily upon the space available. Excellent results may be obtained from speakers of various sizes, ranging all the way from an 8" to 15" cone diameter. The large speakers generally require a housing or enclosure of greater dimensions. The type of reproducer is also affected by individual taste and generally both the multiple speakers with electrical or mechanical crossover networks, as well as the high grade single cone reproducers are serving satisfied listeners. A further discussion of the problem of speaker selection is beyond the scope of this manual.

The amplifier lends itself to operation directly from signal sources that are equipped with volume and tone controls such as some AM and FM tuners, tape or wire reproducers, or record players have.

For signal sources without volume and tone controls such as simple tuners or record players, the use of a preamplifier is recommended. The Heathkit Preamplifier WA-P2 has been designed especially for this purpose.

The installation depends on the individual requirements. Generally the amplifier will be installed in a cabinet or other enclosure. NOTE: This amplifier system consumes 120 watts of power, which is converted to heat. This heat will produce a temperature rise in the cabinet equal to the effect of two standard 60 watt light bulbs burning in the same space. Adequate ventilation should be provided to permit the heat to excape, thus keeping the temperature from rising too high. High temperature operation may adversely affect the life of some of the components in the amplifier and may also damage the finish of the cabinet.

We do not recommend installation of amplifier and power supply inside the speaker housing. Most types of speaker housings do not permit adequate ventilation and the resulting high temperatures may ruin a good speaker.

When planning the actual installation, keep the following points in mind:
1. Select the location of the speaker so that it is aimed at the listeners.
2. Provide adequate ventilation for the amplifier and power supply.
3. Locate the preamplifier as close to the source and the main amplifier as conveniently possible, to reduce high frequency losses in the shielded cables.
4. Keep the preamplifier and source separated from the speaker to prevent acoustic feedback.

Note that this amplifier is designed for domestic applications and that its use for public address applications is not recommended. The weight is high for the output obtained and the outstanding quality of reproduction available is generally lost because of acoustic conditions.

REPLACEMENTS

Material supplied with Heathkits 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 tube or 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 the order number and 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. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. 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.

SERVICE

In event continued operational difficulties of the completed instrument are experienced, the facilities of the Heath Company Service Department are at your disposal. Your instrument may be returned for inspection and repair for a service charge of $5.00 plus the cost of any additional material that may be required. THIS SERVICE POLICY APPLIES ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned not repaired.

The Heath Company is willing to offer its full cooperation to assist you in obtaining the specified performance level in your instrument. Factory repair service is available for a period of one year from the date of purchase or you may contact the Engineering Consultation Department by mail. For information regarding the possible modification of existing kits, the volumes listed in the Bibliography section are recommended. They can be obtained at or through your local library, as well as at any electronic outlet store. 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 specific purposes. Therefore, such modifications must be made at the discretion of the kit builder according to information which will be much more readily available from some local source.

SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted. Attach a tag to the instrument giving name, address and trouble experienced. Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

SPECIFICATIONS

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.

WARRANTY

The Heath Company limits its warranty of parts supplied with any kit to a period of three (3) months from the date of purchase. Replacement will be made only when said part is returned postpaid, with prior permission and in the judgment of the Heath Company was defective at the time of sale. This warranty does not extend to any Heathkits which have been subjected to misuse, neglect, accident and improper installation or applications. Material supplied with a kit shall not be considered as defective, even though not in exact accordance with specifications, if it substantially fulfills performance requirements. This warranty is not transferable and applies only to the original purchaser. This warranty is in lieu of all other warranties and the Heath Company neither assumes nor authorizes any other person to assume for them any other liability in connection with the sale of Heathkits.

The assembler is urged to follow the instructions exactly as provided. The Heath Company assumes no responsibility or liability for any damages or injuries sustained in the assembly of the device or in the operation of the completed instrument.

HEATH COMPANY
Benton Harbor, Michigan

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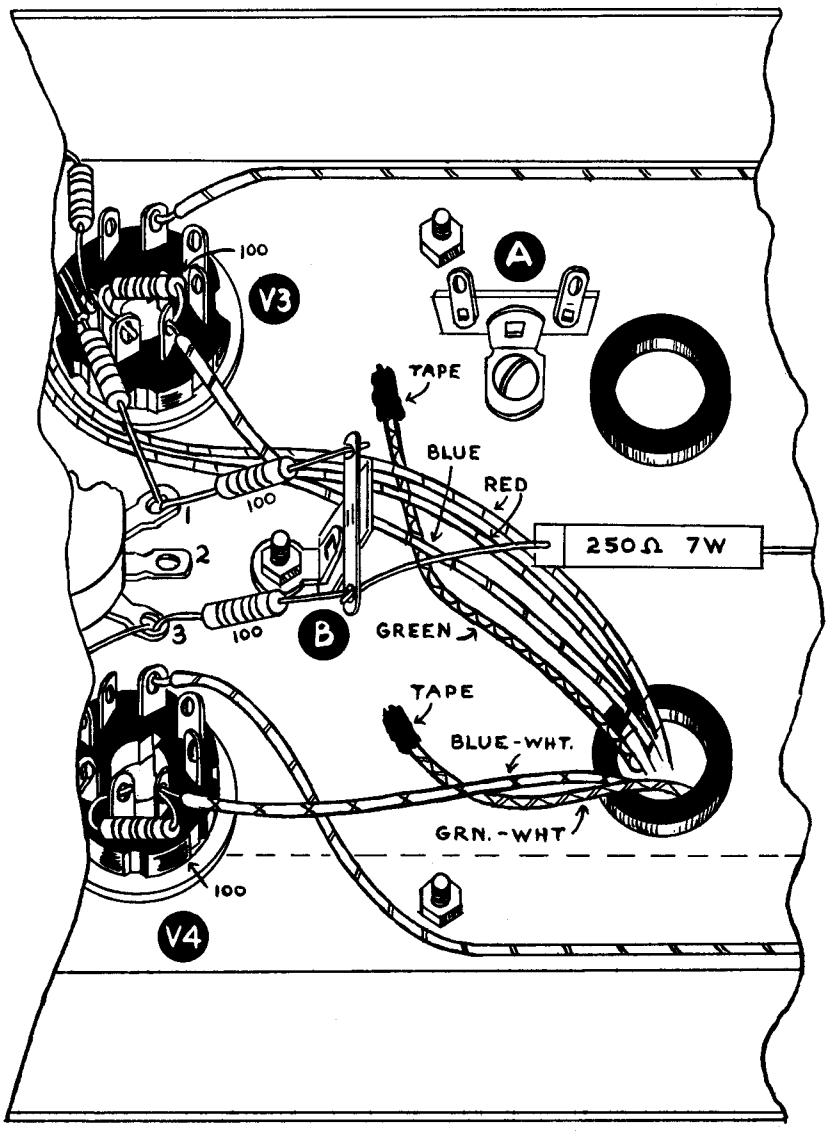


INSTRUCTIONS FOR USING OPTIONAL OUTPUT AMPLIFIER CIRCUIT

If it is desired to utilize the original Williamson type output amplifier circuit, disregard the steps designated by asterisks on Page 12 and substitue the following:

*( ) Connect a 100 Ω resistor (brown-black-brown) between pin 4 (S) and pin 3 (S) on socket V3. The green output transformer lead is not used and it should be taped carefully to prevent the bare wire from shorting to another component or the chassis.

*( ) Connect a 100 Ω resistor (brown-black-brown) between pin 4 (S) and pin 3 (S) on socket V4. The green-white output transformer lead is not used. It also must be taped carefully.

These connections are shown above. Resistors for wiring the circuit in this way have been included with this kit.

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors-Controls		
1-3	2	100 Ω
1-48	1	390 Ω
1-6	1	470 Ω
1-9	2	1000 Ω
1-19	1	6800 Ω
1-22	2	22 KΩ (matched)
1-24	1	33 KΩ
1-25	1	47 KΩ
1-26	2	100 KΩ
1-33	2	470 KΩ
1-37	1	2.2 megohm
1-11B	1	22 KΩ 2 watt
1-10B	2	47 KΩ 2 watt (matched)
3-5G	1	250 Ω 7 watt
11-1	1	100 Ω control
Condensers		
21-7	1	33 μμf
23-10	3	.05 μfd
23-24	2	.25 μfd
25-6	1	20-20 μfd 450 volt 20 μfd 25 volt
25-16	2	20 μfd 350 volt
25-17	2	50 μfd 350 volt
25-19	1	20 μfd 150 volt
Tubes		
411-15	2	6SN7 GT
411-45	2	5881
411-35	1	5V4G
Sockets-Jacks-Plugs-Fuse		
421-2	1	Fuse
423-1	1	Fuse holder
434-58	2	Octal socket, saddle
434-4	5	Octal socket, ring
434-18	1	Phono socket
434-20	1	110 volt socket
436-4	2	Phone jack
438-4	1	Phono plug
438-6	1	Octal plug
440-1	1	Octal plug cap

PART No.	PARTS Per Kit	DESCRIPTION
Terminal Strips-Wafers		
431-1	2	1-lug terminal strip
431-2	3	2-lug terminal strip
431-6	1	2-screw terminal strip
481-4	3	3-prong mounting wafer
Sheet Metal Parts		
200-M21	1	Power supply chassis
200-M39	1	Amplifier chassis
205-M8	2	Bottom plate
Wire		
89-1	1	Line cord
344-1	1	roll Hookup wire
346-1	1	length Sleeving
347-1	1	length Cable
Choke-Transformers		
46-6/1	1	Filter choke
51-11	1	Output transformer
54-13	1	Power transformer
Hardware		
73-1	3	3/8" grommet
73-2	4	3/4" grommet
207-5	1	3/16" cable clamp
250-8	13	#6 sheet metal screw
250-9	19	6-32 x 3/8 screw
250-13	1	6-32 x 1 screw
250-17	12	8-32 x 1/4 screw
252-3	20	6-32 nut
252-4	12	8-32 nut
252-7	3	Control nut
253-10	3	Nickel washer
253-15	2	3/8" fiber flat washer
253-16	2	3/8" fiber shoulder washer
254-1	20	#6 lockwasher
254-2	12	#8 lockwasher
254-4	1	Control lockwasher
259-1	4	#6 solder lug
261-1	8	Rubber feet
435-1	5	Tube socket ring
595-106	1	Instruction manual

HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual through thoroughly to familiarize yourself with the general procedure. Note the relative location of pictorials and pictorial inserts in respect to the progress of the assembly procedure outlined.

This information is offered primarily for the convenience of novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronics enthusiast may benefit by a brief review of this material before proceeding with kit construction. In the majority of cases, failure to observe basic instruction fundamentals is responsible for inability to obtain desired level of performance.

RECOMMENDED TOOLS

The successful construction of Heathkits does not require the use of specialized equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 100 watt iron with a small tip. The use of long nose pliers and diagonal or side cutting pliers is recommended. A small screw driver will prove adequate and several additional assorted screw drivers will be helpful. Be sure to obtain a good supply of rosin core type radio solder. Never use separate fluxes, paste or acid solder in electronic work.

ASSEMBLY

In the actual mechanical assembly of components to the chassis and panel, it is important that the procedure shown in the manual be carefully followed. Make sure that tube sockets are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer color coded wires will be available at the proper chassis opening.

Make it a standard practice to use lock washers under all 6-32 and 8-32 nuts. The only exception being in the use of solder lugs—the necessary locking feature is already incorporated in the design of the solder lugs. A control lock washer should always be used between the control and the chassis to prevent undesirable rotation in the panel. To improve instrument appearance and to prevent possible panel marring use a control flat nickel washer under each control nut.

When installing binding posts that require the use of fiber insulating washers, it is good practice to slip the shoulder washer over the binding post mounting stud before installing the mounting stud in the panel hole provided. Next, install a flat fiber washer and a solder lug under the mounting nut. Be sure that the shoulder washer is properly centered in the panel to prevent possible shorting of the binding post.

WIRING

When following wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.

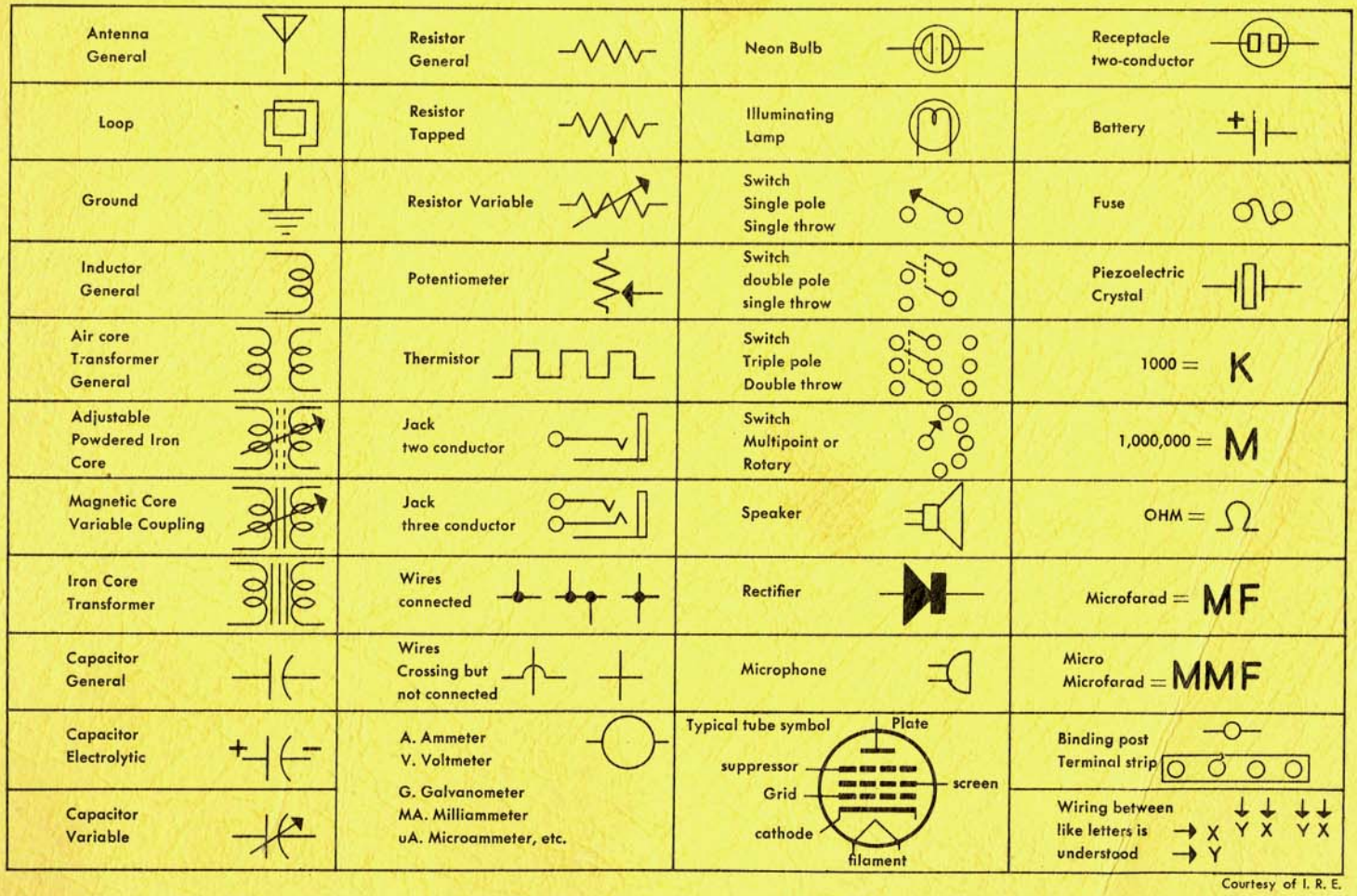
When removing insulation from the end of hookup wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect to nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown baked enamel coating. After the transformer leads have been trimmed to a suitable length, it is necessary to scrape the enamel coating in order to expose the bright copper wire before making a terminal or soldered connection.

In mounting parts such as resistors or condensers, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby wiring.

It is urgently recommended that the wiring dress and parts layout as shown in the construction manual be faithfully followed. In every instance, the desirability of this arrangement was carefully determined through the construction of a series of laboratory models.

SOLDERING

Much of the performance of the kit instrument, particularly in respect to accuracy and stability, depends upon the degree of workmanship used in making soldered connections. Proper soldered connections are not at all difficult to make but it would be advisable to observe a few precautions. First of all before a connection is to be soldered, the connection itself should be clean and mechanically strong. Do not depend on solder alone to hold a connection together. The tip of the soldering iron should be bright, clean and free of excess solder. Use enough heat to thoroughly flow the solder smoothly into the joint. Avoid excessive use of solder and do not allow a flux flooding condition to occur which could conceivably cause a leakage path between adjacent terminals on switch assemblies and tube sockets. This is particularly important in instruments such as the VTVM, oscilloscope and generator kits. Excessive heat will also burn or damage the insulating material used in the manufacture of switch assemblies. Be sure to use only good quality rosin core radio type solder.



Courtesy of I. R. E.

HEATH COMPANY

BENTON HARBOR, MICHIGAN

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