Assembling
and Using Your...

Heathkit

MONOAURAL-STEREO
HIGH FIDELITY
PREAMPLIFIER

MODEL SP-2A

HEATH COMPANY
A Subsidiary of Daystrom Inc.
BENTON HARBOR, MICHIGAN
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 1/4 watt, 1 or 2 watt may be color coded but the first band will be double width.

### Molded Mica Type Capacitors

#### RMA 3-Dot (Obsoleted) Rated 500 W.V.D.C. ± 20% Tol.

<table>
<thead>
<tr>
<th>Current Standard Code</th>
<th>JAN &amp; RMA Code</th>
<th>Class</th>
<th>1st Significant Figure</th>
<th>Tolerance</th>
<th>2nd Significant Figure</th>
<th>Tolerance</th>
<th>Blank</th>
</tr>
</thead>
</table>

#### RMA 6-Dot (Obsoleted)

<table>
<thead>
<tr>
<th>Working Voltage</th>
<th>Multiplier</th>
<th>2nd Significant Figure</th>
<th>Tolerance</th>
<th>Working Voltage</th>
<th>Blank</th>
</tr>
</thead>
</table>

#### RMA 4-Dot (Obsoleted)

<table>
<thead>
<tr>
<th>Working Voltage</th>
<th>Multiplier</th>
<th>Tolerance</th>
<th>Blank</th>
</tr>
</thead>
</table>

### Molded Paper Type Capacitors

#### Tubular Capacitor

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

#### Molded Flat Capacitor

- Normally stamped for value
- Commercial Code
- Working Volt

#### Jan. Code Capacitor

- Characteristic
- Tolerance
- Multiplier

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
ASSEMBLY AND OPERATION OF THE HEATHKIT MONAURAL-STereo HIGH FIDELITY PREAMPLIFIER
MODEL SP-2A

SPECIFICATIONS

The following specifications on the Model SP-2A Monaural-Stereo Preamplifier are presented in the belief that you are entitled to a factual and comprehensive technical report on the performance of the preamplifier.

These specifications are based on actual measurements taken on a typical SP-2A Preamplifier, using the most modern and accurate test equipment available today. Measurements were made under the most carefully controlled conditions, not to present the most favorable advertising information, but in strict accordance with generally accepted standard conditions. These conditions are listed with, or at the end of the specifications.

Minor variations from these specifications may be encountered in individually assembled kits. Such factors as exact lead placement, component variations and tube characteristics are possible sources of deviations. However, in a highly stable preamplifier such as the SP-2A, these minor variations may be disregarded from a performance point of view.

11/6/59
Inputs:

There are six inputs in each of the two preamplifier channels or twelve in all. Each is terminated in a standard phono socket on the bottom of the chassis. These twelve inputs insure the compatibility of the preamplifier with nearly any possible source of monaural or stereo sound. The six inputs contained in each channel are as follows:

1. TAPE HEAD
2. MAGNETIC PHONO
3. MICROPHONE
4. AUXILIARY 1
5. AUXILIARY 2
6. AUXILIARY 3

Input Sensitivity: (For 2.5 volts RMS output) with BASS and TREBLE controls set with pointer approximately at 12 o'clock.

TAPE HEAD ......................... 0.002 volts at 1 KC.
MICROPHONE ...................... 0.015 volts.
MAGNETIC PHONO .................. 0.002 volts at 1 KC (level control at maximum).
AUXILIARY 1, 2, and 3 ............ 0.25 volts (with level controls at maximum).

Input Impedances:

TAPE HEAD ......................... 100 K ohm load resistor at input socket.
MAGNETIC PHONO .................. A 47 K ohm resistor is supplied for the magnetic phono load. This value may be changed if suggested by the manufacturer of the cartridge used.
AUXILIARY 1, 2, and 3 ............ 0.6 megohm each.

NOTE: When Function Selector switch is in the AB MIX position, a 5 db loss in gain will be noted.

Input and Output Level Controls:

There are five level controls in each of the two preamplifier channels. All are Audio Taper Controls with knurled screwdriver slotted shafts. The function and value of individual controls are as follows:

1. MAGNETIC PHONO level set....... 500 K ohm.
2. AUXILIARY 1 level set........... 500 K ohm.
3. AUXILIARY 2 level set........... 500 K ohm.
4. AUXILIARY 3 level set........... 500 K ohm.
5. "OUTPUT TO POWER AMPLIFIER" level set........ 10 K ohm.

Note: The above group of controls is duplicated in each preamplifier channel.

Outputs:

Two in each channel; OUTPUT TO TAPE RECORDER, and OUTPUT TO POWER AMPLIFIER. Each is terminated in a standard phono socket on the bottom of the preamplifier chassis.
OUTPUT TO POWER AMPLIFIER is variable from 0 to 2.5 volts RMS from any normal program source, with individual control (in each channel) of input selection, record and tape compensation, level, loudness, and balance. Cathode followers are used for both Power Amplifier Outputs; it is recommended that a 200 K ohms or more load be used. This may be shunted with 1000 μfd with less than 1.5 db loss at 20,000 cycles, or up to 40 feet of (RG-58-AU) coaxial cable may be used between the preamplifier and power amplifier.

TAPE RECORDER OUTPUT provides a minimum of 0.5 volts RMS from any normal program source, with individual control (in each channel) of input selection, and record or tape compensation, but independent of level, loudness, and tone controls. With 200 K ohms or higher load this output may be shunted by 600 μfd with less than 3 db attenuation at 14,000 cycles, or 24 feet of (RG-58-AU) coaxial cable may be used between the preamplifier and tape recorder.

Frequency Response:

± 1.0 db from 20 cps to 20,000 cps.

± 1.5 db from 15 cps to 30,000 cps.

The above measurements were taken through the three AUXILIARY INPUTS with all controls set flat and level controls at maximum. Measurements taken through the MICROPHONE input are shown below:

± 1.0 db from 25 cps to 30,000 cps.

± 3.0 db from 20 cps to 35,000 cps.

Harmonic Distortion:

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

<table>
<thead>
<tr>
<th>Input</th>
<th>20 cps</th>
<th>1000 cps</th>
<th>10,000 cps</th>
<th>20,000 cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 mv at TAPE HEAD</td>
<td>.4%</td>
<td>.35%</td>
<td>.3%</td>
<td>.3%</td>
</tr>
<tr>
<td>6.0 mv at MAGNETIC PHONO</td>
<td>.4%</td>
<td>.35%</td>
<td>.3%</td>
<td>.3%</td>
</tr>
<tr>
<td>20 mv at MICROPHONE</td>
<td>.4%</td>
<td>.25%</td>
<td>.25%</td>
<td>.25%</td>
</tr>
<tr>
<td>0.25 V at AUXILIARY INPUTS</td>
<td>.15%</td>
<td>.15%</td>
<td>.15%</td>
<td>.15%</td>
</tr>
</tbody>
</table>

Intermodulation Distortion:

Measured at 60 and 6000 cps with 12 db or 4.1 input voltage ratio, the lower frequency being at the higher voltage. Tone and loudness controls set at flat positions, with level controls at maximum. Indicated output voltage obtained by adjustment of input signal level from the generator.
Hum and Noise:

2.5 mv at TAPE HEAD input........... 50 db or more below 2.5 volts RMS output.

6 mv at MAGNETIC PHONO input level control set for 6 mv sensitivity, selector switch at RIAA position. Readings are similar in LP or 78 positions................. 65 db below 2.5 volts RMS.

20 mv at MICROPHONE input......... 65 db below 2.5 volts RMS.

0.1 volt at AUXILIARY inputs........ 75 db below 2.5 volts RMS.

Phonograph and Tape Compensation:

For magnetic type phonograph cartridges three equalization circuits are provided; RIAA (Recording Industry Association of America, Inc.), Columbia LP and 78.

For TAPE HEAD input the NARTB (National Association of Radio and Television Broadcasters) equalization characteristic is provided. Graph A shows the frequency response of the equalized inputs. Note that the preamplifier has been carefully designed to reproduce each playback characteristic accurately, thereby insuring faithful reproduction of recorded material.
Tone Controls:

Separate BASS and TREBLE controls in each channel. BASS control provides approximately 15
db boost and 17 db cut at 30 cps. TREBLE control provides approximately 12 db boost and 20
db cut at 15,000 cps. See Graph B for curves.

![Graph B](image)

Loudness and Level Controls:

For more critical adjustment of sound level and loudness compensation (compensates for loss
of sensitivity of the human ear to high and low frequencies at low listening levels) separate
LOUDNESS and LEVEL controls are provided in each preamplifier channel. LOUDNESS con-
trols very closely reproduce the Fletcher-Munson frequency response curves for any setting of
the LEVEL control. Loudness compensation may be bypassed if control is set in OFF position.
See Graph C for typical frequency response of control.

![Graph C](image)
Scratch Filter (A Channel only):

A constant K low pass filter designed to cut off very sharply (24 db/octave) at 5000 and 7000 cps, depending on SCRATCH FILTER switch setting. Filter minimizes scratch and high frequency noise from tapes or records. See Graph D for typical response.

![Graph D](image)

Remote Stereo Balance Control:  

A 100 K ohm linear control with 20 feet of cable for balancing the stereo system from the listening position. May or may not be used; unit is plugged into the bottom of the rear (B) preamplifier chassis. Provides for 7 db gain change in either preamplifier channel, for a total of 14 db.

Switch Controls:

**INPUT SELECTOR (2)................** 8 position rotary type.

Individual switch positions as follows:

1. **TAPE HEAD**
2. **MICROPHONE**
3. **MAGNETIC PHONO - RIAA**
4. **MAGNETIC PHONO - LP**
5. **MAGNETIC PHONO - 78**
6. **AUXILIARY 1**
7. **AUXILIARY 2**
8. **AUXILIARY 3**

**NOTE:** One Input Selector switch in each channel for independent selection of program source and equalization.
SCRATCH FILTER (1)................. 3 position rotary type, located in and effective in the A channel only.

Switch positions as follows:
(1) Off
(2) 5 KC
(3) 7 KC

FUNCTION SELECTOR (1)............ 4 position rotary type, contained in the B channel only.

Switch positions as follows:
(1) STEREO......................... Separate output for each channel.
(2) A CHANNEL....................... A Channel monaural.
(3) B CHANNEL....................... B Channel monaural.
(4) A - B MIX....................... Two channel mixing.

AC POWER (1)....................... 2 position (off-on) rotary 5 ampere line switch. Controls preamplifier power, Auxiliary AC Power Switch, and four (4) receptacles on the chassis.

AUXILIARY AC POWER (1)........... 2 position (off-on) rotary 5 ampere line switch. Controls one AC receptacle on the chassis.

HUM BALANCE CONTROLS (2)....... 100 ohm wire wound. One in each channel for balancing out hum which may be introduced by tube heaters.

Power Supply:

Built in DC power supply is contained in a separate plug-in chassis mounted at the rear of the two preamplifiers. Five AC receptacles are provided within the power supply to facilitate complete control of the High Fidelity system from the preamplifier control center. AC receptacles are listed below with their respective switch control:

<table>
<thead>
<tr>
<th>Receptacles</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) AC NORMAL..................</td>
<td>Unswitched (for record changer).</td>
</tr>
<tr>
<td>(2) AC SWITCHED...............</td>
<td>AC Power Switch.</td>
</tr>
<tr>
<td>(3) AC SWITCHED...............</td>
<td>AC Power Switch.</td>
</tr>
<tr>
<td>(4) AC SWITCHED...............</td>
<td>AC Power Switch.</td>
</tr>
<tr>
<td>(5) AUXILIARY AC SWITCHED.....</td>
<td>AC Power and Auxiliary AC Power Switch.</td>
</tr>
</tbody>
</table>

Power Requirements:............... 117 volts-60 cycles AC, 21 watts at 117 volts (for preamplifier only, no load on AC receptacles).
Tube Complement: ................ 2 - EF86  
2 - 12AU7  
2 - 12AX7

NOTE: One of each tube type is contained in each preamplifier channel.

Accessories: ....................... Two octal (8 pin) plugs are provided with each kit for power amplifiers which require an external line switch.

Finish:

Control Panel: ...................... Black with gold lettering. Trim strip is gold anodized aluminum (brush finish) with black lettering.

Cabinet: ............................ Vinyl-clad steel; has leather texture in black with inlaid gold design.

Dimensions:

With Cabinet. ........................ 15 5/16" wide x 4 5/8" high x 8 1/2" deep.

Without Cabinet. .................... 15" wide x 4 1/2" high x 7 13/16" deep.

NOTE: Depth dimensions are taken from the front surface (not including knobs) of the control panel or vinyl cover, to the rear of the preamplifier chassis. Feet are not included in height dimensions.

Mounting: ........................... May be mounted in any position.  
14 3/4" x 4 1/4" opening required for panel mounting.

Weight:

Net Weight. .......................... 11 lbs.

Shipping Weight. ................... 15 lbs.

The preceding performance measurements were taken on a preamplifier representative of the average production unit. Variations from the specifications are to be expected. However, these deviations will be at a minimum due to the encapsulated printed circuits, and printed circuit board construction. Unless otherwise stated in the specifications, the following control settings were maintained during test.
"Level" Controls.................... MAXimum
"Loudness" Controls................... off
"Auxiliary" Level Controls........... MAXimum
"Mag Phono" Level Controls.......... 6MV sensitivity position
"Output" Level Control............... MAXimum
"Hum Balance" Control................ optimum; for particular selector switch setting

In accordance with good engineering practice a list of the test equipment used in making the specification measurements for the SP-2 Monaural Stereo Preamplifier is given below:

AC Voltage Metering................... Hewlett Packard Model 400 D
                                      Vacuum Tube Voltmeter
                                      Heathkit Model AV-3 Vacuum Tube Voltmeter

Generators......................... Krohn-Hite Model 440-A Test Oscillator
                                      Hewlett Packard Model 650 A
                                      Test Oscillator
                                      Heathkit Model AG-10 Sine-Square Generator

Distortion......................... Hewlett Packard Model 330 B
                                      Harmonic Distortion Meter
                                      Heathkit Model AA-1 Intermodulation
                                      Distortion Meter

Oscilloscope....................... Tektronix Type 515 Oscilloscope

Line Voltage Control................. General Radio Co. Type W5MT Variac
                                      Beckman Instruments, Inc. Model 6R115C10A
                                      A. C. Voltmeter
GENERAL DESCRIPTION

The Heathkit Monaural-Stereo Preamplifier is available in three distinct kits. It is possible to purchase a versatile stereo preamplifier (SP-2A, or buy the high quality monaural version (SP-1A) and add a second, or stereo, channel later on if desired.

A unique building block design makes possible converting the monaural preamplifier to stereo, or two separate preamplifier channels, by adding the CSP-1A conversion kit. To make the conversion, no rewiring is required in the already existing monaural channel. The conversion kit is simply wired and plugged into the rear of the original A Channel preamplifier. The cabinet and chassis of the monaural preamplifier are specially designed to accommodate the additional chassis.

The new preamplifier B Channel added is identical with the A Channel with the following exceptions: A function selector switch is provided in the B Channel instead of a scratch filter. This outstanding feature provides two-channel mixing, as well as A Channel monaural, B Channel monaural, and stereo; a remote balance control with 20 feet of cable allows balancing the stereo system from the listening position. Only a few minutes are required to plug the B Channel into the preamplifier. The control shafts plug directly through the A Channel control knobs, allowing the smaller B Channel control knobs to operate concentrically with the A Channel knobs.

The preamplifier chassis and power supply chassis are completely separate; in this way hum and noise are reduced to an absolute minimum. For ease of construction, a printed circuit board is also used in each preamplifier channel. The printed circuit board in each channel further assures that each assembled unit will be constructed exactly as intended by the designer. Three encapsulated printed circuits are also used in each channel; each of which has been designed so that it may be soldered directly to controls and in this way minimize lead length and number of solder connections required.

CIRCUIT DESCRIPTION

In addition to the information given in the General Description, a comprehensive circuit description will be presented. This description is presented in the belief that a basic understanding of circuit operation will be of help in utilizing the preamplifier to its fullest capabilities. A functional block diagram will be used to facilitate a better understanding of the circuit operation. Here each portion of the circuit will be separated into individual blocks or stages, and a brief description of each given.

The SP-2A Preamplifier may be divided into three basic units: The A Channel Preamplifier, the B Channel Preamplifier, and the Power Supply. In Figure 1, these three units are shown by dotted lines which encompass the necessary stages for each. As each amplifier is an independent audio channel, it is possible to reproduce two sound channels simultaneously, therefore making possible the reproduction of stereophonic sound.

For ease of explanation, the A Channel Preamplifier will be discussed in detail and then the differences in the B Channel will be covered. Refer to the block diagram in Figure 1.

Three low-level inputs are provided in this preamplifier: "Microphone", with a flat frequency response; "Magnetic phono", with RIAA (Recording Industry Association of America) LP and 78 equalization; and "Tape Head" with NARTB (National Association of Radio and Television Broadcasters) equalization. With the selector switch in the "Tape Head" position, the output from a tape play-back head may be applied directly to the "Tape head" input of the preamplifier. The audio signal reproduced by the head is applied through a standard phono jack into the preamplifier via the selector switch. From the selector switch the audio signal is applied to the grid of V1, a low noise EF86 pentode amplifier. In this stage, the audio signal is amplified about two and one half times and then coupled to the compensation network. When one of the two compensated inputs (tape head or magnetic phono) is selected by the selector switch, the proper
components in the compensation network are simultaneously selected. The purpose of the compensation network is to shape the frequency response of the low voltage amplifier (EF86) to conform to one of the four compensation characteristics provided by the preamplifier. The entire compensation network is enclosed in an encapsulated or durez dipped printed circuit (P. E. C. 84-8), making possible mounting the network on the selector switch; therefore, the leads coming from the network are as short as possible.

The output of the compensation network is then applied to the 12AU7 amplifier, V2-A. In this stage the signal will be amplified to approximately one tenth of a volt, or to a voltage level which corresponds with the normal high-level input. In this way, the signal from the low-level inputs and the high-level inputs are approximately the same at this point in the circuit. Therefore, little or no change in sound level should be experienced when switching from low-level to high-level inputs.

The three high-level inputs are also selected by the "selector switch" as shown in the block diagram. Either the high or the low-level inputs are then applied to the scratch filter switch circuit. The "scratch filter switch" determines whether the signal is coupled through the scratch filter itself or is bypassed on to the next stage. There are three settings on the scratch filter switch: OFF, 5 KC, and 7 KC. It is, therefore, possible to determine the frequency beyond which the scratch filter attenuates the signal. If the switch is set in the 5 KC position, the frequency response of the preamplifier will be flat to 5 KC and then cut off at approximately 24 db per octave beyond this point. If the switch is set at 7 KC, the scratch filter will cut off at 7 KC at the same rate. The scratch filter is a constant K type circuit, composed of a 2.2 henry high Q coil (L1) and four capacitors (C8, C9, C10, and C11). Two of these capacitors are placed in shunt with the filter coil at each switch setting; the frequency at which the scratch filter begins to cut off being primarily determined by the size of the two shunt capacitors selected.
If the scratch filter switch is set in the OFF position, the audio signal is shunted past the scratch filter and applied directly to V2-B, a 12AU7 amplifier. Here the signal is again amplified approximately two and one half times and coupled out to the tone control network (P. E. C. 84-1) and the tape recorder output jack. With most signal sources, the tape recorder output can be expected to provide approximately .5 volts rms output. This will be more than sufficient for almost all tape recorders.

All of the components in the tone control network are enclosed in an encapsulated printed circuit, which is soldered directly to the bass and treble controls. The tone control incorporated in this preamplifier makes possible the adjustment of the bass boost or cut, and treble boost or cut independently. Independent bass and treble controls are considered necessary for adequate control of tone coloration of the normal program material.

Due to losses inherent in the tone control circuit, it is necessary to have an additional stage of gain before applying the audio signal to the output cathode follower of the preamplifier. For this reason, the signal is coupled from the tone control network into V3-A, one half a 12AX7 triode amplifier, where the signal is amplified approximately 20 db to compensate for the loss in the tone control network. From here the signal is applied to the loudness control network.

The loudness control network (P. E. C. 84-9) is mounted on the rear of the one megohm loudness control in an encapsulated printed circuit. This network, along with the specially constructed loudness control, has been designed to compensate for the hearing characteristics of the average listener as dictated by the Fletcher-Munsen curves. If desired, the network may be bypassed by placing the loudness control in the full clockwise or OFF position.

Refer to the block diagram and note the shorting wire "S" between the loudness control and the output cathode follower. If the A Channel preamplifier is used independently, this wire is placed in the circuit and the audio signal from the loudness control is applied directly to the 12AX7 cathode follower V3-B. The purpose of this stage is to provide a low impedance output from the preamplifier, so that a relatively long length of shielded cable may be used between the preamplifier and the power amplifier with relatively little loss of high frequencies.

This completes the circuit operation of the A Channel preamplifier. Now refer to the block diagram and note that the B Channel is the same except that it does not contain a scratch filter. The output from the 12AU7 amplifier V2-A and the high-level inputs are applied directly to 12AU7 amplifier V2-B. In place of the scratch filter, a function selector switch has been added in the B Channel. When the two Channels are used together the shorting wire "S" in the A Channel is removed, and the output from the A Channel loudness control network is applied to the function switch. In this way the outputs from either the A or B Channels may be controlled by the function selector switch contained in the B Channel.

Figure 2 illustrates the action of the function selector switch. Note that the switch has been introduced into both channels between the loudness control networks and the output cathode followers. When the switch is in the A Channel position, the output from the A Channel is applied to the grids of the two (A and B Channel) output cathode followers, as shown in Figure 2A. If the switch is placed in the B Channel position, the output from the B Channel is applied to the grids of the two output cathode followers as shown in Figure 2B. In this way the stereo preamplifier will reproduce monaural program material from either preamplifier through one or both of the power amplifiers normally used with the stereo system. For two-channel mixing, the switch is placed in the A-B Mix position. When this is done, the output from the A and B preamplifiers is mixed immediately following the loudness control networks, as shown in Figure 2C, and then applied to both the A and B Channel output cathode followers. The combined output is then applied to a power amplifier from either Output to Power Amplifier socket. If desired, the unused Output to Power Amplifier socket may then be used to record the resulting mixed material. In the stereo position, each preamplifier channel is an independent unit. Therefore, two channels of sound may be reproduced simultaneously.
Figure 2  "Function Selector Switch" Functional Block Diagram

To facilitate equalizing the relative level of the two stereo preamplifier channels, a stereo balance control may be plugged into the B Channel. This is a 100 K ohm linear control connected to the end of 20 feet of 3-wire shielded cable. With this control, it is possible to vary the gain of either channel approximately 7 db for a total change of 14 db.

This completes the circuit description of the two preamplifier channels. Now consider the power supply portion of the circuit. The power supply is a conventional transformer operated, full wave, voltage doubler circuit contained on its own separate chassis. The power transformer windings which are used in the two preamplifier channel independently. The utilization of independent filament supplies, along with independent filament balance controls, insures that hum will be at the practical minimum.

Also included in the power supply channel are five AC receptacles one connected across the line for powering a turntable, or record changer, three switched by the AC power switch for accessory equipment, and one controlled by the auxiliary AC power switch. These may be wired in other ways to accomodate special needs, but the 5 ampere rating of the switches should not be exceeded.

PRELIMINARY INSTRUCTIONS

This manual is supplied to assist you in every way to complete the instrument with the least possible chance for error. We suggest that you take a few minutes now and read the entire manual through before any work is started. This will enable you to proceed with the work much faster when construction is started. The large fold-in pictorials are handy to attach to the wall above your work space. Their use will greatly simplify the completion of the kit. These diagrams are repeated in smaller form within the manual. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.
UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with each part. Refer to the charts and other information shown on the inside covers of the manual to help you identify any parts about which there may be a question. 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 and if a few are missing, please obtain them locally if at all possible.

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

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are carefully checked before they are approved and the parts supplied will work satisfactorily. By checking the parts list for resistors, for example, you may find that a 120 K ohm resistor has been supplied in place of a 100 K ohm as shown in the parts list. These changes are self evident and are mentioned here only to prevent confusion in checking the contents of your kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used. Read through the entire manual before starting construction. In this way you will become familiar with the techniques employed in the building of your kit. As a further deterrent to errors, read each step of the construction and wiring completely before performing that step.

We suggest you do the following before any work is started:
1. Attach the large fold-in pictorials to the wall above your work bench.
2. Go through the entire assembly and wiring instructions. This is an excellent time to read the entire instruction section through and familiarize yourself with the procedure.
3. Lay out all parts so that they are readily available. Refer to the general information inside the front and back covers of this manual to help you identify components.

The following instructions are presented in a simple, logical, step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before you start to do it. When the step is completed, check it off in the space provided.
A CHANNEL PREAMPLIFIER

PICTORIAL 1

Step-By-Step Assembly

( ) Identify the A Channel Preamplifier Chassis. It may be identified by the notch in the front apron. Further identification may be made by comparing the chassis with Pictorial 1. Be absolutely sure that you have the proper chassis before proceeding with the assembly.

( ) Are you sure that you have selected the proper chassis?

( ) Place the chassis on the worktable and orient it as shown in Pictorial 1. The side with the large rectangular opening must be resting on the table with the 4 round holes to your right.

( ) Select the Triple Phono Socket S, shown in the lower right corner of the chassis. Mount the Triple Phono Socket S on the chassis as shown in Detail 1, with solder-lug S1 to the left. Be sure that the insulating wafer and nuts are on the correct side of the chassis. Use four 6-32 x 3/8" screws, #6 lockwashers and 6-32 nuts.

( ) Mount a second Triple Phono Socket R in the same way next to the one just installed. Use the same type hardware and be sure that all screws installed thus far are tightened securely. R1 must be positioned as shown.
Locate a plastic clamp. Refer to Detail 2 and clip off one corner as shown.

Mount Double Phono Socket P on the left end of the chassis. Place the plastic cable clamp, just prepared, on the upper left mounting screw, as shown in Pictorial 1. Do not tighten the nut holding this clamp. Use the same hardware as before.

Locate four 500 Kohm #10-35 level controls with screwdriver slotted shafts and install one of each at J, K, L, and M on this chassis. Mount the four controls, using one control lockwasher between the control bushing and the chassis as shown in Detail 3. Before tightening the control nut position the terminals exactly as shown in Pictorial 1.

In the same way install a 10 Kohm #10-88 level control with screwdriver slotted shaft at H on the chassis. Position the terminals as shown.

Pictorial 2 illustrates the procedure for mounting the Control Plate and its associated parts on the front apron. Refer to Pictorial 2 and mount the "Heathkit" nameplate on the outside of the front panel. Insert the pins through the two small holes provided in the center of the gold trim strip. Touch the ends of the pins with a soldering iron, so that the plastic material flows enough to secure the nameplate to the panel.

Select the two control bushings and install on the outside of the front panel in the holes provided at either end of the gold trim strip. Use one flat steel washer between the gold trim strip and the shoulder of each bushing, as shown in Pictorial 2. Secure each bushing with a control lockwasher and nut.

Orient the control panel with respect to the chassis as shown in Pictorial 2. Note that the hole marked SELECTOR is to the right and over hole G in the chassis. The rear of the control plate must be positioned next to the apron.

Identify the 1 megohm Hollow Shaft (tapped) Control #10-79. This is the only hollow shaft control with 5 solder terminals. Mount the control as follows: Place the control plate on the outside of the chassis apron with the hole marked SELECTOR over hole G. Place a control lockwasher on the bushing of the control and insert the bushing into hole B. Place a flat control washer on the outside of the control panel and secure (do not tighten) with a control nut. Position the control terminals as shown in Pictorial 2.

Mount the 250 Kohm Hollow Shaft Control #10-83 at C in the same way. Orient the solder terminals as shown. Do not tighten the control nut.

Install one of the 1 megohm Hollow Shaft Controls #10-81 at E with the terminals up. Do not tighten the control nut.
( ) Install the other 1 megohm Hollow Shaft Control (10-81) at F, with the terminals up as shown. Do not tighten the control nut.

( ) Locate the Pilot Light Socket, red lens and lens nut. Insert the red lens through hole D from the outside. Pass it through the control panel first and then through the notch in the chassis apron. Place the pilot light socket on the shank of the lens as shown. Secure the pilot light assembly with the lens nut, while keeping the pilot light bracket perpendicular to the bottom of the chassis. Tighten the lens nut firmly.

( ) Select four of the large black knobs. Remove the gold inserts by inserting a screwdriver or similar device through the hollow bushing in the center of the knob, and press out the insert.

( ) Install all four knobs on the shafts of the controls just mounted, and turn all four controls to the maximum clockwise position. Now align the pointers on the knobs with the appropriate panel markings by rotating the controls slightly. It should not be necessary to rotate any one of the four controls more than a few degrees. If a pointer is opposite its appropriate panel marking, remove the knob and replace it in the opposite direction. Tighten the controls nuts after the pointers are aligned.

All parts except those that are wired as sub-assemblies are now assembled to the chassis.
PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

Correct soldering technique is extremely important. Good solder joints are essential if the performance engineered into the kit is to be fully realized. If you are a beginner with no experience in soldering, a half-hour’s practice with odd lengths of wire and a tube socket will be a worthwhile investment.

High quality solder of the proper grade is most important. There are several different brands of solder on the market, each clearly marked "Rosin Core Radio Solder." Such solders consist of an alloy of tin and lead, usually in the proportion of 50:50. Minor variations exist in the mixture such as 40:60, 45:55, etc. with the first figure indicating the tin content. Radio solders are formed with one or more tubular holes through the center. These holes are filled with a rosin compound which acts as a flux or cleaning agent during the soldering operation.

NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes. Such compounds, although not corrosive at room temperatures, will form residues when heated. The residue is deposited on surrounding surfaces and attracts moisture. The resulting compound is not only corrosive but actually destroys the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will create erratic or degraded performance of the instrument.

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 "ROBIN CORE RADIO SOLDER" BE PURCHASED.

If terminals are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good joint is made without relying on solder for physical strength. To make a good solder joint, the clean tip of the soldering iron should be placed against the joint to be soldered so that the terminal is heated sufficiently to melt solder. The solder is then placed against both the terminal and the tip of the iron and will immediately flow out over the joint. Refer to the sketch below. Use only enough solder to cover wires at the junction; it is not necessary to fill the entire hole in the terminal with solder. Excess solder may flow into tube socket contacts, ruining the socket, or it may creep into switch contacts and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.

CRIMP WIRES
HEAT CONNECTION
APPLY SOLDER
ALLOW SOLDER TO FLOW
A poor solder joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface, caused by movement of the joint before it solidified is another evidence of a "cold connection. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance. Illustrations below clearly indicate these two characteristics.

COLD SOLDER JOINT CONNECTION INSUFFICIENTLY HEATED

PROPER SOLDER CONNECTION

COLD SOLDER JOINT CONNECTION MOVED WHILE COOLING

A good, clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 30 to 60 watt iron, or the equivalent in a soldering gun, is very satisfactory. Smaller irons generally will not heat the connections enough to flow the solder smoothly over the joint and are recommended only for light work, such as on etched circuit boards, etc. Keep the iron tip clean and bright. A pad of steel wool may be used to wipe the tip occasionally during use.

Take these precautions and use reasonable care during assembly of the kit. This will insure the wonderful satisfaction of having the instrument operate perfectly the first time it is turned on.

NOTES ON WIRING

Read the notes on soldering and wiring on the inside rear cover. Crimp all leads tightly to the terminal before soldering. Be sure both the lead and terminal are free of wax, corrosion or other foreign substances. Use only the best rosin core solder, preferably a type containing the new activated fluxes such as Kester "Radio-TV Solder", Ersin "Multicore" or similar types.

Unless otherwise indicated, all wire used is insulated. Wherever there is a possibility of the bare leads on resistors and capacitors shorting to other parts or to chassis, the leads should be covered with insulated sleeving. This is indicated in the instructions by the phrase "use sleeving." Bare wire is used where the lead lengths are short and the possibility of short circuits is non-existent.

Leads on resistors, capacitors and transformers are generally much longer than they need to be to make the indicated connections. In these cases, the excess leads should be cut off before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points. Not only does this make the wiring much neater but in many instances, the excessively long leads will actually interfere with proper operation of the instrument.

The pictorials indicate actual chassis wiring and designate values of the component parts. We very strongly urge that the chassis layout, lead placement and grounding connections be followed exactly as shown. While the arrangement shown is probably not the only satisfactory layout, it is the result of considerable experimentation and trial. If followed carefully, it will result in a stable instrument operating at a high degree of accuracy and dependability.
Space has been provided for you to check off each operation as it is completed. This is particularly important in wiring and it may prevent omissions or errors, especially where your work is interrupted frequently as the wiring progresses. Some kit builders have also found it helpful to mark each lead in colored pencil on the pictorial as it is added.

PRELIMINARY WIRING

Special Instructions: The abbreviation "NS" indicates that the connection should not be soldered as yet, for other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" used to indicate this. Note that a number appears after each solder (S) instruction. This number indicates the number of leads connected to the terminal in question. For example, if the instructions read, "Connect a 47 K ohm resistor from socket E1 (S-2) to E6 (NS)", it will be understood that there will be two leads connected to the terminal at the time it is soldered. This additional check will help avoid errors.

○ Refer to Detail 4, Wiring of the SCRATCH FILTER switch. Locate the scratch filter switch A. This is a single wafer hollow shaft switch bearing part number B63-162 on the metal bracket. Carefully inspect the switch and identify contact A1 from the detailed drawing. Orient the switch as shown and connect a 2 1/4" length of bare wire to A1 (S-1).

○ Connect a 500 μμfd disc ceramic capacitor from A2 (S-1) to A6 (NS) (use sleeving). Position the body of the capacitor alongside the switch wafer exactly as shown in Detail 4. Do not position components or leads in front of the hollow shaft.

○ Connect a .001 μfd disc ceramic capacitor from A3 (S-1) to A7 (NS). Use sleeving on both leads. Position exactly as shown.

○ Connect a 500 μμfd disc ceramic capacitor from A4 (S-1) to A7 (NS). Position the capacitors alongside the wafer as shown. Use sleeving on both ends.

○ Connect a .001 μfd disc ceramic capacitor from A5 (S-1) to A6 (NS).

This completes the scratch filter switch sub-assembly. Set it aside for installation on the front panel later.

Now refer to Detail 5, Wiring of the SELECTOR switch.

○ Identify Selector switch G. This is a hollow shaft double wafer switch marked with part number A63-164. Compare the switch with Detail 5 and locate contact GA3. This contact is on the front or A wafer.

○ Select a 470 K ohm (yellow-violet-yellow) resistor and pass one lead through contact GC3 (NS) just far enough to reach GA3 (S-1). Use sleeving between GC3 and GA3.

○ Cut one lead of a 1 megohm (brown-black-green) resistor to a length of 3/4" and connect this lead to switch contact GC3 (S-2).

Page 20
( ) Cut a pair of 3 1/2" lengths of hookup wire, and strip about 1/4" of insulation from both ends of one of the wires. Now twist the two leads firmly together. At one end of this pair, connect the stripped lead to switch contact GC2 (S-1). Leave the other wire free.

( ) In the same way, cut a pair of 2 1/2" lengths of hookup wire, and strip both ends of one of the wires. Twist the two leads firmly together.

( ) At one end of this pair, connect the stripped lead to switch contact GC4 (NS). Leave the end of the other wire free.

( ) Connect a bare wire from GC4 (S-2) to GA4 (S-1). Do not let the lead short to the switch shield. Use sleeving.

( ) Cut a 9 3/4" length of shielded cable and prepare both ends as shown in Detail 5A. At one end cut away 3/4" of the outside insulation. Take care not to cut into the wire shield wrapped around the insulation of the inner conductor. Unwind the shield and twist into a pigtail or single wire as shown. Now remove about 1/4" of insulation from the inner conductor. Tin or apply a small amount of solder to the two exposed leads and pigtail.

( ) Prepare the other end as shown in Detail 5A. In this case, cut away the shielding when the outer insulation is removed. Tin the exposed center conductor.

( ) Connect the pigtail (at one end of this cable) to GA6 (NS).
( ) Now connect the inner conductor (at the pigtail end) to switch contact GA5 (NS) and GB5 (NS).

( ) Cut a 6 1/2" length of shielded cable and prepare both ends as before. Refer to Detail 5A.

( ) Connect the inner wire (at the pigtail end) to GD7 (S-1). Leave the pigtail and other end of the cable free.

( ) Cut a 1 3/4" length of bare wire and connect one end to GB5 (S-2) and GA5 (S-2).

( ) Cut a 1 3/4" length of bare wire and connect one end to GA6 (S-2).

( ) Connect a 1 megohm (brown-black-green) resistor from GC5 (NS) to GD6 (S-1). Position the body of the resistor as shown.

( ) Cut a 6 3/4" length of bare wire and connect one end to GC5 (S-2). Leave the other end free.

( ) Cut a 13 3/4" length of hook up wire and strip both ends. Connect one end to GB8 (S-1). Leave the other end free.

( ) Cut 3 1/4" length of hook up wire and strip both ends. Connect one end to terminal GA9 (S-1) and GB9 (S-1).

( ) Cut a 2 3/4" length of hook up wire and strip both ends. Connect one end to GA10 (S-1) and GB10 (S-1).

( ) Cut a 2 3/4" length of hook up wire and strip both ends. Connect one end to GA11 (S-1) and GB11 (S-1). Leave the other end free.

( ) Cut a 2 3/4" length of bare wire and connect one end to GC11 (NS).

( ) Select the encapsulated printed circuit containing the compensation network. This part may be identified by the five (5) leads protruding from one side. It is also stamped with part number 84-8. Further identification may be made by referring to the parts drawing at the rear of the manual. Cut all five leads to a length of 1 inch.
Inspect the encapsulated network and note that the five leads coming from the network are numbered. Refer to Detail 6 on Page 22 and insert each lead into the five switch terminals as follows:

<table>
<thead>
<tr>
<th>Network lead</th>
<th>Switch terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>GD12</td>
</tr>
<tr>
<td>No. 2</td>
<td>GC11</td>
</tr>
<tr>
<td>No. 3</td>
<td>GD10</td>
</tr>
<tr>
<td>No. 4</td>
<td>GD9</td>
</tr>
<tr>
<td>No. 5</td>
<td>GD8</td>
</tr>
</tbody>
</table>

Now position the unit exactly as shown in Detail 6 and solder all five terminals. Clip off excess lead lengths.

Cut a 3 1/4" length of bare wire and connect one end to GB12 (S-1). Leave the other end free.

This completes the Selector switch sub-assembly. Set it aside for installation on the chassis later.

CIRCUIT BOARD ASSEMBLY

Before attempting any work on the circuit boards, study Figure 3 and read the general instructions below carefully.

The following general rules are very simple and a few minutes spent in learning them will be an excellent investment. The growing application of circuit boards on all electronic equipment will soon require all technicians to be familiar with these practices.

1. NEVER USE SO-CALLED "NON-CORROSIVE" PASTES OR OTHER FLUXES. The copper foil on the circuit board has been specifically processed for ease in soldering. It will take solder perfectly, provided radio-grade rosin-core solder is used. Very little solder is required to make a perfect connection.

2. DO NOT OVERHEAT THE CONNECTION. A 20 to 60 watt iron is entirely adequate for circuit board wiring. A soldering pencil is ideal. If a soldering gun is used, be very careful to avoid excessive heating. Try to develop a technique to "solder it and get off."

3. Remember that components are generally placed on the phenolic side of the board, with their leads passing through holes to the foil side of the board. Bend the leads slightly to prevent parts falling out as they are mounted. It is generally easier to mount most or all the parts in this way and then solder all the connections at one time.

The markings on the phenolic side of the board are there to assist you in wiring and to expedite your assembly. Refer to Pictorial 3 on Page 24 when performing the following steps.

Insert the three 9-pin molded tube sockets in the holes marked V1, V2, and V3. The body of the socket goes on the phenolic side of the board, with the contacts extending through to the pattern or foil side. Align the blank space, or shield contactor spring, on the socket
Start Here

*Observe polarity (+) marking on electrolytic capacitors.
**Use sleeving on (+) lead.
with the arrow screened on the circuit board. Be sure that each socket contact is in line with a hole in the board before pushing it through. Carefully solder each contact (including center pin) to the adjacent pattern. Do not attempt to cut off the tip of the contact before or after soldering.

( ) Follow the wiring sequence diagrams (Pictorial 3) and check off each step when completed so that no parts or jumpers are omitted. Please note that the 31 steps on Pictorial 3 must be completed before proceeding with the next step. Solder all connections and clip off excess leads.

This completes the preliminary assembly of the circuit board.

FINAL ASSEMBLY AND WIRING

( ) Mount the circuit board just completed on the chassis using a 3-48 screw, nut, and #3 lockwasher in each of the four small mounting holes as shown in Pictorial 4 on Page 26. Mount lockwasher and nut on top of Printed Circuit Board. The board must be positioned as shown, with the 25 µfd 25 volt electrolytic capacitor to your right. It may be necessary to loosen the nut on control J in order to mount the circuit board more easily.

( ) Cut a 21 1/2" length of 8 conductor cable. Remove the outer jacket to expose 7" of the inner conductors (see Detail 7). This can be done by slitting the jacket with a sharp knife for a length of 7" and then peeling the jacket off by pulling with a pair of pliers.

( ) Prepare the exposed conductors by cutting each lead to the following lengths:

Yellow .... 1 1/2"  White .... 2"  Green .... 3 3/4"  Brown .... 7"
Orange .... 1 1/2"  Black .... 3 3/4"  Red ....... 6 1/2"  Blue ...... Cut this lead off at the insulation (not used).

Strip about 1/4" of insulation from all but the blue lead.

( ) At the other end of the 8 conductor cable, slip the vinyl plug cover over the cable, with its open end toward the unstripped end of the cable. Remove about 3/4" of the outer jacket from the cable. Cut off the blue lead at the jacket and strip the remaining 7 conductors to expose about 1/4" of bare wire (see Detail 7). Tin the exposed bare wires.

( ) Identify the molded 9 pin connector and note that the pins are numbered on the eyelet side of the plug. Follow the numbering on the plug and connect the 3/4" exposed wires as follows: See Detail 7.

Yellow to pin 4.  Red to pin 6.  Green to pin 8.  Blue is not used.

( ) Solder each wire firmly to the eyelet. See that none of the pins are shorted together by excess solder or an adjacent lead. After all the connections are properly made, slip the cap over the plug.
PICTORIAL 4

( ) Refer to Pictorial 4 and insert the end of the cable without plug through cable clamp N so that the clamp bears on the outer jacket. The inner conductors should fan out at the edge of the circuit board as shown. Tighten the clamp screw.

( ) Twist the orange and yellow leads together and connect either lead to the circuit board at hole Z1 (NS) and the other to Z2 (NS). Insert the bare portion of the wire through each hole and bend over slightly to secure.

( ) Insert the brown lead into the unsoldered hole (NS) with the resistor lead previously installed (force through with long nose pliers if necessary). Now turn the chassis over and solder and clip both leads.

( ) Connect the white lead to CB2 (NS) on the board and position as shown.

( ) Connect the black lead to CB3 (NS) on the board and position as shown.

( ) Connect the green lead to CB4 (NS) on the circuit board and position as shown.

( ) Connect the red lead to CB5 (NS) on the circuit board and position as shown.

( ) Carefully recheck the above connections. When satisfied that the work is done correctly, turn the chassis over and solder each of the 6 points. Clip off any excess leads.

( ) Orient the chassis as shown in Pictorial 5 and install the prewired SELECTOR switch at G. Use one control lockwasher between the switch and the chassis. When installing the selector switch, position the encapsulated network to your left as shown in the Pictorial; terminal GB12 must be near the top edge of the apron. Secure with a flat washer and control nut, but do not tighten at this time.
PICTORIAL 5

( ) Now carefully dress or position each lead coming from the switch as shown. The longest lengths of hookup wire and coaxial cable must extend to the left between the 4 controls and the apron of the chassis. The short length of coaxial cable must rest on the chassis, between the input sockets (R and S) and controls J, K, L, and M.

( ) Select one of the large black knobs and remove the gold insert as before.

( ) Install the knob on the selector switch shaft, and turn the control to its maximum clockwise position. Align the pointer with the "Auxiliary 3" point on the control panel and tighten the control nut.

Wiring of the selector switch to the chassis. Refer to Pictorial 5.

( ) Bend control terminals J3, K3, and L3 down against the shielded cable. Twist each terminal as shown in Detail 8.

( ) In the same way align terminal M3 with L3.

( ) Now pass a length of bare wire through terminals M3 (NS), L3 (NS), K3 (NS), and J3 (NS), to hole CB6 (NS) on the circuit board. Use sleeving between J3 and CB6.

( ) Locate the bare wire coming from GB5 and GA5 on the selector switch. Place sleeving over this wire and connect to M1 (S-1).

( ) Locate the bare wire coming from GA6 and connect to M3 (NS). Use sleeving.
Refer to Pictorial 6.

( ) Connect a hookup wire from S1 (NS) to S4 (NS).

( ) Locate the twisted pair of wires extending from GC4. Connect the lead that has the insulation removed to S5 (NS).

( ) Remove approximately 1/4" of insulation from the remaining lead at this end of this pair and connect to M3 (S-3).

( ) Connect the bare wire (use sleeving) extending from GB12 to M2 (S-1). Do not allow this lead to pass in front of the hollow shaft; position as shown.

( ) Connect the 1 megohm (brown-black-green) resistor extending from GC3 to S4 (NS). Use sleeving.

( ) Solder the pigtail from the shielded cable that is connected to GD7 to the bare wire between control terminals L3 and M3.

( ) Locate the twisted pair of wires extending from GC2. Connect the lead that has the insulation removed to S3 (NS).

( ) Remove the insulation from the remaining lead in this pair and connect to L3 (NS).

( ) Connect a 100 K ohm (brown-black-yellow) resistor from S5 (S-2) to S4 (NS).

( ) Connect a 47 K ohm (yellow-violet-orange) resistor from S4 (S-4) to S3 (S-2).

( ) Connect a bare wire from L3 (S-3) to S1 (NS).
Connect the bare wire (use sleeving) extending from GC11 to S1 (S-3).

Connect the 470 K ohm (yellow-violet-yellow) resistor extending from GC3 to S2 (S-1).

Connect the hookup wire extending from AB11 to L2 (S-1). Position as shown.

Connect the hookup wire extending from AB10 to K2 (S-1). Position as shown.

Connect the hookup wire extending from AB9 to J2 (S-1). Position as shown.

Connect a bare wire from R4 (S-1) to K3 (S-2). Use sleeving.

Connect a bare wire from R1 (S-1) to J3 (NS).

Connect a 100 K ohm (brown-black-yellow) resistor from R2 (S-1) to J1 (S-1).

Connect a 100 K ohm (brown-black-yellow) resistor from R3 (S-1) to K1 (S-1).

Connect a 100 K ohm (brown-black-yellow) resistor from R5 (S-1) to L1 (S-1).

Cut a 5 3/4" length of sleeving and place over the bare wire extending from GC5.

Cut a 5" length of spiral shielding and unwind about 1/2" of the wire at one end.

Cut a 5 1/4" length of the clear plastic tubing and slip it over the spiral shielding.

Now place the spiral shielding with jacket over the sleeve covered bare wire extending from GC5. The unwound end of the spiral shield must be at the free end of the bare wire.

Connect the bare wire on the inside of the sleeving to CB7 (NS) on the circuit board.

Connect the wire which was unwound from the spring or spiral shield to CB8 (NS).

Locate the short length of shielded cable extending from GD7. Connect the free end to CB9 (NS) on the circuit board. Make sure the shielding does not short to another lead.

Locate the shielded cable extending from GA5. Connect the free end to CB10 (NS) on the circuit board. Make sure the shielding does not short to another lead.

Installation of the Tone Control Network.

Identify the encapsulated tone control network. This unit may be identified by the eight (8) leads extending from one side. Part number 84-1 is stamped on one side.
Detail 9

( ) Prepare the network for installation on the chassis as shown in Detail 9. Cut leads 1 and 8 to 3/4" lengths.

( ) Cut lead number 4 to 1/4" and connect a 6 1/4" length of bare wire to it as shown. Solder the connection securely.

( ) Slip a 5 3/4" length of sleeving over the bare wire just connected to lead 4 on the network.

( ) Cut a 5" length of spiral shielding and unwind about 2 1/2" of the wire at one end and then place a 5 1/4" length of clear plastic tubing over the spiral shield.

( ) Now slip the spiral shield with tubing over the bare wire and sleeving extending from lead 4 on the network, with the pigtail on the free end of the bare wire.
( ) Install the network on the rear of controls E and F as shown in Pictorial 7. Connect lead number 1 to E3 (S-1). Position the shielded wire coming from lead 4 between the network and apron. Position the network exactly as shown.

( ) Connect lead number 8 to F1 (S-1).

( ) Connect lead number 7 to J3 (S-3). Use sleeving.

( ) Connect lead number 6 to E1 (S-1). Use sleeving.

( ) Connect lead number 5 to E2 (NS). Use sleeving.

( ) Connect lead number 4 (shielded hookup wire) to CB11 (NS) on the circuit board.

( ) Connect the pigtail from the shielded cable to control terminal C1 (NS).

( ) Connect lead number 3 to F2 (S-1). Use sleeving.

( ) Connect lead number 2 to F3 (S-1). Use sleeving.

This completes the installation of the Tone Control Network.

( ) Cut a pair of 2 3/4" lengths of hookup wire, strip all four ends and twist the two wires firmly together.

( ) At one end of this pair, connect either lead to CB12 (NS) on the circuit board and the adjacent lead to CB13 (NS).

( ) At the other end of this pair, connect either lead to D1 (S-1) on the pilot light bracket, and the other to D2 (S-1).

( ) Cut a 2 1/2" length of hookup wire and strip both ends. Connect one end to CB-24 (NS) and then the other end to C3 (S-1).

( ) Connect a bare wire from CB23 (NS) on the circuit board to C1 (NS).

( ) Cut a 6" length of bare wire. Place a 5" length of sleeving over it extending 1/2" from each end as shown in Detail 10. Cut a piece of spiral shield spring to an overall length of 4 1/2" and unwind the spring at one end to form a pigtail about 1 3/4" long. Slip the spiral shield over the bare wire and sleeving and crimp the pigtail lightly around the sleeving to prevent the shield and sleeving from slipping. Place a 5" length of plastic tubing over the spiral shield as shown.
PICTORIAL 8

( ) Connect the bare wire at the end without pigtail to E2 (S-2). Connect the other end of the bare wire to CB14 (NS) on the circuit board. Now secure the pigtail to C1 (NS). Check the position of the spiral shield and position it so that it cannot touch either the chassis or other wiring, also see that a short does not exist between the spiral shield and bare wire.

( ) Connect a 3 1/2" length of hookup wire from CB15 (NS) to B2 (S-1). Dress this lead against the circuit board.

Installation of the Loudness Control Network.

( ) Identify the encapsulated loudness control network, part number 84-9. This unit has four leads extending from one side.

( ) Install the network on the rear of the loudness control B as shown in Pictorial 8. Note the position of all four leads. Pass lead four through B1 (NS) to C1 (NS). Use sleeving between terminals B1 and C1 as shown. Now solder B1 (S-1).

( ) Pass lead one through B3 (NS) to C2 (S-1). Use sleeving between B3 and C2. Now solder B3.

( ) Position the body of the network at a right angle with the control as shown. Place sleeving over lead number three and connect to B5 (S-1).

( ) Place sleeving over lead number two and connect to B4 (S-1). Position the lead as shown. The body of the network must not rest against the rear of the control and cover the opening on the hollow shaft.

( ) Connect a 6" length of hookup wire from CB16 (NS) to P3 (NS). Dress the lead as shown.
Connect a 6 1/2" length of hookup wire from CB17(NS) to control terminal H1(S-1). Dress the lead as shown. Note: CB17 may be under the 2 μfd capacitor previously installed.

Connect a bare wire from P1(S-1) to H3(NS). Use sleeving.

Connect a bare wire from H2(S-1) to P2(S-1).

Connect a 1 megohm resistor (brown-black-green) from P3(S-2) to P4(S-1).

Locate the pre-wired SCRATCH FILTER switch, part number B63-162, and install at hole A on the chassis, using one control lockwasher between the switch and the chassis. Identify contact A1 and position up and to the right as shown in Pictorial 8. Secure the control with a washer and nut but do not tighten at this time.

Select the last large black knob and remove the gold insert.

Install the knob on the selector switch shaft, with the pointer down, and turn the control to its maximum clockwise position. Now align the pointer with the 7 KC point on the control panel and tighten the control nut.

Connect the free end of the hookup wire, previously connected to GB8, to A7(NS).

Cut a 6 3/4" length of hookup wire and strip both ends. Cut a 1 1/2" length of spirasheild and on one end, unwind a 1" pigtail. Cover the length of spirasheild with clear plastic tubing. Insert the 6 3/4" length of hookup wire through the spirasheild and position as shown in Pictorial 8.

Connect one end of the hookup wire to CB18(NS), connect the other end of the wire to A6(NS), connect the pigtail to C1(S-5).

Locate the 2.2 henry coil (part number 46-20) and install on the circuit board at hole X as shown in Detail 11. Use one 6-32 nut, small flat fiber washer, and #6 lockwasher. Position the two leads as shown.

Connect one of the coil leads to A6(S-4). Use sleeving.

Connect the other coil lead to A7(S-4). Use sleeving.

Connect the bare wire extending from A1 to H3(S-2). Use sleeving.

Cut two 3 1/2" lengths of hookup wire and strip all four ends. Install a spade lug at one end of each wire and solder securely. See Detail 12. A good connection will be assured if the tabs on the lugs are bent over the wire slightly before soldering. Connect the other end of each wire to CB19(NS) and CB-20(NS).

This completes the assembly and wiring of the A channel preamplifier. Turn the chassis over and solder the remaining 17 points on the foil side of the circuit board. At this time all holes in the circuit board (except CB21 and CB22) should be occupied. Disregard unmarked holes.

Install the pilot light in the pilot light bracket.

Set the completed preamplifier chassis aside; it will be assembled to the completed B preamplifier and power supply later.
STEP-BY-STEP ASSEMBLY OF THE B CHANNEL PREAMPLIFIER

( ) Identify the B channel preamplifier chassis. This unit is similar to the A channel chassis just completed.

PICTORIAL 1

( ) Place the chassis on the work table and orient it as shown in Pictorial 1. The side with the large rectangular opening must be resting on the table with the large round holes to your right.

( ) Select the triple phono socket SS, shown in the lower right corner of the chassis, and mount as shown in Detail 1, with solder lug SS1 to the left. Be sure that the insulating washer and nuts are on the correct side of the chassis. Use four 6-32 x 3/8" screws, #6 lockwashers and 6-32 nuts.

( ) Mount a second triple phono socket RR in the same way next to the one just installed. Use the same hardware and be sure that all screws installed thus far are tightened securely.

( ) Mount double phono socket PP on the left end of the chassis. Use four 6-32 x 3/8" screws, the #6 lockwashers, and 6-32 nuts.

( ) Locate four 500 K ohm level controls with screwdriver slotted shafts and install one of each at JJ, KK, LL, and MM on the chassis. Mount the four controls, using one control lockwasher between the control bushing and the chassis as shown in Detail 2. Before tightening the control nut, position the terminals exactly as shown in Pictorial 1.
Detail 2

( ) In the same way, install a 10 K ohm level control with screwdriver slotted shaft at HH on the chassis. Position the three terminals as shown.

( ) Identify the 1 megohm (tapped) control BB. This control has 5 solder terminals and no control shaft. Mount the control as follows: Insert the control bushing into hole BB and then rotate the body of the control until the lug seats itself into the slot provided. Place a flat washer on the bushing and secure with a control nut. See Pictorial 2.

PICTORIAL 2

( ) Mount the 250 K ohm control CC (without shaft) at CC in the same way. Seat the control lug and secure with a flat washer and control nut.
( ) Install one of the 1 megohm controls (with long shaft) at EE. Align the control lug with the slot and secure.

( ) Install the other 1 megohm control (with long shaft) at FF. Tighten securely.

( ) Identify the two-screw terminal strip NN and install on the outside of the chassis apron, passing the two solder lugs through the rectangular opening provided, to the inside. Refer to Pictorial 2 Page 35 for mounting procedure. Use two 6-32 x 3/8" screws, #6 lockwashers, and nuts.

( ) Refer to Detail 2 and note that the contacts on a 9-pin wafer tube socket are numbered consecutively in a clockwise sequence, when viewed from the bottom of the socket. Also note that pin 1 is the first pin in a clockwise direction from the blank space.

( ) Mount a 9-pin wafer socket at DD with the blank space between pin 1 and 9 to the left as shown. Use 3-48 screws and nuts. No lockwashers are used when mounting wafer tube sockets. Note that the wafer is on the inside of the chassis, do not pass the terminals through hole DD.

( ) Locate the four-terminal socket Q shown in Detail 2. Note that pin 1 is the first pin in a clockwise direction from the open space indicated by the arrow. Install the socket on the chassis at Q with pin 1 next to the large rectangular opening. Use two 6-32 x 3/8" screws, #6 lockwashers and nuts.

PRELIMINARY WIRING

Refer to Detail 3, Wiring of the Function Selector Switch.

( ) Locate the function selector switch V. This is a single wafer solid shaft switch. Carefully inspect the switch and identify contact V1 from the detailed drawing. Orient the switch as shown and connect a 10 μfd disc ceramic capacitor from V1 (NS) to V6 (NS). Use sleeving on both leads.

( ) Cut a 5 3/4" length of hookup wire and strip both ends. Connect to V1 (S-2). Leave the other end free.

( ) Cut another 5 3/4" length of hookup wire and strip both ends. Connect to V2 (S-1). Leave the other end free.

( ) Cut a 1 1/2" length of hookup wire and strip both ends. Connect to V3 (S-1). Leave the other end free.

( ) Cut another 1 1/2" length of hookup wire and strip both ends. Connect one end to V4 (NS), leave the other end free.

( ) Connect a 10 μfd disc ceramic capacitor from V4 (S-2) to V6 (S-2).

( ) Cut a 2 1/2" length of bare wire and pass 1" of the wire through terminal V5 (S-1). Refer to the detailed drawing before soldering this connection. This completes the function switch. Set it aside for installation later.
Now refer to Detail 4, Wiring of the Selector Switch.

( ) Identify the selector switch W. This is a solid shaft double wafer switch marked with part number A63-165. Compare the switch with Detail 4 and locate contact WA3. This contact is in the front or A wafer.

( ) Select a 470 K ohm (yellow-violet-yellow) resistor, and pass one lead through contact WC3 (NS) just far enough to reach WA3 (S-1). Use sleeving between WC3 and WA3.

( ) Cut one lead of a 1 megohm (brown-black-green) resistor to a length of 3/4" and connect this lead to switch contact WC3 (S-2).

( ) Cut a pair of 3 1/2" lengths of hookup wire, and strip about 1/4" of insulation from both ends of one of the wires. Now twist the two leads firmly together. At one end of this pair, connect the stripped lead to switch contact WC2 (S-1). Leave the other wire free.

( ) In the same way, cut a pair of 2 1/2" lengths of hookup wire, and strip both ends of one of the wires. Twist the two leads firmly together.

( ) At one end of this pair, connect the stripped lead to switch contact WC4 (NS). Leave the end of the other wire free.

( ) Connect a bare wire from WC4 (S-2) to WA4 (S-1). Use sleeving.
( ) Cut a 9 3/4" length of shielded cable and prepare one end as shown in Detail 4A. At one end cut away 3/4" of the outside insulation. Take care not to cut into the wire shield wrapped around the insulation of the inner conductor. Unwind the shield and twist into a pigtail or single wire as shown. Now remove about 1/4" of insulation from the inner conductor. Tin or apply a small amount of solder to the exposed lead and pigtail.

( ) Prepare the other end as shown in Detail 4A. In this case, cut away the shielding when the outer insulation is removed. Tin the exposed center conductor.

( ) Connect the pigtail (at one end of this cable) to WA6 (NS) on the selector switch.

( ) Now connect the inner conductor (at the pigtail end) to switch contact WA5.(NS) and WB5 (NS).

( ) Cut a 6 1/2" length of shielded cable and prepare both ends as before. Refer to Detail 4A.

( ) Connect the inner wire (at the pigtail end) to WD7 (S-1). Leave the pigtail and other end of the cable free.

( ) Cut a 1 3/4" length of bare wire and connect one end to WB5 (S-2) and WA5 (S-2).

( ) Cut a 1 3/4" length of bare wire and connect one end to WA6 (S-2).

( ) Connect a 1 megohm (brown-black-green) resistor from WC5 (NS) to WD6 (S-1). Position the body of the resistor as shown.
Cut a 6 3/4" length of bare wire and connect one end to WC5 (S-2).

Cut a 10 3/4" length of hookup wire and strip both ends. Connect one end to WB8 (S-1). Leave the other end free.

Cut a 3 1/4" length of hookup wire and strip both ends. Connect one end to terminal WA9 (S-1) and WB9 (S-1).

Cut a 2 3/4" length of hookup wire and strip both ends. Connect one end to WA10 (S-1) and WB10 (S-1).

Cut a 2 3/4" length of hookup wire and strip both ends. Connect one end to WA11 (S-1) and WB11 (S-1). Leave the other end free.

Cut a 2 3/4" length of bare wire and connect one end to WC11 (NS). Leave the other end free.

Select the encapsulated printed circuit containing the compensation network. This part may be identified by the five (5) leads protruding from one side. It is also stamped with part number 84-8. Further identification may be made by referring to the parts drawing at the rear of the manual.

Cut all five leads to a length of 1 inch.

Inspect the encapsulated network and note that the five leads coming from the network are numbered. Refer to Detail 5 and insert each lead into the five switch terminals as follows:

<table>
<thead>
<tr>
<th>Network lead</th>
<th>Switch terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>WD12</td>
</tr>
<tr>
<td>No. 2</td>
<td>WC11</td>
</tr>
<tr>
<td>No. 3</td>
<td>WD10</td>
</tr>
<tr>
<td>No. 4</td>
<td>WD9</td>
</tr>
<tr>
<td>No. 5</td>
<td>WD8</td>
</tr>
</tbody>
</table>

Now position the unit exactly as shown in Detail 5 and solder all leads connected to the above points. Clip off excess lead lengths.

Cut a 3 1/4" length of bare wire and connect one end to WB12 (S-1). Leave the other end free.

This completes the selector switch sub-assembly. Set it aside for installation on the chassis later.

CIRCUIT BOARD ASSEMBLY

Before attempting any work on the circuit boards, study Figure 1 and read the general instructions that follow carefully.

The following general rules are very simple and a few minutes spent in learning them will be an excellent investment. The growing application of circuit boards to all electronic equipment will soon require all technicians to be familiar with these practices.
Start Here

1. ( ) 25 µfd 25 V capacitor electrolytic tubular
2. ( ) 10 µfd 400 V capacitor plastic molded tubular
3. ( ) .05 µfd capacitor plastic molded tubular
4. ( ) 2.2 megohm resistor (red-red-green)
5. ( ) 470 KΩ resistor (yellow-orange-red)
6. ( ) 330 KΩ resistor (low noise)
7. ( ) 100 KΩ resistor (low noise)
8. ( ) .02 µfd capacitor disc ceramic
9. ( ) 6.8 KΩ resistor (blue-gray-red)
10. ( ) Cut and strip both ends of a 6" length of hook-up wire. Insert one end (as illustrated) into the same hole with the 6.8 KΩ resistor (blue-gray-red).

22. ( ) .02 µfd capacitor disc ceramic
21. ( ) 270 KΩ resistor (red-violet-yellow)
20. ( ) 1 megohm resistor (brown-black-green)
19. ( ) 1 KΩ resistor (brown-black-red)
18. ( ) 15 KΩ resistor (brown-green-orange)
17. ( ) 2 µfd 50 V capacitor * electrolytic tubular **
16. ( ) .1 µfd 200 V capacitor plastic molded tubular
15. ( ) .02 µfd capacitor disc ceramic
14. ( ) 1 megohm resistor (brown-black-green)
13. ( ) .02 µfd capacitor disc ceramic
12. ( ) 2.2 K Ω resistor (red-red-red)
11. ( ) .002 µfd capacitor (disc ceramic)
28. ( ) 1 megohm resistor (brown-black-green)
29. ( ) .02 µfd capacitor disc ceramic
30. ( ) Wire jumper (hookup wire)
31. ( ) .05 µfd 200 V capacitor plastic molded tubular
32. ( ) 2.7 KΩ resistor (red-violet-red)

*Observe polarity (+) marking on electrolytic capacitors.
** Use sleeving on (+) lead.

Pictorial 3
1. **NEVER USE SO-CALLED "NON-CORROSIVE" PASTES OR OTHER FLUXES.** The copper foil on the circuit board has been specifically processed for ease in soldering. It will take solder perfectly, provided radio-grade rosin-core solder is used. Very little solder is required to make a perfect connection.

2. **DO NOT OVERHEAT THE CONNECTION.** A 20 to 60 watt iron is entirely adequate for circuit board wiring. A soldering pencil is ideal. If a soldering gun is used, be very careful to avoid excessive heating. Try to develop a technique to "solder it and get off".

3. Remember that components are generally placed on the phenolic side of the board, with their leads passing through holes to the foil side of the board. Bend the leads slightly to prevent parts falling out as they are mounted. It is generally easier to mount most or all the parts in this way and then solder all the connection at one time.

The markings on the phenolic side of the board are there to assist you in wiring and to expedite your assembly. Refer to Pictorial 3 when performing the following steps.

( ) Insert the three 9 pin molded tube sockets in the holes marked V1, V2, and V3. The body of the socket goes on the phenolic side of the board, with the contacts extending through to the pattern or foil side. Align the blank space, or shield contactor spring, on the socket with the arrow screened on the circuit board. Be sure that each socket contact is in line with a hole in the board before pushing it through. Carefully solder each contact (including center pin) to the adjacent pattern. Do not attempt to cut off the tip of the contact after soldering.

( ) Follow the wiring sequence diagrams (Pictorial 3) and check off each step when completed so that no parts or jumpers are omitted. Please note that the 31 steps on Pictorial 3 must be completed before proceeding with the next step. Solder all connections and clip off excess leads.

This completes the preliminary assembly of the circuit board.
FINAL ASSEMBLY AND WIRING (Refer to Pictorial 4)

( ) Mount the circuit board just completed on the chassis using a 3-48 screw, nut and lock-washer in each of the four small mounting holes as shown in Pictorial 3. Place nuts and lockwashers on top of Printed Circuit Board. The board must be positioned as shown, with the 25 μfd 25 volt electrolytic capacitor to your right.

( ) Connect the loose end of the 6" length of hookup wire, previously installed on printed circuit board, to Q1 (S-1). Dress as shown.

( ) Cut a pair of 6 1/2" lengths of hookup wire, strip all four ends and twist the two leads firmly together.

( ) At one end of this pair, connect either lead to Z1 (NS) on the circuit board and the other to Z2 (NS).

( ) At the other end of this pair, connect either lead to DD8 (NS) on the tube socket and the other to DD9 (NS)

( ) Cut a 5 1/4" length of hookup wire and strip both ends. Connect one end to DD1 (NS). Dress the wire along the circuit board and connect to CB2 (NS).

( ) Cut a 4 1/4" length of hookup wire and strip both ends. Connect one end to DD2 (NS). Dress the wire along the circuit board and connect to CB4 (NS).

( ) Cut a 4 1/2" length of hookup wire and strip both ends. Connect one end to DD3 (NS). Dress this lead along the chassis apron and connect the other end to CB3 (NS).

( ) Cut a 4 1/2" length of hookup wire and strip both ends. Connect one end to DD4 (NS). Dress this lead between the 320 K ohm precision and the 470 K ohm (yellow-violet-yellow) resistors in the circuit board and connect to CB5 (NS).
( ) Carefully recheck the previous connections. When satisfied that the work is done correctly, turn the chassis over and solder each of the 6 points. Clip off any excess leads.

PICTORIAL 5

( ) Orient the chassis as shown in Pictorial 5 and install the prewired Selector switch at W. Seat the lug on the switch onto the notch on the front apron. Place a flat washer over the bushing and secure with a control nut.

( ) Now carefully dress or position each lead coming from the switch as shown. The longest lengths of hookup wire and coaxial cable must extend to the left between the four controls and the apron of the chassis. The short length of coaxial cable must rest on the chassis, between input sockets (RR and SS) and controls JJ, KK, LL, and MM.

Wiring the Selector Switch to the Chassis. Refer to Pictorial 5.

( ) Bend control terminals JJ3, KK3, and LL3 down against the shielded cable. Twist each terminal as shown in Detail 6.

( ) In the same way align terminal MM3 with LL3.

( ) Now pass a length of bare wire through terminals MM3 (NS), LL3 (NS), KK3 (NS), and JJ3 (NS), to hole CB6 (NS) on the circuit board. Use slewing between JJ3 and CB6.

( ) Locate the bare wire coming from WB5 and WA5 on the selector switch. Place slewing over this wire and connect to MM1 (S-1).

( ) Locate the bare wire coming from WA6 and connect to MM3 (NS). Use slewing.

Detail 6
PICTORIAL 6

( ) Locate the twisted pair of wires extending from WC4. Connect the lead that has the insulation removed to SS5 (NS).

( ) Remove approximately 1/4" of insulation from the remaining lead in this pair and connect to MM3 (S-3). Leave the other end free.

( ) Connect the bare wire (use sleeving) extending from WB12 to MM2 (S-1). Position as shown.

( ) Connect the 1 megohm (brown-black-green) resistor extending from WC3 to SS4 (NS). Use sleeving.

( ) Solder the pigtail from the shielded cable that is connected to WD7 to the bare wire between control terminals LL3 and MM3.

( ) Locate the twisted pair of wires extending from WC2. Connect the lead that has the insulation removed to SS3 (NS).

( ) Remove the insulation from the remaining lead in this pair and connect to LL3 (NS).

( ) Connect a hookup wire from SS1 (NS) to SS4 (NS).

( ) Connect a 100 K ohm (brown-black-yellow) resistor from SS5 (S-2) to SS4 (NS).

( ) Connect a 47 K ohm (yellow-violet-orange) resistor from SS4 (S-4) to SS3 (S-2).

( ) Connect a bare wire from LL3 (S-3) to SS1 (NS).

( ) Connect the bare wire (use sleeving) extending from WC11 to SS1 (S-3).
Connect the 470 K ohm (yellow-violet-yellow) resistor extending from WC3 to SS2 (S-1).
Connect the hookup wire extending from AB11 to LL2 (S-1). Position as shown.
Connect the hookup wire extending from AB10 to KK2 (S-1). Position as shown.
Connect the hookup wire extending from AB9 to JJ2 (S-1). Position as shown.
Connect a bare wire from RR4 (S-1) to KK3 (S-2). Use sleeving.
Connect a bare wire from RR1 (S-1) to JJ3 (NS).
Connect a 100 K ohm (brown-black-yellow) resistor from RR2 (S-1) to JJ1 (S-1).
Connect a 100 K ohm (brown-black-yellow) resistor from RR3 (S-1) to KK1 (S-1).
Connect a 100 K ohm (brown-black-yellow) resistor from RR5 (S-1) to LL1 (S-1).
Cut a 5 3/4" length of sleeving and place over the bare wire extending from WC5.
Cut a 5 1/4" length of spiral shielding and unwind about 1/2" of the wire at one end.
Place a 5 1/4" length of the clear plastic tubing over the spiral shielding.
Now place the spiral shielding with jacket over the sleeve covered bare wire extending from WC5. The unwound end of the spiral shield must be at the free end of the bare wire.
Connect the bare wire on the inside of the sleeving to CB7 (NS) on the circuit board.
Connect the wire which was unwound from the spring or spiral shield to CB8 (NS). Refer to Pictorial 6 for proper lead placement.
Locate the short length of shielded cable extending from WD7. Connect the free end to CB9 (NS).
Locate the shielded cable extending from WA5. Connect the free end to CB10 (NS) on the circuit board.

Installation of the Tone Control Network. See Pictorial 7.

Identify the encapsulated tone control network. This unit may be identified by the eight (8) leads extending from one side. Part number 84-1 is stamped on the body of this unit.

Prepare the network for installation on the chassis as shown in Detail 7, and outlined in the steps on the following page.
PICTORIAL 7

( ) Cut leads 1 and 8 to 3/4" lengths.

( ) Cut lead number 4 to 1/4" and connect a 6 1/4" length of bare wire to it as shown. Solder the connection securely.

( ) Slip a 5 3/4" length of sleeving over the bare wire just connected to lead 4 on the network.

( ) Cut a 5" length of spiral shielding and unwind about 2 1/2" of the wire at one end and then place a 5 1/4" length of clear plastic tubing over the spiral shield.

( ) Now slip the spiral shield with tubing over the bare wire and sleeving extending from lead 4 on the network, with the pigtail on the free end of the bare wire.

( ) Refer to Pictorial 7 and install the network on the rear of controls EE and FF. Connect lead number 1 to EE3 (S-1). Position the shielded wire coming from lead 4 between the network and apron. Position the network exactly as shown.

( ) Connect lead number 8 to FF1 (S-1).

( ) Connect lead number 7 to JJ3 (S-3). Use sleeving.

( ) Connect lead number 6 to EE1 (S-1). Use sleeving.

( ) Connect lead number 5 to EE2 (NS). Use sleeving.

( ) Connect lead number 4 (shielded hookup wire) to CB11 (NS) on the circuit board.

( ) Connect the pigtail from the shielded cable to control terminal CC1 (NS).
( ) Connect lead number 3 to FF2 (S-1). Use sleeving.

( ) Connect lead number 2 to FF3 (S-1). Use sleeving.

This completes the installation of the tone control network.

**FINAL WIRING AND ASSEMBLY**

( ) Connect a bare wire from CC1 (NS) to CB23 (NS).

( ) Cut a 6" length of bare wire. Place a 5" length of sleeving over it extending 1/2" from each end as shown in Detail 8. Cut a piece of spirashield spring to an overall length of 4 1/2" and unwind the spring at one end to form a pigtail about 1 3/4" long. Slip the spirashield over the bare wire and sleeving and crimp the pigtail lightly around the sleeving to prevent the shield and sleeving from slipping. Place a 5" length of plastic tubing over the spirashield as shown.

( ) Connect the bare wire at the end without the pigtail to EE2 (S-2). Connect the other end of the bare wire to CB14 (NS) on the circuit board. Now secure the pigtail to CC1 (NS). Check the position of the spirashield and position it so that it cannot touch either the chassis or other wiring, also see that a short does not exist between the spirashield and bare wire.

![Diagram of Detail 8](image)

( ) Connect the hookup wire coming from WB8 on the selector switch to CB18 (NS). Place a 1 1/2" length of spirashield with clear plastic tubing over this wire near CB18. Unwind one end of the spring and connect it to CC1 (NS). Push shielding down against the circuit board as shown in Pictorial 7.

**Installation of the Loudness Control Network. See Pictorial 8.**

( ) Identify the encapsulated loudness control network, part number 84-9. This unit has four leads extending from one side.
PICTORIAL 8

( ) Install the network on the rear of the loudness control BB, as shown in Pictorial 8. Pass lead four through BB1 (NS) to CC1 (S-5). Use sleeving between terminals BB1 and CC1 as shown. Now solder BB1 (S-1).

( ) Pass lead number 1 through BB3 (NS) to CC2 (S-1). Use sleeving between BB3 and CC2. Now solder BB3.

( ) Position the body of the network against the control as shown. Place sleeving over lead number 3 and connect to BB5 (S-1).

( ) Place sleeving over lead number 2 and connect to BB4 (S-1). Position the lead as shown, holding the network against the rear of the loudness control.

( ) Connect a length of hookup wire from CC3 (S-1) to CB24 (NS).

( ) Connect a 3 3/4" length of hookup wire from BB2 (S-1) to CB15 (NS). Position the lead as shown.

( ) Locate the pre-wired FUNCTION SELECTOR switch, part number B63-166, and install at hole V on the chassis. Do not use a control lockwasher between the switch and chassis.

( ) Connect the free end of the hookup wire, previously connected to V4, to NN1 (S-1).

( ) Connect the free end of the hookup wire, previously connected to V3, to NN2 (S-1).

( ) Connect the free end of the 3/4" bare wire, previously connected to V5, to Q3 (NS).
( ) Now connect the free end of the 1 1/2'' length of bare wire, previously connected to V5, to HH3 (NS). Use sleeving.

( ) Connect the free end of the hookup wire, previously connected to V1 to CB19 (NS). Dress the lead close to the chassis as shown in Pictorial 8.

( ) Connect the free end of the hookup wire, previously connected to V2, to CB20 (NS). Dress the lead close to the chassis as shown in Pictorial 8.

( ) Connect a 6 1/2'' length of hookup wire from HH1 (S-1) to CB17 (NS). Dress the lead close to the chassis as shown in Pictorial 8.

( ) Connect a length of bare wire from HH3 (S-2) to PP1 (S-1).

( ) Connect a length of bare wire from HH2 (S-1) to PP2 (S-1).

( ) Select a 1 megohm (brown-black-green) resistor, and connect one lead to PP3 (NS). Connect the other lead to PP4 (S-1).

( ) Connect a 6'' length of hookup wire from PP3 (S-2) to CB16 (NS). Dress the lead close to the chassis.

( ) Connect an 8 1/2'' length of hookup wire from Q4 (S-1) to DD5 (S-1). Dress this lead as shown in Pictorial 8.

( ) Select a 2 μfd 50 v tubular electrolytic capacitor. Identify the POSITIVE (+) end and connect this lead to Q2 (S-1). Use sleeving. Position the body of the capacitor as shown in Pictorial 8.

( ) Connect the NEGATIVE (-) end of the capacitor to Q3 (S-2). Use sleeving.

( ) Cut a 3 1/4'' length of 8-conductor cable. Remove the outer jacket to expose 3/4'' of the inner conductors (see Detail 9). Strip about 1/4'' of insulation from all eight leads and tin the exposed wire.

( ) At the other end of the 8-conductor cable remove the jacket for about 1/2''. Strip the eight conductors to expose about 1/4'' of the bare wire. Tin each wire and slip a vinyl plug cover on the cable with its open end toward the just prepared end of the cable as shown in Detail 9.
Identify the molded 9-pin connector and note that the pins are numbered on the eyelet side of the plug. Follow the numbering on the plug and connect the wires as follows: White to pin 9, Green to pin 8, Black to pin 7, Red to pin 6, Yellow to pin 4, Orange to pin 3, Blue to pin 2, Brown to pin 1, and pin 5 is not used.

Solder each wire firmly to the eyelet. See that none of the pins are shorted together by excess solder or an adjacent lead. After all the connections are properly made, slip the cap over the plug.

Refer to Pictorial 8 and connect the end of the cable without plug to 9-pin wafer tube socket DD. Note the numbering sequence on the socket terminals and connect the 8 leads as follows: White to DD1, Green to DD2, Black to DD3, Red to DD4, Orange to DD6, Yellow to DD7, Brown to DD8 and Blue to DD9. Solder all 14 leads.

Now turn the chassis over, so that the foil side of the circuit board is facing you and solder the 16 leads protruding from the circuit board. At this time all holes in the circuit board (except CB12, CB13, CB21 and CB22) should be occupied.

This completes the B channel preamplifier. Set aside for final assembly later.

( ) Prepare both ends of the 20 foot length of three-wire shielded cable as shown in Pictorial 9. At one end remove about 3/4" of the outer jacket and then unwind the exposed portion of the woven shield. Cut the shield off at the jacket and remove about 1/4" of the insulation from each end of the three inner wires. Tin each of the three leads.

( ) At the other end remove about 1" of the outer plastic jacket. Unwind the woven shield and twist to form a pigtail, or fourth lead. Strip 1/2" of insulation from the three inner conductors. Tin the three leads and the pigtail.

( ) Place the connector cover over the end of the cable that has the pigtail. Note that each pin on the four-pin plug has been identified with a number on Pictorial 9. The identification is made from the TOP VIEW on the side without the pins. Starting from the large space, or key and counting counterclockwise, make the following connections:

NOTE: When inserting the leads through the pins, insert them far enough so that about 1/4" of bare wire extends beyond the pin, then bend the wire so that it will not slip out.

| White to pin 1. | Pigtail to pin 3. |
| Red to pin 2.   | Black to pin 4.   |

( ) Solder the wire in each pin by heating the tip of the pin with the soldering iron and letting the solder flow inside; see that no excess solder sticks to the outside of the pin. If necessary, reheat the pin and wipe off the excess solder with a cloth. Cut off the bent-over portion of wire, and smooth the end of the pin with an emery board, sandpaper or a small file.

( ) Press the cap over the plug and bend the four lugs over and secure the cap to the plug. Refer to Pictorial 9.

( ) Identify the rubber control housing and slip it over the end of the cable without pigtail. Tie a knot in this end of the cable, very close to the end.

( ) Identify the 100 K ohm miniature control RC and make the following connections. When handling this control, do not exert strain on the solder lugs, as this is a miniature type control and is very delicate.

( ) Connect the white lead to terminal RC1 (S-1).

( ) Connect the red lead to terminal RC2 (S-1).

( ) Connect the black lead to terminal RC3 (S-1).

( ) Place the miniature control lockwasher on the control bushing, then place the flat panel washer with the blank side against the lockwasher. Temporarily secure the lockwasher and panel washer with a 1/4-32 control nut. Do not tighten yet. Now turn the control to the extreme clockwise position.

( ) Locate the remaining small black knob and install on the miniature control shaft, and align the pointer with the last position on the panel washer in a clockwise direction by rotating the control. When the pointer is aligned, tighten the control nut and replace the knob.

( ) Carefully pull the cord through the handle until the washer rests against the front of the handle. Insert the washer into the slot provided on the inner rim of the cone. This completes the assembly of the Remote Stereo Balance control.
( ) Study Pictorial 1 and identify the power supply chassis. Place the chassis on the work table and orient it as shown in the pictorial. The five AC receptacle mounting holes on the rear apron must be nearest you with the chassis resting on the side cutouts F and K.

( ) Mount an AC receptacle at hole A on the chassis. The socket must be inserted into the rectangular opening from the inside; the metal bracket is on the inside. Use two 6-32 x 3/8" screws, #6 lockwashers and nuts.

( ) Similarly, install four more receptacles at holes B, C, D and E.

( ) Insert a 3/8" rubber grommet at L on the chassis.

( ) Mount one of the AC snap switches at K as follows: Place a control lockwasher on the control bushing and place the control into notch K on the front apron of the chassis. Place a flat control washer on the outside of the chassis and temporarily secure with a control nut.

( ) In the same way, install the other AC snap switch at F. Secure temporarily.

( ) Refer to Detail 1 and assemble the Hum Balance Control bracket. Install a 100 ohm wire-wound control at H and Z. Follow Detail 1 carefully. Be sure that the insulating washers are centered so that the brass bushing on each control is not shorted to the chassis. The solder lugs must be oriented as shown.

( ) Now install the bracket on the power supply chassis. Secure the bracket to the chassis at holes HH and ZZ with two 6-32 x 3/8" screws, #6 lockwashers and nuts. Be sure the solder lug points toward the front apron.
( ) Install a 2-lug terminal strip at U on the front apron. Use 6-32 x 3/8" machine screw, nut and lockwasher. Study the pictorial and orient the solder lugs as shown.

( ) In the same way, install a 4-lug terminal strip at T. Orient as shown and secure with 6-32 hardware.

( ) Mount one of the selenium rectifiers at SS. Note that there is a POSITIVE (+) mark on one side of the rectifier. When installing, position this mark down as indicated on Pictorial 1. Use a #6 lockwasher and 6-32 nut.

( ) In the same way, install another selenium rectifier at S. Position the POSITIVE (+) mark up as shown.

( ) Refer to Detail 2 and note that the contacts on the 9-pin wafer tube sockets are numbered consecutively in a clockwise sequence when viewed from the bottom of the socket. Also note that pin 1 is the first pin in a clockwise direction from the blank space.

( ) Mount a 9-pin wafer socket in hole R with the blank space between pin 1 and 9 to the left as shown. Place solder lug RR between the chassis and wafer on the right mounting screw. Bend lug up as shown. Use 3-48 screws and nuts. No lockwashers are used when mounting wafer tube sockets. Note that the wafer portion of the socket is on the inside of the chassis. Do not pass the terminals through hole R.

( ) Install a dual 1-lug terminal strip at O. Orient the lug as shown and clip off the upper lug as shown.

( ) Install a 2-lug terminal strip at Q. Orient as shown.

( ) Install a 1-lug terminal strip at N. Orient the solder terminal as shown.

( ) Mount a dual 1-lug terminal strip at P. Orient as shown.
Refer to Pictorial 2, Preliminary Wiring.

( ) Cut a 3 1/2" length of hookup wire and strip both ends. Connect one end to E2 (NS) and the other to D1 (NS).

( ) Cut a pair of 8 1/2" lengths of hookup wire, strip all four ends and twist the two leads firmly together.

( ) At one end of this pair, connect either lead to D1 (S-2) and the other to D2 (NS).

( ) At the other end of this pair, connect either lead to C1 (NS) and the other to C2 (NS). Study the pictorial and place the hookup wires exactly as shown.

( ) Cut a 3" length of hookup wire and strip each end. Connect one end to K1 (S-1) and the other end to E1 (NS).

( ) Prepare another 3" length of hookup wire and connect one end to K2 (S-1). Connect the other end to D2 (S-2).

( ) Cut a pair of 4 1/4" lengths of hookup wire, strip all four ends and twist the two leads firmly together.

( ) At one end of this pair, connect either lead to C1 (S-2) and the other to C2 (S-2).

( ) At the other end of this pair, connect either lead to B1 (NS) and the other to B2 (NS).

( ) Cut a 3 3/4" length of hookup wire and strip both ends. Connect one end to A1 (S-1). Connect the other end to B1 (NS).
( ) Cut a 3" length of hookup wire and strip both ends. Connect one end to F2 (S-1) and the other end to A2 (S-1).

( ) Cut a 3 1/2" length of hookup wire and strip both ends. Connect one end to F1 (S-1) and the other end to B2 (NS).

( ) Cut a 2 1/2" length of hookup wire and strip both ends. Connect one end to Z2 (S-1) on the 100 ohm control. Pass this wire under the control terminals and connect the other end to H2 (NS).

( ) Cut a pair of 3 1/4" lengths of hookup wire, strip all four ends and twist the two leads firmly together.

( ) At one end of this pair, connect either lead to Z1 (S-1), and the other to Z3 (S-1).

( ) At the other end of this pair, connect either lead to R6 (NS) and the other to R7 (NS).

( ) Cut a pair of 3" lengths of hookup wire, strip all four ends and twist the two leads firmly together.

( ) At one end of this pair, connect either lead to H3 (S-1) and the other to H1 (S-1).

( ) At the other end of this pair, connect either lead to R8 (NS) and the other to R9 (NS).

( ) Connect a 15 K ohm (brown-green-orange) resistor from H2 (NS) to ground lug RR (NS).

( ) Connect a 220 K ohm (red-red-yellow) resistor from H2 (S-3) to R1 (NS). Use sleeving between R1 and the body of the resistor.
Refer to Pictorial 4, Component Parts Assembly.

( ) Select a dual 20 μfd 350 volt tubular capacitor. Observe the polarity marking on the body of the capacitor and connect one of the leads on the POSITIVE (+) end to T4 (NS). Connect the other POSITIVE lead to T3 (NS).

( ) Connect the single lead at the other end to U2 (NS). Observe Pictorial 4 for proper placement of the capacitor body.

( ) Select another dual 20 μfd 350 volt tubular capacitor. Again observe the polarity marking and connect one of the POSITIVE (+) leads to T2 (NS). Connect the other POSITIVE (+) lead to T1 (NS).

( ) Pass the single lead at the other end through U1 (NS) to U2 (NS). Now solder U1 (S-1). Position the body of the capacitor as shown.

( ) Cut a 6 1/4" length of hookup wire and strip both ends. Connect one end to U2 (S-3) and the other end to SS1 (NS). Dress this lead along the apron of the chassis as shown.

( ) Connect a 5 1/2" length of hookup wire from T4 (NS) to R1 (S-2). Pass this wire under the selenium rectifiers.

( ) Connect a 5" length of hookup wire from T3 (NS) to R2 (S-1). Dress this lead parallel to the one just installed.

( ) Connect a 4 3/4" length of hookup wire from T2 (NS) to R 3(S-1).

( ) Connect a 4 3/4" length of hookup wire from T1 (NS) to R4 (S-1).
( ) Connect a bare wire from S2 (NS) to SS2 (S-1).

( ) Connect a 2 3/4" length of hookup wire from SS1 (S-2) to solder lug RR (NS).

( ) Connect a .002 \( \mu \)fd disc capacitor from R5 (S-1) to solder lug RR (NS).

( ) Connect a 3 1/4" length of hookup wire from Q2 (NS) to solder lug RR (S-4).

( ) Connect a 2 3/4" length of hookup wire from Q1 (NS) to lug O1 (NS).

( ) Connect a 4" length of hookup wire from terminal lug N1 (NS) to Q2 (NS). Dress this lead against the chassis.

( ) Connect a 4" length of hookup wire from S1 (NS) to O1 (NS).

( ) Refer to Pictorial 4 and connect a 1 K ohm 1 watt (brown-black-red) resistor from S1 (S-2) to T4 (NS). Use sleeving on both leads. Position the body of this resistor against the chassis.

( ) Connect a 1 K ohm 1 watt (brown-black-red) resistor from T4 (S-4) to T3 (NS).

( ) Connect a 47 K ohm 1 watt (yellow-violet-orange) resistor from T3 (S-4) to T2 (NS).

( ) Connect a 22 K ohm 1 watt (red-red-orange) resistor from T2 (S-4) to T1 (S-3).

( ) Identify the power transformer. Note that there are eight (8) leads extending from this unit, six from one side and two from the other. Refer to Detail 3 and note that the transformer is installed on the chassis apron with the two black leads up. Install the transformer on the chassis at holes M and MM. Use two 8-32 x 3/8" screws, #8 lockwashers, and 8-32 nuts.

**Detail 3**

NOTE: In the following steps the transformer leads must be cut to the proper length and about 1/4" of insulation removed or stripped from each lead. The exposed end must then be tinned or a small amount of solder applied. **MAKE EACH LEAD AS SHORT AS POSSIBLE.**

( ) Twist the two black leads together and connect one end to B1 (S-3) and the other end to B2 (S-3). Dress this pair of leads along the apron.

( ) Twist the two blue leads firmly together and connect either lead to R8 (S-2) and R9 (S-2). Position the leads as shown.
( ) Twist the two green leads firmly together and connect either lead to R7 (S-2) and R6 (S-2). See Detail 3 on previous page.

( ) Connect one of the red leads to S2 (S-2). Run this lead along the chassis as shown in Detail 3.

( ) Connect the other red lead to P2 (NS). See Detail 3.

PICTORIAL 5

( ) Select a 40 \( \mu \)fd 350 volt tubular capacitor. Observe the polarity marking on the body of the capacitor and connect the lead on the POSITIVE (+) end to terminal lug Q1 (S-3). Position the body of the capacitor as shown in Pictorial 5. Connect the lead of the other end to N1 (S-2).

( ) Select a 30 \( \mu \)fd 200 volt tubular capacitor. Observe the polarity marking on the body of the capacitor and connect the lead on the POSITIVE (+) end to terminal P2 (S-2).

( ) Connect the other end of the 30 \( \mu \)fd capacitor to terminal lug Q2 (S-3).

( ) Select the other 30 \( \mu \)fd volt tubular capacitor. Observe the polarity markings on the body of the capacitor and connect the lead on the POSITIVE (+) end to terminal lug Q1 (S-2). Position the body of the capacitor as shown in Pictorial 5.

( ) Connect the other end of the 30 \( \mu \)fd capacitor to terminal lug P1 (S-1).

( ) Pass the AC line cord through grommet L. Tie a knot in the cord for strain relief at a point about 3" from the stripped ends. Connect one of the leads to E2 (S-2). Connect the other end to E1 (S-2).

( ) Identify the AC snap switch shield. It is the cup-like metal part with a slot in the wall and a hole in the bottom. Refer to Detail 4 for further identification.
( ) Install an AC switch shield on the back of AC switch K. Make sure the insulating liner is inside the shield and that the slot clears the two leads coming from the back of the switch. Refer to Detail 4 for proper orientation of the slot and the leads.

( ) Apply solder to join the switch shield and switch K. Solder in at least two places.

( ) Now install another AC switch shield over the back of AC switch F. Make sure the insulating liner is inside the shield and that the slot clears the two leads coming from the back of the switch. Refer to Detail 4 for proper orientation of the slot and the leads.

( ) Apply solder to join the switch shield and switch F.

This completes the wiring of the power supply chassis.

ASSEMBLY OF THE PREAMPLIFIER CHASSIS

The following steps cover the assembly of the completed preamplifier sub-assemblies.

( ) Refer to Pictorial 6 and align the A channel (with control plate) preamplifier, the B channel preamplifier, and the power supply chassis, as shown. Insert the B channel shafts into the rear of the A channel controls. It may be necessary to loosen the control nuts to allow the insertion of all the shafts without binding. Locate the power supply immediately behind the B channel preamplifier and insert the two long shafts extending from the power supply into the two bushings on the control panel.
Assemble the right and left plates as shown in Pictorial 7. Place a 6-32 x 3/4" screw into the two holes on the flange of each end plate. Secure each of the four screws with a #6 lockwasher, and two 6-32 nuts. At this time adjust any controls which may be binding, and tighten all control nuts.

Now secure the three preamplifier chassis together by placing the left and right end plates on each end of the chassis. Position the endplates so that the flange faces toward the inside of the chassis. Each end plate is secured with eight sheet metal screws. Do not tighten any sheet metal screws until told to do so.

Follow Detail 5 and insert the two lock shafts into the loudness and level controls. Note that the one shaft has an identification ring machined into it. Insert the shaft with identification ring into the loudness control. This must be done as follows: Pass the flattened end first through the control on the A channel, passing the shaft through the control from the outside. Push the shaft through the control until it bottoms in the B channel loudness control. Turn the shaft until it drops into place; the flat must seat itself into a corresponding slot inside the control.

In the same way install the remaining lock shaft (without identification ring) into the volume controls. Be sure that the flat seats itself into the rear control.

Refer to Pictorial 7 and secure the two wires with spade lugs extending from the A channel circuit board to the two screw terminal strips on the B channel. Connect the wire extending from hole CB19 to terminal 1. Connect the wire extending from hole CB20 to terminal 2.

Insert the 9-pin plugs extending from the A and B channel preamplifiers into the sockets on the B channel and power supply chassis, respectively.

Now install the aluminum chassis cover on the preamplifier as shown in Pictorial 7. Use twelve sheet metal screws, four in each chassis.

Turn all controls without knobs on the front panel, to the maximum clockwise position. Install a setscrew type knob on each of the round shafts. Align the knob pointers with the appropriate markings on the control panel, and tighten the setscrews.

Place a small knob on the two flattened AC switch shafts. It may be necessary to loosen these AC switches and rotate each one to align the pointers with the panel markings.

Tighten all sheet metal screws in the chassis cover plate and the two end plates at this time.
Refer to Pictorial 8 and install the two circuit board cover plates on this two preamplifier chassis. Use four sheet metal screws in each plate.

Included with this preamplifier are three adhesive labels, one for the A channel preamplifier, one for the B channel preamplifier, and one for the power supply. Carefully remove the protective backing from the gummed A Channel label. Cement this label to the bottom of the A channel preamplifier circuit board cover as shown in Pictorial 8. Avoid touching the gummed surface.

In the same way cement the B channel and Power Supply labels to their respective chassis as shown.

Insert tubes in the sockets as follows:

- Socket V1 - Type EF86
- Socket V2 - Type 12AU7
- Socket V3 - Type 12AX7

Place tube shields over all six tubes. Be sure that the tube shield slides over the ground lug extending from the tube sockets.

If the preamplifier is to be used in its wrap around cover (not panel mounted), install the preamplifier in the cover as shown in Pictorial 8. Note that the cover is secured to the chassis by the plastic feet. Install the four feet as shown.

Set the controls on both the preamplifier channels as follows:

- BASS - indicator vertical
- TREBLE - indicator vertical
- LEVEL - full counterclockwise
- AC POWER - off
- AUX. AC POWER - off
- SCRATCH FILTER - off
- SELECTOR - tape head
- LOUDNESS - off
- FUNCTION SELECTOR-A Channel

DO NOT OPERATE YOUR PREAMPLIFIER WITH THE MAG PHONO LEVEL CONTROL IN THE MAXIMUM SENSITIVITY POSITION. Only very low level output (2 mv) magnetic cartridges will require maximum sensitivity from the SP-2A Stereo Preamplifier. Normally setting the MAG PHONO level control in the mid-position will result in sufficient gain.

Prepare the length of shielded cable as shown in Detail 6, using a phono plug at each end. Connect one cable from the OUTPUT TO POWER AMPLIFIER socket on the A channel preamplifier to the input socket on the main amplifier.

Be sure a speaker is connected to the output of the main amplifier.

Plug the main amplifier (or other audio power source) line cord into a switched AC outlet in the rear of the preamplifier.
Plug the preamplifier into a 117 volt AC outlet.

Turn the AC SWITCH to ON. The pilot should light. Allow one minute for tubes to heat, then rotate the LEVEL 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 1, 2 and 3 settings. These inputs should display a great reduction in the background noise.

Turn the LEVEL control full counterclockwise. Turn the SELECTOR switch to the PHONO position and again rotate the LEVEL 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 LEVEL control as this is done. The setting for minimum hum is quite critical. With full LEVEL on, rotate the TREBLE tone control and observe that the high-frequency noise or rushing sound increases as the control is turned clockwise. The high-frequency noise should reduce to successively lower values as the control progresses counterclockwise. With full volume and the BASS control full clockwise, operate the SELECTOR SWITCH. There will be very slight changes in the hum level in the LP, RIAA and 78 positions. 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.

Repeat the above procedure for the B channel. Set the FUNCTION SELECTOR SWITCH to the B channel 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."

This completes the assembly and adjustment of your Heathkit SP-2A Preamplifier kit.

INPUT CONNECTIONS

Most signal sources terminate in a standard EIA phono plug which fits the input sockets of your SP-2A Preamplifier. Eight plugs of this type along with enough coaxial cable to make these cables, 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:

<table>
<thead>
<tr>
<th>AUX. 1, 2 or 3</th>
<th>PHONO</th>
<th>MIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM, FM or TV receivers</td>
<td>Reluctance phono pickups</td>
<td>High-impedance microphones</td>
</tr>
<tr>
<td>Tape recorder output</td>
<td>Magnetic phono pickups</td>
<td>Contact microphone for musical instruments</td>
</tr>
<tr>
<td>Crystal or ceramic phono pickups</td>
<td>Crystal or ceramic phono pickups</td>
<td></td>
</tr>
<tr>
<td>Capacity (FM) phono pickups with required oscillator</td>
<td>Ribbon phono pickups, with matching transformer</td>
<td>Compensated phono pickups with no preamplifier</td>
</tr>
<tr>
<td>Compensated phono pickup preamplifiers (all types)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5 shows the SP-2A as it would be used with a comprehensive high-fidelity stereo system.
NOTES ON USING THE SP-2A PREAMPLIFIER

With the BASS and TREBLE control indicators in the vertical, or 12 o'clock position, the response of the preamplifier is essentially flat.

Final adjustment of concentric controls: In most cases, it will be necessary to readjust one or more pairs of the concentric controls to prevent binding between the inner and outer shafts. Adjustment of binding controls should be done after the preamplifier has been completely assembled in the following manner: (1) Remove the vinyl cover and chassis cover plate. (2) Loosen the control nut on the offending control and rotate the binding shaft, while moving the body of the control in its mounting hole. When a position is found where the control does not bind, tighten the control nut. It may be necessary to loosen the front and rear control nuts independently until the concentric shafts rotate without binding. Also determine that the knobs are not binding together by loosening the setscrew on the small knob and moving it out on the inner shaft.
Adjustment and use of lock shaft: The loudness and level controls are equipped with a special lock shaft which makes possible locking the outer and inner controls together. When the small knobs on the above controls are pushed in, the A Channel control is mechanically connected to the B Channel by friction coupling. When the controls are in the locked position, a spring on the two front (A Channel) controls, rests on the inner lock shaft forming the friction coupling. With the small inner knob in the locked position, the concentric loudness or level controls no longer operate independently, but the controls in both channels rotate simultaneously when the large outer knob is rotated. This feature is intended for slight changes in the settings of the loudness and level control of both channels; therefore the friction between the pairs of concentric controls is only slight. If desired, this locking function may be demobilized by pulling the knob out into the unlocked position, and then loosening the setscrew and moving the small knob forward on the inner shaft. In the event that the lock shafts bind in the unlocked position, follow the adjustment procedure outlined in the previous paragraph.

Use of the loudness controls: The purpose of the loudness control is to compensate for the characteristic losses of very low and very high frequencies of the average listener's hearing at low listening levels.

For proper setting of the loudness control the following procedure is suggested: Set the loudness control to the OFF position and adjust the level control for the most pleasing listening level. Now, if the level is to be lowered, reduce it with the loudness control. In this way, the high and low frequencies will be automatically emphasized at the lower than average levels.

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 SELECTOR control to the TAPE HEAD position so that maximum bass boost is used. As mentioned before, the setting of the HUM control is rather critical.

The octal 8 pin plug supplied with this kit is provided for those power amplifiers which normally supply DC power for the preamplifier. Since this preamplifier has a built-in power supply, no external source is required, however, it is sometimes necessary to use an octal plug with a shorting wire to provide AC line voltage to your power amplifier. See "Service Notes" on the rear of the schematic.

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 SP-2A 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.

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.
HINTS ON STEREOPHONIC REPRODUCTION

During the past few months, the term "Stereo Sound" has been used more and more by the hi-fi enthusiast. Actually, the art of stereo sound has been with us for a long time, but not until recently have the new advancements in the hi-fi field made stereo practical. Two of the most common questions asked today by the hi-fi enthusiast when considering a stereo system are "How does it differ from my present monaural hi-fi system?" and "What will I need to convert my present system into a stereo system?" A monaural system is a single channel sound path and a stereo system is a two channel sound path. To convert your present system, you would need another matching monaural system. Even the finest of the present day monaural hi-fi systems will not give you the realistic effect that stereo sound is capable of reproducing. This realistic effect is the feeling of location and the sound does not appear to come from a single point source, as does the monaural system.

As an example, imagine yourself in a concert hall with a full orchestra on the stage. Between you and the stage there is an invisible, soundproof barrier. On the orchestra side of the barrier is placed a single microphone in the center of the stage. On your side of the barrier, a speaker system is placed in the center. Listening to the orchestra, sound seems to come from a single point source. While the sound reproduction equipment used may be of the finest quality, you definitely note that something is lacking. Now let us introduce another microphone and speaker system, placing one microphone on the right hand side of the stage and placing the other microphone on the left hand side of the stage. At the same time, one speaker system will be placed correspondingly to the right and the other speaker system to the left on your side of the invisible sound barrier. When listening to the orchestra now, you have a feeling that the sound of the violins is coming from their respective side of the orchestra and the woodwinds from their side. We have created a sense of placement in a lateral direction to the sound. In this manner, a full orchestra can be brought into your living room, still retaining to a great extent the sense of direction between the individual sound sources.

There are three basic sources of stereo program material: pre-recorded stereo tape, stereo broadcasts, and the new stereo disc records.

Stereo tape may be reproduced on the newer tape recorders which are equipped with a stereo playback head and the appropriate two channel electronics system. Most of the monaural tape decks in use today can be converted to stereo playback by the addition of a stereo playback head, the outputs of which can be fed directly into the two "Tape Head" input jacks of your Heathkit SP-2A Stereo Preamplifier.

Stereo broadcasts are continuously increasing in popularity; more and more radio stations are offering this service on a daily, or at least frequent, schedule. At this time, most stereo broadcasts are on an FM-AM basis. That is, the FM station might transmit the left, or A channel, while the AM station transmits the right, or B channel. The output from the AM tuner is then connected to one of the "Auxiliary" input jacks on one of the SP-2A Preamplifier channels. The output from the FM tuner may then be connected to the corresponding "Auxiliary" input jack on the other preamplifier channel. In this way, the two channels of sound being transmitted by the AM and FM stations will be reproduced simultaneously by your SP-2A Preamplifier.

The recently released 33 1/3 RPM stereo records offer excellent program material at an economical cost. These may be played effectively on any turntable which is equipped with a stereo cartridge. For best results, both the turntable (or changer) and the stereo cartridge should be of high quality. It is strongly recommended that the stereo cartridge be equipped with a diamond stylus, for longer record life and minimum noise.

For compactness, convenience, and economy, some of the basic components of a stereo system are available as composite, matched, dual channel units; your SP-2A Stereo Preamplifier is an example. In any event, when selecting the components of your stereo system, keep in mind the importance of having the system electrically balanced throughout. That is, the two preamplifiers, and the two power amplifiers, and the two speakers (or speaker systems) should have very similar (preferably identical) characteristics.
Since the stereo effect adds a lateral dimension, indicating placement or movement of sound sources, the lower wattage amplifier will produce the brilliance normally obtainable only with the higher powered amplifiers. For this reason, the size of the room in which the equipment will be installed should be taken into consideration when purchasing the amplifiers and speaker system.

We hope that the preceding information will give you a basic idea of how a stereo system is formed and also how your existing Heath system can be expanded into a stereo system. If you are just starting your stereo system, you will no doubt want to use combined units if at all possible.

The Heath Company has made available several new kits that have been designed especially for stereo operation as well as monaural operation: the AM-FM tuner which provides both simultaneous or selected AM-FM signals. The Stereo Tape Deck provides the playback of pre-recorded stereo-tapes and the monaural record or playback. Full specifications for the individual kits may be obtained upon request. The Heath Company is constantly striving to keep up with customer demand regarding new and better Heathkits. For information along this line, we suggest that you watch our forthcoming advertisements.

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 schematic diagram. 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. For further service information, refer to the "In Case of Difficulty" section on the rear of the schematic.

BIBLIOGRAPHY


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


REPLACEMENTS

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

A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
B. Identify the type and model number of kit in which it is used.
C. Mention the order number and date of purchase.
D. Describe the nature of defect or reason for requesting replacement.
The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

**SERVICE**

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

The Technical Consultation Department is maintained for the purpose of providing Heath customers with a personalized technical consultation service; this service is available to you without charge. The technical consultants are thoroughly familiar with all details of the Preamplifier and can usually localize the trouble from a suitable description of the difficulty encountered. It is, of course, necessary that you provide full and complete information concerning your problem when writing to the Technical Consultation Department for assistance. For instance, clearly identify the kit involved, giving the purchase date and, if possible, the invoice number; describe in detail the difficulty that you have encountered; state what you have attempted to do to rectify the trouble, what results have been achieved, and include any information or clues that you feel could possibly be of value to the consultant who handles your problem. Failure to provide complete descriptive details may lead to incorrect assumptions on the part of the consultant and needless delay in the solution to your problem. Quite frequently, when the information given the consultants is complete, concise and reliable, a diagnosis of the difficulty can be made with confidence and specific instructions given for its correction. If replacement of a component is involved in the correction, the component will be shipped to you, subject to the terms and conditions of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the complete Preamplifier to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a fixed fee of $9.00, plus the price of any additional parts or material required. However, if the Preamplifier is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase and give invoice number, if possible.

Local Service by Authorized Heathkit Dealers is also available and often will be your fastest, most efficient method of obtaining service for your Heathkits. Although you may find charges for local service somewhat higher than those listed in Heathkit manuals (for factory service), the amount of increase is usually offset by the transportation charges you would pay if you elected to return your kit to the Heath Company.

Heathkit dealers will honor the regular 90 day Heathkit Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company. If it will be necessary that you verify the purchase date of your kit by presenting your copy of the Heath Company invoice to the authorized dealer involved.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if your local dealer assists you in locating a defective part (or parts) in your Heathkit, or installs a replacement part for you, he may charge you for this service.

Heathkits purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized Heathkit dealer in order to be eligible for parts replacement under the terms of the Warranty.
THESE SERVICE POLICIES APPLY ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned NOT repaired.

For information regarding modifications of Heathkits for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic outlet stores. Although the Heath Company welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder, according to information which will be much more readily available from some local source.

SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

ATTACH A TAG TO THE INSTRUMENT GIVING NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT.

Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

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

WARRANTY

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

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

HEATH COMPANY
<table>
<thead>
<tr>
<th>PART No.</th>
<th>PARTS Per Kit</th>
<th>DESCRIPTION</th>
<th>PART No.</th>
<th>PARTS Per Kit</th>
<th>DESCRIPTION</th>
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<td>453-69</td>
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| 84-8 | 2 | Compensation network | 390-49 | 1 | Power supply label-adhesive |
| 84-9 | 2 | Loudness control network | 391-6 | 1 | Logo "Heathkit" black and gold |
| 85-20 | 2 | Circuit boards | 413-4 | 1 | Clear red jewel |
| | | | 453-68 | 1 | Lock shaft (with identifying ring) |
| | | | 453-69 | 1 | Lock shaft |
| | | | 455-28 | 2 | Bushing |
| | | | 595-296 | 2 | Manual |

Resistors

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<td>1.2 K ohm 1/2 watt (brown-red-red)</td>
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<td>2.7 K ohm 1/2 watt (red-violet-red)</td>
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<td>6.8 K ohm 1/2 watt (blue-gray-red)</td>
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<td>2</td>
<td>47 K ohm 1/2 watt (yellow-violet-orange)</td>
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<tr>
<td>1-26</td>
<td>14</td>
<td>100 K ohm 1/2 watt (brown-black-yellow)</td>
</tr>
<tr>
<td>1-29</td>
<td>1</td>
<td>220 K ohm 1/2 watt (red-yellow)</td>
</tr>
<tr>
<td>1-30</td>
<td>2</td>
<td>270 K ohm 1/2 watt (red-yellow)</td>
</tr>
<tr>
<td>1-33</td>
<td>4</td>
<td>470 K ohm 1/2 watt (yellow-violet-yellow)</td>
</tr>
<tr>
<td>1-35</td>
<td>12</td>
<td>1 megohm 1/2 watt (brown-black-green)</td>
</tr>
<tr>
<td>1-37</td>
<td>2</td>
<td>2.2 megohm 1/2 watt (red-red-green)</td>
</tr>
<tr>
<td>1-44</td>
<td>4</td>
<td>2.2 K ohm 1/2 watt (red-red-red)</td>
</tr>
<tr>
<td>1A-2</td>
<td>2</td>
<td>1 K ohm 1 watt (brown-black-red)</td>
</tr>
<tr>
<td>1A-5</td>
<td>1</td>
<td>22 K ohm 1 watt (red-red-orange)</td>
</tr>
<tr>
<td>1A-7</td>
<td>1</td>
<td>47 K ohm 1 watt (yellow-violet-orange)</td>
</tr>
<tr>
<td>4-2</td>
<td>2</td>
<td>100 K ohm 1/2 watt (low noise)</td>
</tr>
<tr>
<td>4-3</td>
<td>2</td>
<td>330 K ohm 1/2 watt (low noise)</td>
</tr>
</tbody>
</table>

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SERVICE NOTES

Should continued difficulty be experienced in the operation of the SP-2A after the information under the heading "In Case of Difficulty" in the SP-2A Construction Manual has been consulted, we suggest that the following information be considered.

Isolation of the problem to a major component: Before attempting to troubleshoot and repair the SP-2, it will be necessary to determine which major component is responsible for the problem experienced. In that the SP-2A will normally be used in a stereophonic system (containing in addition to the SP-2A, two signal sources, two amplifiers and two speaker systems) it should be a relatively easy matter to find whether one of the amplifiers, one of the speaker systems, one of the signal sources or the SP-2A is responsible for improper operation. This may be accomplished by interchanging the identical components of the opposite channels of the stereo system. In other words, interchange first the amplifiers, then the speaker systems and reverse the two outputs of the signal sources. If one of the components, other than the SP-2A, is found to be at fault, it should be checked and repaired in accordance with the appropriate information supplied by its manufacturer. If it is found that the SP-2A is not operating properly, the following checks and corrections should be made.

General comments concerning kit construction: It has been our experience that 70% to 80% of Heathkit malfunctions are associated with discrepancies in soldering and positioning of leads, as well as parts. Therefore, it would be a good idea to very carefully inspect the SP-2A to see that all connections are properly soldered and that leads, as well as parts, are placed and connected in accordance with the directions and pictorials in the SP-2A Manual. Resoldering each printed circuit board to insure that no cold solder connections exist is strongly recommended.

Loose mounting hardware is often responsible for a poor ground connection which in turn could cause the SP-2A to function incorrectly or to be completely inoperative. A careful check should be made to determine that all mounting hardware is tight. The screws used to secure the circuit boards deserve special attention.

The importance of proper construction cannot be over-emphasized. Therefore, even if the SP-2A has been assembled by an experienced person and has been previously checked, it could do no possible harm to perform the checks described in the preceding paragraphs.

Isolation of a malfunction in the SP-2A: By interchanging and reversing the major components of the stereo system, as mentioned above, it should be evident whether the A channel, the B channel, the power supply or a combination of these is not operating correctly. The following will help to further isolate the stage in which the problem is originating.

Because neither channel will operate without suitable power, the power supply should be checked first. Power supply voltages are shown on the SP-2A schematic diagram. A check of these voltages with a good voltmeter (20,000 ohms per volt or VTVM) should prove helpful. An incorrect, erratic or missing voltage could easily indicate a faulty part. Voltages in both channels should now be measured for comparison to the reading shown on the schematic.

Operation of the channels may be checked by using a signal source, an amplifier and a speaker known to be in good condition, first with the A channel and then with the B channel.

The function selector circuit and both channels may be checked for proper operation as follows: With a signal source connected to the A channel and with the FUNCTION SELECTOR SWITCH in the STEREO position, there should be an output only from the A channel. In the A channel position there should be an output from both channels. In the B channel position there should be no output from either channel. In the A-B Mix position, there should be an output from both channels. With a signal source connected to the B channel, operation of the function selector circuit may be checked in a similar manner. The block diagrams in Figure 2, page 13, will clarify the results that should be obtained from the functions just mentioned.
If it is found that only one of the channels is not operating properly, the tubes may be checked by interchanging them, one at a time, with those of the other channel. Possibly neither channel is operating as it should, in which case it will be advisable to have the tubes checked.

SPECIFIC TROUBLES

Hum: Hum in a high fidelity preamp is usually caused by excessive heater to cathode leakage in one of the tubes, a poor ground connection, a faulty filter condenser and in many cases, improperly placed leads. Tube leakage, ground connections and lead placement may be checked as mentioned in the preceding paragraphs. A faulty filter condenser that is responsible for hum will allow an excessive amount of AC ripple to be present on the DC B+ voltage. These condensers can be checked either by direct substitution or with a good condenser tester.

If hum is a problem only when using the low level inputs (magnetic-phono, tape head and microphone), the V1 and V2A tube stages as well as the low level input jacks and switching circuitry should be suspected.

Excessive hum with all inputs will indicate that tube stages V2B and V3 or the power supply is responsible. In the A channel, the scratch filter should also be considered.

In many cases, hum will appear to be originating in the preamplifier but is actually being picked up by the signal source, or is the result of a poor connection in the audio cable which inter-connects the signal source to the preamplifier.

When considering hum, the primary concern should be with the hum heard at normal settings of the loudness, level and bass controls. It is logical to expect the hum to be accentuated at the upper extreme settings of these controls.

Distortion: The most likely reason for distortion is oscillation. Oscillations are, in turn, usually caused by poor connections, improper connections and improper lead placement.

Faulty tubes, a shorted coupling condenser or a resistor that has changed value can also cause distortion. The tubes may be checked as suggested above. An ohmmeter will prove helpful in checking for shorted condensers and resistors that are out of tolerance.

Loss of signal: The three most common causes of signal loss are a faulty tube, a short circuit between the signal path and ground and an open coupling condenser.

After checking the tubes, an ohmmeter can be used to check for short circuits. Most coupling condensers have a very high leakage resistance, therefore, an ohmmeter check would not be conclusive. Coupling condensers are best checked on a condenser tester or by direct substitution.

Another way to check for signal loss is by signal tracing. This is done by applying an audio voltage to an appropriate input either from an audio generator or from a high fidelity signal source and then checking progressively from the input jack at various points along the signal path with a signal tracer or an oscilloscope to determine at which point the appropriate signal is lost. After obtaining this information, the associated circuitry should be checked, as previously suggested.

If test instruments are not available for signal tracing, a .01 to .05 μfd capacitor can be used to find the stage that is not passing the applied signal. By holding one lead of this capacitor and touching the other lead to the control grid pin of each tube socket, a 60 cycle hum should be heard from the preamp output. If, upon touching a grid pin, a hum is not heard, the associated circuitry should be suspected and thoroughly checked out.
Crosstalk: From Pictorial 8, page 48, in the SP-2 Manual, it will be noted that a pair of leads run from screw terminal strip NN to switch V. Also, a pair of leads is connected from points CB19 and CB20 of the B channel circuit board to switch V. If these pairs of leads are placed too close together, crosstalk between the A and B channels may result. Crosstalk can usually be minimized by positioning the pairs of leads just mentioned so that they are as far as practical from each other.

MECHANICAL PROBLEMS

Binding of the control and switch shafts which run between the A and B channels can usually be alleviated by careful alignment of the three chassis with respect to each other and to the end plates. Also, because the control and switch mounting holes of the A channel chassis are elongated, it will be possible to adjust the relative positions of the A channel controls.

Should it become necessary to remove the loudness and level control shafts, it will be necessary to separate the A channel chassis from the B channel chassis and then remove the shafts from the rear of the A channel controls.

MISCELLANEOUS

Above, we have listed several specific problems and applicable troubleshooting procedures. If problems other than those we have covered herein are encountered, the above troubleshooting procedures would still apply in that they direct checking of practically all parts of the SP-2A in which malfunctions can develop.

CONNECTING ASSOCIATED EQUIPMENT

Signal Sources: Stereo signal sources have two outputs, one of which should be played through the A channel of the SP-2A. The other should be played through the B channel. Shielded audio cable is normally employed to interconnect the outputs of the signal sources to the appropriate input jacks of the preamplifier. The audio cables should be terminated with standard phono plugs.

High level sources such as tuners, ceramic pickups, crystal pickups and tape recorders having their own playback preamplifier should be played through the auxiliary inputs of the SP-2A.

Low level sources such as magnetic pickups, variable reluctance pickups, microphones and tape heads should be played through the appropriately designated inputs of the SP-2A. At the magnetic phono input, use the value of load resistor recommended by the pickup manufacturer.

Tape Recorder: The "Output to Tape Recorder" jacks of the SP-2A can be connected through shielded audio cable to the input of a tape recorder having its own tape recording preamplifier for tape recording purposes. NOTE: The SP-2A is not a tape recording preamplifier and therefore, cannot be used to tape record with only a tape transport and tape heads.

Amplifiers and Speakers: Each channel of the SP-2A has an output jack intended to drive a separate amplifier. Shielded audio cable, terminated at both ends with phono plugs, should be connected between the outputs of the SP-2A and the audio input jacks of the respective amplifiers. Speakers should be connected to the amplifier's outputs in accordance with the operating directions for the amplifiers and speakers.

Power Switching: Heathkit models W-2M, W-3M, W-4M, W-3AM, W-4AM, W-5M and W-6M Amplifiers are intended to be switched on and off by the preamplifier with which they are used. This makes it necessary to solder a short bare wire between pins #6 and #7 of the octal plug supplied with the SP-2A. These plugs are then inserted into the octal sockets of the amplifiers. Now power can be switched to the amplifiers by inserting their line cord plugs into the switched AC sockets of the SP-2A, and using the power switches of the SP-2A. Also, in these amplifiers, it is necessary to connect the green-yellow power transformer lead to ground.

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Octal plugs are not required when using the Heathkit models UA-1 and W-7M Amplifiers with the SP-2A. It is simply necessary to connect the line cord plugs of these amplifiers to the switched AC sockets of the SP-2A. The power switches of these two models should be placed in the ON position.

Power to the signal sources may also be switched through the AC sockets of the SP-2A.

OPERATION

Input and output level controls: When all of the components of the stereo system are in good operating condition and after they have been interconnected as described in the preceding section, all of the SP-2A level controls, including the main level control, should be placed in their full counterclockwise positions. The TREBLE and BASS controls should be set to 50% of their rotation. Set the LOUDNESS control to its OFF position and set the FUNCTION SELECTOR SWITCH to STEREO. Power may now be applied and time allowed for the equipment to reach operating temperature.

If the power amplifiers have volume controls, set them to 50% of their rotation. Also, set the main level control and the output level controls of the SP-2A to 50% of their rotation.

With signal sources connected to the auxiliary inputs to be used, advance the auxiliary input level controls for approximately equal volume when the SELECTOR switch is turned from "Aux. 1" to "Aux. 2" to "Aux. 3".

The magnetic-phonon input level control should be set for nearly equal volume when switching the selector to one of the magnetic-phonon positions. Of course, a magnetic or VR pickup should be operating through an appropriate input.

After the input and output level controls have been set, the main level control will be equally effective for all inputs. Also, it will now be a simple matter to make changes in the level control settings to meet individual needs.

LOUDNESS control: The purpose of the loudness control is to maintain bass and treble boost at low volume levels. It adjusts the frequency response of the SP-2A to correspond to the frequency response of the human ear at any desired volume level. With the LOUDNESS control in the OFF position, the main level control and the tone controls may be set for good frequency response and good fidelity at a relatively loud listening level. If a lower volume level is desired, the loudness control may be rotated in a counterclockwise direction from the OFF position. As mentioned above, this will reduce the volume without changing the fidelity as heard by the human ear.

Function Selector: Operation of the function selector circuit is described in a preceding section. Briefly, the STEREO position should be used with stereo signal sources. If a monaural source is played through an A channel input, use the A CHANNEL position. The reverse is true for the B channel. The A-B MIX position is used when two monaural sources are connected respectively to the A channel and the B channel and both of these sources are desired in the output. In other words, these two signal sources will be mixed and thereby provide a mixed monaural output.

Remote Balance control: This control will facilitate a small amount of volume adjustment for the two channels of the SP-2A. After setting the controls on the front of the preamplifier for good volume balance between the channels, the remote balance control can be used to optimize volume balance for a particular listening location.
Schematic
Heathkit Stereo Preamplifier
Model SP-2A
A Channel Preamplifier and Power Supply
B CHANNEL PREAMPLIFIER
HELPFUL KIT BUILDING INFORMATION

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

The 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 flowing 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 VTTM, 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.

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[Diagram with symbols and parts list]
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