ASSEMBLING AND USING YOUR.....

Heathkit

PREAMPLIFIER

MODEL WA-P2

595-89

HEATH COMPANY
BENTON HARBOR,
MICHIGAN

PRICE $1.00

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

ASSEMBLY AND OPERATION OF THE HEATHKIT PREAMPLIFIER

MODEL WA-P2

SPECIFICATIONS

INPUTS:

Three high-level and two low-level inputs; individual level controls for each.

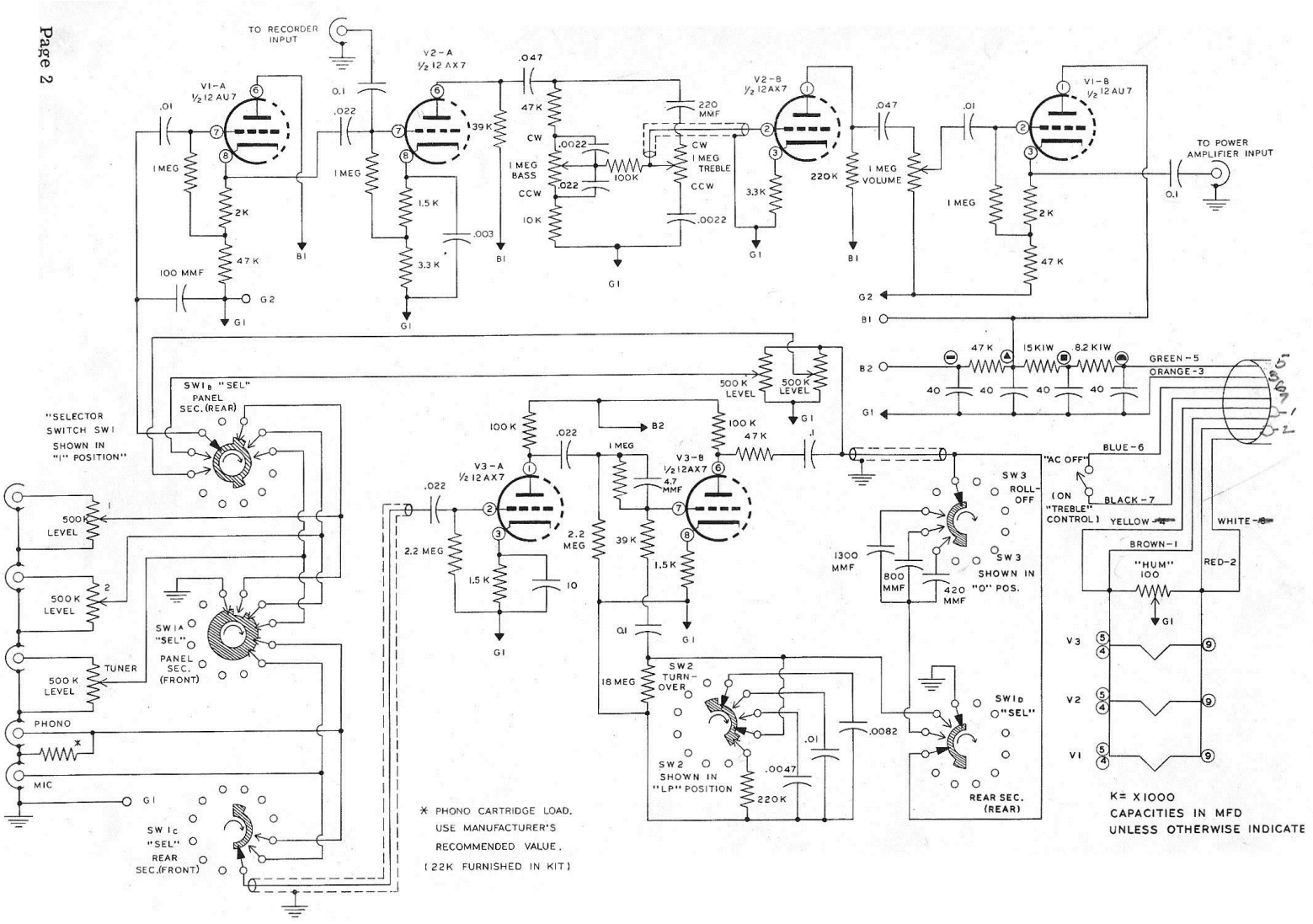
High-level inputs, 1, 2 and TUNER, for 0.1 volts or higher; 0.5 megohm input impedance.

Low-level inputs, PHONO and MIC, for 0.1 volts or lower; phono input impedance normally 22 KΩ for magnetic phono pickup; microphone input impedance 2.2 megohms.

OUTPUTS:

Two: Output to main amplifier variable 0 to at least 2.5 volts RMS from any normal program source; full control of input selection, volume, phono compensation and tone balance, cathode follower output; recommended load impedance 200 KΩ or higher shunted by .007 μfd or less; up to 100 feet of shielded microphone cable, or up to 200 feet of RG-58-AU coaxial cable, may be used between preamplifier and main amplifier with not more than 3 db loss at 10,000 cps.

Output to recorder input providing minimum of 0.25 volts RMS from any normal program source; full control of input selection, phono compensation and individual input level, but independent of volume control or tone controls; cathode follower output with same characteristics as output to main amplifier input.


TO RECORDER INPUT
V1-A ½ 12 AU7
V2-A ½ 12 AX7
V2-B ½ 12AX7
V1-B ½ 12 AU7
TO POWER AMPLIFIER INPUT
V3-A ½ 12 AX7
V3-B ½ 12AX7
SW1B "SEL" PANEL SEC. (REAR)
"SELECTOR SWITCH SW1 SHOWN IN "1" POSITION"
SW1A "SEL" PANEL SEC. (FRONT)
SW1C "SEL" REAR SEC. (FRONT)
SW2 TURN-OVER
SW2 SHOWN IN "LP" POSITION
SW3 ROLL-OFF
SW3 SHOWN IN "0" POS.
SW1b "SEL"
REAR SEC. (REAR)
"AC OFF" (ON "TREBLE" CONTROL)
"HUM" 100
TUNER
PHONO
MIC
BLUE-6
BLACK-7
YELLOW-4
WHITE-8
BROWN-1
RED-2
GREEN-5
ORANGE-3
* PHONO CARTRIDGE LOAD. USE MANUFACTURER'S RECOMMENDED VALUE. (22K FURNISHED IN KIT)
K= X1000
CAPACITIES IN MFD
UNLESS OTHERWISE INDICATE

GAIN:

High-level inputs:

0.05 volt	input produces	0.5 volt	RMS output
0.09	"	1.0	"
0.14	"	1.5	"
0.18	"	2.0	"
0.23	"	2.5	"

Low-level inputs:

1.4 millivolts	input produces	0.5 volt	RMS output
2.5	"	1.0	"
3.6	"	1.5	"
4.9	"	2.0	"
6.2	"	2.5	"

Measurements made at 1000 cps with LEVEL and VOLUME controls set for maximum gain.

FREQUENCY RESPONSE:

1.0 db from 25 cps to 30,000 cps
1.5 db from 15 cps to 35,000 cps

Measurements made through MIC input, tone controls set for flat response at 100, 1000 and 10,000 cps. (See Figure 2.)

HARMONIC DISTORTION:

At 2.5 volts RMS output, total measured harmonic distortion (not corrected for source distortion) is:

Input	20 cps	1000 cps	10,000 cps	20,000 cps
0.5 v at TUNER	0.63%	0.17%	0.33%	0.47%
6 mv at PHONO	1.15%	0.46%	0.54%	0.66%
15 mv at MIC	0.35%	0.26%	0.42%	0.48%
Source distortion from generator	0.74%	0.22%	0.22%	0.24%

NOTE: Where source distortion is greater than measured distortion, it is assumed that certain cancellation effects are responsible.

INTERMODULATION DISTORTION:

Measured at 60 and 7000 cps with 4:1 ratio; tone controls at flat, volume at maximum, output level controlled by adjusting LEVEL control.

Output Voltage (RMS)	MIC Input	TUNER Input
0.5	0.48%	0.2%
1.0	0.50	0.3
1.5	0.50	0.4
2.0	0.55	0.59
3.0	0.70	0.77
4.0	0.88	0.98
5.0	1.1	1.2

HUM AND NOISE:

0.5 volt at TUNER input	72 db below 2.5 volts RMS
6 mv at PHONO input	62 db below 2.5 volts RMS
15 mv at MIC input	70 db below 2.5 volts RMS

Measured with tone controls set for flat response at 100, 1000 and 10,000 cps; volume control at maximum gain; turnover control at LP; rolloff control at 0; power cord polarized

for minimum hum; hum balance control set for minimum hum in PHONO input position; LEVEL control adjusted for 2.5 volts RMS output at input voltage shown.

PHONOGRAPH:

COMPENSATION: Low-frequency compensation provided by four-position TURNOVER control. See Figure 1 for curves.

High-frequency compensation provided by four-position ROLLOFF control. See Figure 1 for curves.

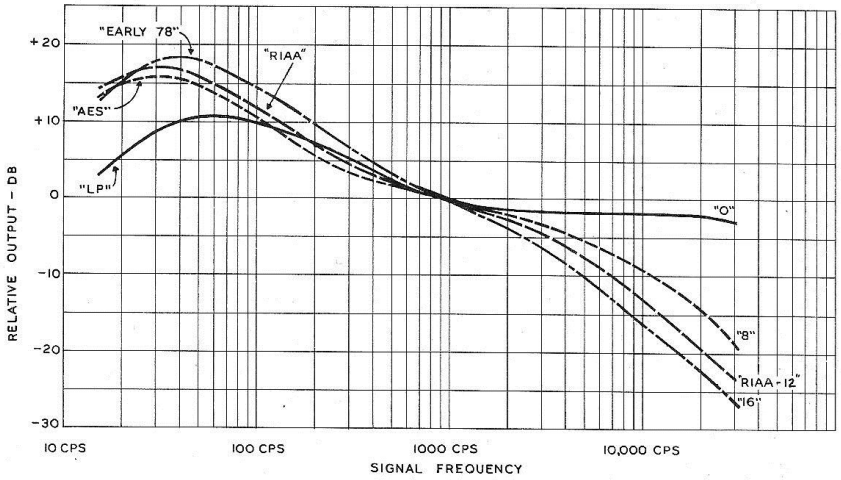


Figure 1

PHONOGRAPH EQUALIZER CURVES

(TURNOVER CURVES TAKEN WITH ROLLOFF SET AT 0)

(ROLLOFF CURVES TAKEN WITH TURNOVER SET AT LP)

TONE CONTROL:

Separate bass and treble tone controls. Bass control provides approximately 18 db boost and 12 db cut at 50 cps. Treble control provides approximately 15DB boost and 20 db cut at 15,000 cps. See Figure 2 for curves.

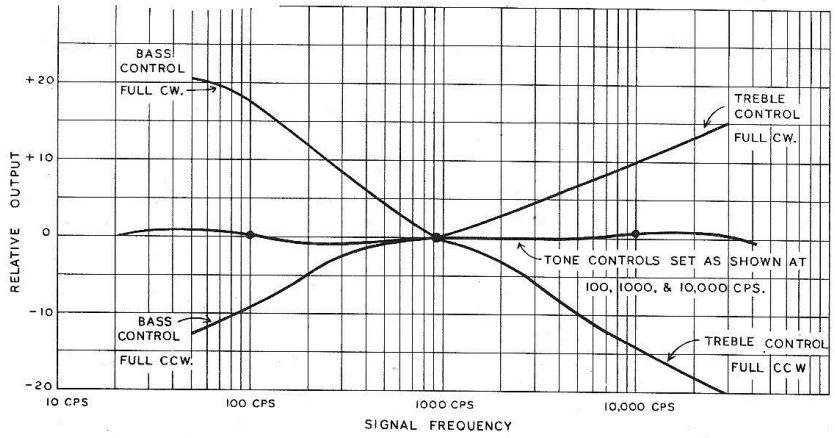


Figure 2

FREQUENCY RESPONSE AND TONE CONTROL CURVES

(BASS CURVES TAKEN WITH TREBLE CONTROL AT FLAT)

(TREBLE CURVES TAKEN WITH BASS CONTROL AT FLAT)

VOLUME CONTROL:

Conventional uncompensated voltage divider type at grid of main amplifier cathode follower output stage. Space is provided to mount a "loudness control" where program source outputs and main amplifier sensitivity permits. See Figure 3 for futher information.

INPUT SENSITIVITY FOR "MIC" AND "PHONO" INPUTS OF HEATHKIT WA-P2 PREAMPLIFIER.

Curve marked "MIC INPUT (VOLUME CONTROL)" represents input-output characteristic for WA-P2 Preamplifier with conventional volume control through "MIC" channel.

Curve marked "PHONO INPUT (VOLUME CONTROL)" same as above except for "PHONO" channel.

Curve marked "PHONO INPUT (LOUDNESS CONTROL)" represents input-output characteristic when using loudness control in place of conventional volume control, through "PHONO" channel.

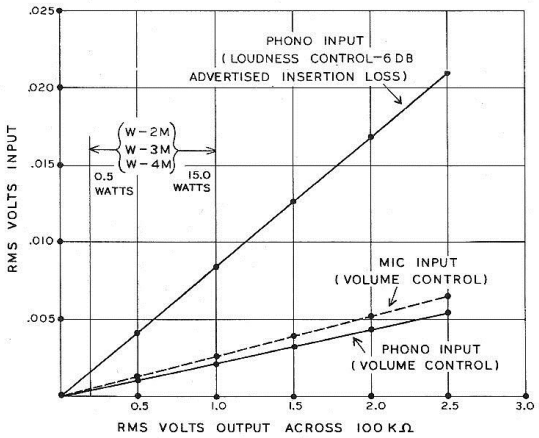


Figure 3

1. VOLUME OR LOUDNESS CONTROL AT FULL CLOCKWISE.
2. TONE CONTROLS SET AT FLAT.
3. TURNOVER CONTROL AT "LP."
4. ROLLOFF CONTROL AT "0."
5. LEVEL CONTROL FULL CLOCKWISE.
6. 1 KC SIGNAL.

To Use This Chart: From the manufacturer's specifications, determine the input voltage required to drive your power amplifier to rated output. At this point along the horizontal axis, marked "RMS VOLTS OUTPUT ACROSS 100 KΩ", draw a vertical line intersecting the three curves of the graph. Using the applicable curve, project this point of intersection to the left-hand vertical axis. Any input source furnishing a signal greater than this value is capable of driving the main amplifier to rated output when the WA-P2 is used as a preamplifier.

For Example: You have a Heathkit Williamson-type main amplifier, model W-2M. You wish to know if you can use the WA-P2 with conventional volume control, working out of a Fairchild 215 phonograph pickup. From the manufacturer's specifications, you determine that 0.75 volts input will drive the W-2M to 5 watts output. At this point, a vertical line intersects the PHONO INPUT (VOLUME CONTROL) curve at a value of approximately 0.002 volts input. From the manufacturer's data, the Fairchild 215 cartridge delivers 3 millivolts (0.003 volts) at 7.5 cm/sec. Since this value is greater than the required input, you are assured that the combination is satisfactory.

LEVEL CONTROLS:

Individual controls for each input to permit adjustment of level thus preventing overloading of input circuits. Input levels may be set so no volume adjustments need be made when selector switch is operated.

POWER SUPPLY:

Requires power from external source, as follows:

6.3 v AC at 1.0 amp.
300 v DC at 10 ma.

These voltages are available from any Heathkit Williamson-Type amplifier, models WA-1, W-2M, W-3M or W-4M. One additional resistor is required; this resistor is supplied with the WA-P2 kit. An eight-conductor cable terminating in an octal plug is supplied with the kit. This plug makes all required power connections to Heathkit main amplifiers.

POWER SWITCHING:

AC on-off switch on treble tone control, rated at 3 amperes, 125 volt AC. Switch leads are brought out through eight-conductor power cable.

DIMENSIONS:

Cabinet only:	12 9/16" long, 3 3/8" high, 4 7/8" deep.
Overall:	12 9/16" long, 3 5/8" high, 5 7/8" deep.

WEIGHT:

Net weight:	3 1/2 pounds
Shipping weight:	7 pounds

NOTE: The measurements given above were taken on a representative preamplifier. Variations from these measurements are to be expected because of normal production deviations in components, lead placement during wiring and similar changes. Unless otherwise stated, the following settings were maintained during test:

Volume control full on
Tone controls set for flat response at 100, 1000 and 10,000 cps
Turnover control set at LP
Rolloff control set at 0
Level controls adjusted for output voltage indicated:
2.5 volts RMS at 1000 cps if not otherwise stated

Output measurements were taken at the end of a four-foot length of shielded cable, with a capacity of 55 $\mu\mu$f per foot. Power supply was taken from a W-2M Heathkit Williamson-type Amplifier, modified in accordance with the instruction manual and operated at 117 volts 60 cycles.

INTRODUCTION

The Heathkit model WA-P2 was designed to fulfill the performance requirements of the most critical audiophile, at the lowest possible cost. It is truly a worthy companion for the Heathkit Williamson-type main amplifiers with which it was designed to be used. Where sufficient filament and plate power is available, it may also be used to great advantage with any other true high-fidelity amplifier.

To our knowledge, the WA-P2 meets or exceeds the specifications for preamplifiers for the most rigorous high-fidelity applications. It will do justice to the finest available program sources whether they be phonograph pickups, tuners, microphones or recorders. But no preamplifier can correct for serious distortion in the following power amplifier or reproducer system. It can only deliver to these units program material conveniently selected, properly compensated and free of contributed distortion or extraneous noise. When constructed and adjusted in accordance with instructions, the WA-P2 is fully capable of meeting these requirements.

CIRCUIT DESCRIPTION

In addition to the data presented in the specifications, the following brief circuit description may be of interest to the technically inclined constructor.

High-level inputs are adjusted to equal and suitable volume levels by the LEVEL controls. The desired input is selected by means of the back contacts of the first wafer of the selector switch. Low-level inputs are selected by the front contacts of the second wafer of the selector switch. (Idle input channels are grounded through the front contacts of the first wafer.) Low-level signals are fed through triode V-3A and passed to the grid of triode V-3B through the .022 coupling condenser and the 1 megohm series resistor, by-passed by the 4.7 $\mu\mu$f condenser. When the input switch is in the PHONO position, signal voltage is also fed through the 39 KΩ resistor and the .01 μfd coupling condenser to the TURNOVER control switch and to ground through the back contacts of the second wafer of the selector switch. This shunt network produces the rising low-frequency characteristics required for proper equalization of phonograph recordings. Variations of this response curve are controlled by the condenser-resistor combinations selected by the turnover control. In the MIC input position, the entire TURNOVER control is shorted to ground.

Audio voltages appearing at the plate of V3-B are fed through the 47 KΩ resistor and the .01 μfd condenser to the paralleled low-level LEVEL controls. When the PHONO input is selected, the back contacts of the second wafer connect the ROLLOFF control between this point and ground. Rotation of the rolloff control connects increasingly larger shunt capacities to ground, thus de-emphasizing the higher frequencies, as shown in the equalization curves. In the MIC input position, the ground return is broken so that the rolloff control is deactivated.

The adjusted outputs from the PHONO and MIC level controls appear at the back of the first wafer of the selector switch at the same approximate level as the high-level inputs.

Audio voltage from the selected source is fed to the cathode follower stage V1-A and appears at a much lower impedance at the recorder input jack. As explained in the specifications, this permits the use of long interconnecting cables without loss of high frequencies. This voltage is also applied to the grid of V2-A, amplified, and fed into the tone control circuits. The signal voltage is then reamplified in triode V2-B. Volume control is accomplished between the plate circuit of this stage and the grid of V1-B, a conventional cathode follower triode with the characteristics outlined previously under SPECIFICATIONS.

Plate supply voltages are developed at the output of the three-section RC filter whose parameters have been established for maximum rejection of very low frequencies as well as reduction in 60 and 120 cycle ripple. This filter system provides a high degree of decoupling and so stabilizes the performance of the preamplifier when powered from a following main amplifier where plate supply coupling might cause motor-boating.

Filament supply is line-frequency AC obtained from an external filament winding. No ground to any portion of the filament winding is used except through the hum-balance control in the preamplifier. By this means, a very substantial reduction in hum level is accomplished.

A great deal of experimentation resulted in the system of shielding and grounding used in the WA-P2 preamplifier. Use of large diameter spiraled conduit reduces the shunting effect of shields at higher audio frequencies. All current-carrying grounds for a particular stage are returned to a common insulated point and individual ground leads are brought to chassis ground near the physical center of the chassis. In this way, chassis currents are reduced to a minimum and coupling in ground returns becomes a minor problem.

Assuming that necessary provisions for power have been made, the following preliminary steps should be taken before the preamplifier is tested:

(✓) 180. Insert tubes in the sockets as follows:

Socket V1 - type 12AU7
Socket V2 - type 12AX7
Socket V3 - type 12AX7

(✓) 181. Place tube shields over the tubes in sockets V2 and V3.

(✓) 182. Slip knobs on the control shafts. Small knobs are used on the TURNOVER, ROLLOFF, BASS and TREBLE controls. Large knobs are used on the SELECTOR and VOLUME controls. The knobs push on the flatted shafts, after proper alignment between the flat and the spring insert in the knob. If necessary, loosen the control nuts to secure proper relation between the knob indicator line and the panel markings. Then retighten the nuts.

(✓) 183. Mount the HEATHKIT nameplate on the front panel. Cut the plastic pins to a length of 1/4". Insert the pins through the small holes in the upper left corner of the panel. Touch the ends of the pins with a soldering iron so that the plastic material flows enough to secure the nameplate to the panel.

(✓) 184. Set the controls on the preamplifier as follows:

TURNOVER to "LP"	TREBLE to "AC OFF"
ROLLOFF to "0"	SELECTOR to "1"
BASS indicator vertical	VOLUME full counterclockwise.
All LEVEL controls (on rear panel) full clockwise.	

(✓) 185. Plug the octal connector into the applicable socket on the main amplifier (or other power source). Temporarily secure the bottom plate to the end-brackets, using 6-32 self-tapping screws. The large center hole should provide access to the HUM control.

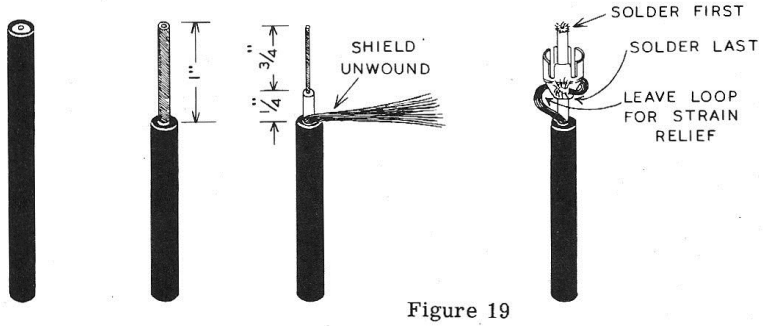


Figure 19

( ) 186. Prepare a length of shielded cable as shown in Figure 19, using a phono plug at each end. Connect this cable from the TO PWR. AMP. INPUT socket on the preamplifier rear panel to the input socket on the main amplifier.

(✓) 187. Be sure a speaker is connected to the output of the main amplifier.

(✓) 188. Plug the main amplifier (or other power source) line cord into an AC outlet.

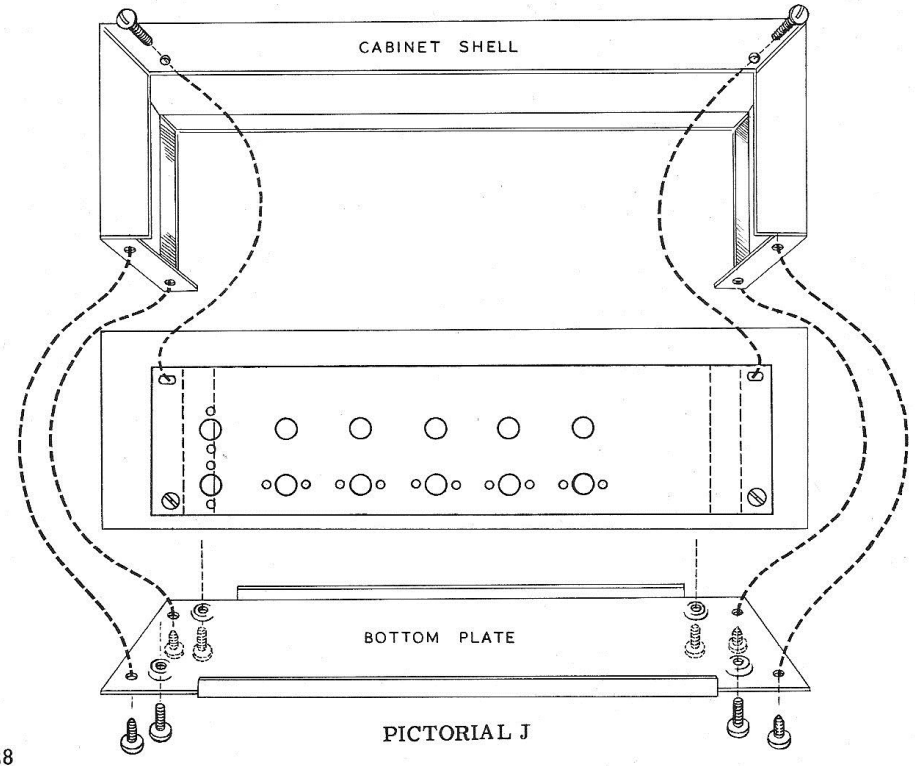
(✓) 189. Turn the TREBLE tone control so the indicator line is vertical. The tube filaments should light. Allow one minute for tubes to heat, then rotate the VOLUME control clockwise

until background noise is heard in the speaker. This noise will quite probably be mostly low frequency hum. Rotate the BASS tone control. The hum should increase with clockwise rotation of the BASS control and vice versa. Now set the SELECTOR switch to the 2 and TUNER settings. These inputs should give exactly the same results as the 1 setting.

( ) 190. Turn the VOLUME control full counterclockwise. Turn the SELECTOR switch to the PHONO position and again rotate the VOLUME control until background noise is heard. The noise level will be considerably higher than before. Rotate the BASS control full clockwise and carefully adjust the HUM control below the chassis for minimum hum. Advance the VOLUME control as this is done. The setting for minimum hum is quite critical. With full volume on, rotate the TREBLE tone control and observe that the high-frequency noise or rushing sound increases as the control is turned clockwise. With full volume on and the TREBLE control clockwise, operate the ROLLOFF control. The high-frequency noise should reduce to successively lower values as the control progresses clockwise. With full volume and the BASS control full clockwise, operate the TURNOVER control. There will be very slight changes in the hum level in the LP, NARTB and AES positions, but a definite increase in hum when the control is set to EARLY 78. If the controls function as described, rotate the SELECTOR control to the MIC setting and again check for background noise. In this position, the overall noise level will be slightly higher than in the phono position, but the hum component will be reduced appreciably, since no low-frequency boost is introduced as in the PHONO position.

If the preamplifier behaves as described above, you may assume that it has been correctly assembled and wired. If operation is abnormal, refer to a later portion of this manual, entitled, "In Case of Difficulty."

BE SURE THAT THE OCTAL PLUG IS NOT CONNECTED TO THE POWER AMPLIFIER WHEN PERFORMING THE FOLLOWING OPERATIONS.



PICTORIAL J

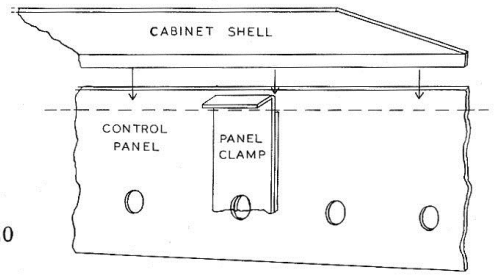


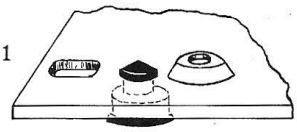
Figure 20

( ) 191. Remove the bottom plate. Drop the cabinet shell over the preamplifier as shown in Figure 20. The narrow flange on the shell goes next to and behind the front panel. Work the grommet on the cable into its notch in the left rear flange. The panel clamp, mounted on the TREBLE tone control bushing, should bear on the inside of the front flange of the shell. This prevents any bowing of the front panel at the center. See Figure 20.

( ) 192. Insert two 6-32 x 1/2" self-tapping screws through the two small holes in the top rear flange of the shell. These screws will pass through slots in the rear panel and thread into the end brackets.

( ) 193. Insert the four rubber feet through the 1/4" holes at the four corners of the bottom plate. See Figure 21.

Figure 21



( ) 194. Turn the preamplifier upside down. Orient the bottom plate so that the large hole falls over the HUM control shaft and attach the bottom plate to the shell (not to the end brackets) using the outside holes at each corner. Sheet metal screws are used for this application.

( ) 195. Remove the knobs from the VOLUME and TURNOVER control shafts. Loosen the nuts mounting these controls slightly so that the panel may be shifted on the end brackets. Be careful not to loosen the nuts too far.

( ) 196. Using 1/2" self-tapping screws, secure the bottom plate to the end brackets through the dimpled holes in the bottom plate.

( ) 197. Adjust the position of the front panel so that an even alignment to the cabinet shell is obtained. Now retighten the VOLUME and TURNOVER control nuts and replace the knobs.

This completes the assembly and adjustment of your Heathkit WA-P2 Preamplifier kit.

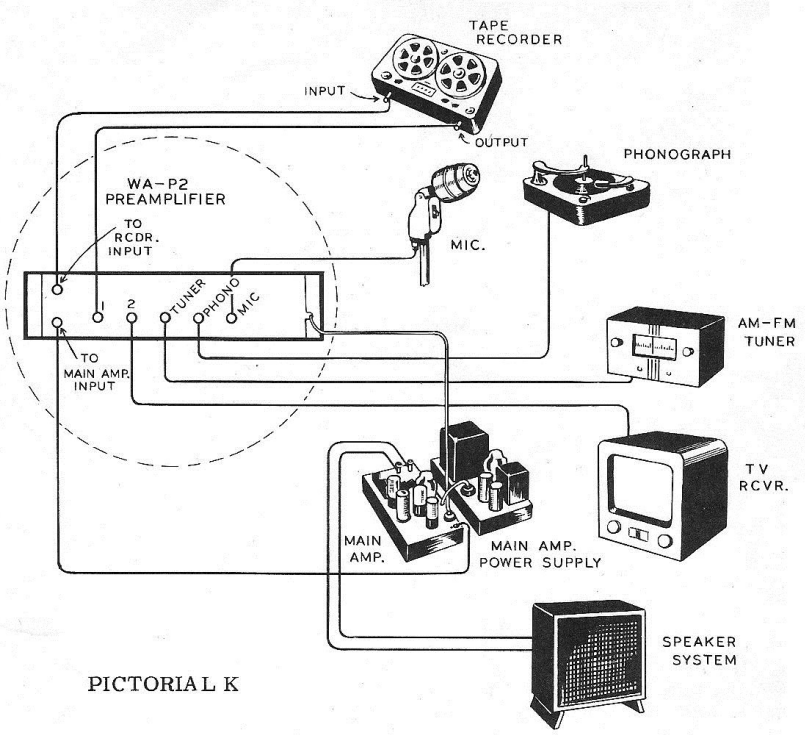
INPUT CONNECTIONS

Most signal sources terminate in a standard RETMA phono plug which fits the input sockets of your WA-P2 Preamplifier. Two plugs of this type are furnished with your kit and may be attached to other equipment where needed. All input leads should be shielded with stranded center conductors for greater flexibility. Connect inputs in accordance with the following table:

1, 2 or TUNER	PHONO	MIC
AM, FM or TV receivers	Reluctance phono pickups	High-impedance microphones
Tape recorder output	Magnetic phono pickups	Contact microphones for musical instruments
Crystal or ceramic phono pickups*	Crystal or ceramic phono pickups*	Compensated phono pickups with no preamplifier
Capacity (FM) phono pickups with required oscillator	Ribbon phono pickups, with matching transformer	
Compensated phono pickup preamplifiers (all types)		

Pictorial K shows the WA-P2 as it would be used with a comprehensive high-fidelity system.

*See Boegli; "New Developments in Phono Equalizers," Radio and Television News, April, 1953



PICTORIAL K

HOW TO USE THE TURNOVER AND ROLLOFF CONTROLS

These controls compensate the response of the preamplifier to correct for the recording characteristic used by the various manufacturers. A committee of the Record Industry Association of America has recently approved a standard curve, to be known as the "RIAA Standard Recording and Reproducing Characteristic." This committee is composed of representatives of Capitol, Columbia, Decca, Mercury and RCA Victor. It may be assumed that the use of the curve will become widespread in the future. THIS CHARACTERISTIC MAY BE MATCHED BY SETTING THE TURNOVER AND ROLLOFF CONTROLS TO THE "RIAA" POSITIONS.

For recordings released prior to 1954, use the following table as a guide for setting these controls:

LP Records labelled	TURNOVER	ROLLOFF	LP Records labelled	TURNOVER	ROLLOFF
Atlantic	RIAA	16	London	LP	8
Bartok	AES	16	Lyricord	AES	16
Blue Note Jazz	AES	RIAA-12	Mercury	AES	RIAA-12
Caedmon	AES	RIAA-12	M-G-M	RIAA	RIAA-12
Canyon	AES	RIAA-12	Oceanic	LP	16
Capitol	AES	RIAA-12	Philharmonia	AES	RIAA-12
Capitol-Cetra	AES	RIAA-12	Polymusic	RIAA	16
Cetra-Soria	AES	RIAA-12	RCA-Victor	RIAA	RIAA-12
Columbia	LP	16	Remington	RIAA	16
Cook Laboratories	RIAA	RIAA-12	Tempo	RIAA	RIAA-12
Decca	AES	RIAA-12	Urania	LP	16
Electra	AES	16	Vanguard-Bach Guild	LP	16
EMS	AES	RIAA-12	Vox	LP	16
Esoteric	RIAA	RIAA-12	Westminster	RIAA	16
Haydn Society	LP	16			

45 RPM records of all labels, except RCA, generally will require AES turnover and 12 db roll-off. For RCA, use RIAA settings.

78 RPM records labelled:

Brunswick	EARLY 78	0	EMI	EARLY 78	0
Capitol	AES	RIAA-12	HMV	EARLY 78	0
Columbia (English)	EARLY 78	0	London	EARLY 78	8
Columbia (USA)	AES	16	Parlophone	EARLY 78	0
Decca	AES	RIAA-12	RCA-Victor	RIAA	RIAA-12

Please bear in mind that there is only one correct combination of turnover and rolloff for a given recording and that is the one which sounds best to you. Do not hesitate to experiment until you find the settings you prefer. Additional information concerning equalization of recordings appears in technical literature. "High Fidelity" magazine publishes an extensive tabulation at intervals and portions of the above list were compiled from this source, with permission of the publishers.

NOTES ON USING THE WA-P2 PREAMPLIFIER

With the BASS and TREBLE control indicators in the vertical, or 12 o'clock position, the response of the preamplifier is essentially flat except for compensation supplied by the turnover and rolloff circuits in the PHONO position.

Be sure to reverse the line plug in the outlet for minimum hum. Also, after all connections are made, readjust the HUM control for the lowest noise level, using PHONO input. Set the BASS control at full clockwise and the ROLLOFF control to the EARLY 78 position so that maximum bass boost is used. As mentioned before, the setting of the HUM control is rather critical.

Occasionally, residual hum of a higher pitch will be evident even with the VOLUME control at minimum. If this occurs, try disconnecting the shield of the output cable at the point where it is connected to the main amplifier plug.

As explained in the Specifications (Page 5), no "loudness control" circuit is incorporated in the WA-P2. Space is provided for these controls if you should desire to use one of them. If a 3-section control is used, it may be necessary to clip off a corner of the chassis flange directly behind the control. This may be done easily with a pair of diagonal cutting pliers. Follow the manufacturer's recommendations for installing and using loudness controls.

SELECTION OF ACCESSORY COMPONENTS

The range of accessory components for use in high-fidelity systems continues to expand. Every attempt has been made to provide in the WA-P2, sufficient flexibility to utilize future as well as current equipment of this kind. Remember that the preamplifier is only one important link in the chain. It cannot eliminate distortion or noise from other parts of the system.

For phonograph reproduction, we seriously recommend the purchase of a cartridge with a replaceable diamond stylus despite the higher first cost. Reduction in damage to records, better tracking and longer life will more than repay the extra original outlay.

Magnetic or reluctance types of cartridges are generally susceptible to external magnetic fields and they should be used only with turntables or changers equipped with motors designed to have very weak external fields. Ceramic and crystal cartridges are not affected in this way and great improvements have been made in the performance of this group of pickups.

In the speaker-enclosure field, a tremendous range in price (and performance) exists. Generally speaking, the performance can be predicted more from the size of the speaker enclosure than from the size of the speaker cone. Good bass reflex baffles, properly designed and adjusted, are probably the best low-cost enclosures available at present. Many of the Helmholz-resonator types of enclosures are excellent but they are more critical as to driver units, construction and other variables. Most speaker manufacturers supply excellent data on enclosure design.

Further discussion of the accessory problem is outside the scope of this manual. We recommend, for a serious and comprehensive review of the subject, any of the books mentioned in the bibliography. "Audio Engineering," "High-Fidelity," "Radio and Television News" and "Radio-Electronics" are publications which regularly feature articles on this subject.

IN CASE OF DIFFICULTY

Recheck the wiring. Trace each lead in colored pencil on the pictorial as it is checked in the amplifier. Most cases of difficulty result from wrong connections. Often having a friend check the wiring will reveal a mistake consistently overlooked.

Compare the tube socket voltages with those shown in the voltage table below. Readings within 20% of those shown may be considered as normal. If a discrepancy is noted, check the associated circuits carefully. Any component in those circuits should be suspected until proved satisfactory.

If voltages and tubes are normal, try the following procedure:

With the VOLUME control about half on and LEVEL control full on, touch terminal V1-3 with one lead of a .01 μfd condenser, hold the other lead in your hand. (CAUTION: Do not touch the chassis or any other metallic body with your other hand while making this test.) This should cause a decided increase in hum level at the speaker, if the circuit from this point is normal. Work back through the circuit, touching terminals V1-2, V2-1, V2-2, V2-6, V2-7, V1-6, V1-7, V3-6, V3-7, V3-1 and V3-2. The hum increase should be noticed at each point and will generally become greater as you work back. At some point, the circuit will appear to be dead and all circuitry following that stage may be disregarded in your trouble shooting. In this way, you can easily locate the source of the trouble and expedite its correction.

VOLTAGE CHART

SOCKET	Pin 1	Pin 2	Pin 3	Pin 4 and 5	Pin 6	Pin 7	Pin 8	Pin 9
V1	180	56	94	H	180	54	90	H
V2	118	0	1	H	155	2.0	3.5	H
V3	96	NS	.64	H	98	NS	0.6	H
Filter Condenser	Terminal ▲ 320		Terminal ■ 270		Terminal ▲ 180		Terminal ▬ 140	

All voltages are positive DC to chassis, measured with Heathkit V-6 Vacuum Tube Voltmeter with 11 megohm input resistance. Voltage between points marked H is 6.3 volts AC. NS indicates reading not significant. Measurements made with 320 volts DC input to filter system.

BIBLIOGRAPHY

"The Saturday Review Home Book of Recorded Music and Sound Reproduction," Prentice Hall, Inc., New York

Read, O.; "The Recording and Reproduction of Sound," Howard W. Sams and Company, Inc. Indianapolis

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IMPORTANT NOTICE

If this preamplifier is to be used with a Heathkit model WA-1, W-2M or W-3M Williamson-type Amplifier, the following changes must be made in the main amplifier before the preamplifier is plugged in. (See Pictorial H.)

( ) 178. Remove the bottom cover of the power supply chassis. Carefully unsolder the green-yellow transformer lead connected to the ground lug of the connector socket. DO NOT disconnect the lead from pin 3 of the socket to this ground lug. This removes any connection between the filament circuit and the chassis of the main amplifier. Tape the free lead and replace the bottom cover.

( ) 179. Remove the bottom cover of the main amplifier chassis. Connect the 15 KΩ 1 watt resistor from the blank pin 5 on the connector socket (use sleeving) (S) to terminal C2 (S) on the 2-lug terminal strip between the connector socket and the 5881 tube socket. (C2 is the terminal nearer the center of the chassis.) The body of the resistor can be placed directly against the chassis below the 0.25 μfd condenser. Replace the bottom cover.

If the preamplifier is to be used with any other power source, make an adapter to supply the following voltages to the octal connector on the 8-conductor cable:

Pin 1 - One side of filament circuit, 6.3 V at 1.0 amp. AC
Pin 2 - Other side of filament circuit*
Pin 3 - Negative plate supply
Pin 4 - No connection
Pin 5 - Positive plate supply, 300 volts at 10 ma DC
Pin 6 and Pin 7 - AC switch terminals
Pin 8 - No connection

*Filament circuit must be isolated from chassis or plate supply.