

(1) The completed Williamson amplifier in a setting. It blends well with room furnishings, and does not require any attention after the original setting up. All controlling of ac power and volume, etc., is performed by the preamplifier.

FOR AUDIOPHILES AND AMATEURS

THE NEW WILLIAMSON AMPLIFIER

The audiophile who decides to build his own equipment either for economy's sake or a desire to "build everything myself," will find this an enjoyable project. The kit is complete, and the parts are relatively few. Being by nature a lazy individual, I dislike soldering dozens of resistors and capacitors into switching and correcting circuits. Of course, the amplifier must have a fair number of these "pesky little fellers," but, probably because there is plenty of room and there are no switches to wire, I didn't find them bothersome.

Construction is simple. I merely mounted the "iron"—radioman's slang name for transformers and chokes—and the other components and then wired up the chassis.

This was my first experience with the "Phase" method of construction used by Heath, and I found it a little strange at first. However, once I got used to it, I seemed to get along faster, and the method of showing all comments and instructions

on the large pictorials was certainly most helpful. To give you an idea of how these drawings look one is reproduced here. Of course the small size of the page crowds it a little, but the general idea is apparent.

Since I intended to use this amplifier with the Heath preamplifier that I described elsewhere in this book, I did not have any problems in connection with power supplies. I merely proceeded with construction according to the instructions in the book.

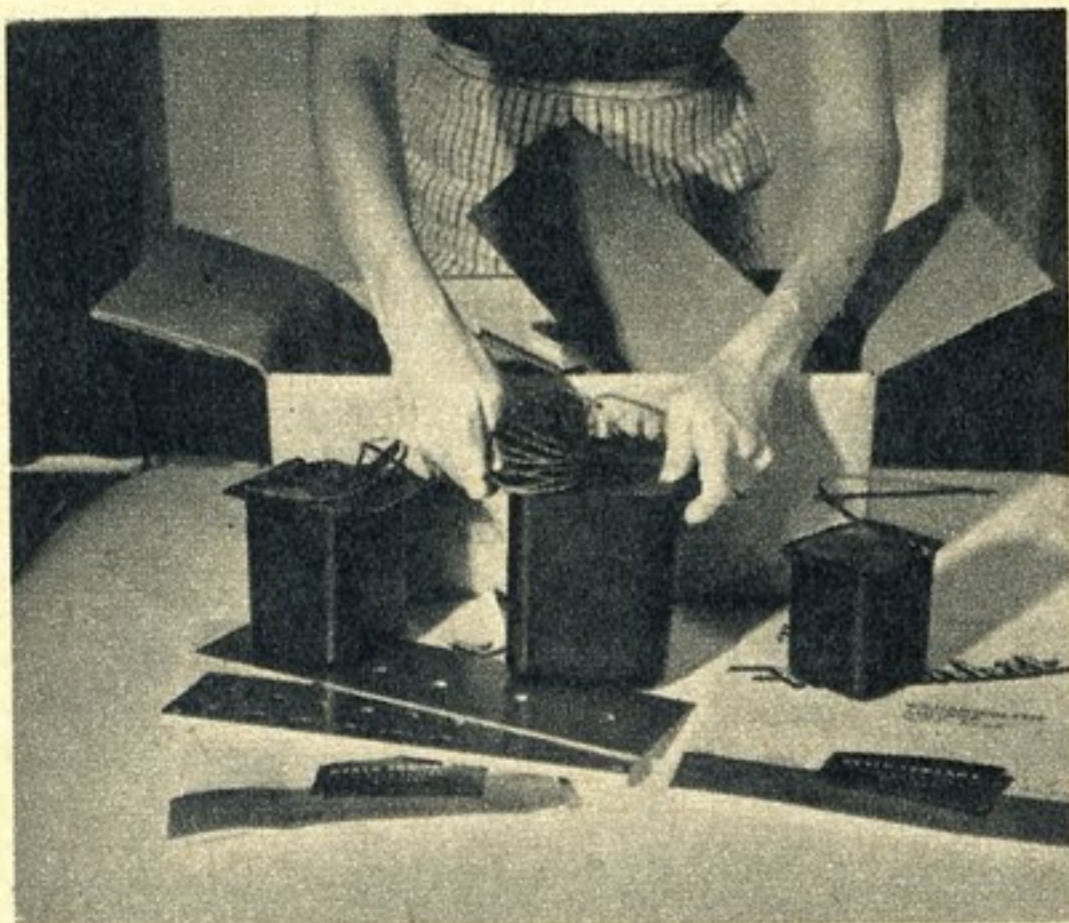
If this is your first experience with hi-fi, you will probably be quite amazed at the size of the transformers used in this amplifier. They are quite large, and as a result, the amplifier is definitely not a featherweight! On the other hand, this requires a very solid chassis and we benefit by the rigidity it provides.

Another good feature provided by these heavily shielded transformers is the smooth finish of the "cans." At first glance, this

may not seem to be too important. However, if you have to contend with "Mrs. Hi-fi," you may find that she had a few things to say about just where you put "that lump of tubes and stuff." Of course, if you are lucky, you will be able to build it into your furniture—that means not only if you are lucky, but also if you are handy with a saw and plane. If you like building your equipment into the walls of your home, you should get a book on building built-in radio and television equipment.¹

The first place I installed the amplifier was in a cabinet in my recreation room. As shown in the photograph, it was placed well back on the middle shelf of the glass cabinet. The construction of the amplifier lends itself perfectly to this type of mounting in the open. There are no live terminals on the top, nor are there any sharp corners on transformers or chokes which could cause trouble with the weaker sex if they should catch their knuckles. As a matter of fact, the amplifier is quite

¹A very good book on this subject is **BUILT-INS**, published by Dell Publishing Co., Inc. 1956, price 75c.



(2) Unpacking the components of the Heathkit Williamson Amplifier. The massive transformers are easily seen; below them on the left are the front and rear panels of the Heathkit preamplifier which is a part of the complete system. These transformers are hermetically sealed to prevent the ingress of moisture. The metal shell also prevents external magnetic fields from being picked up by the transformers or being radiated by them.

"pretty" to look at, and because it has no controls at all on it, unattended operation is quite in order.

However, we finally moved the amplifier to a more secluded place—but equally well ventilated. We placed it on top of a closet where no one can see it, and where it gets a good coating of dust (which doesn't seem to hurt it). Although it is probably not good practice, we extended the audio cable and the power cable to almost 20 feet without any appreciable degradation. In the article on the pre-amplifier it is shown placed on an end table in the living room, where it is now used. The speaker is in a door, and does a fine job.

The response of the amplifier is quite amazing. I have not taken a frequency run (measurement of frequency in, and voltage in, compared with voltage out of the amplifier). The makers curve for a representative unit show it to be about 1 db down at 10 cps, and about .5 db down at 30,000 cps. All other intermediate frequencies were "flat," which means they were all the same value and only the treble and bass at very high and very low frequencies varied by merely about 1 db.

The maximum output is 27 watts, which is ample for any hi-fi purpose, as well as for small public address work, or similar sound reinforcement; such as could be used in churches. With 20 watts output the total harmonic distortion is less than 1%.

POWER SUPPLY

At the auxiliary power socket mounted on the rear apron of the chassis, the following voltages are available for operating a preamplifier, and any small electronic device requiring only 10 to 20 milliamperes dc. By connecting the pins in the tube socket in specified ways, seven circuits are available:

- Pins #1 and #2; 6.3 volts ac at 1 amp
- Pin #3 Ground and B—
- Pin #4 250 volts dc at 10 ma
- Pin #5 275 volts dc at 10 ma
- Pins #6 and #8 117 volts ac unfused and direct.
- Pins #7 and #8 117 volts ac switched and fused
- Pins #6 and #7 Line switch to control panel

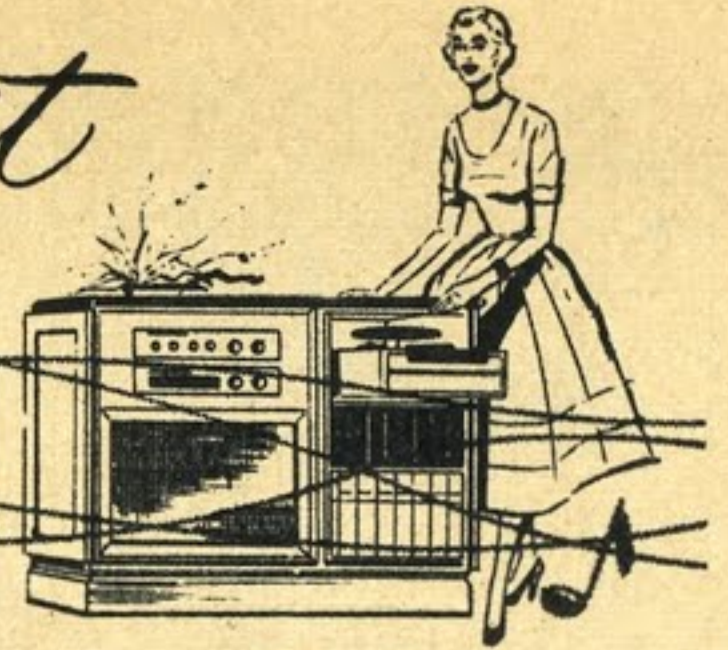
No matter what voltages your preamplifier or control unit takes, you'll be able to take it from the main power supply.

Continued on page 116

"BUILD-IT-YOURSELF" AND ENJOY

high fidelity at its finest

IN KIT FORM



① Heathkit FM TUNER KIT

Features brand new circuit and physical design. Matches WA-P2 Pre-amplifier. Modern tube line-up provides better than 10 uv. sensitivity for 20 db of quieting. Built-in power supply.

Incorporates automatic gain control—highly stabilized oscillator—illuminated tuning dial—pre-aligned IF and ratio transformers and front end tuning unit. Uses 6BQ7A Cascode RF stage, 6U8 oscillator—mixer, two 6CB6 IF amplifiers, 6AL5 ratio detector, 6C4 audio amplifier, and 6X4 rectifier. Shpg. Wt. 7 Lbs.

MODEL FM-3A **\$26.95***

② Heathkit 25-Watt HIGH FIDELITY AMPLIFIER KIT

Features a new design Peerless output transformer and KT66 output tubes. Frequency response within ± 1 db from 5 cps to 160 Kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20-20,000 cps. IM distortion only 1% at 20 watts. 4, 8, or 16 ohms output. Hum and noise, 99 db below rated output. Uses 2-12AU7's, 2-KT66's and 5R4GY. Attractive physical appearance harmonizes with WA-P2 Preamp. Kit combinations:

W-5M AMPLIFIER KIT: Consists of main amplifier and power supply, all on one chassis. Shpg. Wt. 31 Lbs. **\$59.75** Express only.

W-5 COMBINATION AMPLIFIER KIT: Consists of W-5M amplifier kit plus Heathkit Model WA-P2 Preamp. Shpg. wt. 38 lbs. **\$81.50*** Express only.

③ Heathkit HIGH FIDELITY PREAMPLIFIER KIT

Designed specifically for use with the Williamson Type Amplifiers, the WA-P2 features 5 separate switch-selected input channels, each with its own input control—full record equalization with turnover and rolloff controls—separate bass and treble tone controls—and many other desirable features. Frequency response is within ± 1 db from 25 to 30,000 cps. Beautiful satin-gold finish. Power requirements from the Heathkit Williamson Type Amplifier. Shpg. Wt. 7 Lbs.

MODEL WA-P2 **\$21.75***

④ Heathkit HIGH FIDELITY SPEAKER SYSTEM KIT

This speaker system employs two Jensen speakers to cover the frequency range from 50 to 12,000 cps. Response is within ± 5 db through this range. Built-in crossover functions at 1600 cps. System rated at 25 watts, with nominal impedance of 16 ohms. Enclosure is a ducted-port bass reflex type. The attractive "picture frame" molding blends with any decorating scheme. You merely assemble the cabinet, wire the speakers and crossover network, and treat the furniture-grade plywood in the finish of your choice.

MODEL SS-1
Shpg. Wt. 30 Lbs.

\$39⁹⁵

⑤ Heathkit HIGH FIDELITY SPEAKER SYSTEM KIT

This Range Extending Speaker System employs a 15" woofer and a super tweeter to cover the frequencies between 35 and 600 cps, and between 4000 and 16,000 cps. When used with the Model SS-1, it extends the frequency range at both ends of the spectrum for a total coverage of ± 5 db from 35 to 16,000 cps. Provides unbelievably rich sound over the audio range.

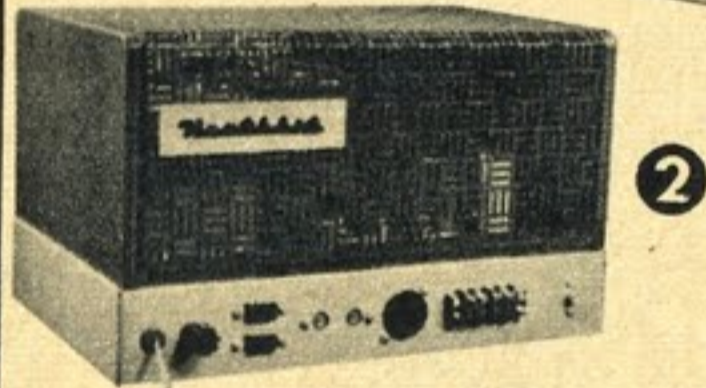
Exposed panels are furniture grade plywood, suitable for light or dark finish of your choice. All parts are pre-cut and ready for assembly. The kit includes necessary crossover circuits and balance control. Crossover frequencies are 600, 1600, and 4,000. Power rating is 35 watts for speech and music. Nominal impedance is 16 ohms.

MODEL SS-1B
Shpg. Wt. 80 Lbs.

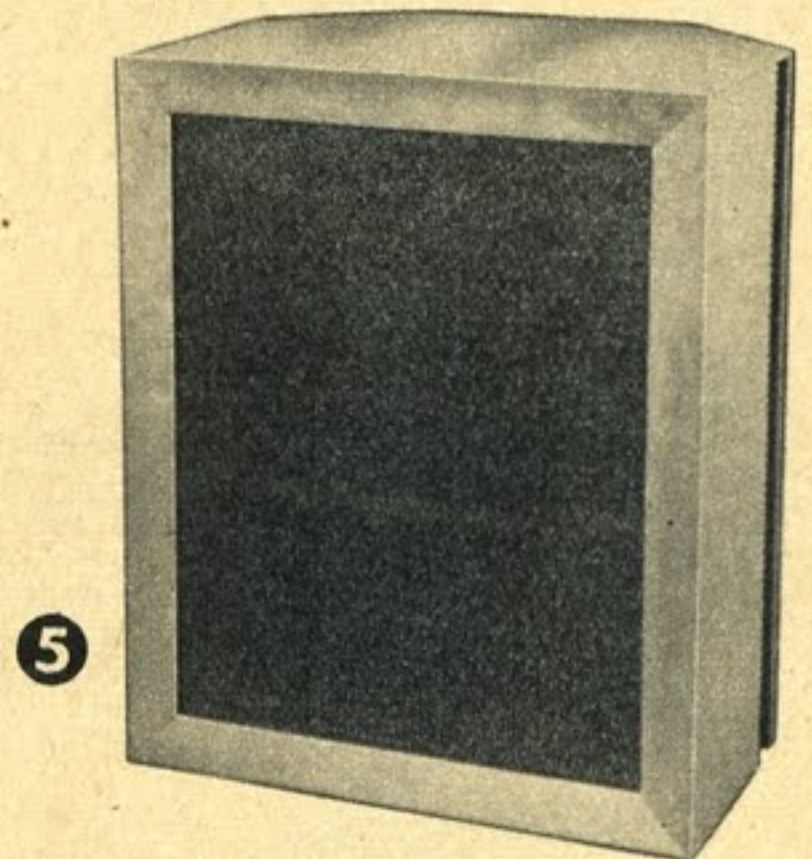
\$99⁹⁵

The SS-1B, alone, measures 29" high by 23" wide by 17½" deep.

Heathkits®



*Price includes 10% federal excise tax.



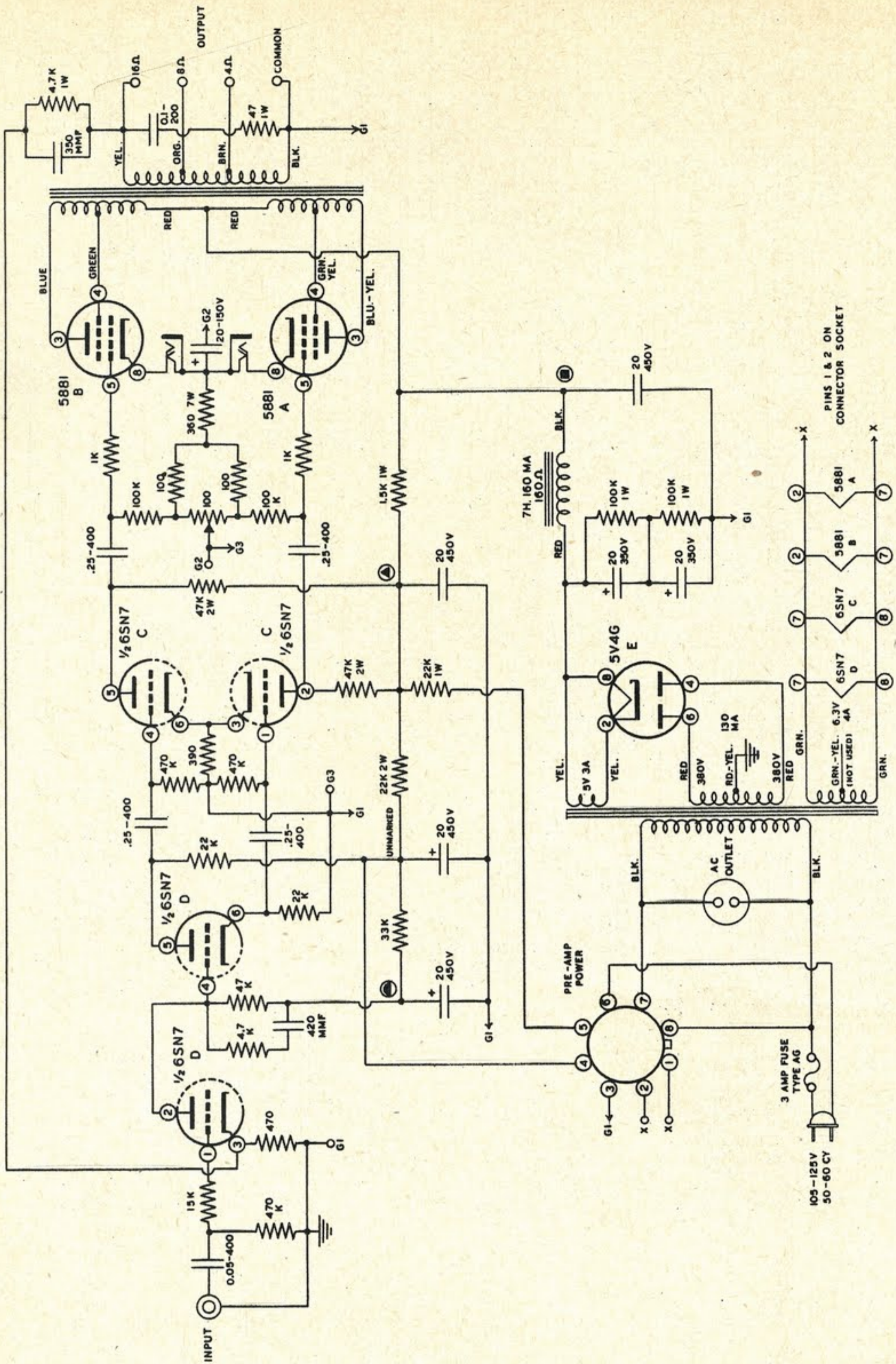
HEATH COMPANY

A Subsidiary of Daystrom Inc.

**BENTON HARBOR 30,
MICHIGAN**



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WILLIAMSON AMPLIFIER *continued*

Also available on the main chassis is an ac outlet that is controlled by the pre-amplifier ac switch.

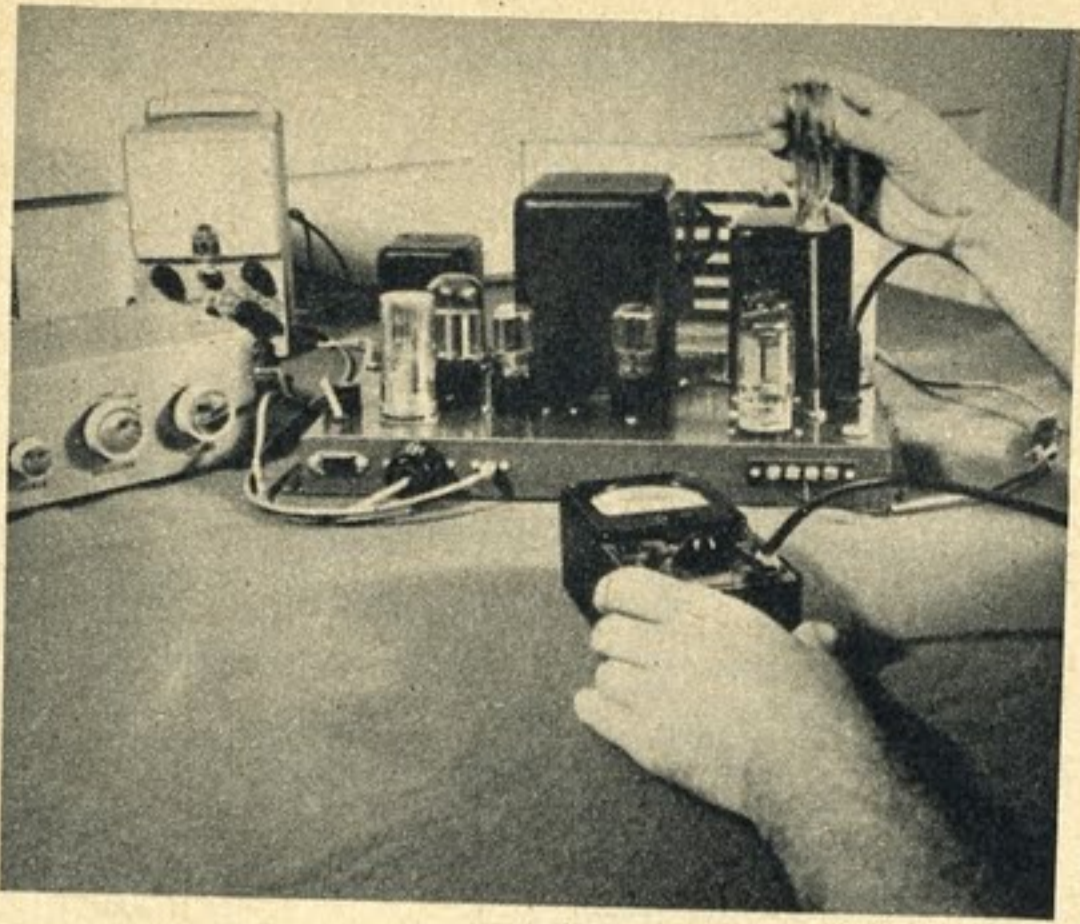
ADJUSTMENTS

The only adjustment required is the balancing of the output plate currents. This amplifier uses a push-pull output stage as do most hi-fi amplifiers. It is essential that exactly the same current be drawn

by each output tube.

All that is needed to balance the output stage is a milliampere meter with a range of 0-100 milliamperes. It should be plugged into one of the two meter (phone) jacks on the top of the chassis. Then the balance control is adjusted until the same current is taken by each tube. If this balancing is not done carefully, low frequency response is liable to be affected and distortion introduced.

(3) Like most high power hi-fi amplifiers, it has a very simple circuit. The last two stages are pushpull and feedback is applied from the last stage to the first. The application of feedback in this manner decreases the distortion of an amplifier, and helps to keep the response "flat". At the same time, it reduces the gain, but this simply means that more gain has to be built into the amplifier to take care of this loss.



(4) After building, the amplifier must be tested. Here I am watching the milliammeter while adjusting the potentiometer balance control for the output stage. Having noted one jack (stage) current the meter is then plugged into the other, and the balance control rotated until both currents are the same. If this is not done harmonic distortion at low frequencies is more likely. At the left can be seen one end of the preamplifier, which is necessary when checking the amplifier. Just behind the amplifier is the extension speaker described earlier which is very useful as a multi-purpose speaker.

LOUDSPEAKER

The actual impedance of the speaker does not matter particularly, provided that it can be properly matched by the taps available on the output transformer. Of course, an amplifier of this high quality should have a speaker worthy of it. It would be fantastic to spend about \$90 on a hi-fi amplifier and preamplifier, and then connect it to a \$5.00 loudspeaker in a small wood box.

Remember that the baffle, or enclosure, is as important as the amplifier and speaker. An effective baffle must prevent the rear wave of the loudspeaker from creeping around to the front, and cancelling or attenuating the desired front wave. The larger the area of the baffle around the loudspeaker, the lower will be the lowest frequency that the loudspeaker system can reproduce. Since sound travels at approximately 1,100 feet a second, you can easily work out the wavelength of the lowest frequency that will not be attenuated by the rear wave. The formula is the same as that for electrical wavelengths, with the exception that 1,100 is substituted for 300,000.

Loudspeaker systems mount all the reproducers on the same center axis of the woofer. Others have a separate tweeter horn mounted above or below the main woofer opening. When these high frequency horns are highly directional, it is essential to orient them correctly in accordance with the manufacturer's instructions.

If the loudspeaker is to be any distance from the amplifier it is better to use a higher impedance speaker. In this way the line losses will not reduce the level as much as with a very low impedance. For example; if the speaker impedance, or resistance, is 4 ohms, and if the line resistance is about 2 ohms, or 1 ohm, as it could easily be, then the line will absorb half as much power as the loudspeaker—

2 ohms for the line, and 4 ohms for the loudspeaker.

You should never use shielded cable for the loudspeaker leads, because of the possibility of providing a high capacity across the lines and shunting, or losing, some of the high frequency. This type of wiring can also lead to instability under certain conditions.

ALTERNATIVE MUSIC SOURCES

Sometimes with a hi-fi amplifier and preamplifier it seems that one does not have sufficient music sources to make it worth having five different inputs. I have used a system in which the record changer is connected to one input, the FM radio to another (when I had a combination AM/FM tuner I used just one input of course) and the AM to another. There is no reason, of course, why you should not connect your television sound to the preamplifier via one of the inputs. But often one does not have the television screen immediately adjacent to the hi-fi loudspeaker.

I therefore designed a little—literally little—AM tuner that I can plug directly into any spare input. Each tuner consists of a tuned circuit and a crystal, and each one is tuned to a different favorite station. Thus, all I do is turn my selector to the number, or position, corresponding to my desired station (AM). There is no tuning to bother with, because each tuner is fixed tuned by means of a small pre-set trimmer mounted on the tuner.

I originally developed the tuner for another purpose in connection with transistor radios, but it has worked so well here that I modified it slightly and adapted it for hi-fi.

*Heathkit Williamson Amplifier
Heathkit Co., Benton Harbor, Mich.
Time to Construct: 18 hours
Price \$39.75*

HI-FI SECTION

■ When you decide to enter the field of high fidelity, you will find that it is not enough to build, or buy, a high quality amplifier, and to buy a good loudspeaker and enclosure. You will also need a *pre-amplifier*. Without one you will be in the position of a man with a fine auto that has an excellent motor and body, but no gear box. In other words you cannot control the power under the hood. The same thing applies in hi-fi.

In most cases, the high fidelity amplifier does not have a volume control, and it may not even have an on-off switch. These functions are expected to be taken care of in the preamplifier. In this article, the construction and operation of the Heathkit Preamplifier is described. It is designed to work with the Heathkit Williamson Amplifier, but slight modifications will make it suitable for use with any high fidelity amplifier. These modifications are described at the end of this article.

CONSTRUCTION

As always, I began by checking the contents of the kit against the maker's parts list. This is advisable, not only to ensure that all parts are present, but to familiarize oneself with the parts used in the kit. Even the expert may sometimes need to look twice at special, or unfamiliar parts; and the pre-construction check is a great time saver.

As one begins building more complicated equipment, and by this I mean more parts—particularly resistors and capacitors—it is a great time saver to segregate the smaller ones into groups. This not only saves time later on, but helps reduce the risk of errors. I try to group my resistors and capacitors in ascending values, and then stick one end of the pigtailed into a piece of corrugated cardboard torn from the packing carton. It is sensible to follow the suggestion of identifying the chassis

(1) This picture gives a good idea of the numerous mechanical jobs that have to be done during assembling. The back of the front panel is on the left. Right is the main tube chassis with the end piece and filter condenser. Being assembled is the rear plate.

YOU WILL ALSO NEED

A VERSATILE PREAMPLIFIER

holes; it helps wiring, and avoids errors which can easily occur when turning the chassis over and around.

This chassis is so versatile that it will not only handle any one of five inputs, but it also provides a low level, corrected output for a tape, or other recorder. The inputs are labelled "Microphone," "Phonograph," "Tuner," and "1" and "2." The purpose of the first three is obvious, and it is convenient to have such a selection



available. The other two can be used for any sources you may wish to amplify.

A convenient feature is the provision of individual pre-set input controls for each of the five inputs. This means that when switching from one source to another there will not be a sudden rise or fall if you have adjusted these controls properly when setting up the amplifier.

As in all low level mixers and amplifiers, exceptionally thorough precautions must be taken to guard against the introduction of hum and circuit noise. The preamplifier is constructed in a rather interesting manner. The main chassis, upon which are the three tubes, is mounted on rubber shock mounts to reduce the possibility of microphonic noise through vibration. Then the chassis and cabinet are built up rather in the fashion of an Erector set. Finally, a golden lacquered case with rubber feet fits over the chassis and provides mechanical protection as well as an extra shield.

A feature that will be new to many readers is the use of individual grounding points. In most of the equipment constructed by the amateur and ham experimenters, the chassis is the ground, and any circuit that has to be grounded is grounded there and then to closest chassis point. But in hi-fi, this is not so. In fact, sometimes ground leads may seem surprisingly long. It has been found that by using only one grounding point for each circuit, or series of circuits, hum can be reduced. What happens, in effect, is that with ordinary haphazard grounding the ac currents flowing in the chassis can flow through sections of chassis that are common to other circuits, and the ac voltage developed by the passage of these currents is introduced into sensitive high gain circuits with the formation of hum, and other unwanted noises. For this reason, be sure to follow, exactly, the grounding connections shown in the wiring diagrams.

I modified these instructions somewhat in that I did as much mechanical work as possible, on each sub-assembly, before setting it aside and returned to wire them later rather than at the time of assembling as was recommended in many cases.

The most difficult assembly was the wiring of the selector switch. It was not exactly hard to do, but it was tedious and called for a lot of careful work. However, by pinning up the large scale wiring dia-



(2) The preamplifier in use. Its pleasing appearance and small size make it suitable for placing in convenient locations.

grams in front of you during construction, there will be no real difficulty.

Assembling completed, the sub-assemblies are not difficult, but again care must be used, and it is much better to take one's time and do a slow, correct job, than to rush as I tried as first, and find it necessary to undo some work because I did not show enough care.

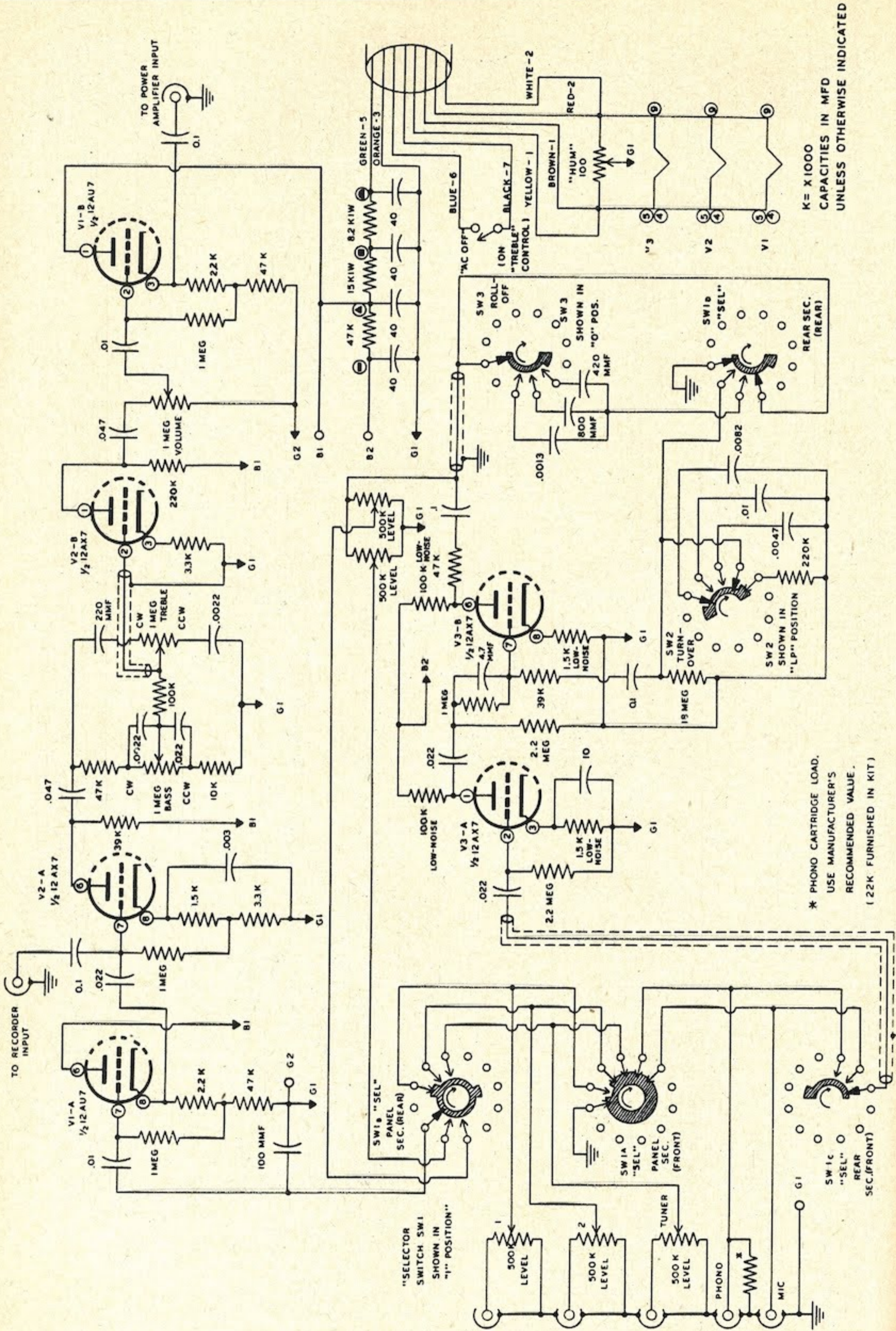
With the assembly of the sub-chassis units, and their connection, most of the wiring is completed. So far we have continued with the description based on use with the Heathkit Williamson Amplifier. This assumption we will continue for a few paragraphs. In the assembly of the preamplifier, a power cable and plug was constructed. This plugs into the chassis of the Heathkit Williamson Amplifier and provides power for the preamplifier and ac control for the main amplifier chassis.

Since we have assumed that the Heathkit amplifier is to be used with this preamplifier we must therefore construct or obtain such a unit before the preamplifier can be tested. However, for the purpose of the operation about to be described, we will assume the power supply is obtained from this amplifier. (If you plan to use this kit with another amplifier, pass over the next section and follow the instructions at the end.)

OPERATION

Assuming your final wiring checks have shown that the preamplifier is properly wired, plug the power cable into the plug on the main amplifier. Be sure to have a speaker connected to the output of the amplifier. *This is essential in any amplifier test!* Without a speaker, or equivalent load, you are liable to damage the output stage. Switch on the equipment and allow it to warm-up.

Continued



K = X 1000
CAPACITIES IN MFD
UNLESS OTHERWISE INDICATED

* PHONO CARTRIDGE LOAD.
USE MANUFACTURER'S
RECOMMENDED VALUE.
(22K FURNISHED IN KIT)

(3) The schematic diagram of the preamplifier. This is considerably more complex than the main amplifier because it has to do many more things.

With volume control at medium, and selector to "phono," and "bass" control to maximum, rotate the hum control on the bottom of the chassis to obtain minimum hum. This hum control is merely a fairly low resistance potentiometer connected across the heater supply. The movable arm is connected to ground. By adjusting this grounding point the ac zero point is obtained. In the old days of radio, before hi-fi was thought of, this control was essential for the directly heated ac tubes; it was known as a "humdinger" control.

After setting minimum hum, check all the positions of the selector and roll-off and turn-over switches to ensure that they are properly wired and work. If the unit behaves satisfactorily, switch it off and unplug from the main amplifier. Then do the final assembly of the cabinet and chassis as described in the instructions.

OPERATING NOTES

The instruction book contains a listing of most of the record manufacturers, and the proper settings for the roll-off and turnover controls. For example—Capitol Long Play records use a setting of "AES" for turnover, and RIAA-12 for roll-off. Other records will require different settings according to the recording correction that was used. But one thing is very definite in high fidelity listening—there is only one correct control setting, and that is the one that sounds best to *you*.

The response of the preamplifier is flat within 1 db from 25 cps to 30,000 cps. This means that between these limits the variation is so small that it is not notice-

able. The tone controls, "treble" and "bass," make it possible to change this response in any way pleasing to the listener. As you can see from the response curve shown in the illustration, it is possible to have minimum treble and minimum bass by turning both controls counterclockwise. Then it will sound like the average small table radio—or worse. Or you can have full treble and full bass. This will probably be a little too overwhelming, unless your music source is very badly lacking in treble and bass. In general, you will find a compromise position is best, but again, much depends on the speaker and the enclosure—and the room conditions.

This would, of course, be a fine unit to drive the "Simulated Binaural Sound System" described elsewhere in this book.

USING THE PREAMPLIFIER WITH ANY AMPLIFIER

If you wish to use the preamplifier with an amplifier that does not have a special output socket to provide power for it, you will require the following power supply.

6.3 volts at 1 amp for the tube heaters.

300 volts dc at 10 ma for B+. The ac power switch is intended to be incorporated with the volume control. However, there is no reason why you must retain this circuit if your existing equipment has different controls.

Heathkit Preamplifier
 Made by: Heathkit Co.
 Benton Harbor, Mich.
 Time to build: About 20 hours
 Price: \$19.75

(4) Response curves for the preamplifier, showing responses obtained for different settings of the bass and treble controls.

