Heathkit of the Month #74:
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STEREO HI-FI EQUIPMENT

HEATHKIT

Heathkit AA-14
Solid-State Stereo Amplifier

Introduction:
Heathkit of the Month #63 covered the AJ-14 Stereo FM Tuner. For many years I was using this tuner with the AA-32 tube-type stereo amplifier (HOM #52). While the combination worked well, I preferred having the matching AA-14 amplifier. One day I had the opportunity to purchase what appeared to be a modified AA-14 at a good price and grabbed it. Getting it unmodified is a story to be told later.

The AA-14 Solid-State Stereo Amplifier:
In the 1966 Heathkit catalog (810 / 60A) the AJ-14 tuner was introduced; but the matching AA-14 amplifier was still unannounced. By the 1967 catalog (810 / 1967), which carries a 1966 copyright date, the AA-14 was being offered. Also offered then was the AR-14, which is a combination of the AJ-14 and AA-14 in a somewhat larger cabinet. The AA-14 was selling for $59.95, the AJ-14 for $49.95 and the AR-14 for $99.95. By 1969 the prices had increased slightly to $64.95, $54.95 and $114.95 respectively. The AA-14 remained in production into 1975. In its last catalog appearance (in my catalog library), the AA-14 was still shown. However, neither of the other two units were listed. A walnut wooden cabinet - AE-55 ($9.95) or a metal cabinet - AE-65 ($3.95) were available for the AA-14. This is the same cabinet that fits the AJ-14.

The AA-14 specifications are shown in Table I. At 15 IHF[1] watts the amplifier can fill a typical living room with loud crisp sound when used with reasonable speakers. Since no expensive

[1] Notes appear on page 12

Figure 1 Heathkit AA-14 Stereo Amplifier (bottom) and AJ-14 FM Stereo Tuner (top)

output transformers are used, and AC coupling is limited with DC coupling in three places per channel, the frequency response is pretty much flat by a large margin over even the widest range of human audio perception.

OPERATION:
The amplifier controls are quite straightforward. Table II lists the front panel controls. The six-position **SOURCE** switch allows the user to select either a turntable, a tuner or an auxiliary device, which might be a tape deck, an additional tuner (AM perhaps) - or in today's world - a CD player, iPod type device or a hookup to your computer audio. This selection may be made as either stereo or monaural. The concentric **VOLUME** controls normally move together, but may be adjusted separately by holding one while moving the other. A **PHONE** jack allows quiet listening with a pair of stereo low-impedance earphones. Plugging in earphones, however, does not automatically disconnect the speakers. The **BASS** control adjusts the low frequency response; -16 dB to +15 dB at 20 cps. The BASS control also disconnects the speakers using a switch that is activated by pulling out the knob, allowing quiet listening using earphones. The complementary output stage does not require a load for safe operation, unlike most push-pull transformer output stages. Finally, the **TREBLE** control adjusts the high frequency response from -13 dB to +15 dB at 20 kc The TREBLE control also turns the AC power on and off by a switch activated by pulling out the knob. The BASS and

SPECIFICATIONS:	AA-14
Power Output:	
Continuous:	10 W per channel
IHF[1] Music:	15 W per channel
Output Impedance:	4 thru 16 Ω
Damping Factor	50 or better
Frequency Response:	
Normal:	12 cps to 60 kc ±1 dB
	6 cps to 100 kc ±3 dB
Power:	15 cps to 50 kc ±1 dB
	7 cps to 90 kc ±3 dB
Channel Separation:	45 dB minimum
Input Impedance:	
Phono:	47 KΩ
Tuner:	180 KΩ
Auxiliary:	180 KΩ
Phono Equalization:	RIAA[2]
Total Harmonic Distortion at rated output:	
	1% or less at 20 cps to 20 kc
	0.5% or less at 1 kc
Intermodulation Distortion at rated output:	
	1% or less using 60 cps an 6 kc mixed 4:1
Power Requirements:	105-125 vac 50/60 cps
	20 watts idling, 60 watts full output
Dimensions:	12" W x 3" H x 10-1/4" D
Net Weight:	8-1/2 lbs.

Heathkit AA-14 Solid State Stereo Amplifier
(From Heathkit Manual 595-767)
Table I

TREBLE controls are dual potentiometers that simultaneously adjust each channel equally.

CONNECTION:

The rear panel is shown in Figure 2, and described in Table II. A pair of two-wire AC outlets are mounted on the rear panel. The upper outlet is switched with the amplifier power switch and is rated for 150 watts; the lower outlet is not switched and is rated for 350 watts. The Cinch-Jones barrier strips for the speakers allow secure connections using standard crimp-type wire lugs, even when using heavier gauge speaker wire. A ground screw allows grounding of the amplifier to a nearby ground, if needed for hum reduction. It, more importantly, allows grounding of the turntable and other source devices. The connection is a simple #6 machine bolt, lock washer and nut, with

FRONT PANEL - Left to Right:

Front panel controls are located in a single row below a full-width lit glass panel showing the Heathkit logo, model number and description, and control names.

SOURCE:	6-position rotary switch
PHONO Ⓜ, PHONO Ⓢ, TUNER Ⓜ, Ⓢ TUNER, Ⓜ AUX, Ⓢ AUX (Ⓜ = mono; Ⓢ = stereo)	
VOLUME:	dual concentric potentiometer (sections are clutched together)
LEFT VOLUME	outer lever control
RIGHT VOLUME	main knob control
PHONES:	1/4" stereo phone jack
BASS:	dual potentiometer
SPKRS OFF - PULL	switch on potentiometer
TREBLE	dual potentiometer
POWER ON - PULL	switch on potentiometer

REAR PANEL Left to Right: (rear view):

FUSE 1 AMP. SLOW BLOW	twist fuse holder
LINE CORD entrance (below fuse)	
117 V. A. C.:	
SWITCHED AC POWER (Top)	2-wire A.C. socket
NORMAL AC POWER (Bottom)	2-wire A.C. socket
SPEAKER:	
RIGHT	2-term. Jones strip (vert. mounted)
LEFT	2-term. Jones strip (vert. mounted)
GrouND	#6-32 1/2" screw with thumb nut
INPUT RIGHT:	triple RCA jack assembly
PHONO, TUNER, AUXiliary	(vert. mounted)
INPUT LEFT:	triple RCA jack assembly
PHONO, TUNER, AUXiliary	(vert. mounted)

Heathkit AA-14 Solid State Stereo Amplifier
Front & Rear Panel Layout
Table II

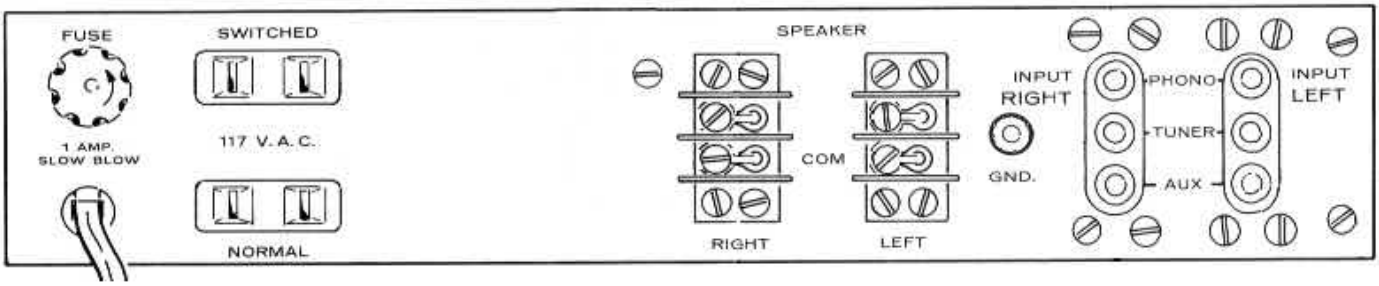


Figure 2 Heathkit AA-14 Stereo Amplifier rear view showing the connections
(Scanned and edited from the Heathkit AA-14 Manual)

washers and a thumb screw added to clamp wire leads or crimp lugs. The input connectors are two assemblies, each having three RCA phono connectors; one is for the RIGHT channel inputs and one is for the LEFT channel inputs. These connectors are made by H.H. Smith.

CIRCUIT DESCRIPTION:

The circuit is made up of three parts: the power supply and identical left and right channels. The left channel's parts carry odd part numbers starting at 1 and the right channel's parts contain even part numbers starting at 2 and typically one higher than the identical left channel part. The Power supply parts have part numbers starting at 100, and the few parts common to both channels (such as the SOURCE switch and headphone jack) are not numbered. There are some part number errors in the manual. Semiconductors used in the AA-14 are given in Table III. The schematic, too large to publish, is at: www.w6ze.org/Heathkit/Sch/AA-14-Sch.gif .

Channel:	LEFT	RIGHT	
Preamplifier (2-stage):	Q1	Q2	2N3391
	Q3	Q4	2N2712
Tone Filter Amplifier:	Q5	Q6	2N2712
Pre-driver: (2-stage):	Q7	Q8	2N2712
	Q9	Q10	2N3416
Driver:	Q11	Q12	2N3053
Complementary Output:	Q13	Q14	TA2577A
	Q15	Q16	2N2148
	D1	D2	1N3754
Power Supply:			
Electronic Filter	Q101		2N2712
Bridge Rectifier	D100 thru D103		U-131[3]

Heathkit AA-14 Solid State Stereo Amplifier
Solid State Component List
Table III

POWER SUPPLY:

The AC line is connected directly to the **NORMAL** AC outlet on the rear panel. From there it goes through the power switch on the TREBLE control to the **SWITCHED** AC outlet, then through a 1 amp fuse to the primary of transformer T1 (T101?). The unfused side of the AC line is connected to the chassis through a 0.01 µf 1600 V ceramic capacitor (C100). The secondary of T1 has a full-wave bridge rectifier using U-131 diodes (Heathkit part number 57-29). I could find no data sheet on these diodes but assume from the size that they are of the 2-amp variety. The voltage developed when D100 is back biased during half an AC cycle is used to light the two #47 pilot-light bulbs that illuminate the front glass panel; a 75 Ω power resistor limits the current through the lamps. The output of the bridge rectifier is filtered by a computer grade 4,000 µf capacitor producing 38 volts that is fed to the driver and output amplifier stages. This 38 volt source is additionally filtered by a 270Ω and 100 µf capacitor to feed the pre-driver amplifier stages, and an active filter circuit that provides very low ripple voltage to the two noise-critical stages. The filter circuit uses Q100 to effectively boost the capacitance of C103, multiplying it by the beta of Q100 which is typically about

100 or more. The output of the filter circuit is further filtered by C104, and supplies 28 volt power to the tone filter circuits (Q5 and Q6) and the second stage of the preamplifiers (Q3 and Q4). Even more filtering by R105 and C105 provides 27 volt power to the sensitive first preamplifier stage (Q1 and Q2).

LEFT CHANNEL:
The left channel consists of five sections consisting of eight transistors and one diode.

Source Selection:
Each of the three source inputs are isolated prior to reaching the source switch. The low level PHONO input is isolated by a series 1K Ω resistor. The higher level TUNER and AUX inputs are isolated by a voltage divider that reduces their signal level by 32 dB, bring it inline with the PHONO level signal. The six-position SOURCE switch selects the desired isolated input and routes it to the preamplifier. When the switch is in one of the monaural positions the isolated left and right signals are tied together, resulting in both channels receiving the identical sum signal. To reduce crosstalk the unused isolated inputs are tied to ground by the SOURCE switch.

Preamplifier:
The preamplifier consists of two stages directly coupled with DC feedback. The first stage uses a low-noise 2N3391 transistor (Q1) as a high gain amplifier. The selected signal is coupled to the base through a 10 uF capacitor. R11 sets the proper load impedance for the PHONO input (The other input load impedances are set by their voltage divider). The collector of Q1 is directly coupled to the base of the second stage of pre-amplification transistor Q3, a general purpose 2N2712 running at a gain of about ten. A portion of the output of Q3 is captured by R23 in the emitter circuit, filtered by C3 and provides DC feedback through R17 to bias Q1.

When the SOURCE switch is in the TUNER or AUX positions AC feedback is provided through the SOURCE switch to the emitter of Q1 via R27. When in the switch is in the PHONO position, however, the AC feedback is through the network comprised of C5, C9 and R25. This network provides RIAA[2] de-emphasis for vinyl records.

Tone Filter Amplifier:
The signal from the preamplifier is routed through the volume control to the tone circuit. The signal is connected to the high end of both the BASS and TREBLE pots. The low side of the pots are connected, through C17, to the collector of the tone amplifier Q5 (another 2N2712) where the amplified signals are out of phase with the incoming signal The bass control is isolated by 5.6 KΩ resistors, and the higher frequencies are bypassed by C11. Thus as the pot changes, the amount of the lower frequency signals is either increased or de-

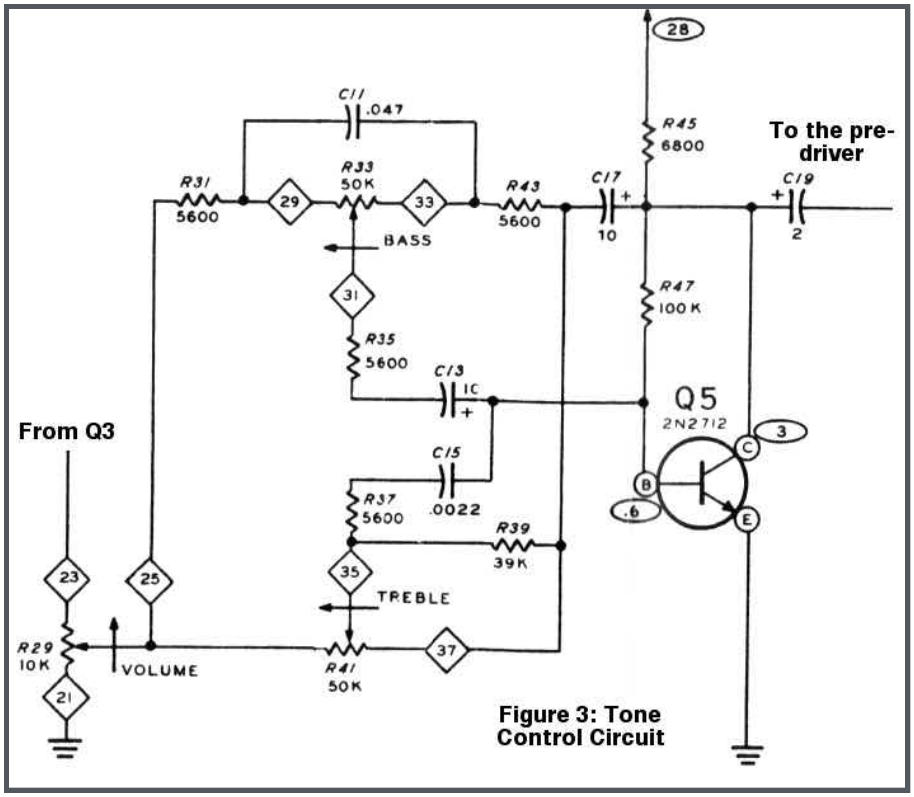


Figure 3: Tone Control Circuit

creased and fed through C13 to the base of Q5. Both bass and treble are either increased or decreased by the treble potentiometer, but only the higher treble signals are coupled to the base of Q5 due to the small size of capacitor C16. The amplified signal at the collector of Q5, besides being fed back to the low end of the tone pots is also coupled to the pre-driver through C19 and R49. See Figure 3.

Pre-Driver:

Q7 and Q9 make up the pre-driver. Like the preamplifier, the two transistors are directly coupled to prevent a loss in frequency response. Q7 is a 2N2712 and Q9 is a 2N3416 which is both low noise and capable of higher collector voltage since it is working into a much lower collector load resistor. Like in the preamplifier, a resistor (R55) provides degenerative feedback from the emitter of Q9 to the collector of Q7.

Driver and Output Stage:

The amplified signal from the collector of Q9 is coupled to the base of Q11, a 2N3053 power transistor in a metal TO-5 case. This coupling is via a high electrolytic capacitor (500µf) to keep the low-frequency response while driving the low impedance presented by the base of Q11. Q11 operates as a class A current amplifier.

Q13 and Q15 make up a rather exotic complementary power output stage See Figure 4. Q13 is a silicon NPN transistor (RCA TA2577A) and Q15 is a germanium PNP transistor 2N2148. Usually complementary transistors are matched closely other than polarity and made of the same material. The collector of the driver transistor is directly connected to the base of Q15 and through diode D1 (1N3754) to the base of Q13. R65 and R 67 provide bias to Q13 and Q15, and load to Q11. With no signal both Q13 and Q15 are lightly conducting and C29 is charged up to about 1/2 of the 38 volt power source. On positive signals Q13 acts as an emitter follower further charging C29 as it drives positive current through the speaker. At the same time Q15 is driven into cutoff. On negative signals Q15 acts as an emitter follower discharging C29 as it drives negative current through the speaker, and driving Q13 into cutoff. Thus, over a full audio cycle these waveforms are combined to faithfully create the complete waveform.

Q11 is mounted on a small heatsink and Q13 and Q15 are mounted near each other on a large heatsink along with diode D1. D1 plays an important role in the operation of the complementary output stage. First it provides a nomi-

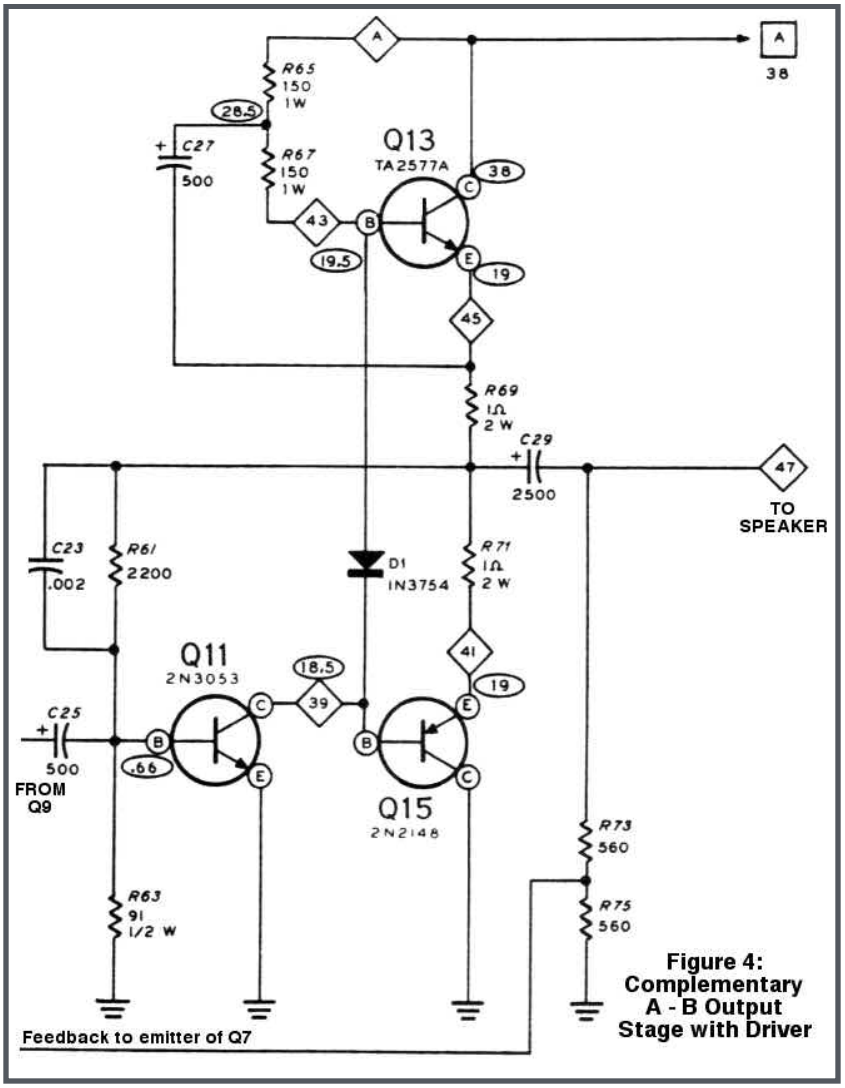


Figure 4: Complementary A - B Output Stage with Driver

nal voltage drop of 1 volt between the base of the complementary pair. This prevents both transistors from being cutoff during the transitions between plus and minus, preventing crossover distortion. Second, it provides temperature stability for the output transistors, especially the germanium Q15. As a germanium transistor, and to a lesser extent a silicon transistor, heat up they tend to draw more current resulting in further heating. This divergent problem is called thermal runaway. D1 is mounted closely between the two complementary transistors. As they heat up and draw more current D1 senses the heat and reduces the bias voltage on the transistors preventing thermal runaway.

RIGHT CHANNEL:

The right channel is identical to the left channel and will not be discussed.

CONSTRUCTION:

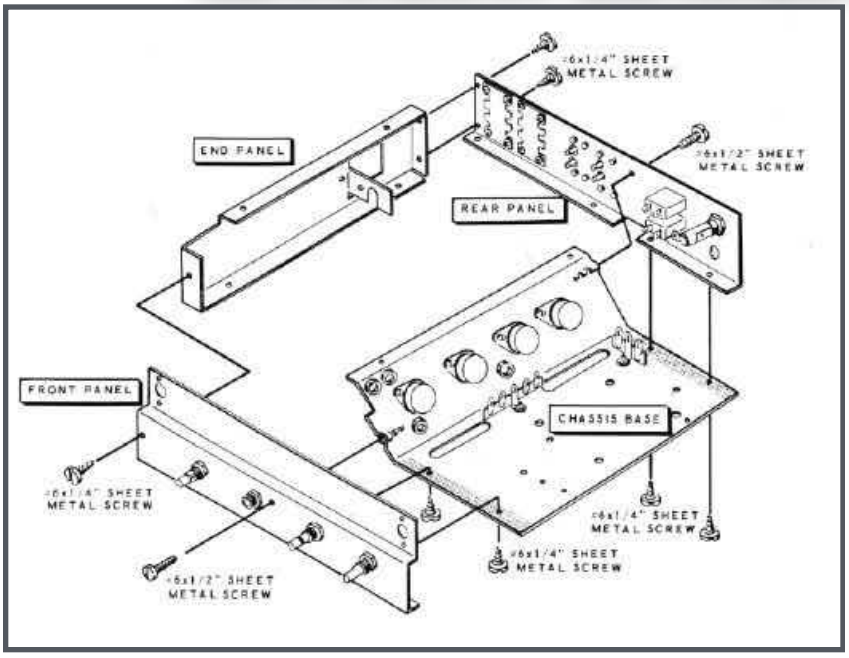
The Heathkit AA-14 uses a large circuit board to mount most of the smaller components. Other than the output transistors and their associated reference diode, the power transformer, the large power supply filter capacitor and panel mounted controls and connectors, only a handful of components, mostly associated with the power supply do not reside on the circuit board. Figure 5 is a top view of the AA-14 from the rear with the cover off.

The circuit board mounts inverted near the top of the chassis (foil side up). An easy to remove shield covers the sensitive preamplifier area of the board. This makes troubleshooting easy, especially if you have the foil side X-ray drawing, printed in the manual, handy. Access to the component side of the board is made by taking off the bottom plate. Components near the SOURCE switch may be a bit hard to reach;

Figure 5: Rear view of the AA-14 Solid-State Stereo Amplifier showing rear connections, and circuit board. Power transformer is to the left and behind it the large 4,000 µf main filter transformer, The four output transistors are on the sloping heat sink. *Photo courtesy of Don Peterson.*

other than that the board's components are readily accessible. A slanting aluminum section of the chassis acts as a heatsink holding the four output transistors. The two reference diodes mount in clips on the back of the heat sink between their associated output transistors so they can sense the output transistor's temperature.

The chassis is modular in construction and is assembled from four sheet metal parts. They are Front Panel, the End Panel (left side), The Rear Panel and the chassis base . See Figure 6. A bottom plate with ventilation slots mounts to cover the left part of the remaining bottom after construction is completed.



RESTORATION:

The AA-14 I bought had been modified and the two triple RCA jack assemblies had been removed and replaced with BNC connectors. Also the Cinch-Jones barrier terminals were replaced with banana jacks. I have to give credit to whoever did the modification as they did it without drilling any additional holes in the rear panel. Instead, they used aluminum plates bolted through the original holes to the back panel and arranged so the new connectors fit through the original holes. the original knobs were missing and the tone control circuitry was wired for a flat response with the tone controls present but unconnected. Evidently this unit was used for some sort of audio measurements.

A bag of parts came with the kit. In it I found the original knobs but not the original barrier strips nor the triple RCA connector assembly, which I found to be the obsolete H.H. Smith part # 1212. I found ONE of these almost immediately. the second took a lot trips to different electronic stores. The barrier strips were easier as they were still in production. Once the AA-14 was physically restored with new knobs and the original style rear connectors, the circuitry was examined. Once the unit was working, components were examined and replaced as needed one stage at-a-time. I generally replace all electrolytic capacitors and just resistors that appear out of tolerance. Restoring one stage at a time, checking operation after each stage, makes finding problems that might arise much easier.

SUMMARY:

The AA-14 currently sits on a shelf in my ham shack under a Heathkit AJ-14 FM tuner. It is used on a day-by-day basis and has given good service driving a pair of Ampex bookshelf speakers. Fidelity seems excellent to my ears, at least until I turn the volume up to the point where the windows rattle!

Notes:

1 IHF (Institute of High Fidelity) a standards organization in the 1950 and 60s. IHF power relates to the peak capability of the amplifier during music peaks.

2 RIAA (Recording Industry Association of America) the organization that set the pre-emphasizing standard for recording most vinyl records. De-emphases is required in the amplifier to return the music to its original response.

3 U131 diode. No info could be found on this part.

Remember if you come across any old Heathkit Manuals or Catalogs that you do not need, please pass them along to me.

Thanks - AF6C

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