Part 5, Attachment 2. <u>First Power-Up</u>

Wall of Sound.ca Tubelab DIY EL84 Amp

Tools Required:

-Multimeter

-RCA Shorting plugs (if amp doesn't have the volume control option)

-Screw drivers

-Sharp knife

-Various pliers

-Electrical tape

-Clamps

-IEC power cord

-Pair of speakers you don't care about. Could even be old car speakers.

And finally, the **TUBES** from the kit of parts.

A Variac, variable voltage transformer is a very useful device for first power-up. AC line voltage can be applied gradually, starting low and ramping up slowly. Great for the naturally cautious. I have an ancient one, saved from a dumpster. New ones aren't cheap and typically beyond the means of all but very serious DIYers.

Inexpensive alternatives exist. A device that will allow a gentle first power-up can be built using an IEC cord, 100-Watt incandescent bulb, a bulb socket and a piece of wood. Of course, this doesn't conform to any electrical code. Caution must be exercised when using it. The parts required for this gizmo are listed below.

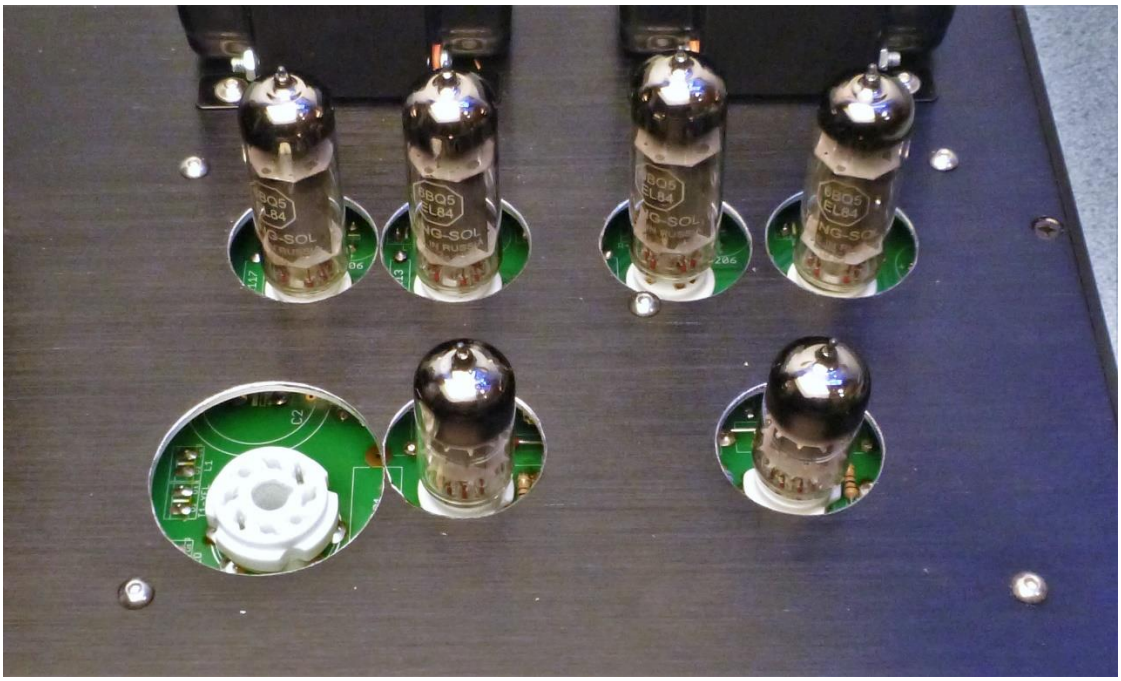
-A second IEC power cord

- 100-Watt incandescent bulb (LED and compact fluorescent bulbs won't work)

-Bulb Socket

-Scrap piece of wood roughly ¾" x 6" x 8"

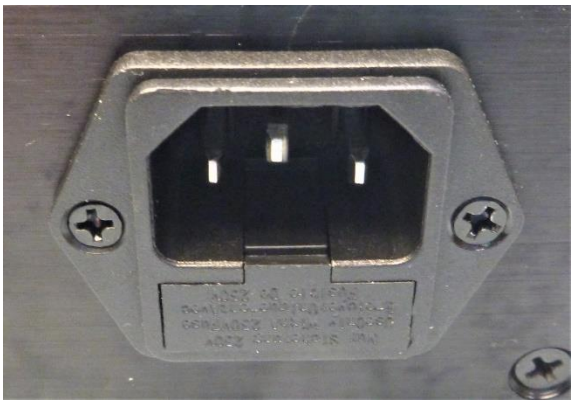
-4 sheet metal or wood screws



Plug the four EL84 tubes into the sockets closest to the output transformers.

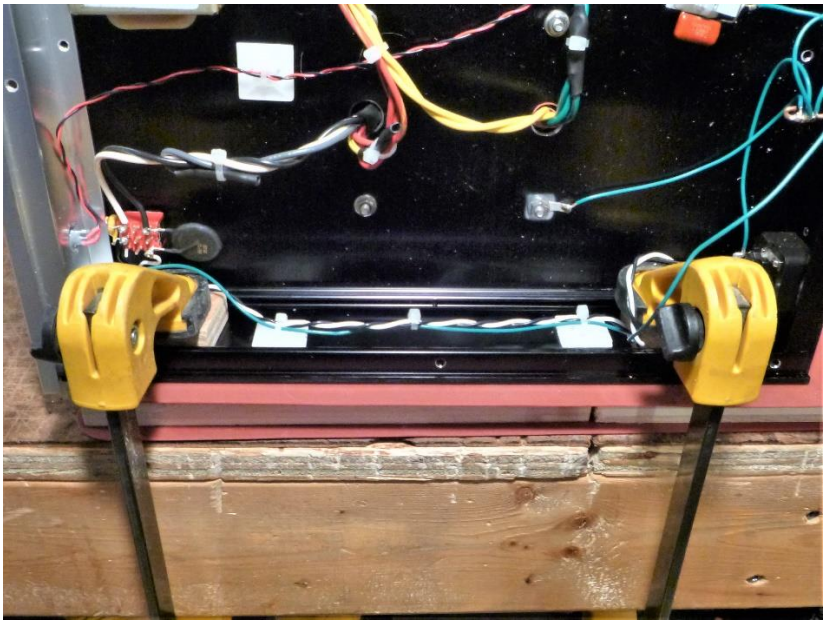
Plug the two 12AT7 tubes into the front sockets.

Leave the rectifier socket empty for now.



Remove the fuse drawer from the AC inlet.

Insert a 3-amp, slow blow fuse in the drawer “hook” and press the drawer into the AC inlet.



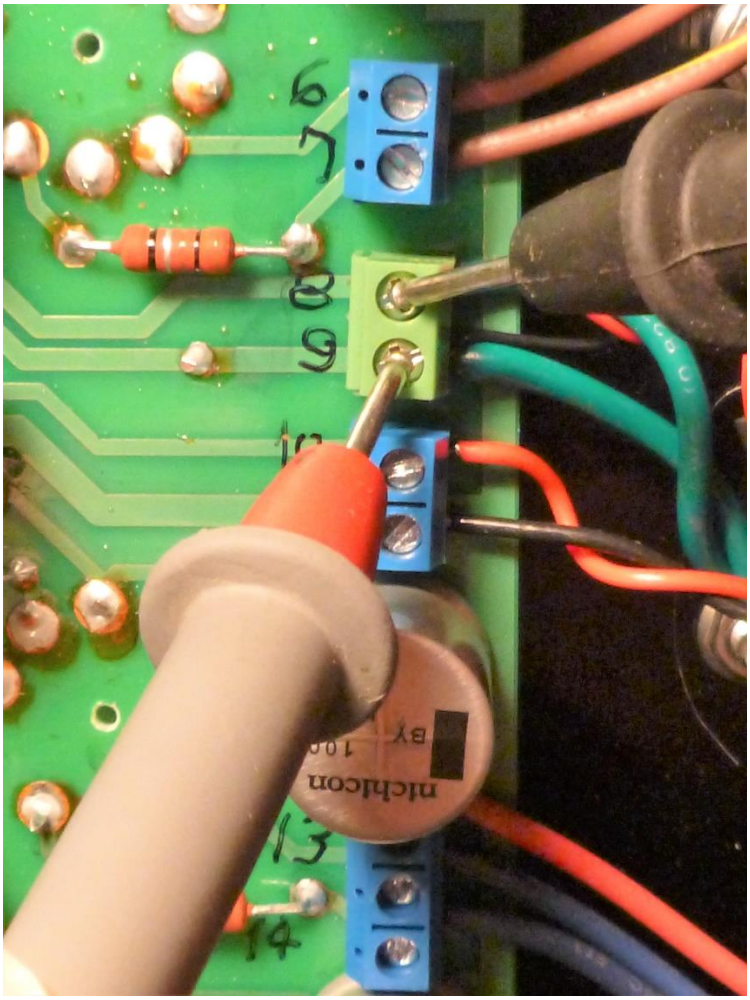
Stand the amp up on the end closest to the power transformer. Use clamps and wood blocks to restrain and support the amp.

From this pint onwards there will be lots of volts coursing through the veins of the component. <u>EXERSISE DUE CAUTION!</u>

Set your multimeter to **AC** volts. If it's not an auto ranging type, set it to the first range above 6 volts.

Insert an AC cord into the AC inlet.

Plug the cord in to an AC outlet **and switch the amp on**.



Measure the voltage at connector points **8** and **9.**

The nominal expected is **6.3** volts. It should measure *around* **6** volts. The inrush limiter will ramp the voltage up slowly. It might take a minute or two for the voltage to reach its maximum.

After a minute or so look at all of the tubes. The filaments should be glowing.

So far, so good.

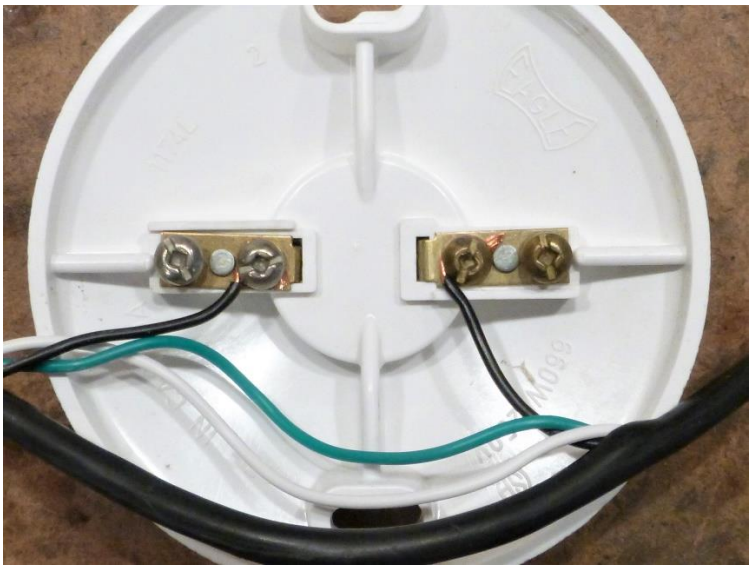
Switch the power off, unplug the amp from the AC socket and remove the cord from the AC inlet.

Insert the 5AR4 rectifier tube into its socket. Some of the porcelain bases on octal sockets can be a little sloppy. Be sure to properly align the key on the tube base with the slot in the socket.

If you don't have access to a Variac build the device shown below. This will allow a gentle first power-up of the amp.

Carefully slit about 4" or 5" in the middle of an IEC power cord.

Cut the **black** wire and strip off about ½" of insulation from each end.



Connect the ends to the lamp base connections.

Attach the lamp base to a board with screws.

Don’t pinch the wires tightly.

Screw a 100-Watt bulb into the socket.

Note: This device only works with conventional light bulbs. It **won’t** work with LED or compact fluorescent bulbs.

If there is a chance someone other than yourself might interact with this device take it apart and stash the cord away in a safe place when testing is finished.

Plug the IEC connector of this contraption in to the amplifier.

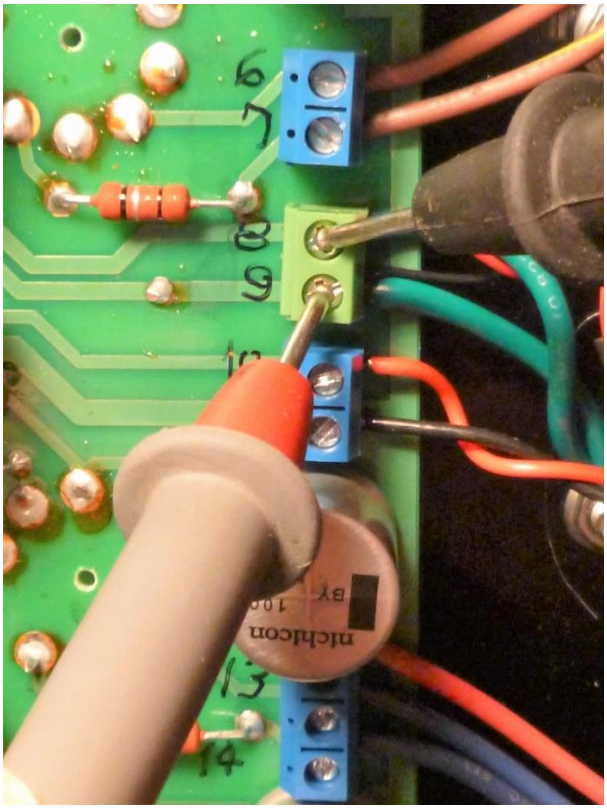
Insert the plug into an AC outlet.

Switch on the amplifier.

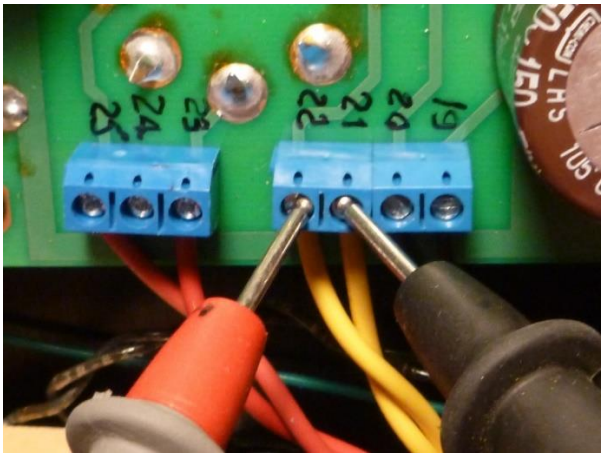
Though you can’t judge from the picture above, the bulb should glow SIGNIFICANTLY LESS BRIGHTLY than you would expect from a 100-watt bulb.

If the amp is running correctly about half of the line voltage will be dissipated by the bulb (~60 volts) and the other half by the amp.

After the amp has run for a couple of minutes – this gives the power supply caps a chance to form and the tubes a chanced to stabilise – measure voltages at the following places:

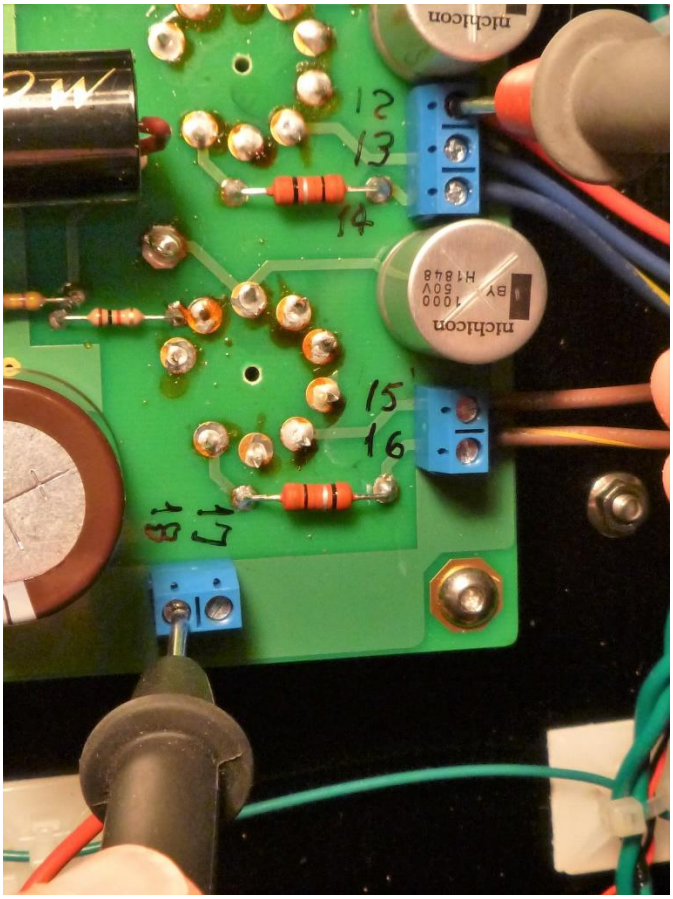


Connection points **8 & 9:** Approximately **3** volts **AC** expected.



Connection points **21 & 22:** Approximately **2.5** volts **AC** expected.

Warning: Even though is a small AC voltage across points 21 & 22 there is a <u>significantly</u> higher DC voltage between these points and the circuit ground.



Connection points **18 & 12:** Approximately **150** volts **DC** expected.

All tubes should be glowing dimly.

After 5 or so minutes turn the amp off. Unplug the light bulb contraption from the amp and the wall socked and disassemble or store in a safe place.

Measure the voltage at connection at points **18 & 12** again. There should be no more than **1 or 2** volts **DC.**

Connect your, who-gives-a-crap speakers, to the speaker binding posts.

If you built the version with the optional volume control, set the volume to **zero**.

If you **didn't** build the volume control version, inset shorting plugs into the input jacks.

Connect an IEC power cable to the amp and switch it **ON**.

Give the amp a minute or two to warm up.

If everything is correct all the tubes should light, the fuse shouldn't blow and <u>nothing</u> should be heard from the speakers. And of course, there should be no smoke an/or smell of burning.

The full voltage should be applied to the tubes now. <u>Be careful making the following measurements.</u>

Measure at connection points **8 & 9:** expect **5.9** to **6.3** volts **AC**

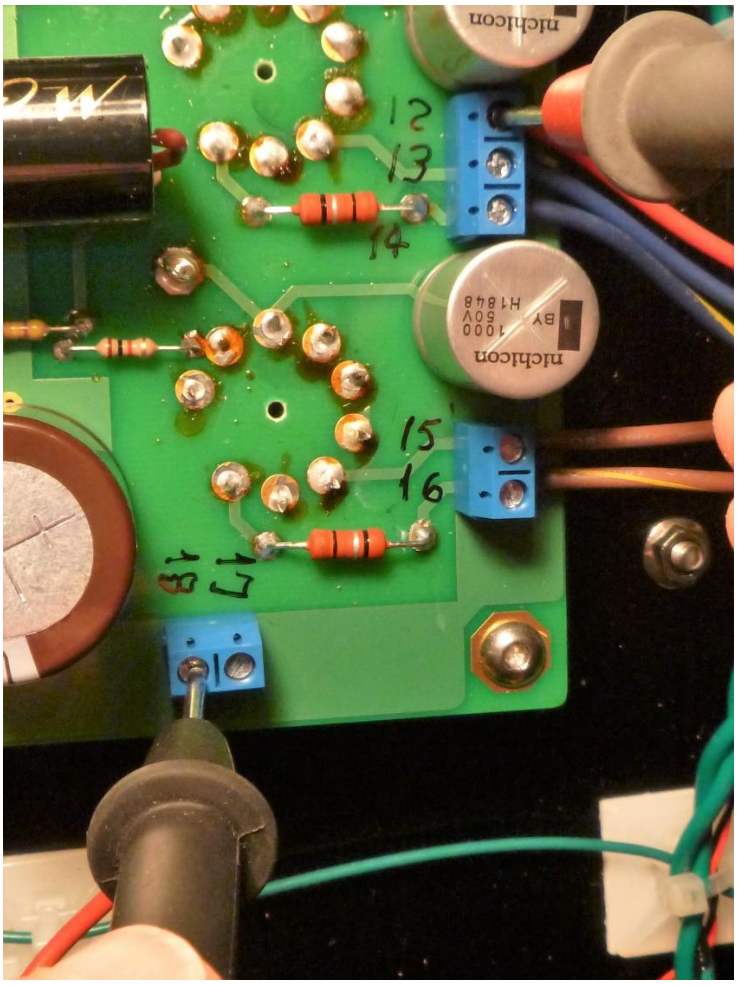
Measure at connection points **21 & 22:** expect **4.7** to **5.0** volts **AC**

Your line voltage and the tap used on the primary of the power transformer will determine the filament voltages.

If you are using the black wire (125 volts) and the voltage is too low, try removing the black wire from the switch and connecting the gray wire. Performed with the amp powered down <u>of course</u> and AC power removed.

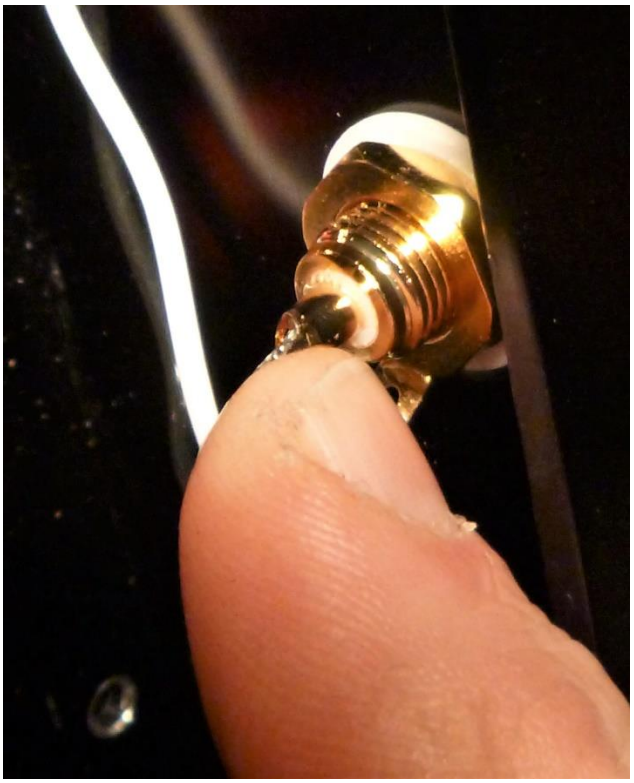
If you are using the gray wire (115 volts) and the voltage is too high, try removing the gray wire from the switch and connecting the black wire. Performed with the amp powered down <u>of course</u> and AC power removed.

The patron's amp measured **6.1** volts on connection points **8 & 9** and **4.8** volts on connection points **21 & 22**. This was using the 125-volt tap and with the AC line at 117 volts. This an ideal voltage for the filaments. Slightly under-running them helps increase tube life.



Measure the **<u>DC</u>** voltage at connector points **12** and **18.** It should be around **320** volts.

Make a note of the voltage. It will be used later to calculate tube power dissipation.



Turn up the volume control, if used, or remove the shorting plugs.

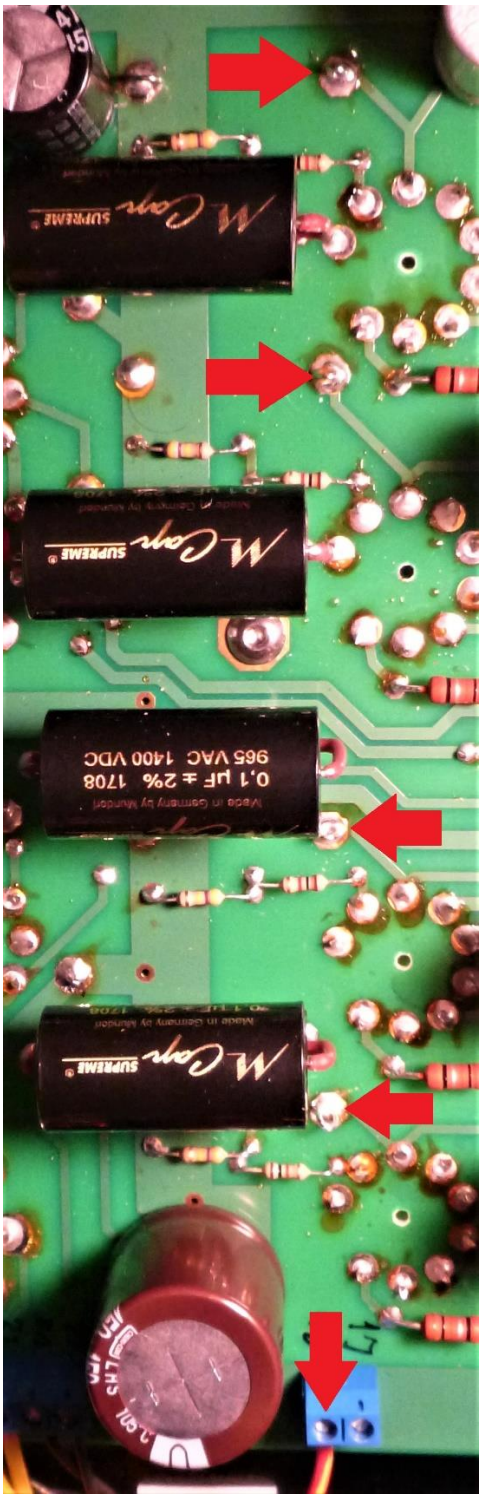
Touch the centre conductor of the input jacks, one at a time. Don't worry, there isn't any voltage to speak of on the jack.

A buzz should be heard from each speaker in turn.

Connect a source to the input jacks, I used a portable music player. Music should be heard from the speakers.

Pause the music player or mute the source.

If all is well one more measurement remains.



Measure the **DC** voltage on each cathode of the four EL84 tubes.

As shown above, measure between connector **18** and the loops near the coupling caps made during board assembly.

Measured voltage should be between **11** and **12** volts.

Calculate the power dissipated by the tubes as follows:

-Subtract the cathode voltage, measured just above, **11.8** in the patron's amp, from the voltage on connector **12**, measured a few pages back. 320 – 11.8= **308.2** volts.

-Divide the voltage measured just above (**11.8** in the patron's amp) by the resistor value of R111, 116, 2111, 216 (**270**Ω in the patron's amp) to calculate the current in the tube. 11.8 / 270= **0.044** Amps.

-Multiply the current, **0.044** Amps, times the voltage calculated above, **308.2** volts, to yield the power dissipated. 0.044 X 308 = **13.5** Watts.

A more thorough explanation of output tube biasing can be seen in my WOS article from 2017. https://wallofsound.ca/audioreviews/amplification/output-tube-biasing-an-introduction-part-2/

When we compare the measured dissipation, 13.5 watts, with the typical maximum dissipation of Russian-made EL84s of 16.2 watts (the Tung-Sols used in the patron's amp are made in Russia) we are running the tubes at 83% of their max. dissipation.

This is a bit high and I've updated the parts list to include alternatives for resistors R111, 116, 211 & 216 that will ease back on dissipated power. This will be especially important if using JJ EL84 tubes, as their dissipation limit is 12 watts.

If using anything <u>other than</u> Hammond output transformers there is more testing to do, detailed in Attachment 3. Leave the amplifier clamped to the bench.

If you <u>are</u> using Hammonds, power down the amp and disconnect any cords or cabling.

Carefully loosen the clamps and lay the amp on the bench with the interior facing up. Be careful not to damage the tubes. Use wood blocks or similar to keep the amp from rocking on its transformers. There's more for the Hammond faithful to do part way through Attachment 3.

Proceed to Part 5, Attachment 3.