

Heathkit AJ-11 Tuner

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Introduction

The Heathkit Model AJ-11 Tuner is two independent tuners; an AM (amplitude modulation) and an FM (frequency modulation) contained onto one single chassis. Heathkit touted high quality construction, versatility, excellent performance and attractive styling of the AJ-11's design. See photos of AJ-11.

Heathkit utilized a prebuilt pre-aligned FM front end in an all steel vinyl clad cabinet, and the heavy die-cast flywheels which provide positive action of the individual AM and FM tuning controls. The separate tuning indicator eye tubes simultaneously monitor AM and FM tuning. This feature is very desirable when receiving FM and AM broadcasts. Adjustable automatic frequency control and a limiter-ratio detector combination provide stable broad band FM reception. The AM section contains a built-in rod type antenna with provision for connecting an external antenna if needed.

A pre-aligned and preassembled FM front end is supplied for ease of construction, and to provide for consistently good FM performance. The full-wave, voltage-doubler power supply uses silicon rectifiers which reduce heat and provide excellent voltage regulation.

Circuit Description

AM Tuner

AM (Amplitude Modulation) refers to a constant frequency RF signal (carrier) whose amplitude is varied (modulated) by the audio being transmitted. See figure 1.

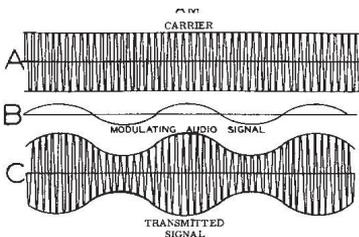


Figure 1

The modulated RF signal is received by the tuner's AM antenna and is applied to the grid of the RF amplifier tube V1 (6BA6). The amplified signal from V1 is then coupled to the grid of the mixer-oscillator tube V2 (6BE6). The AM oscillator is then tuned to a frequency of 455 kilohertz higher than that of the RF signal being received at the grid of V2. As a result, both the oscillator and RF signals are present at the grid of V2, along with the sum and difference of these two signals. These signals contain the same modulation as the received RF carrier, are applied to T2, the first IF transformer. Transformer T2 is designed to accept only the difference of 455 kilohertz. The electrical makeup of the transformer contributes to the excellent fidelity of the AJ-11. It has a special winding to control the amount of inductive coupling between the primary and secondary circuits. When the AM fidelity switch is placed in the MAX. position, Transformer T2 is over-coupled, and a response curve as shown in figure 2A results. In the NORMAL position, the coupling is decreased, and the resulting response curve is shown in figure 2B. The signal from the secondary winding of T2 is applied to the grid of the IF amplifier V3 (6BA6).

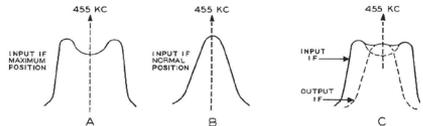


Figure 2

The diodes of V4A (6BN8) are connected to provide a negative DC voltage and an audio signal across R11 (150 K ohm), the diode load. The negative DC voltage is applied to the grid of each tube in the previous stages to control their gain. Strong stations provide more negative DC voltage which reduces the gain of the previous stages. This action is called AVC (automatic volume control). Negative DC voltage from V4A (6BN8) is also applied to the control grid of the tuning

indicator eye tube V10 (6M-E5) which indicates received signal strength and proper tuning by the amount of eye closure. Coupling capacitor C22 (.02uf) allows the audio signal from V4A to pass to the grid of the cathode follower V4B (6BN8). This stage provides isolation between the output jack and the detector stage, preventing loading of the detector. The audio signal is then coupled from the AM LEVEL control, in the cathode circuit of V4B, through the MODE SELECTOR switch to the output sockets. A whistle filter in the cathode circuit of V4B is used to reject the 10 kilohertz beat signal that often occurs between two adjacent stations when received on a wide band AM tuner.

FM Tuner

FM (frequency modulation) means that the carrier amplitude is held constant while the carrier frequency is varied above and below the station frequency at a rate determined by the audio being transmitted. This can be seen in figure 3. The audio signal (B) is applied to

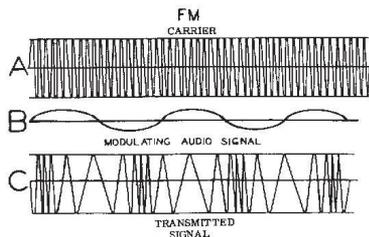


Figure 3

the RF carrier (A) to produce the FM signal (C). This signal is received by the FM tuner antenna and is applied through a bandpass filter, consisting of coil L5 and C29A to the grid of RF amplifier tube V5A (6C9). The amplified signal from V5A is coupled through C33 (1.5pf) and the secondary of L7 to the grid of the mixer oscillator tube V5B (6C9). The local oscillator tank circuit made up of C29E and the primary coil of L7 is tuned to operate the 10.7 megahertz above the received FM signal. The oscillator signal and the received signal are mixed in V5B. The output of the tube then contains three frequencies; the received FM signal frequency, the sum of the oscillator and the signal frequencies and the difference of the oscillator and signal frequencies. These signals are then applied to the first IF transformer T5, which passes only

the difference frequency of 10.7 megahertz. Then the 10.7 megahertz signal from T5 is applied to IF amplifier tube V6 (6AU6) and is then coupled through transformer T6 to the second amplifier tube V7 (6AU6). From V7 the amplified 10.7 megahertz signal is applied through transformer T7 to limiter stage V8 (6AU6).

The amount of signal at the grid of V8 determines the value of negative DC voltage developed at this point. The negative DC voltage is applied to the grid of eye tube V11 (6M-E5) which indicates signal strength and proper tuning. V8 acts as an IF amplifier for weak signals and as a limiter for strong signals. The limiter stage in the FM tuner is used to remove any amplitude modulation of the FM signal. See fig 4. The limited signal from V8 is ap-

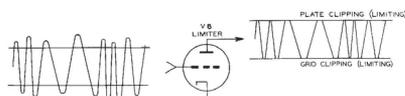


Figure 4

plied through transformer T8, to ratio detector tube V9A (6BN8). The ratio detector does the same job in an FM tuner as it does in an AM tuner. It recovers audio from the modulated IF signal. If the oscillator frequency changes (drifts), a small negative DC voltage is developed in the ratio detector. This voltage is applied back to the grid of the oscillator tube to correct the frequency drift. The audio signal from the ratio detector is coupled through the MODE SELECTOR switch to the output sockets.

Power Supply

The power supply uses a full wave voltage doubler circuit consisting of D1, D2 (1N4003), and capacitors C67 and C68 (40, 40uf@150VDC). Capacitors C69A, C69B and C69C (80, 40, 20uf @150VDC) with resistors R46 and R47 (220, 330 ohms 2W) make up the filter network to remove ripple from the DC voltage.

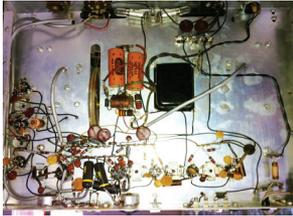
Common Types of Repairs

These tuners usually show up either on EBAY or at garage sales or swap meets. I personally own one of these tuners and I have had the opportunity to repair several others for friends. The following types of repairs are

what I did to get them going again. I normally do most of this before I attempt to power the unit up. I have also provided the Heathkit Schematic of the AJ-11 for reference.

Power Supply – Replace all the electrolytic capacitors, resistors and the silicon diodes in the power supply. I also upped the wattage of the 2 resistors in the power supply from 2 to 5 watts. I then scoped the DC output to insure that the DC is as clean as possible. As these units were made in the early 1960's it just makes sense.

Tube Testing -- Next would be to pull all the tubes and test them to see if there are any that are weak or shorted.



Chassis -- After that I would use a cleaner degreaser on the underside of the chassis to remove the dust and dirt buildup of over 50 years. I then would check for any loose or cracked wiring and repair that. Also look for any cold solder or too much solder on the point to point wiring.

Components -- Next is to measure all the resistors to see if any have gone up in value and replace those. If there are any electrolytic or tubular capacitors definitely replace those. It is also a good idea to check the variable capacitors and make sure they turn freely and do not bind. Make sure the tuning plates are not touching. I have also seen the tuning flywheels bind up on these tuners so a careful cleaning and lubrication may be needed. If you need to restring the tuners to the dial it is recommended that you have the service manual. It is also recommended that you clean the rotary switches and potentiometer using a good cleaner / degreaser.

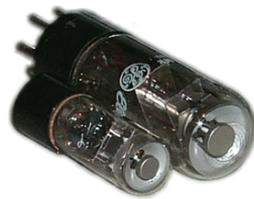
Start Up -- At this point I was ready to power up the tuner. Even though I went through the set I always use a variac and bring the voltage up slowly. I then performed the alignment on the AM and FM tuners. You need a signal generator, scope and a meter to do this correctly. I did run across some of the ceramic disc capacitors that Heathkit used had changed in value and had to be replaced. In the re-alignment process you may need to touch up

the IF (intermediate frequency) transformers to achieve maximum results especially if you replace the capacitors in the IF circuit. I have this tuner connected to my EICO ST40 and it works well.

6M-E5 Eye Tube



Heathkit decided to use the now scarce 6M-E5 tube in their AJ-11 tuner. This tube is a smaller version of the more popular 6E5 tube. The 6M-E5 uses a smaller 7 pin base and its heater current is 150 milliamps versus the 6E5 300 milliamp current. The 6M-E5 can be tested on a TV-7 using the following settings. For an emission and pattern open measurement set the TV7 to 6.3V and the selector switches to ET0-5070, bias 0, shunt 0, range A and push 4. To measure for gm set the TV7 to 6.3V and the selector switches to ET1-2070, bias 17, shunt 0, range B and push 3. To measure the pattern closure set the TV7 to 6.3V and the selector switches to ET-1 5270, bias 0, shunt 100, range A and push 3. You will also need a 7 pin miniature tall test socket adapter to fit the TV7 miniature test socket. A recent check on EBAY shows these tubes being sold for \$39.00 so they still come up from time to time. The 6M-E5 tubes I saw are



EICO labeled so they were also used in some of their products. A photo of the 6M-E5 and a 6E-M5 next to a 6E5 shows the size difference.

Observations

The Heathkit AJ-11 is a simple tuner performs well with an adequate antenna. The AM portion of the tuner has only one IF stage so weak stations will be hard to pull in unless you add the external antenna. The FM portion of the tuner has two stages of IF and with an adequate antenna the weaker, distant stations can be picked up. The unit is reliable

and does need to have ventilation especially when placed into an audio cabinet or enclosed wall unit with a tube amplifier. Excessive heat will affect its operation. Heathkit and other manufacturers at the time provided the ability to connect an external MPX (multiplexer) unit to achieve FM stereo. This was done because the FCC had not yet settled on a FM stereo MPX design and radio manufacturers weren't going to speculate on which MPX design was going to be adopted so they provided an FM output to allow for the final FM MPX design to use. Heathkit as well as several other radio manufacturers provided separate external MPX adapters so you did not need to use the Heathkit MPX adapter with the AJ-11.



References

- Heathkit AJ-11 Assembly Manual
- RCA Receiving Tube Manual

