

PRICE \$1.00



Assembling
and Using Your...

Heathkit

WILLIAMSON TYPE
AMPLIFIER

MODEL W4-AM

HEATH COMPANY

A Subsidiary of Daystrom Inc.

BENTON HARBOR, MICHIGAN

STANDARD COLOR CODE — RESISTORS AND CAPACITORS

AXIAL LEAD RESISTOR Brown — Insulated Black — Non-insulated Tolerance Multiplier 1st and 2nd Significant Figures Wire wound resistors have 1st digit band double width	INSULATED UNINSULATED Color BLACK BROWN RED ORANGE YELLOW GREEN BLUE VIOLET GRAY WHITE	FIRST RING BODY COLOR First Figure 0 1 2 3 4 5 6 7 8 9	SECOND RING END COLOR Second Figure 0 1 2 3 4 5 6 7 8 9	THIRD RING DOT COLOR Multiplier None 0 00 ,000 0,000 00,000 000,000 0,000,000 00,000,000 000,000,000	DISC CERAMIC RMA CODE 5-Dot Capacity Multiplier Tolerance Temp. Coeff. 3-Dot
	RADIAL LEAD DOT RESISTOR Multiplier 2nd Figure Tolerance 1st Figure	5-DOT RADIAL LEAD CERAMIC CAPACITOR Temp. Coeff. Capacity Multiplier Tolerance	EXTENDED RANGE TC CERAMIC HICAP Temp. Coeff. Capacity TC Multiplier Multiplier Tolerance		
RADIAL LEAD (BAND) RESISTOR Multiplier 2nd Figure Tolerance 1st Figure	BY-PASS COUPLING CERAMIC CAPACITOR Capacity Multiplier Tolerance Voltage (Opt.)	AXIAL LEAD CERAMIC CAPACITOR Temp. Coeff. Capacity Multiplier Tolerance			

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 1/2 watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors 1/2 watt, 1 or 2 watt may be color coded but the first band will be double width.

MOLDED MICA TYPE CAPACITORS

CURRENT STANDARD CODE White (RMA) Black (JAN) Class Tolerance 1st Significant Figure 2nd Significant Figure Multiplier	JAN & 1948 RMA CODE	RMA 3-DOT (OBSOLETE) RATED 500 W.V.D.C. ± 20% TOL. Multiplier 2nd Significant Figure 1st Significant Figure	BUTTON SILVER MICA CAPACITOR Class Tolerance Multiplier 1st Digit 2nd Digit 3rd digit
RMA (5-DOT OBSOLETE CODE) 1st Significant Figure 2nd Significant Figure Multiplier Front Working Voltage Rear Tolerance	 1st Significant Figure 2nd Significant Figure Multiplier Tolerance Working Voltage Blank	RMA 6-DOT (OBSOLETE) 1st Significant Figure 2nd Significant Figure 3rd Significant Figure Multiplier Tolerance Working Voltage	RMA 4-DOT (OBSOLETE) Working Voltage Multiplier 2nd Significant Figure 1st Significant Figure

MOLDED PAPER TYPE CAPACITORS

TUBULAR CAPACITOR 1st Significant Figure 2nd Significant Figure Multiplier Tolerance 2nd Significant Voltage Figure Normally stamped for value	MOLDED FLAT CAPACITOR Commercial Code Working Volts Multiplier 2nd Significant Figure 1st Significant Figure	JAN. CODE CAPACITOR Silver Tolerance Multiplier 1st Significant Figure 2nd Significant Figure Characteristic
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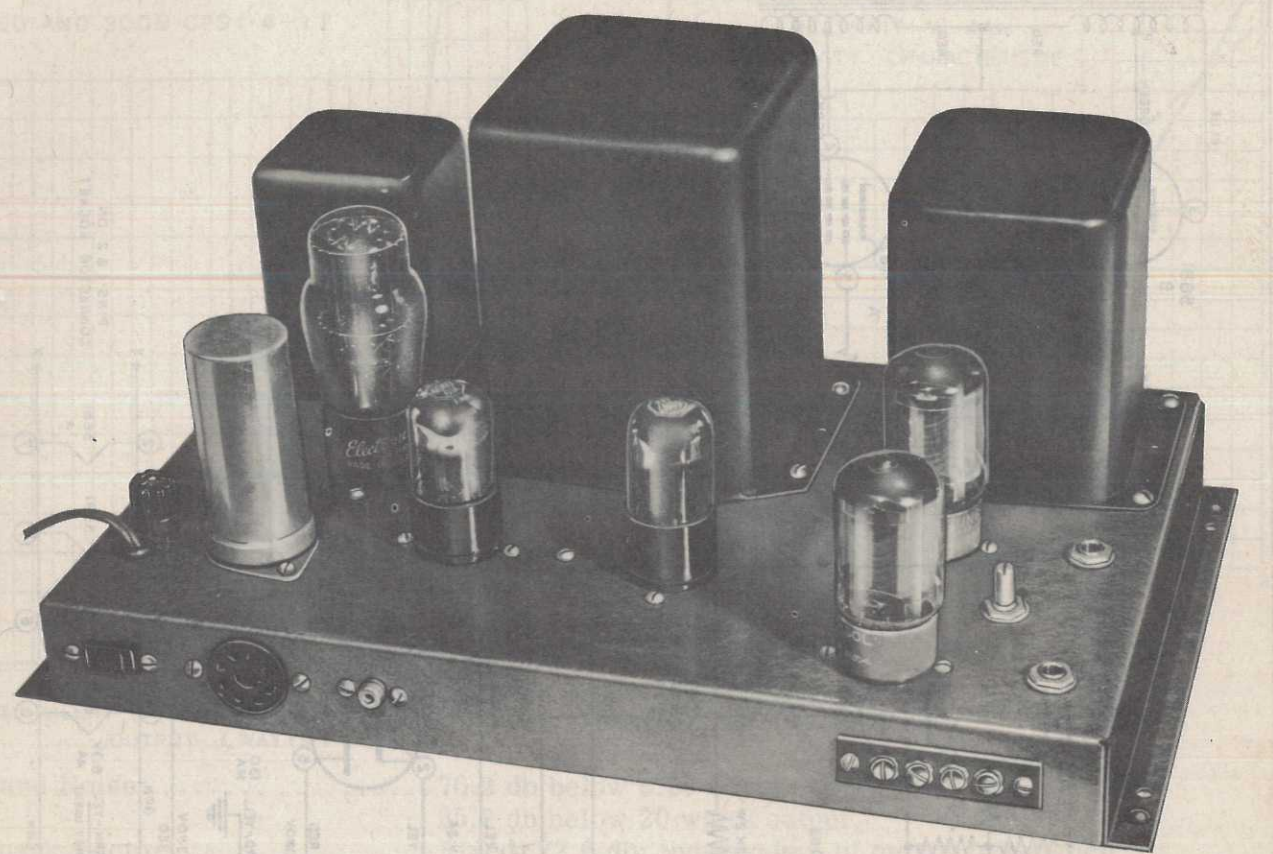
A 2 digit voltage rating indicates more than 900 V. Add 2 zeros to end of 2 digit number.

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 ceramic or mica capacitors is not generally a critical factor and therefore Heathkit manuals avoid reference to temperature coefficient specifications.

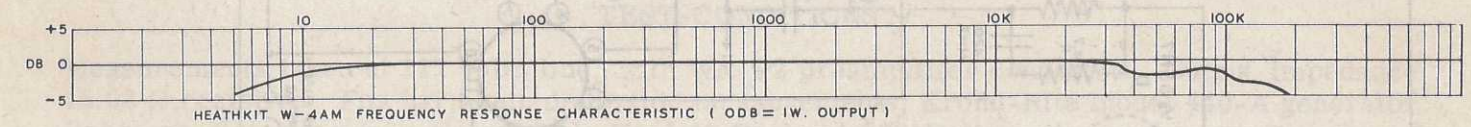
Courtesy of Centralab

HEATHKIT WILLIAMSON-TYPE AMPLIFIER MODEL W4-AM



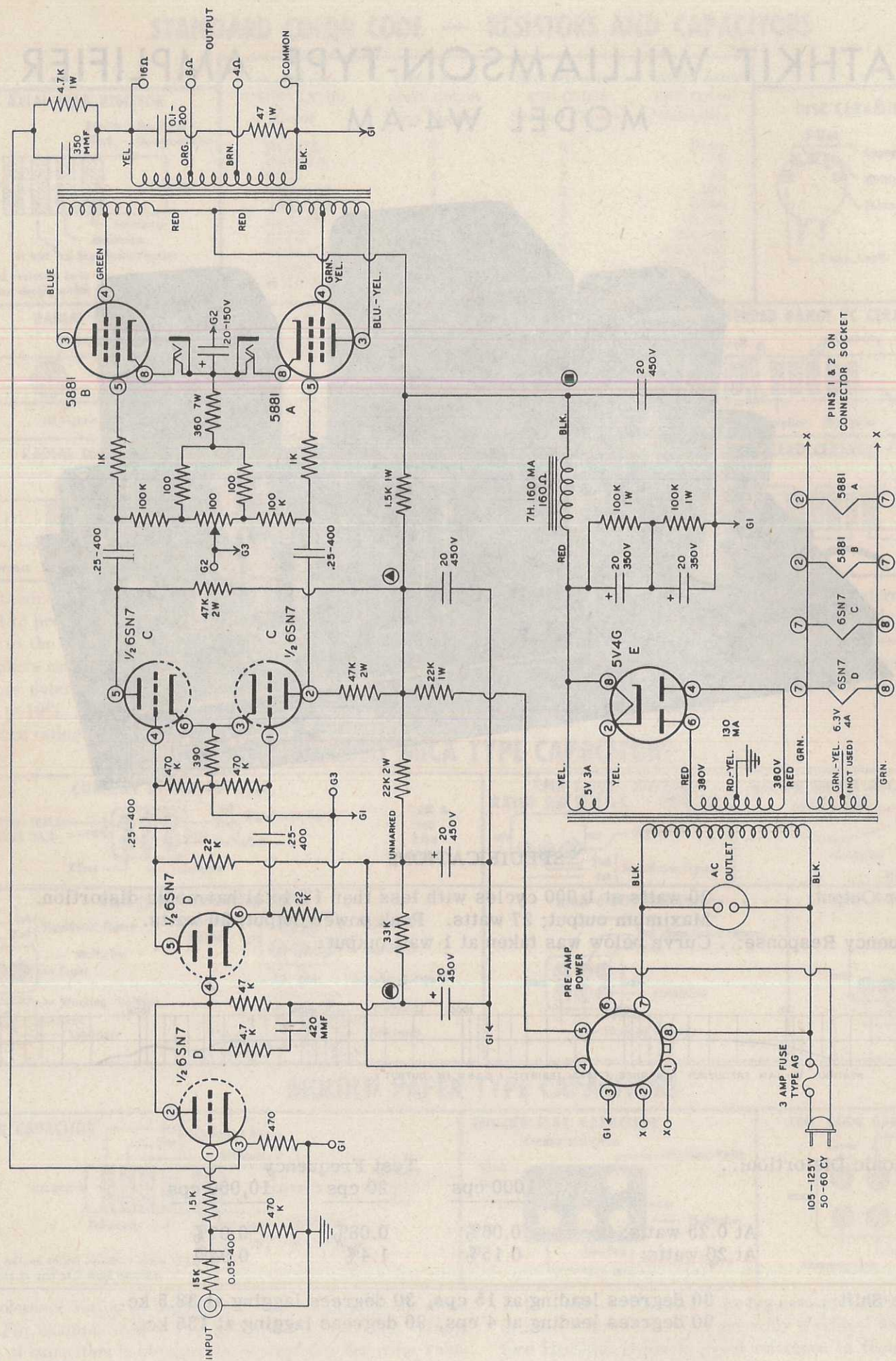
SPECIFICATIONS

Power Output: 20 watts at 1,000 cycles with less than 1% total harmonic distortion.
 Maximum output; 27 watts. Peak power output; 36 watts.
 Frequency Response: . . Curve below was taken at 1 watt output:



Harmonic Distortion: . .	Test Frequency		
	1000 cps	20 cps	10,000 cps
At 0.25 watts:	0.06%	0.08%	0.07%
At 20 watts:	0.15%	1.4%	0.94%

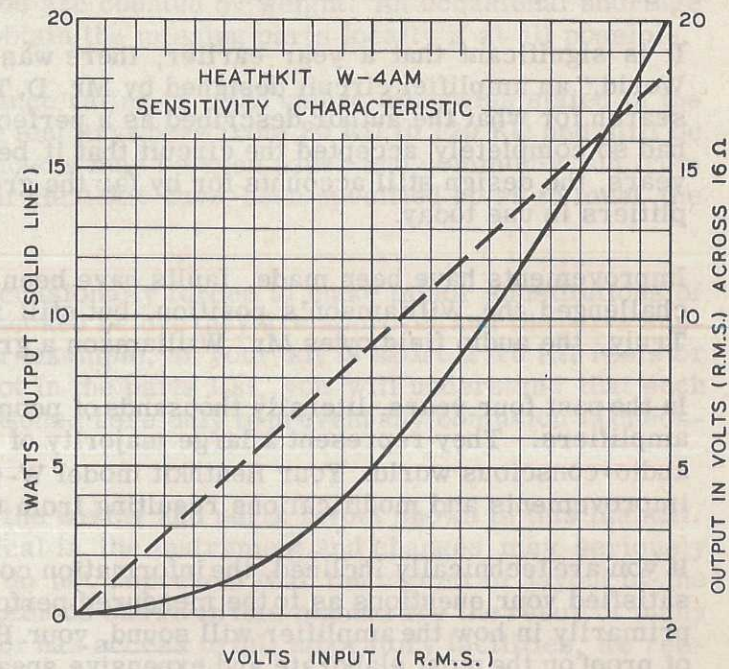
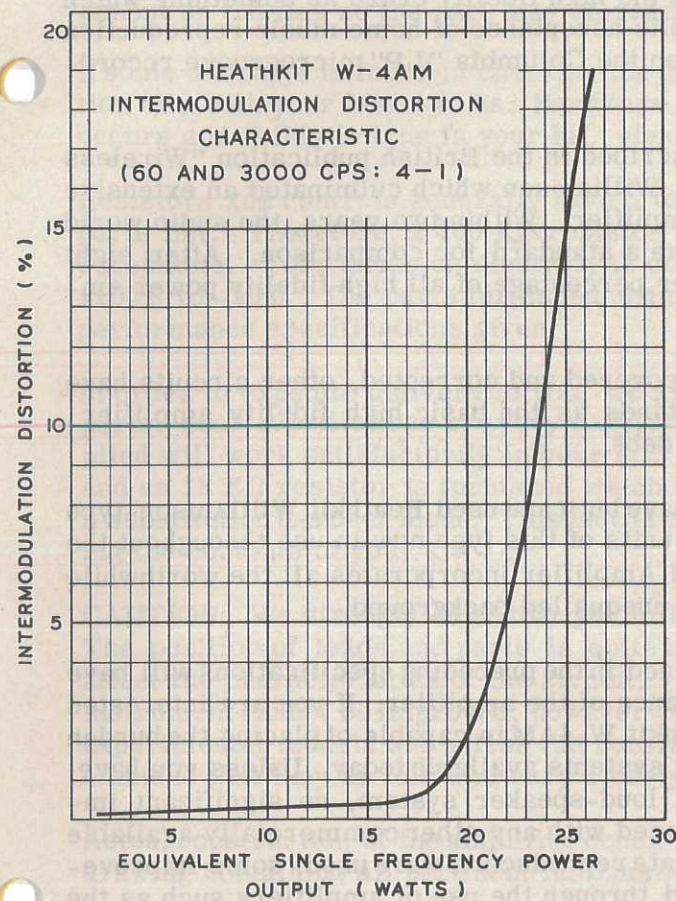
Phase Shift: 30 degrees leading at 15 cps, 30 degrees lagging at 38.5 kc.
 90 degrees leading at 4 cps, 90 degrees lagging at 136 kc.



HEATHKIT WILLIAMSON-TYPE AMPLIFIER
MODEL W4-AM

Intermodulation Distortion: See curve below.

Sensitivity: See curve below.



- Hum and Noise: 76.2 db below 0.25 watts output.
95.2 db below 20 watts output.
- Feedback Factor:..... Fixed; 22.6 db; independent of output impedance.
- Damping Factor:..... Fixed; 28.5 to 1; independent of output impedance.
- Output Impedances:..... 4, 8, and 16 ohms.
- Input Requirements:..... 105-125 volts, 50-60 cycles AC, 115 watts at 117 volts.
- Dimensions:..... Single unit; 15 1/4" x 8 7/8" shelf space, 7" high.
Allow 1 1/2" x 15 1/4" additional shelf space for cables and connections.
- Weight:..... Net: 23 1/4 lbs.
Shipping: 28 lbs.

TEST CONDITIONS

Measurements taken at 117 volts line, with WA-P2 preamplifier connected. Output impedance 16.02 Ω resistive. For harmonic distortion measurements; Krohn-Hite model 440-A generator (inherent distortion less than 0.1%), Hewlett-Packard 330-B distortion analyzer. For intermodulation distortion measurements; Measurements Corporation model 31 intermodulation meter. For frequency response measurement, Hewlett-Packard model 650-A test oscillator. For phase shift measurements, same oscillator with Tektronix 531 oscilloscope with 53-C pre-amplifier. For output power, voltage measurements across 16.02 Ω resistive load, taken with Hewlett-Packard model 400-D vacuum tube voltmeter.

Measurements given are those taken on a representative amplifier under conditions stated. Minor variations from these figures may be encountered in kit-assembled amplifiers because of tube characteristics, component variations and exact lead placement. In a highly stabilized amplifier such as the W-4AM, these variables may be disregarded from a performance point of view.

INTRODUCTION

Most people are inclined to view the meteoric rise of the high fidelity craze as something which has taken place in the last two years. Actually, public acceptance of home music reproduction probably dates from the summer and fall of 1948 when the Columbia "LP" microgroove recording techniques were introduced.

It is significant that a year earlier, there was described in the British publication "Wireless World," an amplifier circuit designed by Mr. D. T. N. Williamson which culminated an extensive search for what the author described as a perfect amplifier. Within two years, the audio world had so completely accepted the circuit that it became a standard for comparison. After eight years, the design still accounts for by far the greater percentage of all high fidelity power amplifiers in use today.

Improvements have been made, faults have been discovered and corrected, other circuits have challenged the Williamson's position, but still it stands as the basic high fidelity amplifier. Truly, the audio field owes Mr. Williamson a great debt.

In the past four years, literally thousands of people have built and used Heathkit Williamson-type amplifiers. They represent a large majority of the units of this type now in use throughout the audio-conscious world. Your Heathkit model W-4AM Amplifier incorporates all the worthwhile improvements and modifications resulting from this unequalled background.

If you are technically inclined, the information contained in the preceding specifications will have satisfied your questions as to the measured performance of the amplifier. If you are interested primarily in how the amplifier will sound, your Heathkit W-4AM is capable of placing the burden of proof on the most elaborate and expensive speaker systems available today. Unless you have, or expect to have, more than \$300.00 to spend for a loud-speaker system, no significant improvement would be audible if the W-4AM were replaced with any other commercially available power amplifier, regardless of price. If more elaborate reproducers were used, some improvement at extremely low frequencies might be expected through the use of amplifiers such as the Heathkit W-5M.

In this discussion, we have attempted to convince you that your investment in the W-4AM kit is worthy of extreme care in construction and installation. Hurried or careless construction can only lead to trouble, either initially or after some period of satisfactory performance. TAKE ENOUGH TIME TO DO THE JOB RIGHT THE FIRST TIME and you will be repaid many times in personal satisfaction and long, trouble-free service.

If you have built Heathkits before, you will note a change in the usual step-by-step procedure for assembling and wiring. The new "all-on-one-drawing" plan used in this manual has been developed to make your work even more enjoyable.

PLEASE READ THE MANUAL ALL THE WAY THROUGH BEFORE ANY WORK IS STARTED. Only a very small percentage of Heathkit assemblers encounter any difficulty whatsoever in completing kits of this kind. Large fold-in pictorial diagrams are included in the manual for your convenience and are quite helpful if attached to the wall above your work space. The diagrams are repeated in small form within the manual proper. We suggest that you retain the manual in your files for future reference in the use of the amplifier and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. DO NOT DISCARD ANY PACKING MATERIAL UNTIL THIS HAS BEEN DONE. In so doing, you will become acquainted with each part and the chance of accidentally throwing away some part will be eliminated. Full size sketches of each of the parts categories appear on Page 16. Use this in checking against the parts list and in identifying any questionable components.

Components with wire pigtail leads can be conveniently sorted by inserting one of the leads into the corrugated edge of the shipping carton flap. It may be helpful to mark the value of the component on the flap so the part may be readily located when needed.

If some shortage is found in checking the parts, please notify us promptly and return the inspection slip with your letter to us. Hardware items are counted by weight. An occasional shortage occurs and if this is true in your kit, please obtain the missing parts locally if at all possible.

Resistors and controls generally have a tolerance rating of $\pm 20\%$ unless otherwise stated in the parts list. Therefore, a 100 K Ω resistor may test anywhere from 80 K Ω to 120 K Ω and still be acceptable. Tolerances on electrolytic condensers may be even wider and commonly run from +100% to -50%. The parts furnished with your Heathkit have been specified so as to meet the performance specifications given.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are very carefully checked before they are approved and the parts supplied will work satisfactorily in your kit. For example, if your kit is short a 15 K Ω resistor and an 18 K Ω resistor is furnished which is not in the parts list, you will understand that such a substitution has been made. This fact is mentioned here only to prevent any confusion in checking the contents of your kit.

CAUTION: We strongly urge that you follow the wiring and parts layout shown in this manual. The position of leads and parts is quite critical in the instrument and changes may seriously affect the characteristics of the circuit. We do not represent that the circuit or layout of the instrument cannot be improved; however the methods shown in this manual are the result of many experimental models and unless the constructor has access to full laboratory facilities, we recommend that they be followed very closely.

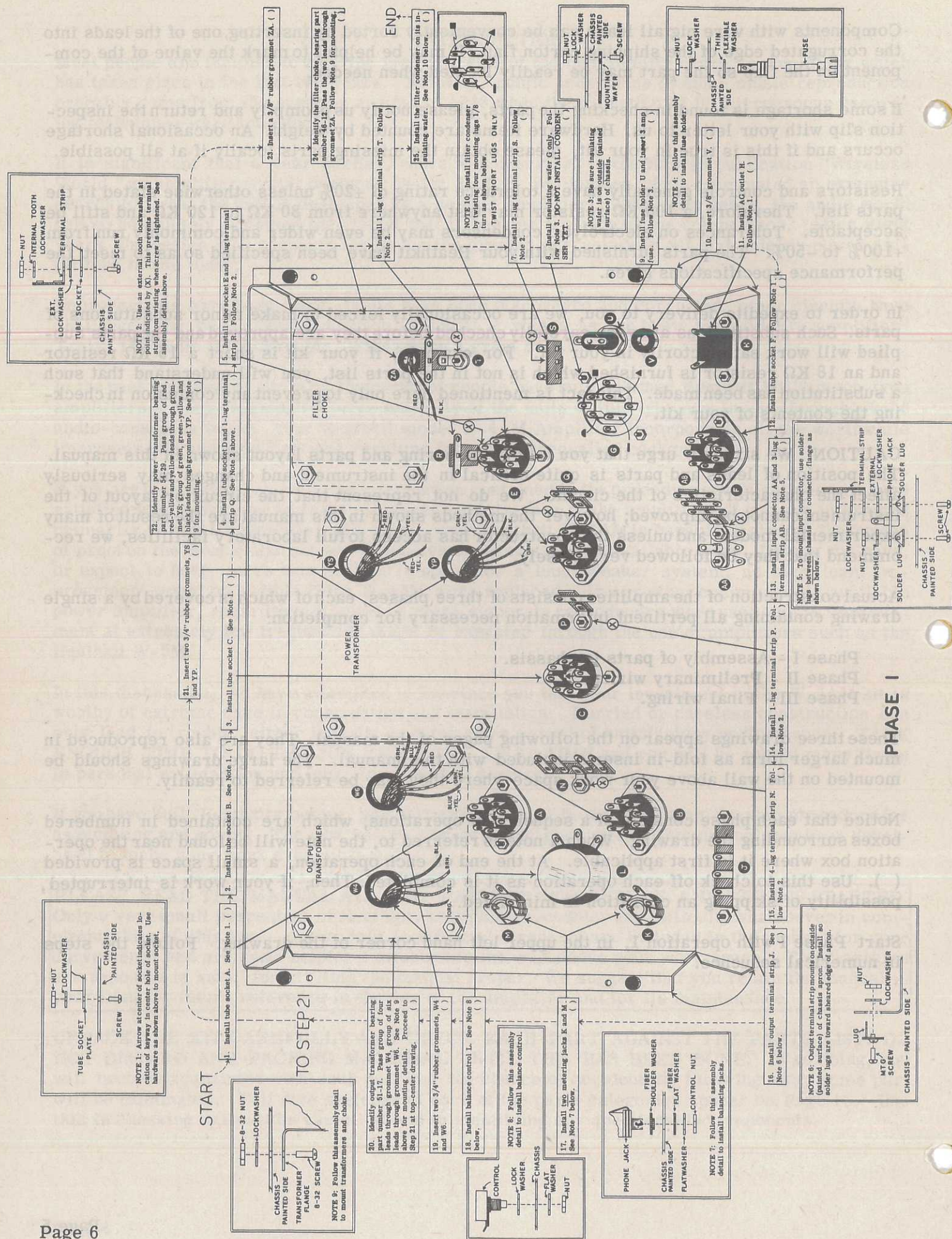
Actual construction of the amplifier consists of three phases, each of which is covered by a single drawing containing all pertinent information necessary for completion:

- Phase I - Assembly of parts to chassis.
- Phase II - Preliminary wiring.
- Phase III - Final wiring.

These three drawings appear on the following pages of the manual. They are also reproduced in much larger form as fold-in inserts included with this manual. The large drawings should be mounted on the wall above your work space where they may be referred to readily.

Notice that each phase consists of a sequence of operations, which are contained in numbered boxes surrounding the drawing. When a note is referred to, the note will be found near the operation box where it is first applicable. At the end of each operation, a small space is provided (). Use this to check off each operation as it is completed. Then, if your work is interrupted, possibility of skipping an operation is minimized.

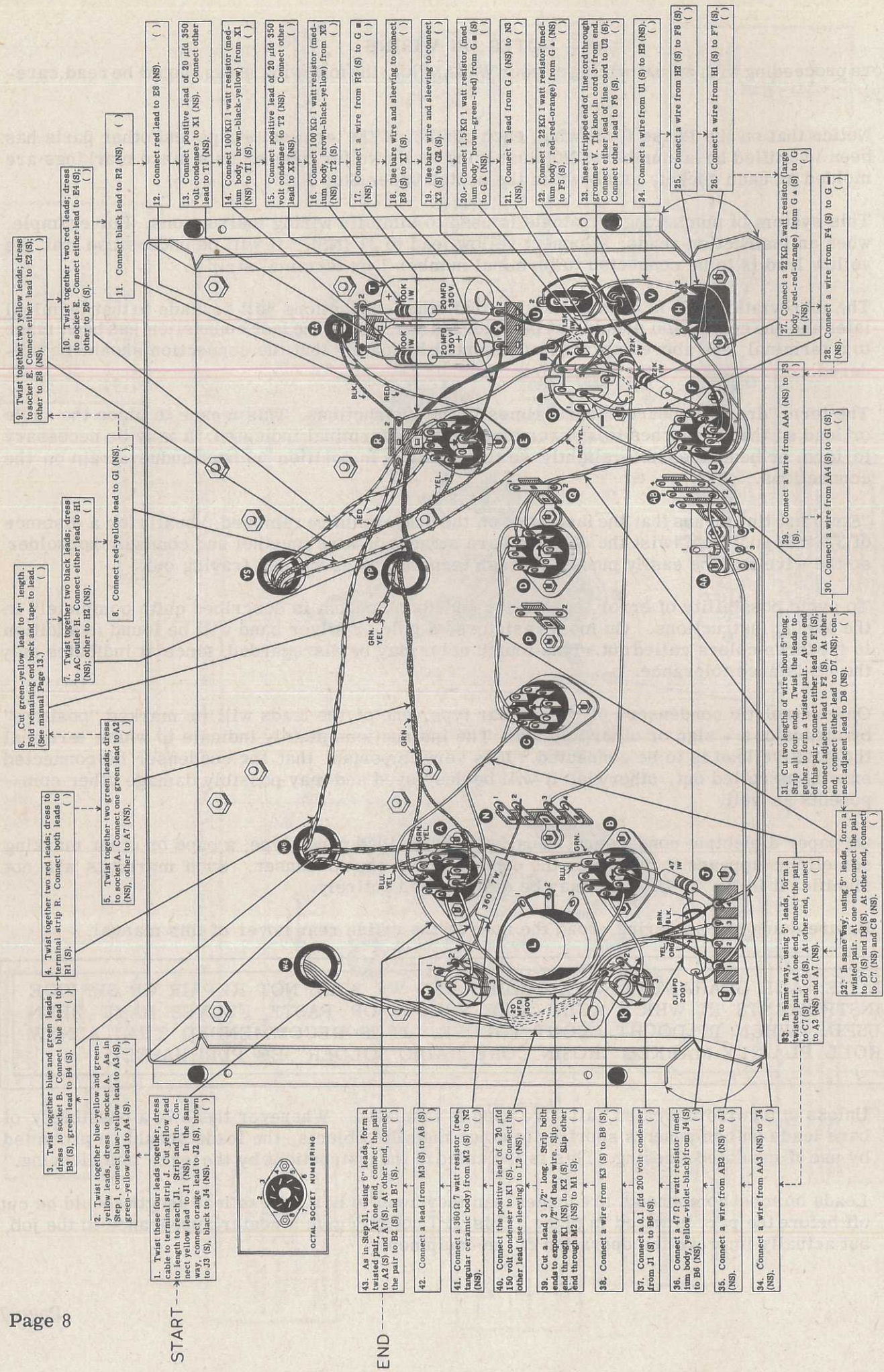
Start Phase I with operation 1, in the upper left hand corner of the drawing. Follow the steps in numerical sequence.



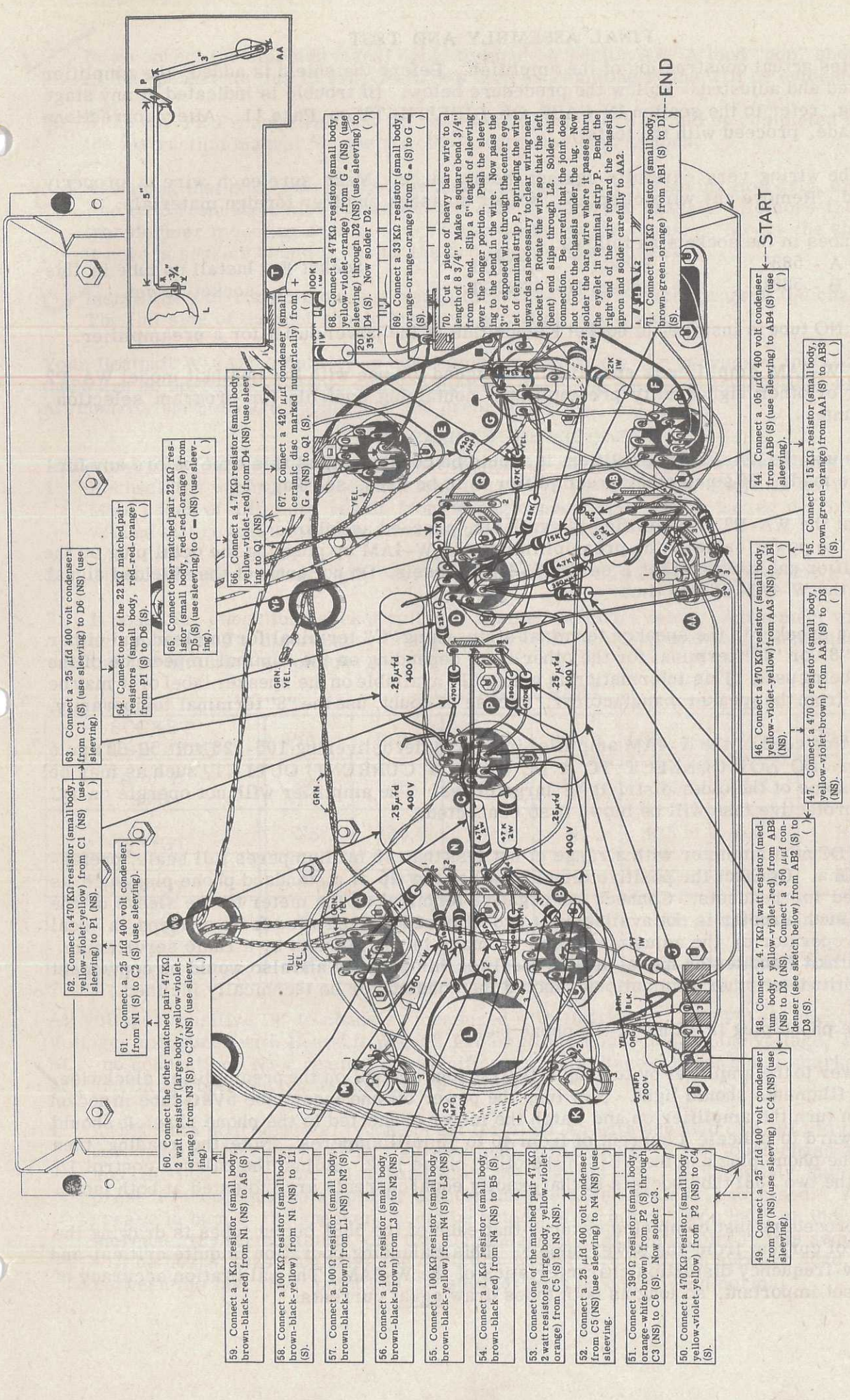
NOTES ON WIRING

Before proceeding with actual wiring of your W-4AM kit, the following notes should be read carefully.

1. Notice that on the Phase II drawing, each contact of the terminal strips and other parts has been identified by a number. No numbering is shown for tube sockets since markings are molded on each socket, as shown in the sketch under Step 1.
 2. This system of numbering terminals is used to simplify wiring instructions. For example, when an instruction reads, "Connect yellow lead to J1 (NS)," it will be understood that the yellow lead is to be connected to terminal number 1 on terminal strip J.
 3. The abbreviation (NS) is used to indicate that other connections will be made to that terminal later and the connection should not be soldered yet. When the last connection has been made to a terminal, the abbreviation (S) is inserted indicating that the connection should be soldered.
 4. The term "dress" appears several times in the instructions. This means to place the cable or lead so that it reaches to and remains near the terminal indicated. It may be necessary to form or bend the cable slightly so that it stays in position without undue strain on the connections.
 5. "Strip and tin" means that the insulation on the lead should be removed, usually for a distance of 3/8" or so. Then twist the exposed bare strands of wire together and coat with hot solder so the wire may be easily pushed through terminal holes without fraying out.
 6. To avoid possibility of error, each color coded component is described quite completely in the wiring instructions. On most resistors, a gold or silver band will be found in addition to the three colors called out. This fourth color may be disregarded, since it indicates only the resistance tolerance.
 7. On electrolytic condensers of the tubular type, one of the leads will be marked "positive" by means of a + sign or other method. The instructions plainly indicate to which terminal the positive lead is to be connected. It is very important that the condenser be connected exactly as called out, otherwise it will be destroyed and may possibly damage other components as well.
 8. On paper dielectric condensers, usually of the molded paper type, a band or other marking sometimes appears to designate the outside foil of the condenser. Such markings are not significant in the W-4AM and may be disregarded entirely.
 9. Before doing any soldering, read the note on the inside rear cover of this manual.
- 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.
10. Unless otherwise indicated, all wire used is insulated. Wherever there is a possibility of bare leads on components shorting to other metallic objects, the leads should be protected by use of insulated sleeving. This is indicated in the instructions by the term "use sleeving."
 11. Leads on most components are longer than they need to be. Excess lead length should be cut off before the part is wired in place. This will not only give a neater appearance to the job, but actually improve the operation of the equipment.



PHASE 2



PHASE 3

FINAL ASSEMBLY AND TEST

This completes actual construction of the amplifier. Before the shield is added, the amplifier must be tested and adjusted. Follow the procedure below. (If trouble is indicated at any stage of the testing, refer to the section IN CASE OF DIFFICULTY on Page 11. After corrections have been made, proceed with the tests.)

- ✓ Check the wiring very carefully against the drawings. Make sure each wire is properly soldered. Remove any wire clippings, solder splashes or other foreign materials.
- ✓ Install tubes in the sockets as follows:

Socket A - 5881	Socket C - 6SN7GT	Socket E - Install no tube in this
Socket B - 5881	Socket D - 6SN7GT	socket as yet.

Be sure NO tube is installed in socket F since this is the power outlet for a preamplifier.

The Heathkit W-4AM Amplifier is specifically designed for use with the Heathkit model WA-P2 Preamplifier or other high-quality preamplifiers containing controls for program selection, tone and volume.

If you plan to use the WA-P2 preamplifier, it should be constructed at this time before any further tests are made. If some other preamplifier is to be used, see Page 14.

Assuming that the WA-P2 preamplifier is available, proceed as follows:

- ✓ Connect the power cable of the preamplifier to the W-4AM by plugging the octal plug on the preamplifier cable into socket F on the W-4AM chassis. Do not connect the shielded signal cable to the W-4AM at this time.
- ✓ Connect a speaker to the speaker terminal strip, using "C" terminal for one lead and either the "4," "8" or "16" terminal for the other lead, depending on the nominal impedance of the speaker being used. This information is generally available on the speaker label or it may be obtained from the speaker manufacturer. In case of doubt, use the "8" terminal temporarily.
- ✓ Plug the line cord of the W-4AM amplifier into an outlet delivering 105-125 volt 50-60 cycle AC power. DO NOT CONNECT TO A DC (DIRECT CURRENT) OUTLET, such as may be found in some of the older districts of large cities. The amplifier will not operate on DC and the protective fuse will be blown if so connected.
- ✓ Obtain a DC milliammeter with a range of not less than 75 milliamperes full scale, preferably 100 ma. Connect the positive terminal (+) to the tip of a standard phone plug such as those used for headsets. Connect the negative terminal of the meter to the sleeve of the plug. If such a meter is not available, it probably can be borrowed from a friend, a local amateur operator or the adjustments can be made in ten minutes by a radio serviceman. (The Heathkit Handitester model M-1 is ideal for this purpose and also would be convenient for a multitude of other applications, should the constructor be technically inclined.)

✓ Insert the phone plug in either of the phone jacks.

47 ma
47 ma
✓ Apply power to the amplifier by turning TREBLE tone control on the preamplifier clockwise. The tube filaments should light. Now turn the power off and insert the 5V4G tube in socket E. Again turn the amplifier on and watch the meter connected to the phone plug. It should swing upward to indicate a current of from 40 to 75 milliamperes. Note the reading, then remove the phone plug and insert it in the other phone jack. Adjust the balance control L, between the two 5881 tube sockets so that exactly equal currents are indicated at both jacks.

NOTE: The procedure just completed assures that each of the 5881 output tubes is drawing the same amount of current from the power supply. This balancing operation is quite critical and affects the low-frequency distortion characteristics of the W-4AM. The calibration accuracy of the meter is not important, so long as both tubes draw equal currents.

- ✓ Now connect the shielded signal cable to input connector AA. A loud "pop" should be heard in the speaker as this is done and a low hum or rumbling sound will be evident.
- ✓ If the WA-P2 Preamplifier has not been tested, this work should be completed now. Follow the instruction manual for the WA-P2 for detailed instructions.
- ✓ Assuming that both power amplifier and preamplifier are behaving properly, disconnect the line cord from the outlet and attach the shield below the chassis. Remove the two power transformer mounting screws nearest the center of the chassis. Mount the shield so that it covers sockets C and D, using the two transformer screws.
- ✓ Install the four rubber mounting feet in the larger holes in each corner of the chassis flanges. The flat side of the foot should support the weight of the chassis.

Your Heathkit W-4AM Amplifier is now complete and ready for permanent installation. Since there are no operating controls on the amplifier itself, no operation instructions are required. All control functions are supplied by the preamplifier.

IN CASE OF DIFFICULTY

If the test procedure above indicates that things are not normal, follow the plan given below:

1. Recheck the wiring. Trace each lead in colored pencil on the drawings as it is checked. Most cases of difficulty result from wrong connections. Often having a friend check the wiring will reveal a mistake consistently overlooked.
2. Check the tubes. Most radio service shops will do this at no charge or for a nominal fee.
3. If possible, check tube socket voltages against the chart below. Agreement within 20% can be expected. If a discrepancy is apparent, check the wiring and components associated with the circuit under suspicion.

VOLTAGE CHART

SOCKET TUBE TYPE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
A or B 5881	NC	H	370 v	375 v	NS	NS	H	38 v
C 6SN7GT	NS	135 v	4.0 v	NS	135 v	4.0 v	H	H
D 6SN7GT	NS	54 v	1.2 v	54 v	200	60 v	H	H
E 5V4G	NC	440 v*	NC	380 vac	NC	380 vac	NC	440 v*
F Preamplifier Power	H	H	0	250 v	275 v	See Table, Page 13		

All voltages positive DC to chassis, measured with Heathkit V-7 VTVM (11 megohm input). Voltages measured with Heathkit WA-P2 Preamplifier connected. Line voltage, 117 volt AC. NC - no connection. NS - reading not significant. H - voltage between points marked, 6.3 volts AC. * Voltage between points marked, 5.0 volts AC.

4. If difficulty still persists, touch socket terminal A5 with one lead of a .01 μ f paper condenser, holding the condenser by its other lead. (CAUTION: Do not touch chassis or any other metallic body with your other hand while making this test. Dangerously high voltages are present throughout the amplifier circuit and due care should be exercised.) A decided increase in hum at the speaker should be noted. If terminal A5 is "hot" as indicated by hum increase, try terminals B5, C2, C5, D5, D2 and D1. At some point in this sequence, no hum will be heard; thus localizing the difficulty to that circuit which appears dead. All circuits between the last "hot" point and the speaker may be considered normal.

UNUSUAL TROUBLES AND CORRECTIVE PROCEDURES

Certain difficulties often appear to originate in the power amplifier but actually have their source in associated equipment. Some of these are outlined below.

1. High hum level at the loudspeaker may be caused by several external effects. Assuming that the W-4AM is used with a WA-P2 preamplifier, a very decided reduction in hum will be noticed upon proper setting of the "HUM" control on the preamplifier. This will take place at nearly the center of rotation. To check hum level, adjust the volume control for slightly higher than normal room volume. Then lift the pickup arm from the record or turn off power to the tuner being used for a program source. The hum level at the loudspeaker should just barely be audible at a distance of three feet or so from the speaker. A louder hum indicates abnormal conditions which can generally be corrected. Try the following:
 - (a) Reverse the line cord in its outlet for minimum hum.
 - (b) Try disconnecting the shield of the signal cable at the power-amplifier end where it connects to the shell of the phono plug. This will prevent a "ground loop" through the shield of the cable which might actually induce hum rather than eliminate it.
 - (c) Try eliminating possible "ground loops" between various program sources (phono pickups, tuners, recorders, etc.) and the preamplifier by opening the shield grounds at one end or the other.
 - (d) Try disconnecting each program source from the preamplifier and determine if the hum level is affected in any way. Even idle tuners or phono pickups will occasionally develop into hum sources because of leakage in power circuits.
 - (e) As a last resort, try connecting the frame or chassis of each component to a good ground such as a cold water pipe or driven ground.
2. "Motor boating" is a term used to describe a low-frequency (2 to 5 cps) oscillation of an amplifier system. It is generally caused by inadequate amplifier loading at low frequencies. For example, a speaker with a nominal impedance of $16\ \Omega$ may actually look like 150 to 200 Ω at frequencies near speaker system resonance. Sufficient low frequency stability is included in the W-4AM to prevent this difficulty in the vast majority of cases. However, all-inclusive safety margins are quite expensive. In general, the better speaker systems are less likely to cause trouble in this way.

Under no conditions should shielded speaker leads be used and every attempt should be made to keep the capacity across speaker lines to a minimum. Other less frequent causes of motor boating are:

- (a) Unbalanced output tubes. Recheck balance settings.
- (b) Defective filter condenser sections, either in the power amplifier or preamplifier.
- (c) Feedback factor too high. Feedback is controlled by the $4.7\ \text{K}\Omega$ 1 watt resistor from AB2 to D3. In rare cases, it may be necessary to increase the value of this resistor to eliminate motorboating. A change to $6.8\ \text{K}\Omega$ will generally correct a persistent case, with very slight degradation to performance in other respects.
- (d) Low frequency oscillation may sometimes be triggered or touched off because of oscillation of the amplifier at a supersonic frequency around 100 kc. This type of difficulty will cause the amplifier to sound strained or muddy. It may be readily identified by connecting an oscilloscope across the speaker terminals. If oscillation is present, it will be evidenced by a steady high frequency output voltage with a highly distorted wave form. This output voltage will exist even in the absence of input signals. The condition may be caused by an improper or defective condenser across the feedback resistor or by improper components in the phase correction network, the $4.7\ \text{K}\Omega$ resistor and $420\ \mu\text{f}$ condensers connected to D4 and G.

3. Output tubes will not balance. First, try interchanging the tubes in sockets A and B. If the unbalanced effect is also interchanged, one of the tubes is probably defective. If not, carefully check the wiring associated with the cathode circuits of the output tubes. Be sure neither of the jacks is shorting to the chassis; they should be completely free of metallic contact to chassis except through the $360\ \Omega$ bias resistor and the balancing network. Check voltages carefully against the voltage chart if unbalance still persists. Do not attempt to balance tubes while program material is being reproduced.

INSTALLATION

When the amplifier is completely tested, it should be permanently installed in the system. Since no operating controls are associated with the W-4AM, it may be installed wherever convenient with the following precautions:

- (a) Allow sufficient ventilation to prevent overheating. Bear in mind that while in operation, the unit will develop about as much heat as a 150 watt lamp bulb.
- (b) Provide access room for connecting cables, occasional balancing of the output tubes and tube replacement.
- (c) Protect the amplifier from dampness or physical damage. Since the tubes run very hot, the unit should be installed where it cannot be tampered with by small children.

An AC outlet is provided on control apron of the amplifier. It may be used to supply power to a tuner, phonograph record changer or other accessory. If used for a record changer, be sure the unit is allowed to pass completely through its change cycle so it shuts itself off. Otherwise, idlers in the changer may be left in contact with other parts causing flats to develop and ruining the idlers.

A complete discussion of how to install the high fidelity system is too lengthy to carry in this manual. We suggest a review of current issues of "High Fidelity" and "Music at Home." These magazines carry specific sections on installation. This type of information also appears frequently in other periodicals on home building and decorating.

USING THE W-4AM AMPLIFIER WITH OTHER PREAMPLIFIERS

As previously stated, the W-4AM is designed specifically for use with the Heathkit model WA-P2 Preamplifier. It may, however, be used with other preamplifiers or AM-FM tuners which incorporate the necessary control functions.

Sufficient power is available from the W-4AM to operate both filament and plate circuits of the usual preamplifier where independent power supplies are not included in the preamplifier itself. The following circuits are available at socket F:

6.3 volts AC at 1 ampere	Socket contacts F1 and F2.
Ground and B -	Socket contact F3.
250 volts DC at 10 ma	Socket contact F4.
275 volts DC at 10 ma	Socket contact F5.
117 volts AC, switched and fused	Socket contacts F7 and F8.
117 volts AC, not switched and fused	Socket contacts F6 and F8.
Line switch, to control amplifier	Socket contacts F6 and F7.

It is suggested that an adapter cable be made up to supply power and/or switching circuits to preamplifiers other than the WA-P2. This cable should terminate in a standard octal plug, with cap, similar to Amphenol's type 86-PM8, and may be wired in accordance with the above information. The cable may then be connected to the W-4AM using socket F.

DO NOT, UNDER ANY CIRCUMSTANCE, EXCEED THE POWER RATINGS GIVEN ABOVE FOR ADDITIONAL FILAMENT AND PLATE SUPPLY. To do so may seriously damage power supply components in your W-4AM amplifier. If the preamplifier used has no provision for hum balancing through an adjustable resistor across the filament line, it will be necessary to ground the center tap of the filament winding of the W-4AM power transformer. This can be done by connecting to chassis the green-yellow lead passed through grommet YP. This may be done by soldering the lead to terminal strip P1.

PART No. PARTS Per Kit DESCRIPTION

Resistors

1-3	2	100 Ω 1/2 watt
1-48	1	390 Ω 1/2 watt
1-6	1	470 Ω 1/2 watt
1-9	2	1 KΩ 1/2 watt
1-16	1	4.7 KΩ 1/2 watt
1-21	2	15 KΩ 1/2 watt
1-22	2	22 KΩ 1/2 watt (matched)
1-24	1	33 KΩ 1/2 watt
1-25	1	47 KΩ 1/2 watt
1-26	2	100 KΩ 1/2 watt
1-33	3	470 KΩ 1/2 watt
1-15A	1	47 Ω 1 watt
1-22A	1	1.5 KΩ 1 watt
1-48A	1	4.7 KΩ 1 watt
1-5A	1	22 KΩ 1 watt
1-28A	2	100 KΩ 1 watt
1-11B	1	22 KΩ 2 watt
1-10B	2	47 KΩ 2 watt (matched)
3-7G	1	360 Ω 7 watt wirewound
11-1	1	100 Ω control

Condensers

20-34	1	350 μμf mica
21-23	1	420 μμf ceramic
23-61	1	.05 μfd 400 volt paper
23-28	1	.1 μfd 200 volt paper
23-63	4	.25 μfd 400 volt paper
25-19	1	20 μfd 150 volt electrolytic
25-16	2	20 μfd 350 volt electrolytic
25-21	1	20-20-20-20 μfd 450 volt elec.

Tubes

411-15	2	6SN7GT
411-35	1	5V4G
411-45	2	5881

Sockets-Jacks-Plugs-Fuse

434-42	1	Phono input socket
434-20	1	AC power socket
434-58	6	Octal tube socket
436-4	2	Phone jack
438-4	1	Phono plug
421-2	1	Fuse
423-1	1	Fuse holder w/hardware

PART No. PARTS Per Kit DESCRIPTION

Terminal Strips-Wafer

431-1	4	1-lug terminal strip
431-2	1	2-lug terminal strip
431-4	1	3-lug terminal strip
431-5	1	4-lug terminal strip
431-13	1	4-screw terminal strip
481-3	1	Condenser mounting wafer

Sheet Metal Parts

200-M86F101A	1	Chassis
206-M22	1	Shield

Wire

89-1	1	Line cord
340-3	1	length Solid wire
344-1	1	length Hookup wire
346-1	1	length Sleeving

Transformers-Chokes

51-17	1	Output transformer
54-29	1	Power transformer
46-12	1	Filter choke

Hardware

73-1	2	3/8" grommet
73-2	4	3/4" grommet
250-9	24	6-32 x 3/8" screw
250-17	12	8-32 x 1/4" screw
252-3	24	6-32 hex nut
252-4	12	8-32 hex nut
252-7	3	3/8-32 hex nut
253-10	3	Flat nickel washer
253-15	2	Flat fiber washer
253-16	2	Shoulder fiber washer
254-1	24	#6 lockwasher, internal
254-6	7	#6 lockwasher, external
254-2	12	#8 lockwasher
254-4	1	3/8" lockwasher
259-1	2	#6 solder lug
261-1	4	Rubber feet

595-107 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 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.

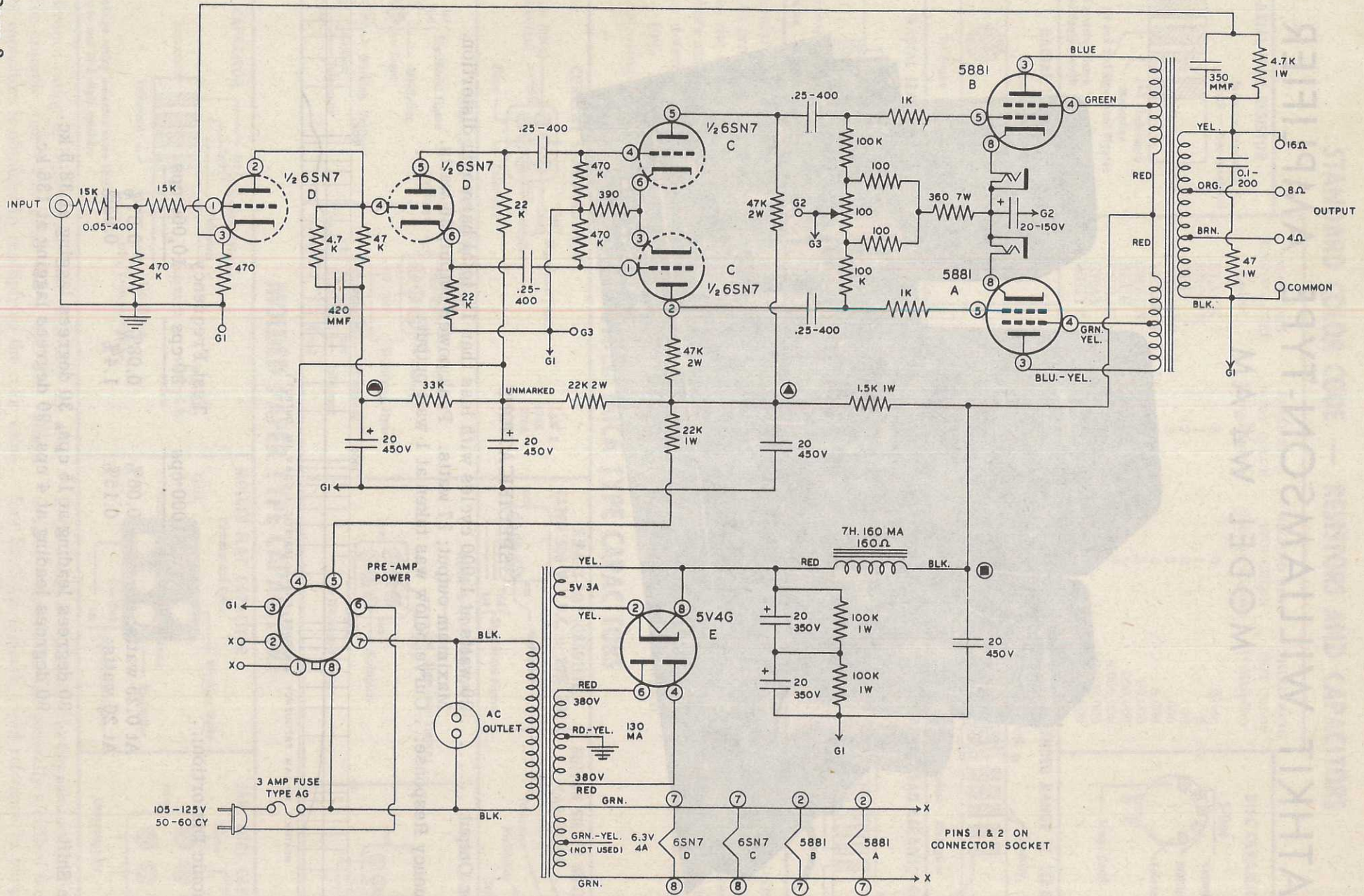
In mounting parts such as resistors or condensers, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby wiring.

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.

Antenna General		Resistor General		Neon Bulb		Receptacle two-conductor	
Loop		Resistor Tapped		Illuminating Lamp		Battery	
Ground		Resistor Variable		Switch Single pole Single throw		Fuse	
Inductor General		Potentiometer		Switch double pole single throw		Piezoelectric Crystal	
Air core Transformer General		Thermistor		Switch Triple pole Double throw		1000 = K	
Adjustable Powdered Iron Core		Jack two conductor		Switch Multipoint or Rotary		1,000,000 = M	
Magnetic Core Variable Coupling		Jack three conductor		Speaker		OHM = Ω	
Iron Core Transformer		Wires connected		Rectifier		Microfarad = MF	
Capacitor General		Wires Crossing but not connected		Microphone		Micro Microfarad = MMF	
Capacitor Electrolytic		A. Ammeter		Typical tube symbol Plate screen Grid cathode filament		Binding post	
Capacitor Variable		V. Voltmeter				Terminal strip	
		G. Galvanometer				Wiring between like letters is understood	
		MA. Milliammeter					
		uA. Microammeter, etc.					



HEATHKIT WILLIAMSON-TYPE AMPLIFIER
MODEL W4-AM