350 Watt Vacuum Tube Amplifier

Owner's Manual

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CIRCUIT DESCRIPTION

The input stage consists of a 12AX7 current sourced long-tailed balanced pair, which is direct coupled to a second long-tailed balanced pair comprised of a 12AT7. The 12AT7 drives the grids of the KT150/KT120 output tubes through a pair of coupling capacitors that provide low frequency loop-gain stability. A 6AL5 DC restorer ensures that the bias voltage remains correct over the entire audio signal cycle.

The output tubes are arranged in push-pull parallel, three up, three down for a total of six in all. The screen grids are operated at approximately 360 volts provided by a separate power supply formed by one-half of a voltage doubler supplying the plates with 720 volts.

The power supply consists of a large power transformer, with energy storage that is far greater than necessary. AC filament voltage is biased to approximately 60 volts. Multiple decoupling filter sections are used with load regulation obtained through constant current loading.

Turn-on in-rush current limiting is provided by a thermistor, bias voltage adjustment by a bias control, feedback gain by a top-mounted front panel switch, volume by a volume control, and bias voltage is measured across a one ohm sense resistor that senses current for all six output tubes simultaneously. A tube fuse is mounted on the rear apron and provides protection for the output section in the event of a catastrophic vacuum tube failure. Additionally, a rear mounted power line fuse provides overall protection for the amplifier.

VACUUM TUBES

The output tubes do not need to be matched, as the sound of the amp does not at all depend on matched output tubes. That's because the DC restorer circuit eliminates the need to match tubes. The only caveat here is that the output tubes should all be the same type and vintage.

Looking at the amplifier from the front, from left to right: the first tube is a 12AX7, then a 12AT7, and finally the 6AL5. The output tubes are KT120's. Any of the popular derivatives such as '88, '90, or '100 may also be installed. The mighty 6550 may be used as well, even the ubiquitous EL34. However, performance will suffer a bit with the EL34 because the design has been optimized for the KT88 / KT120 / 6550.

FEEDBACK SWITCH

The small switch mounted on the top front of the chassis controls the amount of negative feedback used. When the toggle handle is pushed LEFT (classic), the feedback is approximately 20 dB, a value used by almost all vintage amplifier designers and is my personal preference. When toggled RIGHT (contemporary), feedback is limited to about 11 dB. This represents the practice of many modern day designers. Please try it both ways and make your own determination based on your listening experience and your speakers.

VOLUME CONTROL

Under normal circumstances, this control should remain in the maximum (fully clockwise) position. If you have a noisy preamp, turning it halfway down and centering it at the 12:00 o'clock position will reduce the preamp noise by half, or 6 dB. It should always be turned all the way down (fully counterclockwise) when connecting or disconnecting any input or output in your system.

Either the XLR (balanced) or RCA (single-ended) audio input jacks are used to feed the signal into the amplifier from your signal source.

FUSES

The rear panel line fuse is a 6 ampere (3 ampere for 240 volt operation), fast blow type, and should be replaced with the same type and rating if it ever needs replacing. Do not, *under any circumstances*, use a "slow-blow" fuse here. The (rear panel) vacuum tube cathode fuse is a 1.0 ampere and should be replaced with the same type and rating. If the fuse blows during bench testing, it may be *temporarily* replaced with a 1.25 or 1.5 ampere fuse. Normally, a 1.0 ampere fuse will be perfect for music because the peak-to-average power ratio of speech and music is about 10:1. If you find that the 1.0 amp fuse blows with music, you may replace it with a 1.25 ampere fuse, or even a 1.5 ampere unit.

ADJUSTING THE OUTPUT TUBE BIAS

The front panel incorporates a bias meter. Turn the volume control all the way down while performing bias adjustments. Use a small screwdriver and adjust the bias control (located on the rear of the amplifier) for 80 mA after the unit has warmed up for about 20 minutes. The normal range to use is from 60 mA to 150 mA, and changes here will vary the damping factor of the amplifier slightly. More current increases the damping factor, whereas less current provides a softer more tube-like sound. The design center is 80 mA, and that should be your starting point if you want to experiment. Personally, I found that I loved the sound best on my speakers when I had it set for their design center of 80 mA. It will vary from speaker to speaker, and most importantly with your taste.

The meter reads the combined current for all six output tubes, and it is normal for this current to vary slightly with changes in power line voltage.

SPEAKER CONNECTIONS

From the rear view: the black binding post is common, and (moving to the right) the next red post is two ohms, then four ohms, and the far right post is for eight ohms. The power curve is quite flat, hence the two ohm tap may be used for one ohm speakers, and the eight ohm tap may be used for sixteen ohm speakers.

POWER SWITCH

Up is on, down is off. There is no power-on indicator except for the glow of the tubes, so you will have to remember whether you turned it on for about 10 seconds until you can see the tubes glow. It is safe to switch the amplifier on and off at will.

LINE VOLTAGE

This amplifier may be configured for operation with 120 volts or 240 volts, 50 / 60 Hz. The changeover must be performed by qualified personnel. It is a standard under the chassis wiring configuration. See the circuit diagram for details. When used with 240 volts, the AC line fuse must be replaced with a 3 ampere unit.

COOLING

Convection cooling. Cool air is drawn from under the chassis by the heat from the tubes acting as an air pump, and exhausting the warm air out the chassis through the top vents. Do not place the amplifier on a carpet without something hard to sit on like a piece of nice glass cut to the same size as the unit. This will allow the feet to do their job by keeping the bottom raised, allowing unimpeded airflow. A glass shop can make such a base plate and in colors if you wish. A nice translucent brown, burgundy or smoke looks beautiful. It should be at least a quarter of an inch thick. 12 1/4" X 14 1/2".

MONITORING

Once the idling current has been set, it will normally not need to be adjusted for several years unless you want to experiment for different sound. Or if you install different output tubes, or the amplifier suddenly starts to sound funny. If you hear a POP and see a flash, yet the amp continues to play, you should first check the current and then the output tube fuse. If the fuses blow, the output current will drop to zero. If the tube fuse blows, replace it WITHOUT replacing any tubes. Turn the amp on and monitor the current. If it climbs to within the range you had set, and if the amp sounds good, all is well.

Often, an output tube has a speck of dust-like impurity, which comes into contact with an internal element, shorting the element, and is vaporized into gaseous oblivion. The getter, the mirror-like shiny plating on the inside of the tube does its job, absorbs the vaporized material and the tube is like new again. All it takes is a new fuse.

If you install a new fuse and it blows again, you will need to determine which tube is the culprit. Proceed as follows: remove all output tubes and turn the volume control all the way down. Turn the amp on and leave it on. While monitoring the current, put a pair of tubes into sockets number five and number six. Allow one minute on the clock for the two tubes to warm up. If the current comes up to about one third the normal amount, both those tubes are good. Remove those tubes and install another pair, also in sockets five and six. Continue on until a fuse blows, or the tubes won't bias up.

Then borrow a known good tube from the other amplifier, and using it as a mate, place it temporarily in socket number five, use the process of elimination to figure out which of the last two tubes is bad. At this point, if you get lucky, only one trial will be needed. If you are not lucky, then it will take two trials. Now you can turn the amp off.

You will be able to install and remove the tubes with your bare fingers if you do it within about a minute or so of installing each fresh set. That's because it takes substantially longer than a minute for the tubes to get too hot to hold.

TUBE TESTER

The front panel meter may be used to test the tubes. Remove all the power output tubes; plug the amp into the AC wall socket with the main rear panel power switch OFF.

Insert the tube you wish to test into socket #6 (the far right front socket). Turn the bias control such that the slot is at 12:00 o'clock (straight up and down) and turn the main power switch ON. With a watch, time the warm-up period for exactly one and a half minutes and note the current reading. Turn the amplifier OFF,

Remove the tube and insert the next one. You can hold the tube with your bare fingers - it will not be too hot after only a minute and a half, provided it was cool to start with. Keep track of each reading, and repeat until all tubes have been checked. If any single tube does not bias up or "runs away" with its current climbing substantially higher, ≈200% than the others, then it must be replaced. It is okay to turn the amp on and off at will. Return the bias control to its original position and put all the tubes back into their sockets. This completes the tube testing operation.

MATCHING OUTPUT TUBES

Matching output tubes is not necessary, thanks to the DC restorer. But it's fun to do anyway. As noted above, as you wrote down each bias current, you will end up with six numbers. The goal is to select two groups of three whose sum (from any three tubes) is as close as you can get to the other group of three tubes. Install the first group in sockets #1, #3, and #5, the odd sockets. Then install the other group into sockets #2, #4, and #6, the even sockets. The socket positions on the amp, from left to right, looking from the front are: #1, #2, #3, and #4. The last two positions, #5 and #6, are the front tubes on the right.

The new KT120's are quite variable, and I recommend that when using the KT120 tube, one should go through the exercise of matching them as outlined above.

SMALL TOGGLE SWITCH

There is a small toggle switch on the top front, and it controls the feedback as mentioned earlier. Thrown left = classical, right = contemporary.

NEW AMPLIFIER SMELL

Like a brand new car, this amplifier possesses a "new amplifier smell," even though it has been built from both new and vintage parts. When powered up for the first time, the fresh paint and recent skin oils on the tubes will create a new, hot amp smell. I find it sort of pleasant, but you may not. It will dissipate with use, usually requiring about four weeks of normal operation.

SPECIFICATIONS

Gain	30 dB
Power	More than 350 Watts
Noise	Better than 100 dB A-weighted, referred to 200 watts
Frequency response	2 Hz to 85 kHz, without filters
Distortion	Less than 0.5%
Vacuum tubes	KT150 / KT120 / KT88 / 6550, 12AX7, 12AT7, 6AL5
Speaker outputs	One ohm, two ohms, four, eight and sixteen ohms
Input impedance	100 kohms
Weight	84 pounds for a stereo pair, 42 pounds each
Color	Champagne gold, Bright chrome, Natural aluminum and Strawberry metallic Red and Gloss black.