How to build the Seth PP2A3

Or how I discovered that things are never as simple as planned, especially when writing such a "How-To" thing.

By Jean-Francois Lessard ing. Ph.D.
Pantheon Audio MagneQuest distributor.
(http://www.pantheon-audio.com)

Introduction

I've been procrastinating for a looooong time before finally writing this. Say thanks to my dear friend and excellent web designer Mr. Mobile Homeless, AKA Kelly Holsten, (http://www.i-vol.com) and Mike Lafevre, from the MagneQuest fame, (http://www.magnequest.com) to have bugged me so I would finally produce what I promised on a drunken evening.

Right from the start you should be aware that the goal of this amplifier is to provide a new "simple" tube amp for the newbie in DIY tube audio. I wanted it to be a working platform, from which one can make the design evolve. Hopefully I'll have achieved this goal with the Seth. BTW, why the heck did I called this amplifier Seth? For one, I couldn't resist the pun as I find it as a nice SET flavour in the midrange. Second reason is that in Egyptian mythology, Seth was Horus competitor, The Horus being another design of mine I've been loving much. You'll notice that the picture quality in this manual could be higher. Due to the large number of pictures, having high resolution pictures would have made for a pretty large file. A CD containing all the pictures contained here but in a higher resolution will be given for free to all those who will have bought the Seth iron package from Pantheon Audio.

Boring stuff and other horror stories

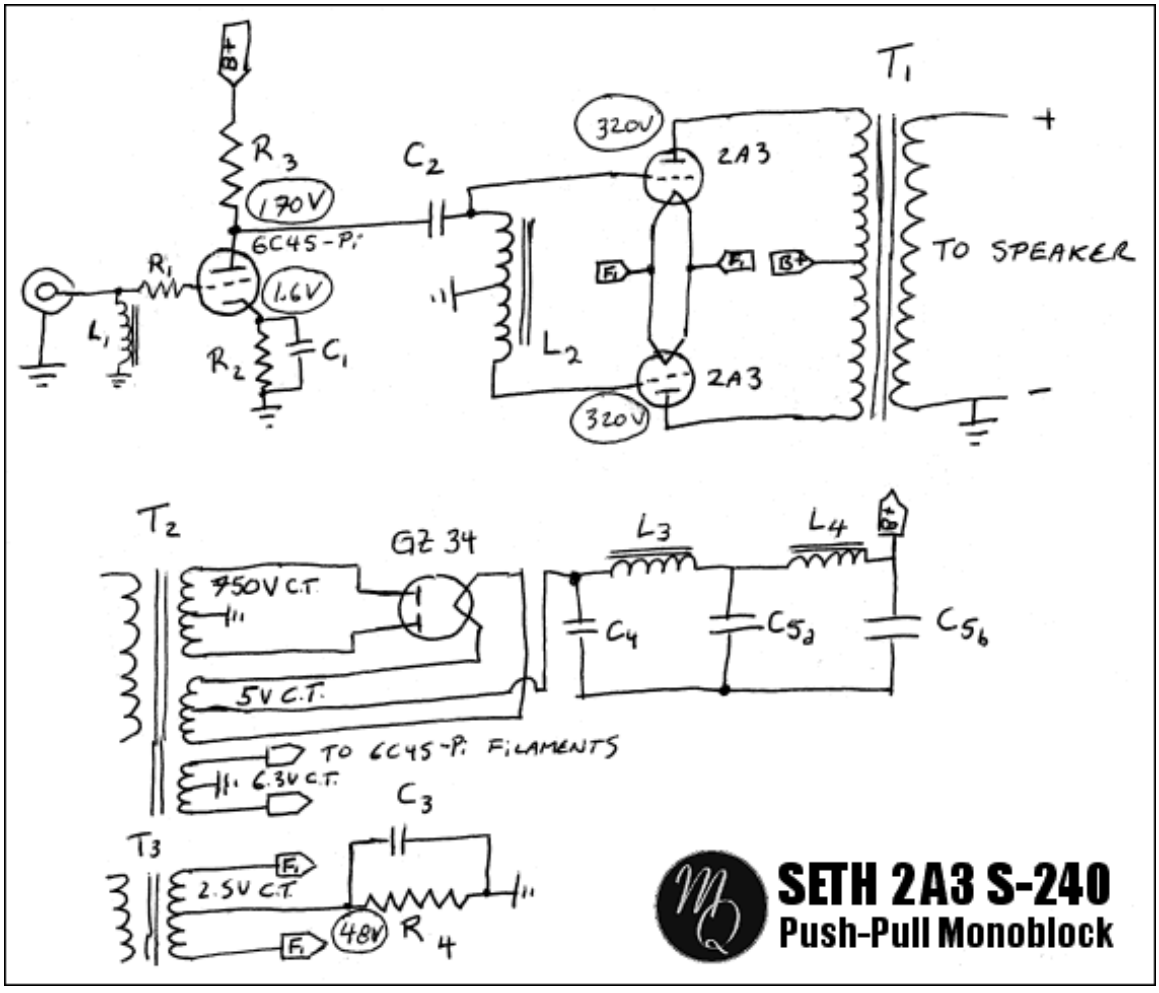
First and foremost before you jump into this here is the usual disclaimer. If you are clumsy and/or do not know anything about electricity please stay away from playing with tubes circuits and high voltage without learning the basics and being cautious... carelessness may harm or kill you! This article is not intended as a class in electronic so it is your responsibility to learn the safety rules when working with tube circuit. You have to be aware that the way to build the amps that is described here (circuit wiring method, AC wiring, etc.) might definitively not lead to a "UL approved" product. It might end up in a device that will not meet the requirements of the regulations in your area. It is your responsibility to do all the necessary work to make sure the amps will be "legal and safe" to use in your home.

Still there? OK… let's begin.

Schematic

The Seth has a very low part count. It is actually deceptively simple. It is in fact an out of fashion design. No choke loading on the driver stage, no CCS, no bells and whistles. Why? Simply for the newbie to build this amp easily. Does it sound good despite being more or less fashionable? You bet.

Have a look at the schematic (note if you can't read a schematic would it be to save your life, I suggest you learn how to. Ain't that complicated). The heart of this amp simplicity is L_2, the EXO-173 PPS center tapped choke. It acts as the phase splitter in a simple but so elegant way. Putting the choke center tap to ground will create a reflected signal inverted 180^o on the bottom leg from the one that is fed on the top leg (where C_2 is connected).



The rest of the amp is as simple. It is a two stage design where a 6C45-Pi drives a pair of 2A3 in push pull class A. The PSU is a double pi filter, making for a very low ripple. This amp is self biased. The pair of 2A3 shares a single bias resistor so this will ask for closely matched tubes. The list of the parts I used in these amps is given below. Feel free

to experiment with the parts and please do not follow my choices blindly. After all, it's your amp your building, not mine.

R1	Two Dale metal film 100 ohms 1/4W in parallel
R2	Holco metal film 43.5 ohms 1/2W
R3	Mills Wirewound 4.02 K 12W
R4	Mills Wirewound 12W 1 K in parallel with Mills Wirewound 12W 750 ohm
C1	Black Gate "FK" 100 uF /16 V (optional I did remove it after listening with and without)
C2	Solen 3.3 uF/630V
C3	Black Gate "FK" 100 uF/100 V
C4	Solen 1.5 uF/630V
C5a,b	Cerafine 47 uF+47 uF/500 V
T1	MagneQuest "Peerless" S-240-A Ni
T2	Hammond 374BX 375V-0-375 V 175 mA
T3	Hammond 166Q2 2.5 V CT 6A
L1	MagneQuest BCP16 GC Ni
L2	MagneQuest EXO-173 PPS Ni
L3	Hammond 193H 5 H 200 mA 65 ohms
L4	Hammond 193H 5 H 200 mA 6 5ohms

Building the wood chassis.

I always use wood chassis. I'll be pretty vague here since you'll find better advises that I could give on the miscellaneous woodworking web sites so I'll skip the details here. In a nutshell I used a copper plate 18 AWG thick measuring 16" by 9" for the top plate. Bottom plate is the same size but in aluminum (utility grade). I will usually oil the chassis with either boiled linseed oil or Tung Oil for finishing the chassis.

I usually use a router to do a recess on the top and bottom of the chassis so the plates will rest flush in them. I always use hard woods for my chassis so I can tap 6/32" threaded holes into the wood in order to secure the plates with 6/32" machine screws. I always work with 1" to 1"1/2 thick wood planks (once planed). I cut the wood with a mitre saw according to my top plate size then I glue the four side with a special holding jig to ensure square enclosure will be well … square!. You can find those jigs in most hardware stores. Figure 1 illustrates a picture of a chassis drying while being clamped by the jig. Once the chassis as set dry, I round the corners with a router despite a certain Kelly Holsten always giving me shit about it.

Figure 1. Drying chassis (no it is not the chassis from the Seth…).

Figure 2 is a photo of the Seth chassis. Note the recess on the top of the chassis and the tapped holes to secure the top plate. Figure 3 shows a detailed view of the "major holes" to do in the chassis.

Once the chassis is done and finished, it's time to install the components that will go on the side of the chassis and start doing some of the AC wiring. Figures 4 to 8 will show you how.

Figure 2. Completed chassis

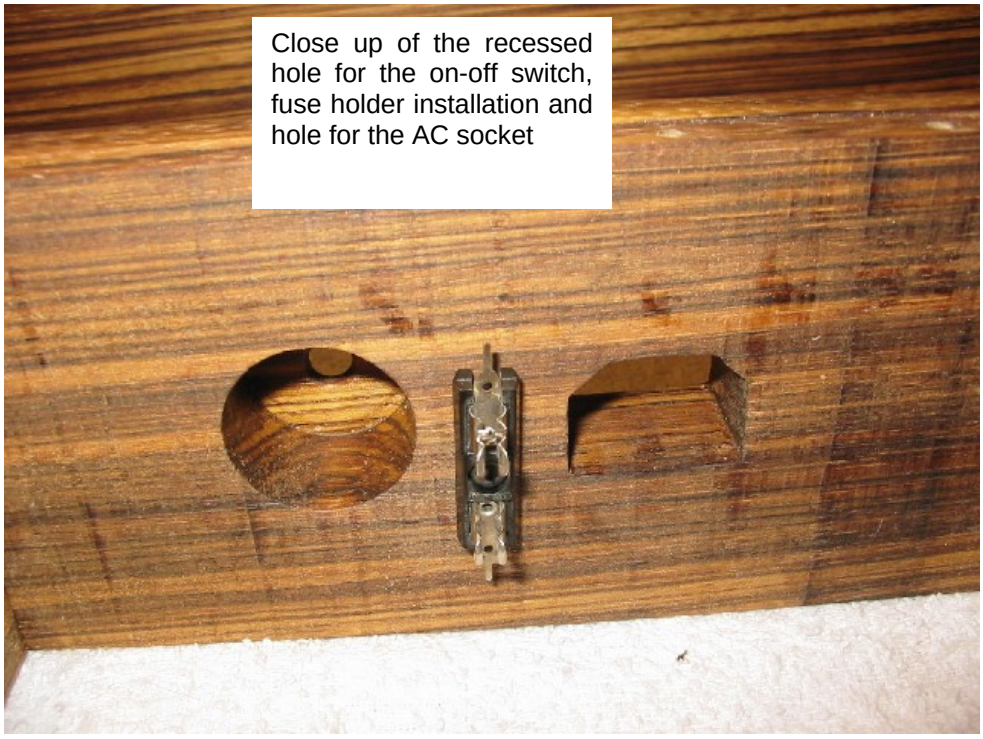


Figure 3. Detail of the chassis holes.

Figure 4 illustrate an overview of the parts location on the internal sides of the chassis. Figures 5 and 6 shows close up of the PSU chokes and the two 2A3 filament transformer installation. I used a “recycled” filament transformer (T_3) so I had to make the leads longer.

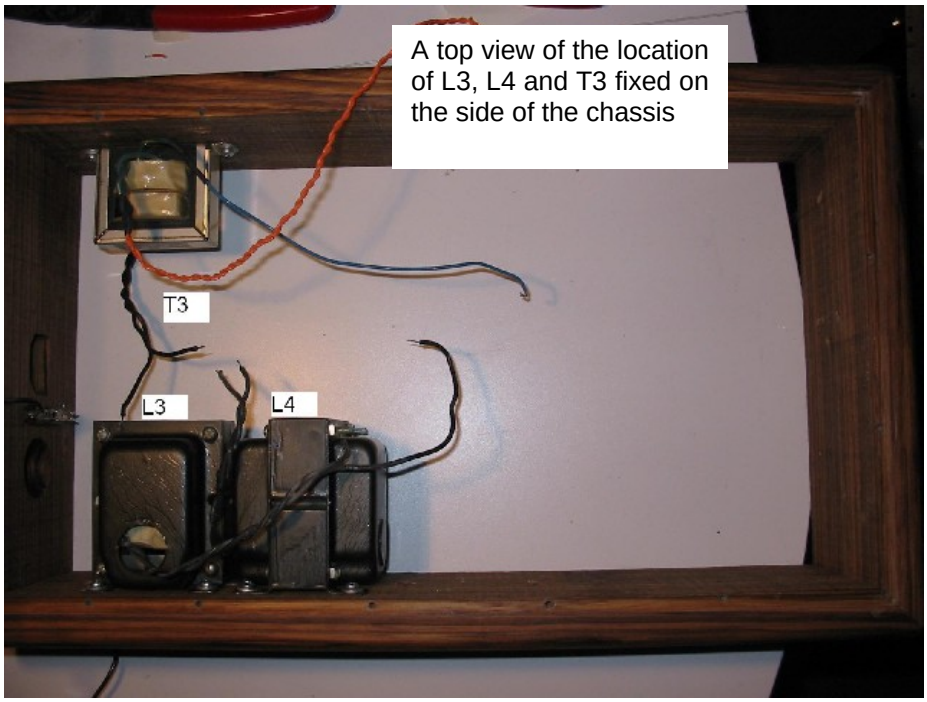


Figure 4. Location of the chokes and the 2A3s filament transformer

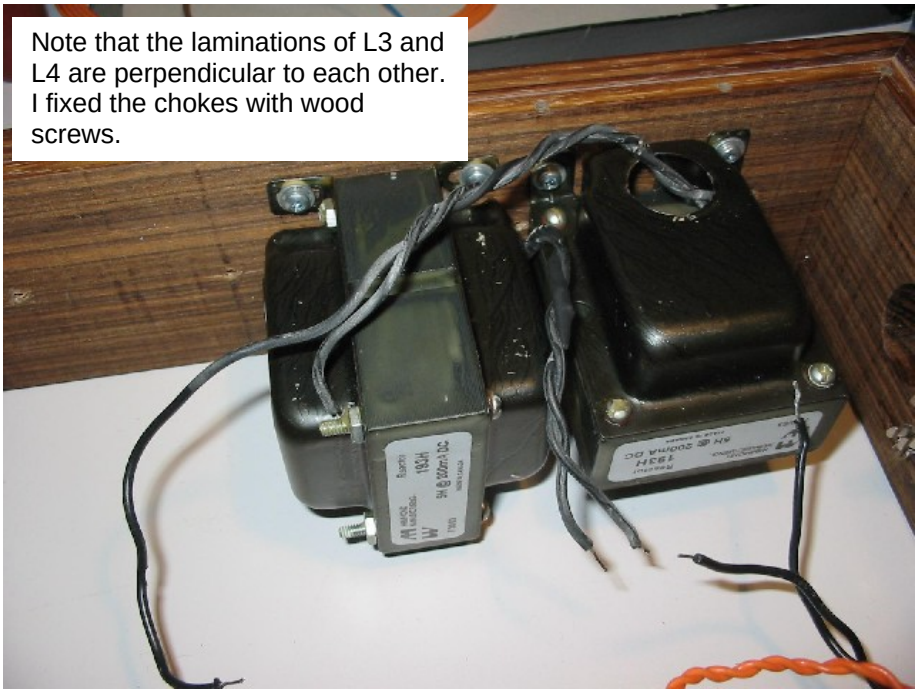


Figure 5 Close up of the PSU chokes (L3 and l4 on the schematic of the amp)

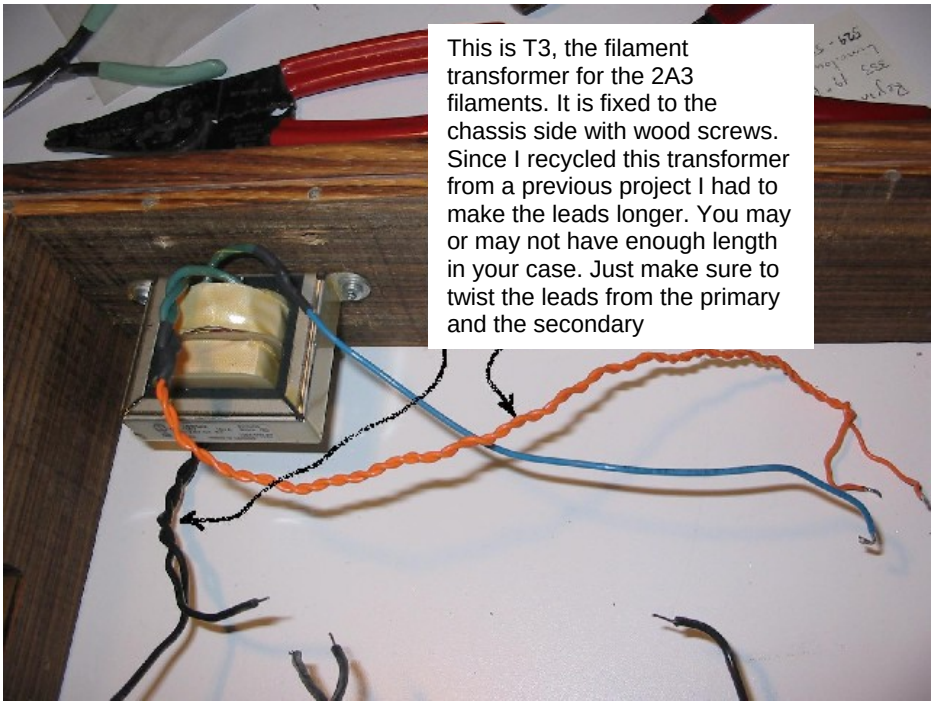


Figure 6. Close up of the filament transformer (the blue wire is the secondary center tap)

Time to start wiring the AC now. **It is important that you understand the method I show here might be illegal in your area.** This is your responsibility to make sure your amp is safe and "legal" to use. Most electronic technician will be able to help you on this. I am not. Figures 7 and 8 show the wiring of the fuse and the switch. I install them on the "live" lug of the AC socket (often denoted by a "L" in the socket near the lug).

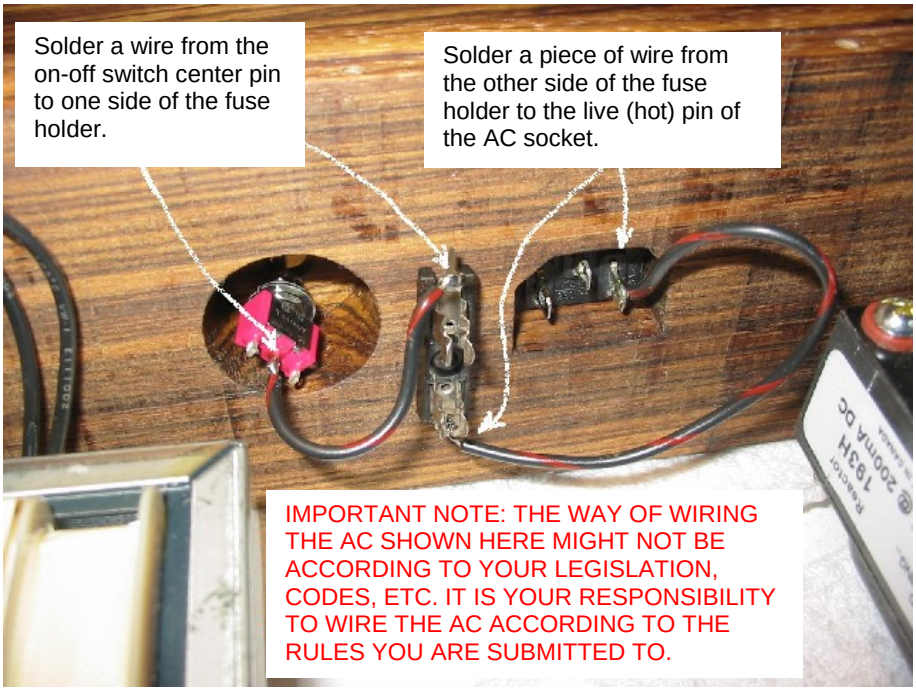


Figure 7. First step of the AC wiring

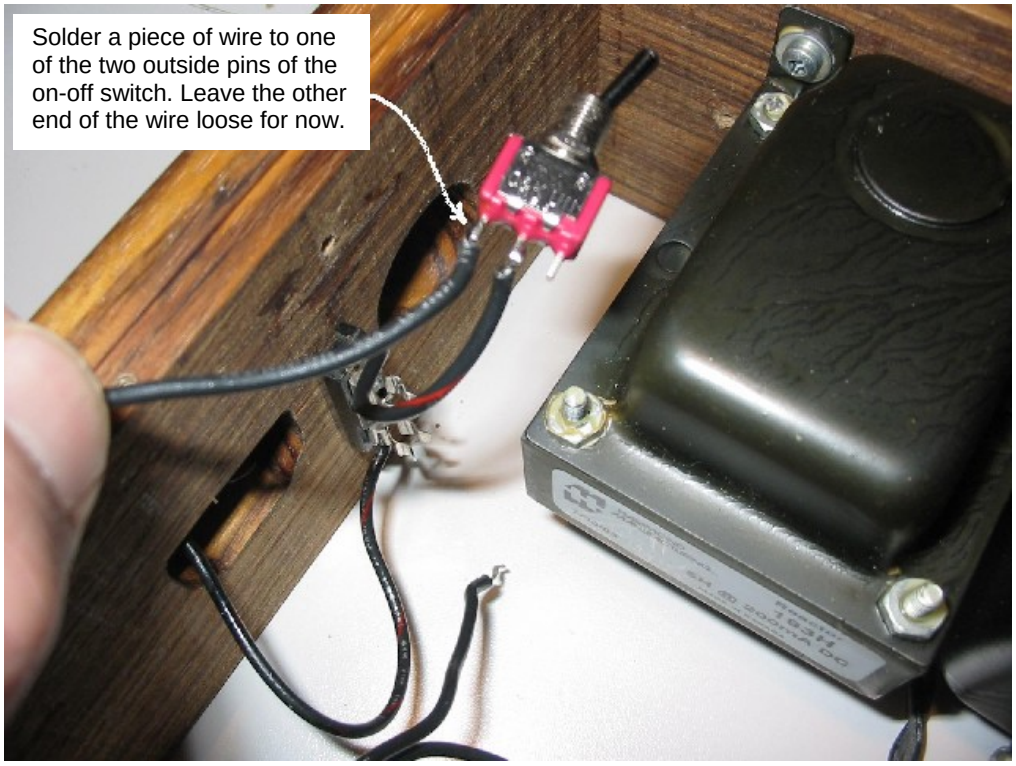


Figure 8. Wiring the on-off switch.

Metal work.

Here is the part of the amp building process I don't really enjoy. But that is just me… About 90% of the amp building time is spent on the chassis (both wood and metal work). I usually start by covering the top plate with masking tape and try out different layout that will be both functional and aesthetic (at least to me…). Figure 9 illustrate this process.

Once the lay out is figured out I mark the location of the holes to be done and start the punching process. Most holes are small holes for machine screws so they can be done with a power drill. I personally use a small press drill. It goes like a charm. The larger tube socket holes are done with Greenlee punches. I won't recommend any dimension here as it will be up to you to make sure you have the good punch dimension that will fit your tube sockets size. For example, depending of the type of octal tube socket you will get, you will need a 1" or a 1"1/8 punch.

Once all the holes are punched, I sand both side of the plate with an orbital sander. Figure 10 shows a finished and punched top plate waiting for the painting or coating or whatever. I'll be honest with you, I don't paint those myself. I have a cat in the house and no matter how careful I am, I always end up with a cat hair or two landing on the wet paint. So I send them to the paint shop instead. Do I hear some of you say "Oh! What a gorgeous copper plate! He should polish them and clear coat them!" Well be my guest and go for it. Expect to spend a huge amount of time polishing these plates! Life is too short in my case.

Figure 9. “Honey… What do you think of that one?”.

Figure 10. Once you are there you’ll have done 90% of the job.

Figure 11 shows the mechanical mounting of the parts. The capacitor mounting bracket is a nice gizmo I have made by batch of 20 by a machinist. But it is something you can do yourself easily. This bracket will allow you to install the filtering cap (C5) in a convenient way. Don't bother with figuring out why the stick-on tying pads are already on the copper plate. I cheated and dismantled a perfectly operating Seth to write this "How-to" so they were already installed. See how I like you guys!

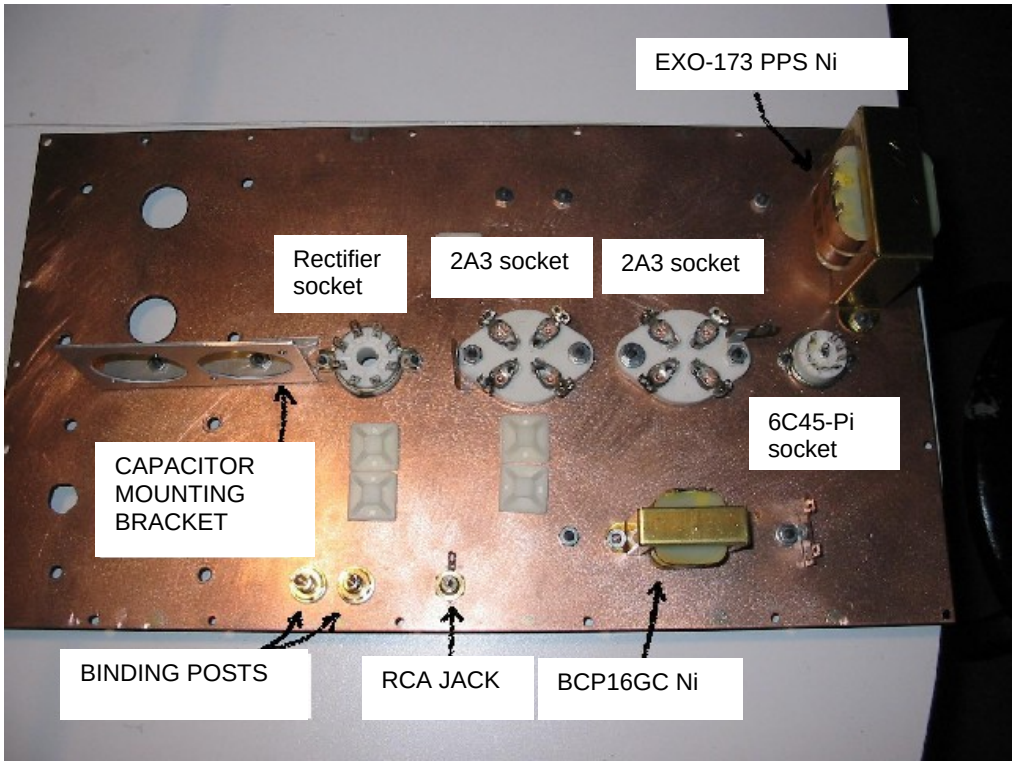


Figure 11. Internal mechanical mounting of the parts.

So… where will you punch your tube socket holes? Assuming you want a layout like mine, all the tubes are straight on the centerline according to the long axis of the plate. Assuming that the side of the plate on the rear of the amplifier is the reference point, the rectifier tube is located at 6.25", the first 2A3 is at 9", the second 2A3 is at 11.5" and the driver tube is at 14". I suggest you punch the other holes by locating all the transformers, choke, binding posts, RCA jack in a similar fashion than I did. Mark the holes location and punch them. Sorry not to be more precise but I was too lazy to make a plan.

You'll need 3 solder lug strips for each monoblock for building this amp the way I did. Two of these will be single lug strips and one will be a dual lug strip. Make sure the lugs are not of the grounded type. Install them as shown in Figure 12. Done? How about a beer now?

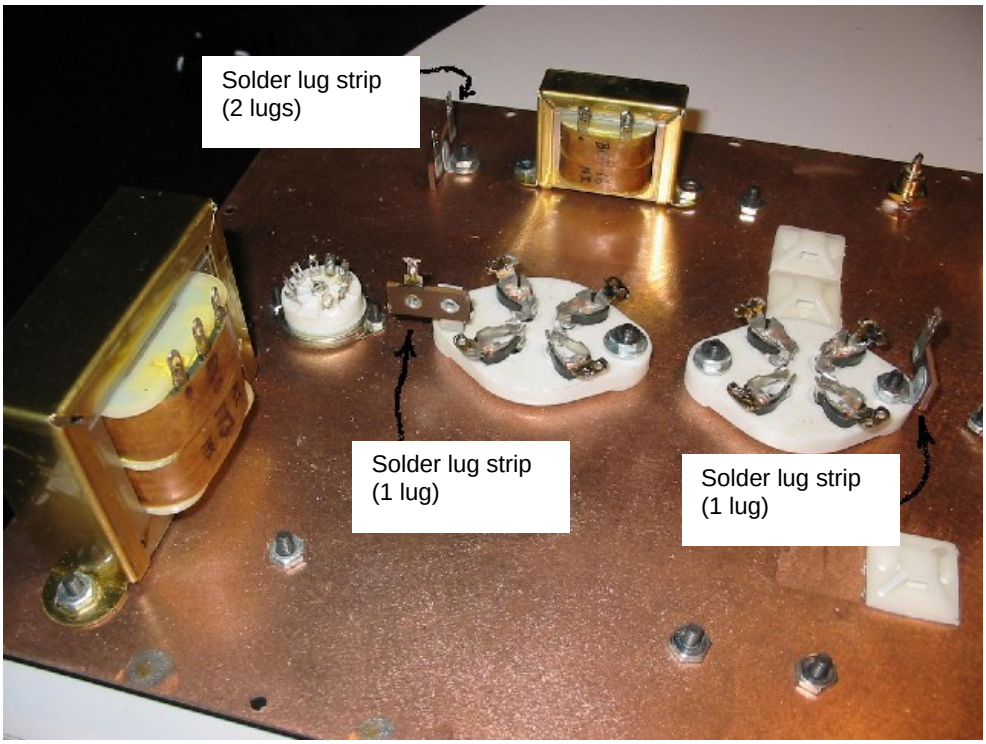


Figure 12 localisation of the solder lug strip.

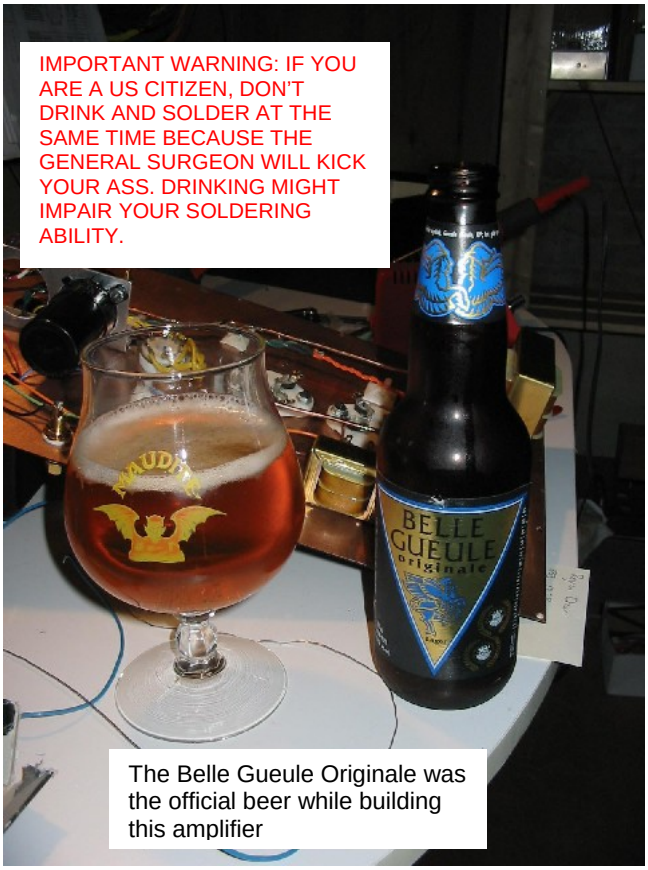
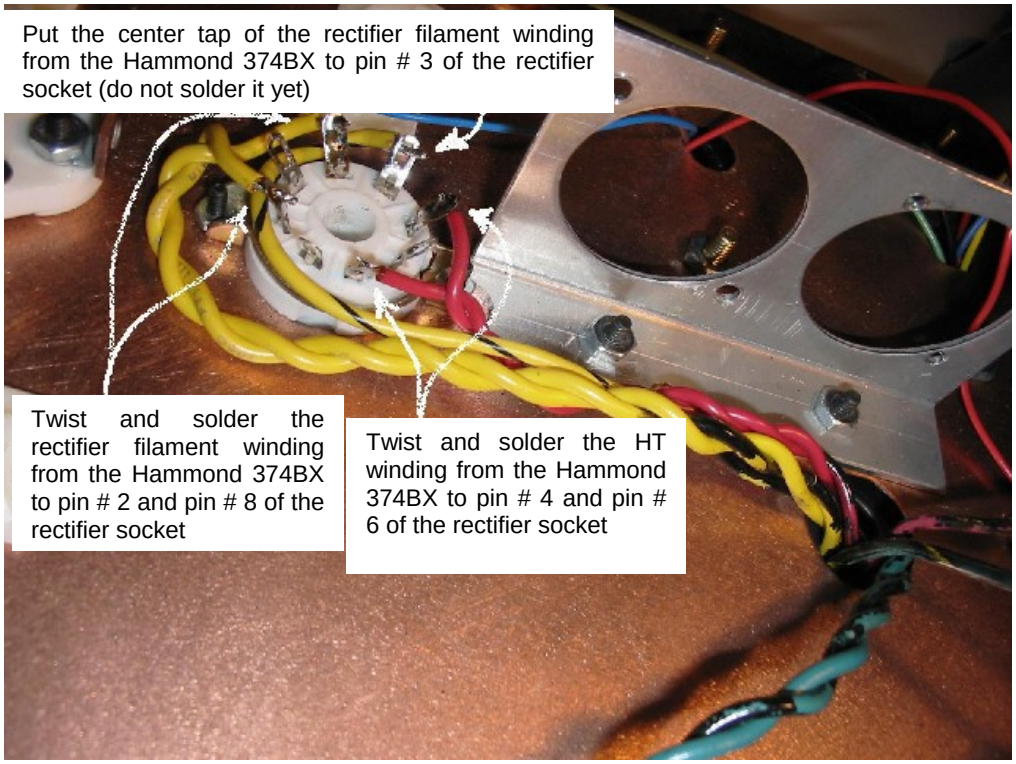


Figure 13. Time for a cold one.

Installing and wiring the power transformer

Assuming you punch your holes properly, installing the power transformer (T_2 on the schematic) on the copper top plate should be pretty self intuitive. If not please refrain from continuing this project… In this article, the Hammond 374BX has been used so everything here is given in reference to it. Figure 14 shows the wiring of the rectifier filament winding and the HT winding from T_2 to the rectifier socket. The pinout numbering of an octal socket and the GZ34 are given in Figure 14.



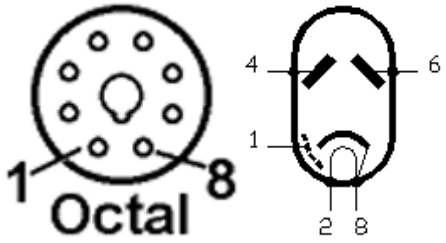


Figure 14. Wiring of the rectifier socket.

Installing and wiring the output transformer

Install the S-240-A (T_1) on the copper top plate and wire the primary and the secondary windings as shown in Figures 15 and 16. The pinout of the 2A3 is given in Figure 16. The primary center tap of T_1 is left loose for now.

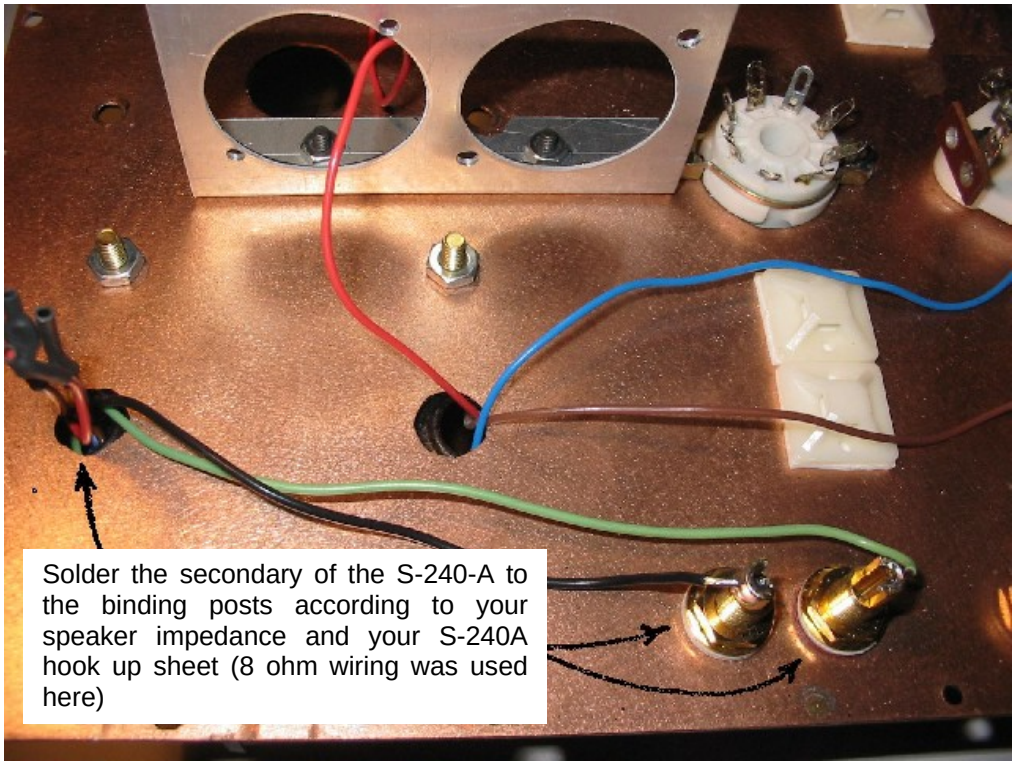


Figure 15. Wiring the secondary winding of the S-240-A (T_1).

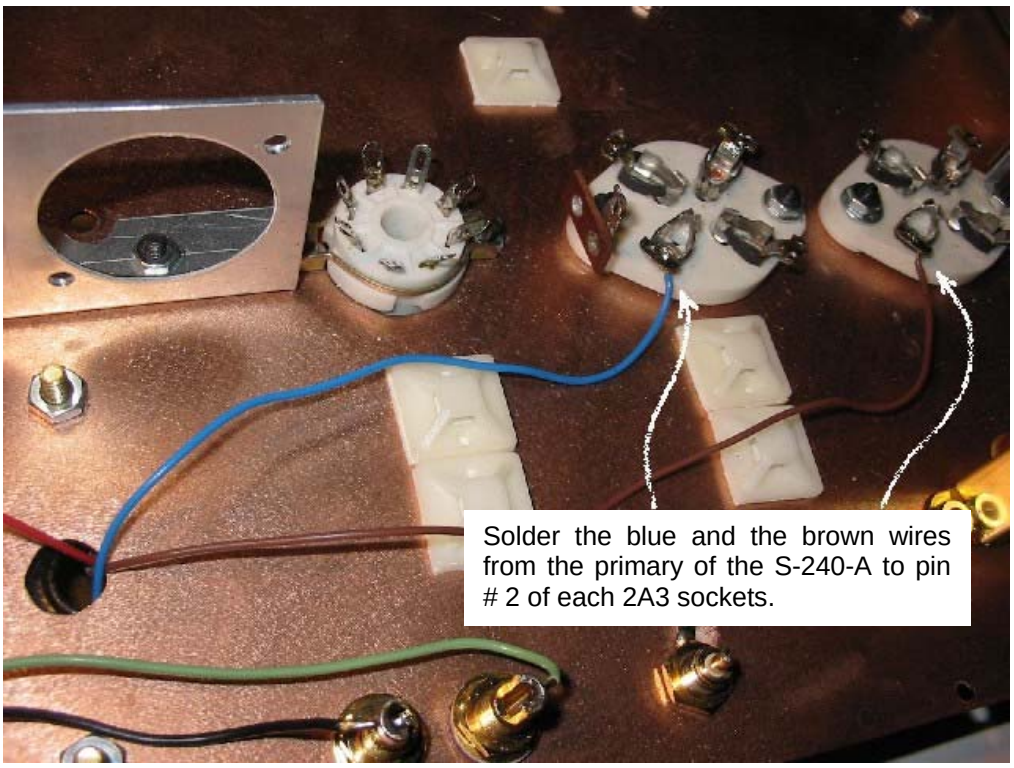


Figure 16. Wiring the secondary winding of the S-240-A (T_1).

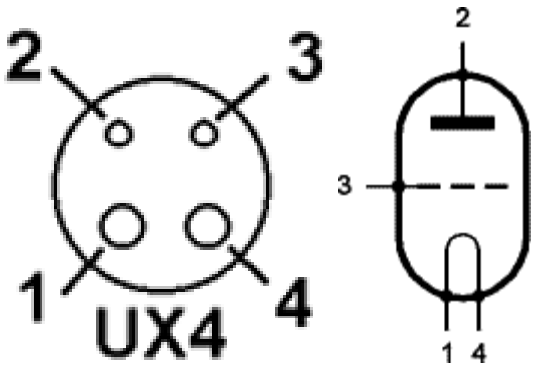


Figure 17. Pin out of the 2A3.

Installing the PSU filter capacitor and the ground buss

Install the PSU filtering capacitor (C_5) and the ground buss as shown in Figures 18 to 22. Make sure the ground buss won't be in the way of the chokes (L_3 and L_4) and the 2A3s filament transformer (T_3) already installed on the side of the wood chassis. Do some "dry fit" trial by placing the wood chassis on the copper plate to see if anything is clear.

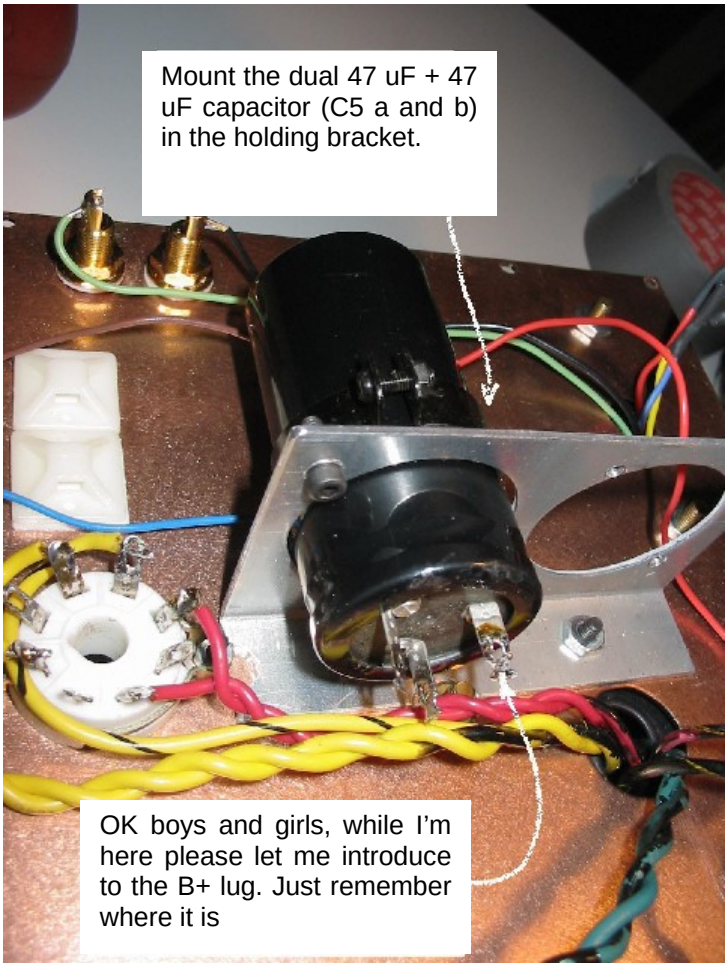


Figure 18. Installing C_5.

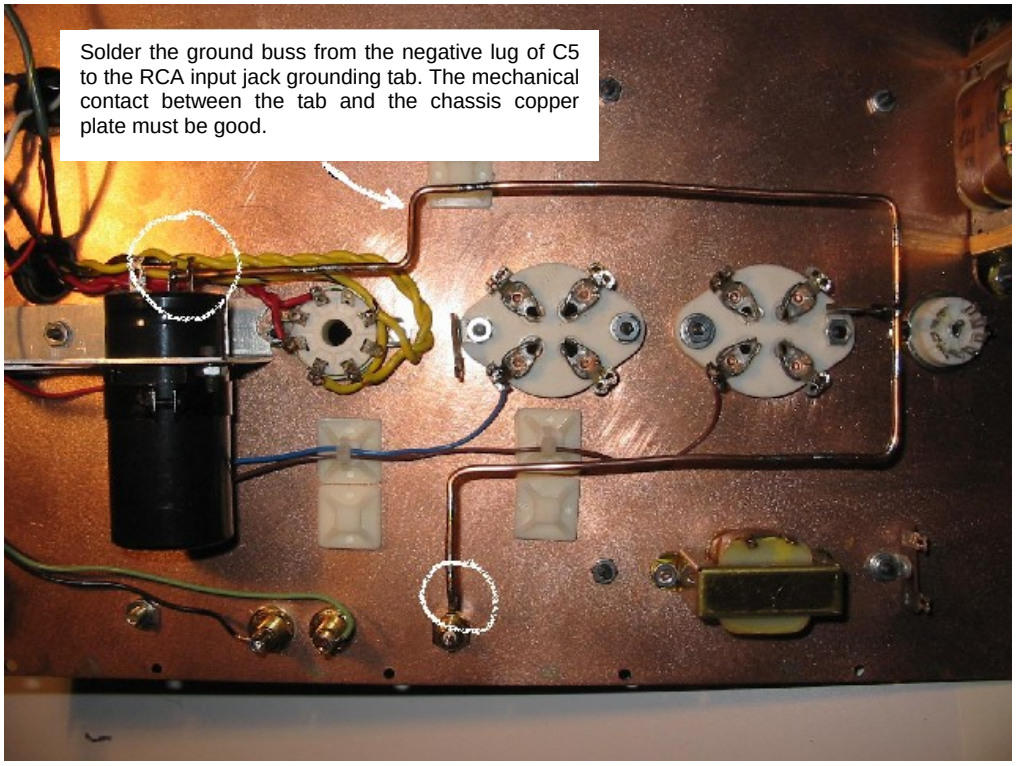


Figure 19. Overview of the ground buss location.

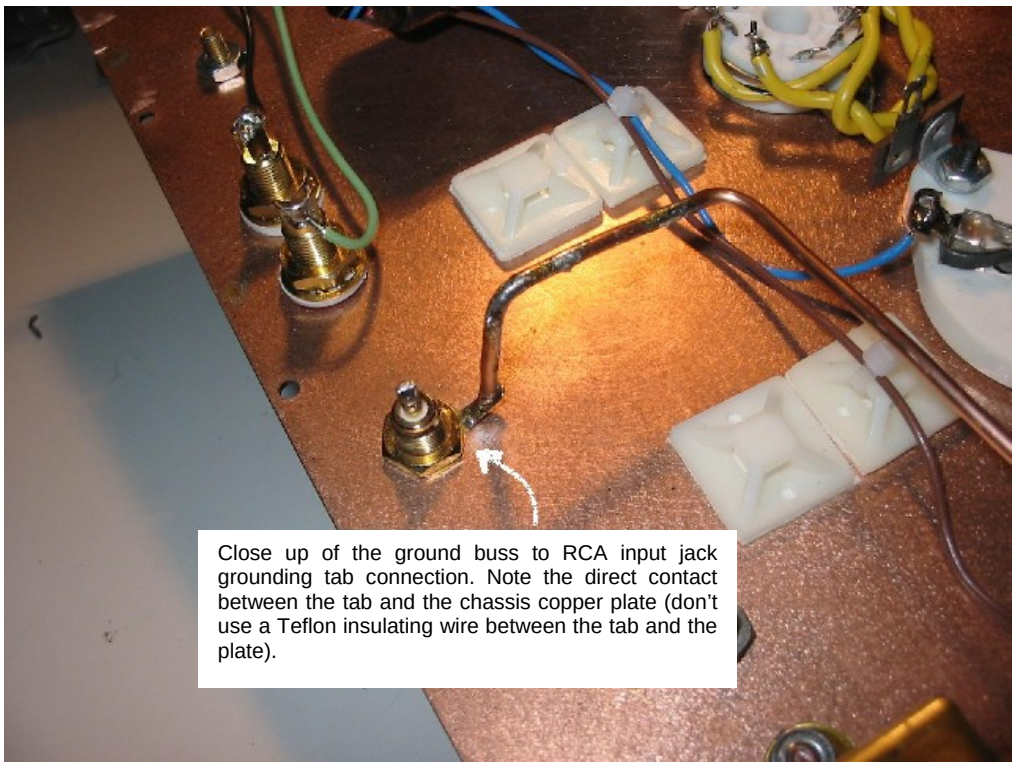


Figure 20. Detail of the ground buss connection to the RCA input jack.

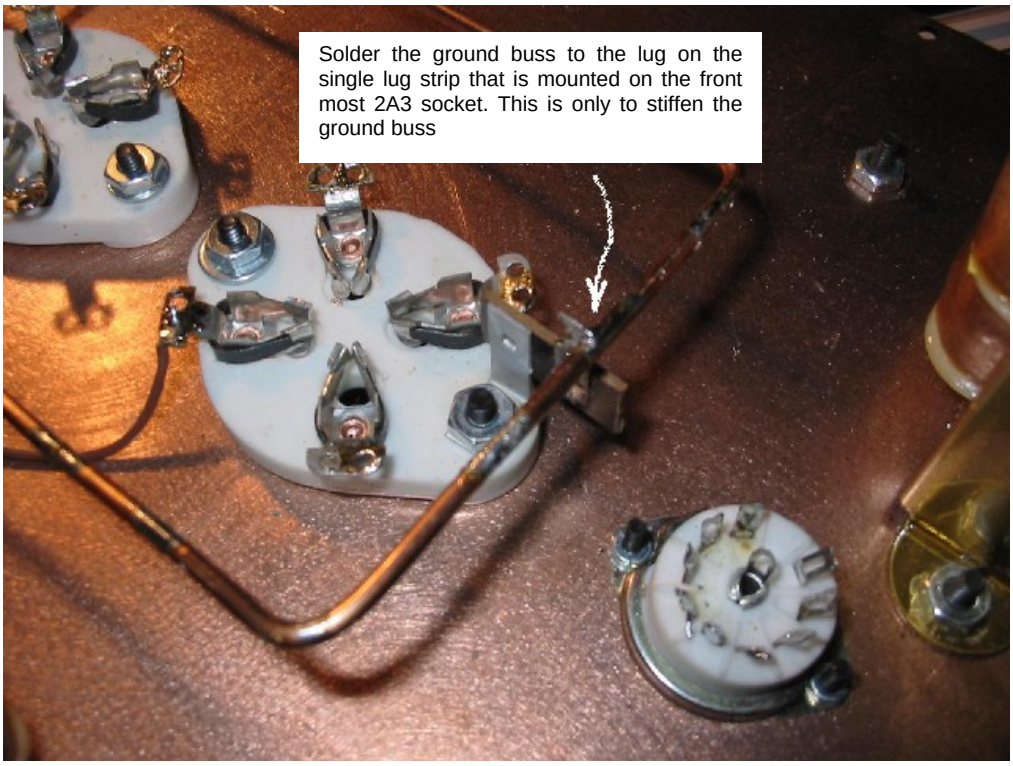


Figure 21. Detail of the ground buss connection to the stiffening solder lug.

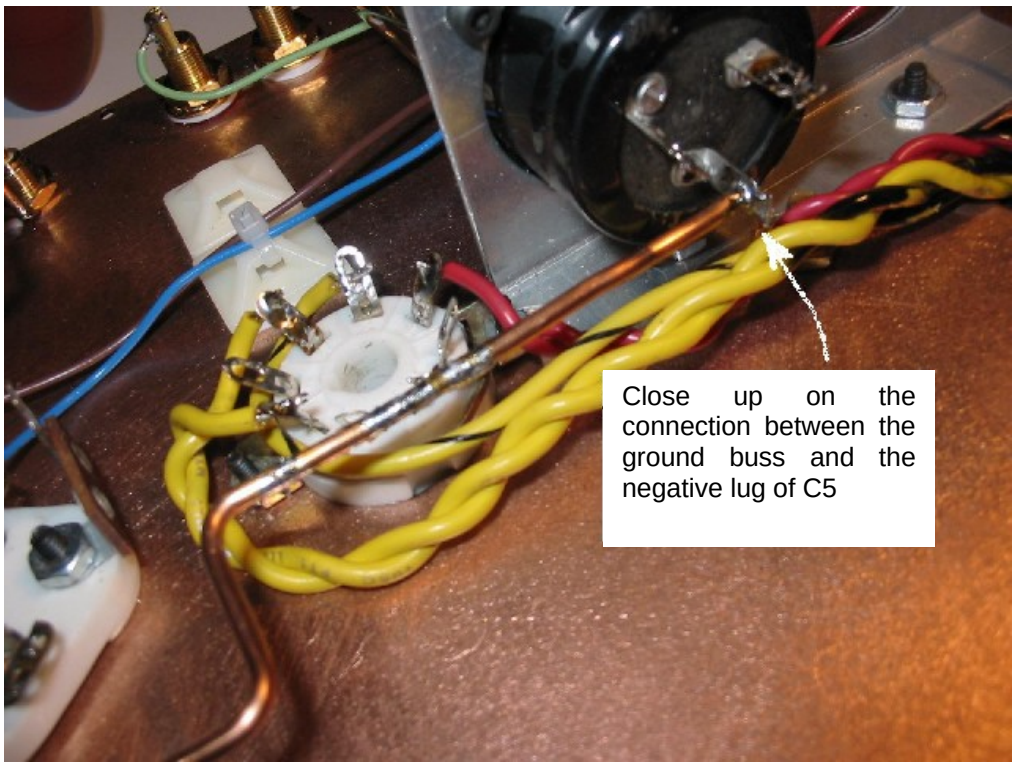
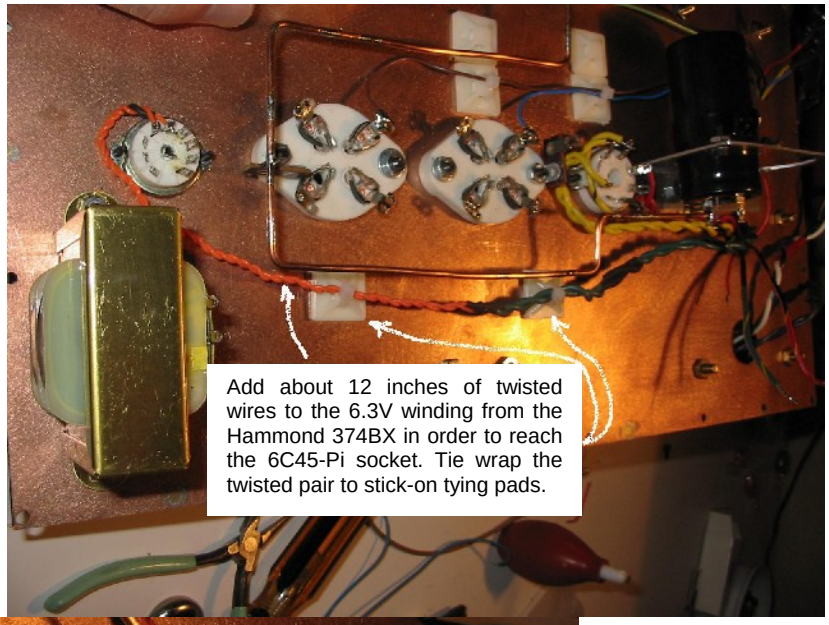
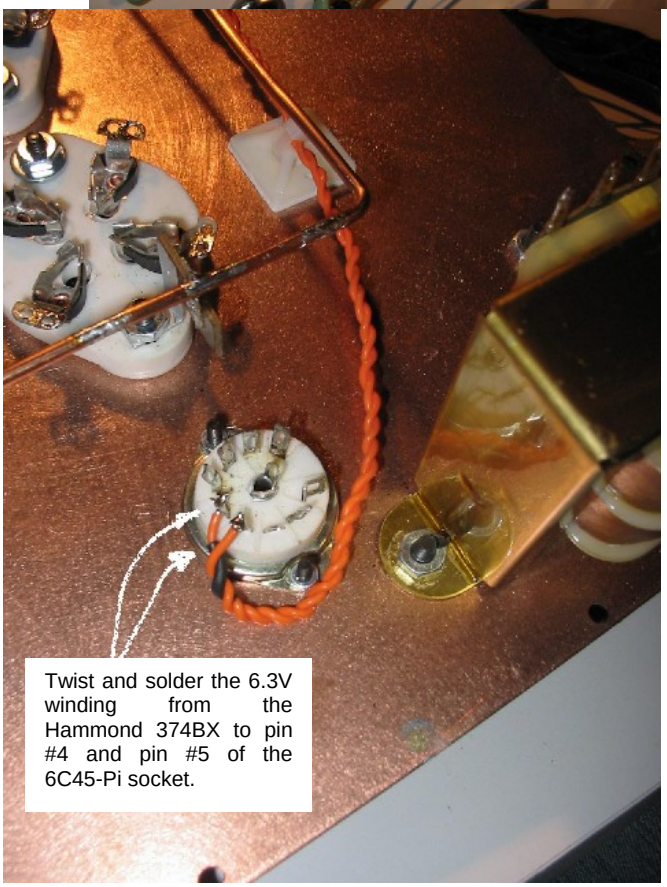


Figure 22. Detail of the ground buss connection to C_5 negative lug.

Finishing wiring T_2 secondary windings

Wire the 6.3V winding of T_2 as described in Figures 23 to 25. Tie wrap the twisted wire pair to stick-on tying pads. The pinout of the 6C45-Pi is shown in Figure 23.





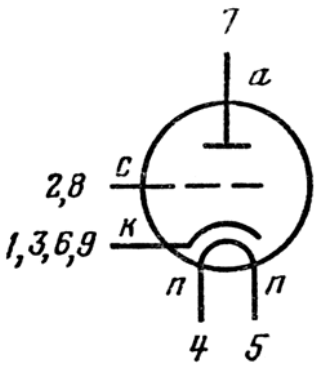


Figure 23. Wiring the 6.3V winding to the 6C45-Pi socket.

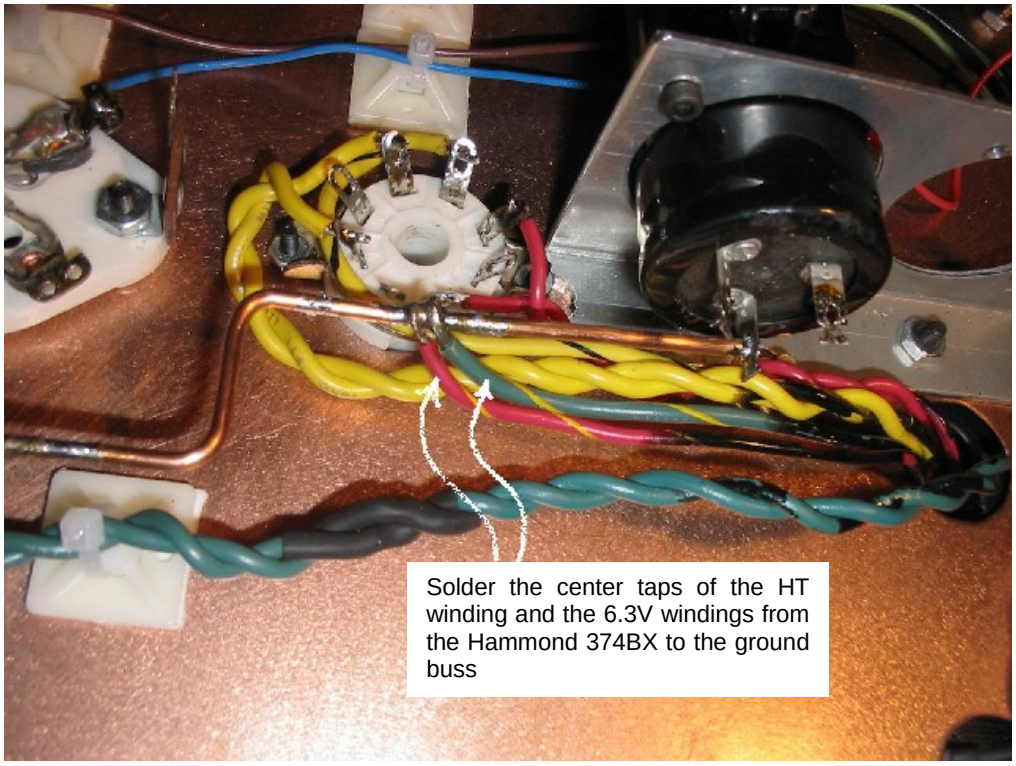


Figure 24. Soldering the center taps of the HT and the 6.3V to the ground buss.

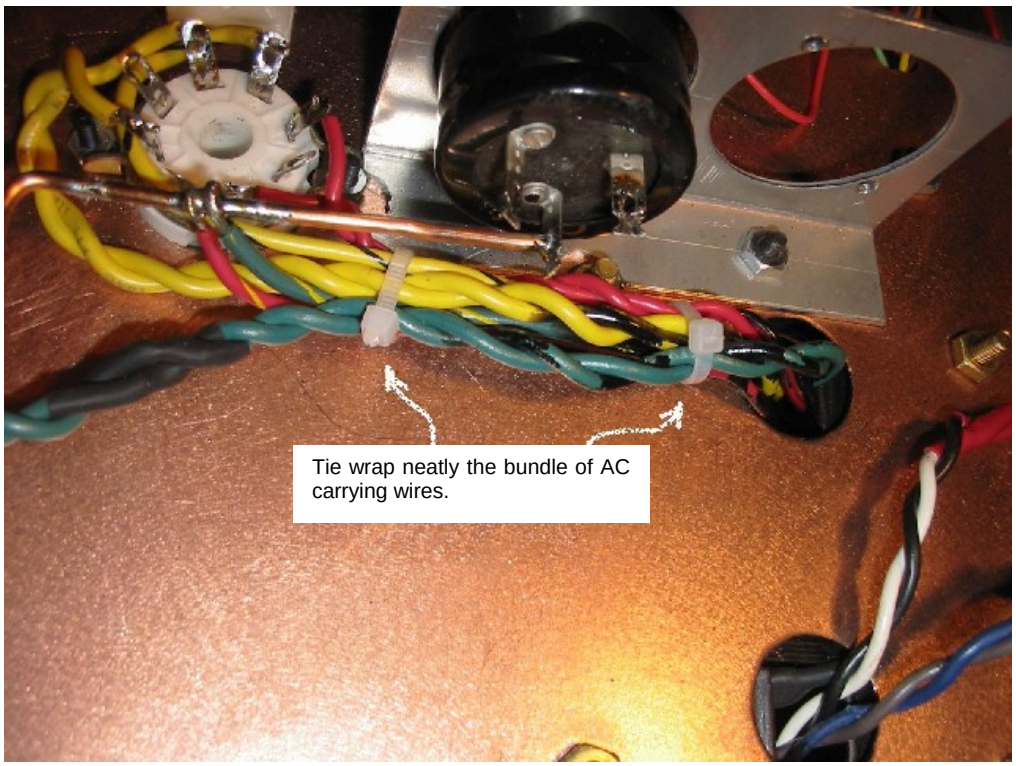


Figure 25. Tie-wrapping the AC wires bundle.

Wiring the 6C45-Pi plate resistor.

Wire the 6C45-Pi plate resistor (R_3) as shown in Figures 26 to 27.

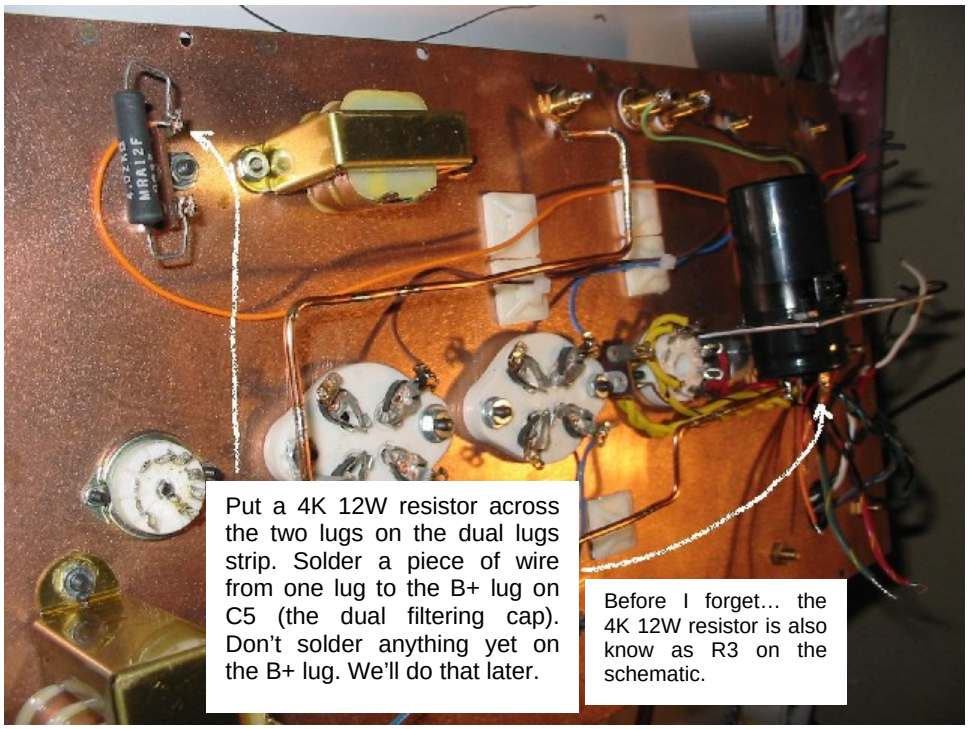


Figure 26. Wiring R_3 (part 1).

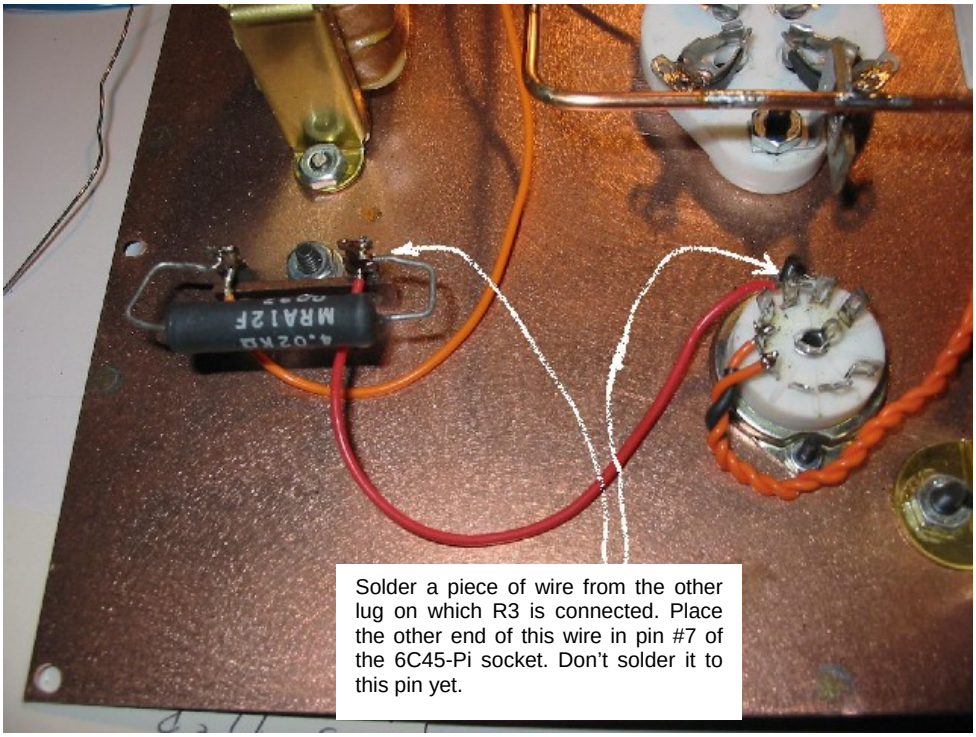


Figure 27. Wiring R_3 (part 2).

Wiring the EXO-173 PPS

Wire the EXO-173 PPS (L_2) as shown in Figures 28 to 30. Be really careful when soldering the EXO-173 lugs so the solder won't flow into the coil.

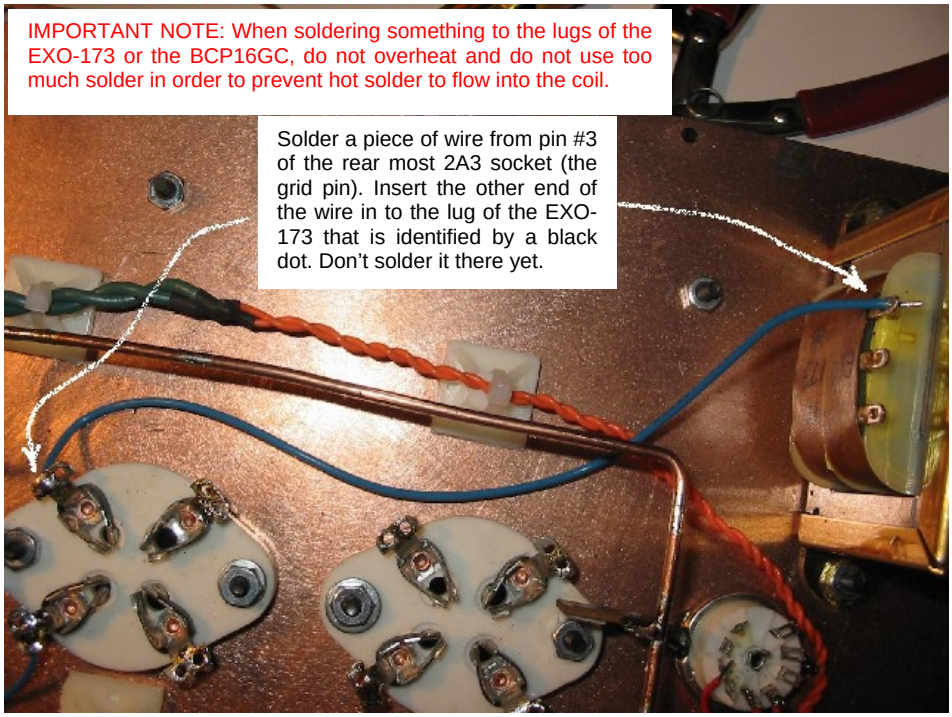


Figure 28. Wiring L_2 (part 1).

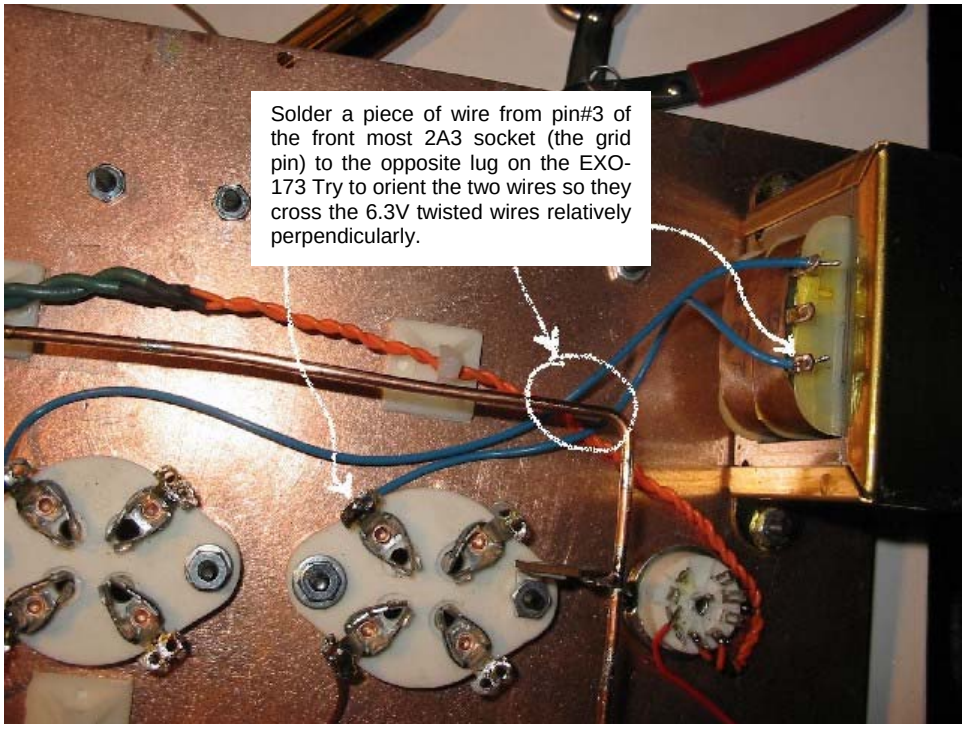


Figure 29. Wiring L_2 (part 2).

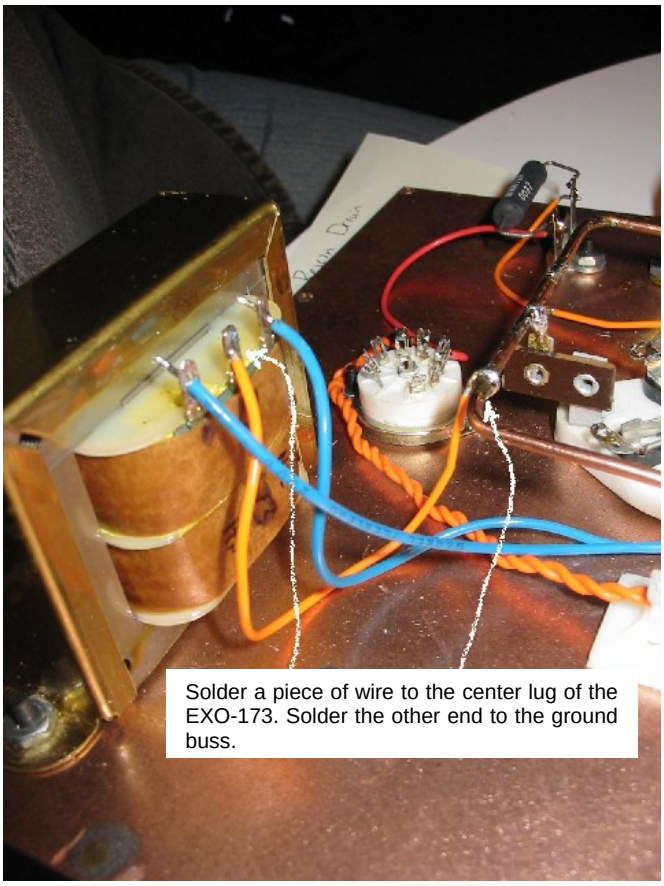


Figure 30. Wiring L_2 (part 3).

Finishing wiring the 6C45-Pi tube socket.

Wire the 6C45-Pi cathode resistor, grid stopper resistors and coupling capacitor as shown in Figures 31 to 33. Please note that I didn't use the cathode bypass cap (C_1) in my case. I suggest you try the amp with and without this cap to make your mind yourself. Putting C_1 is easy just hook it exactly like R_2 as shown in Figure 31 (i.e. from pin # 6 to the ground buss).

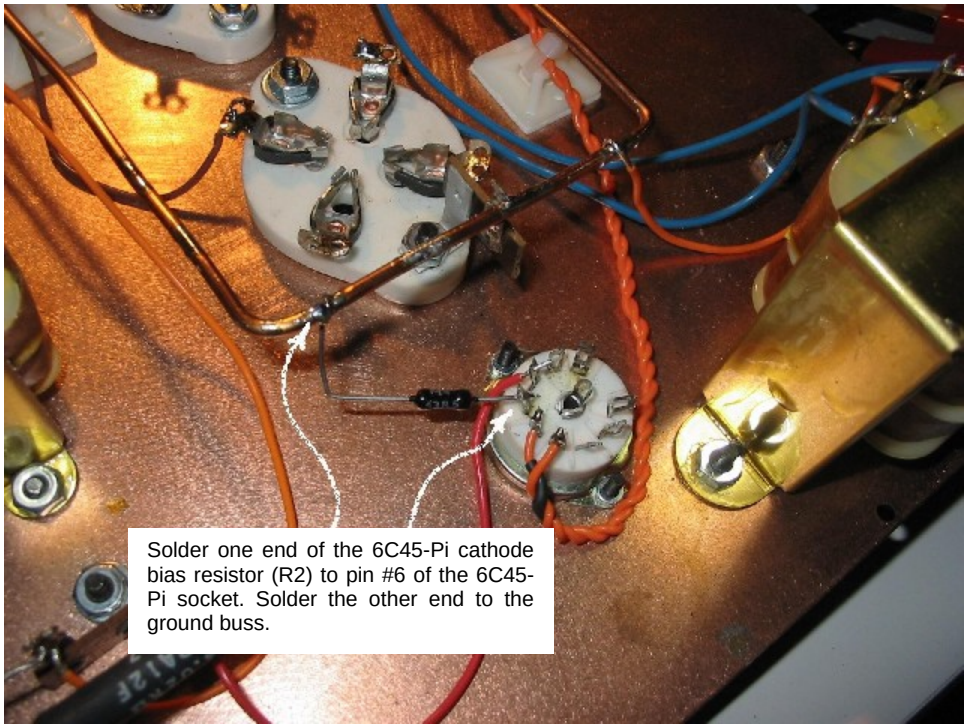


Figure 31. Wiring R_2.

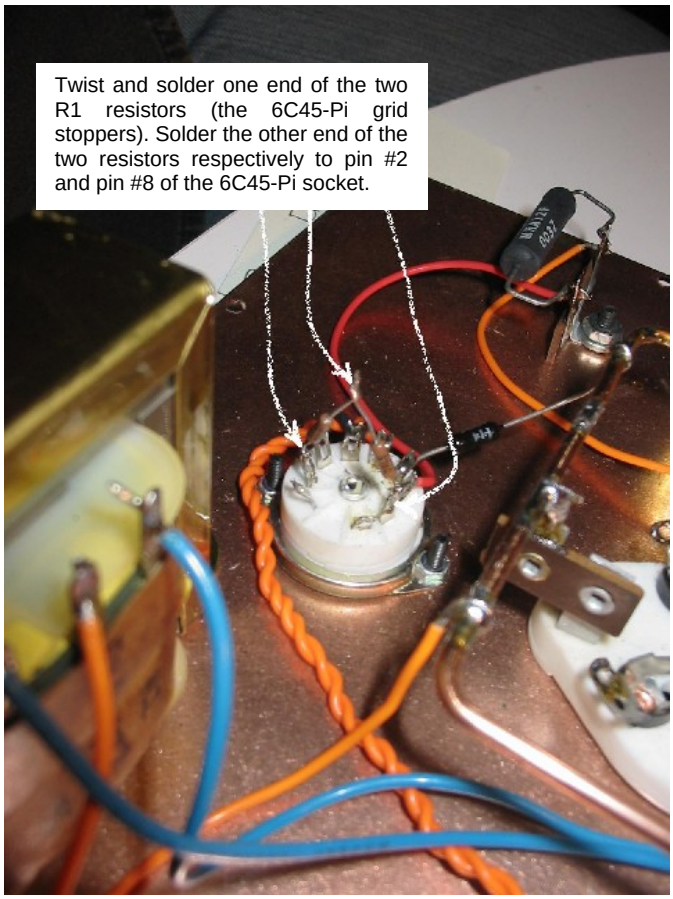


Figure 32. Wiring the grid stopper resistors (R_1).

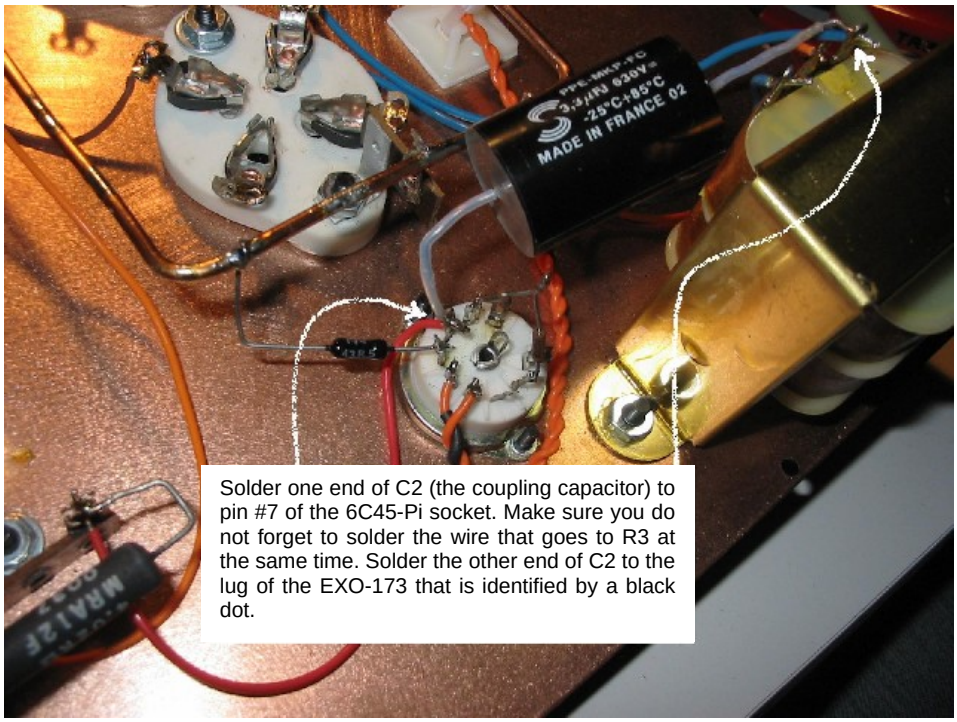


Figure 33. Wiring the coupling capacitor (C_2).

Wiring the 2A3 sockets

Wire the heaters of 2A3 socket R_4 and C_3 as shown in Figures 34 to 36.

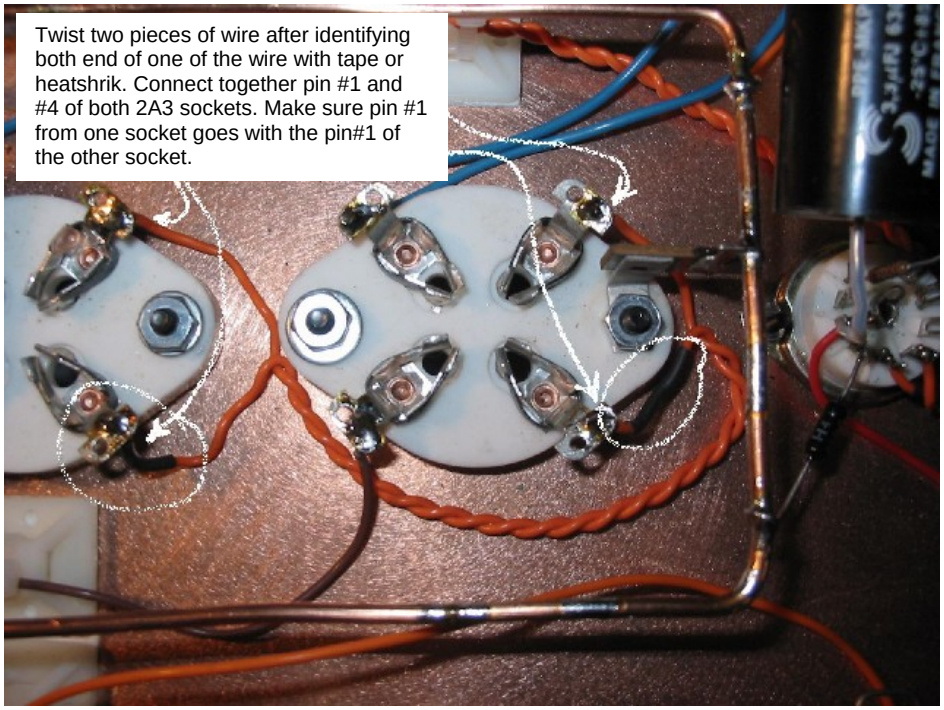


Figure 34. Wiring the heaters between the 2A3 sockets.

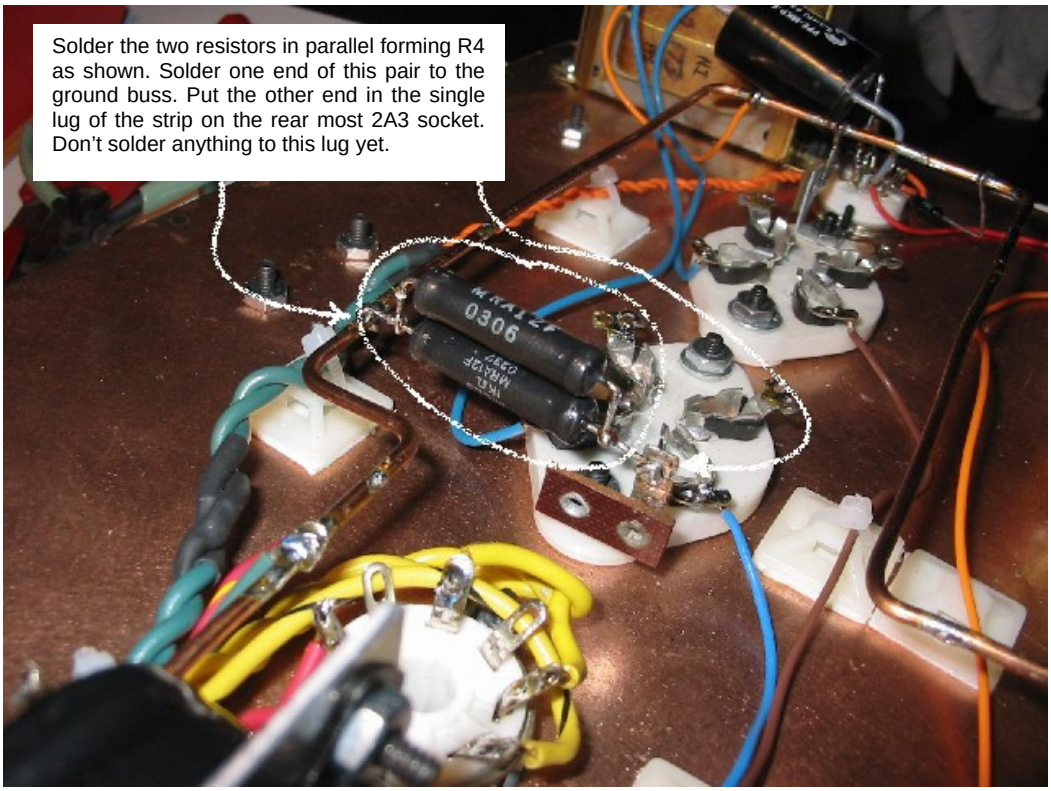


Figure 35. Installing R_4.

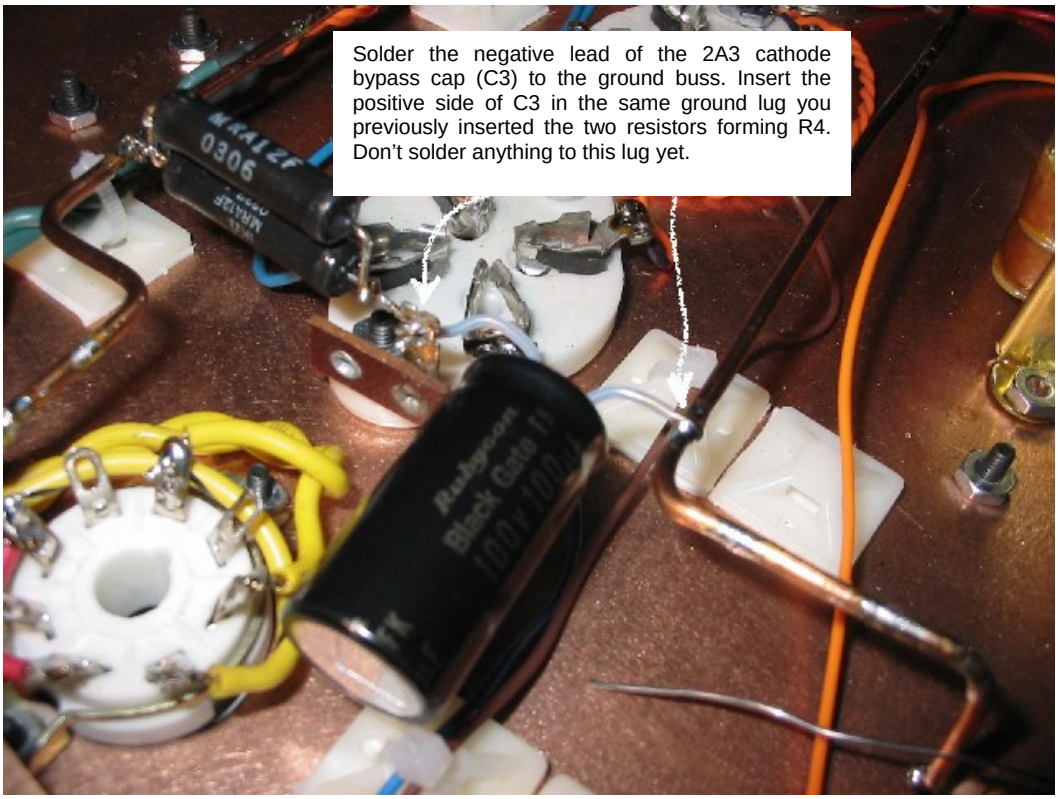


Figure 36. Installing C_3.

Wiring the PSU input capacitor.

Wire C_4 as illustrated in Figure 37.

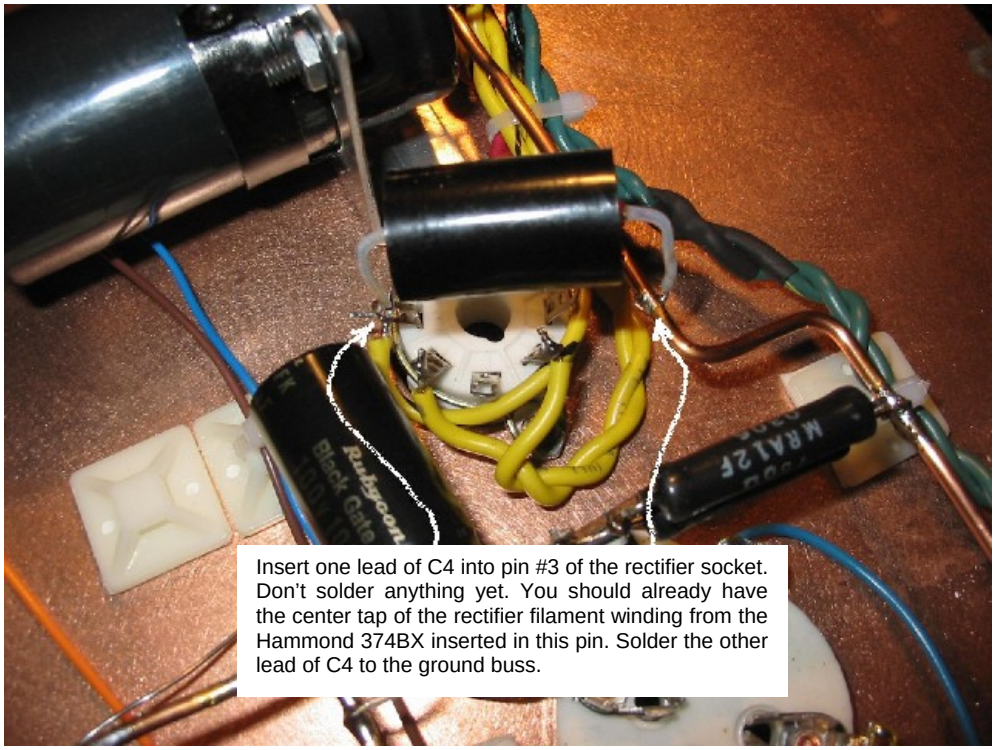


Figure 37. Wiring C_4.

Wiring the input cable and the BCP16GC.

Wire the input cable and the grid choke (L_1) as shown in Figures 38 to 41. I strongly suggest you use shielded cable for wiring the RCA jack to the 6C45-Pi grid stopper resistors.

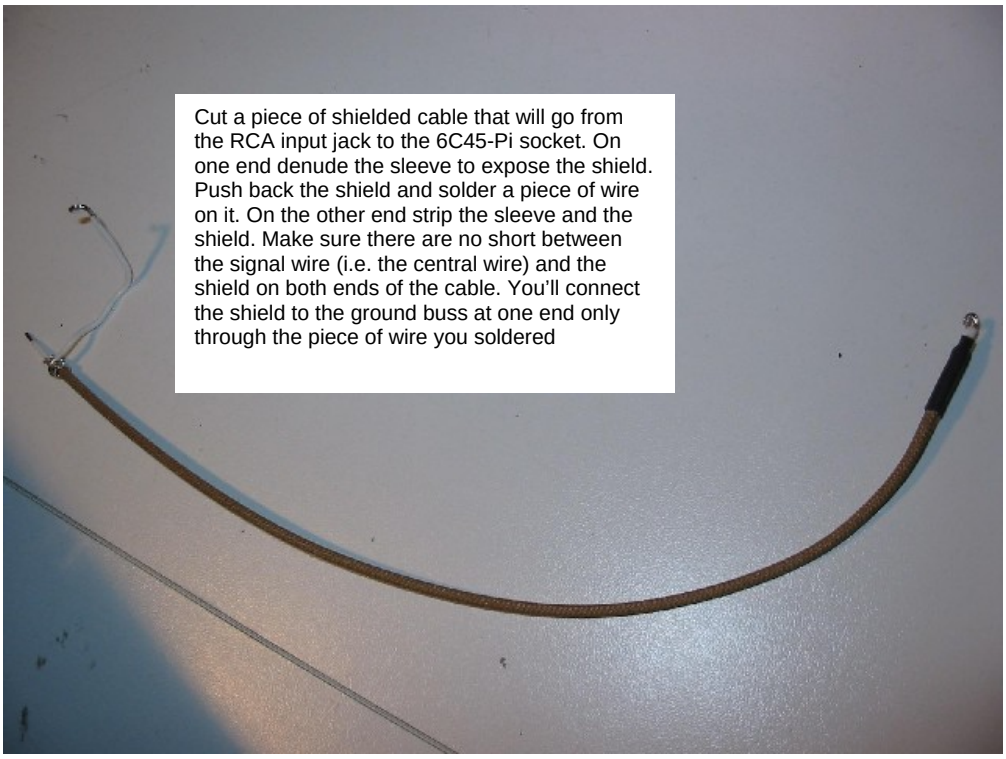


Figure 38. Preparing the input cable

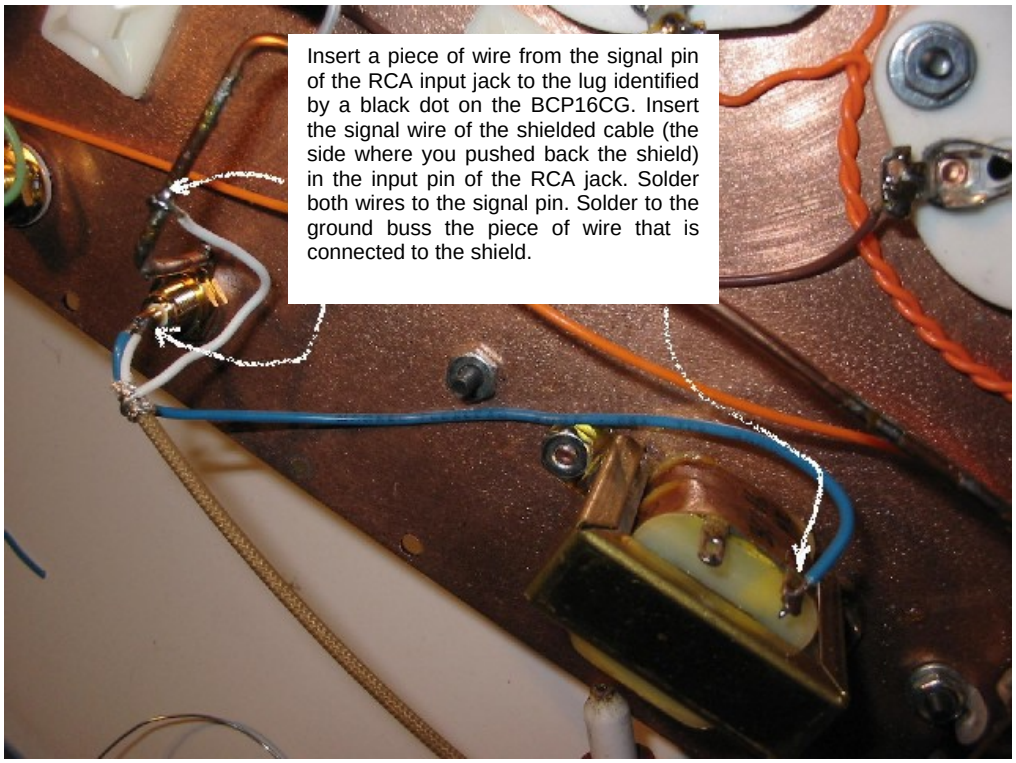


Figure 39. Wiring the input cable and L_1 to the RCA input jack.

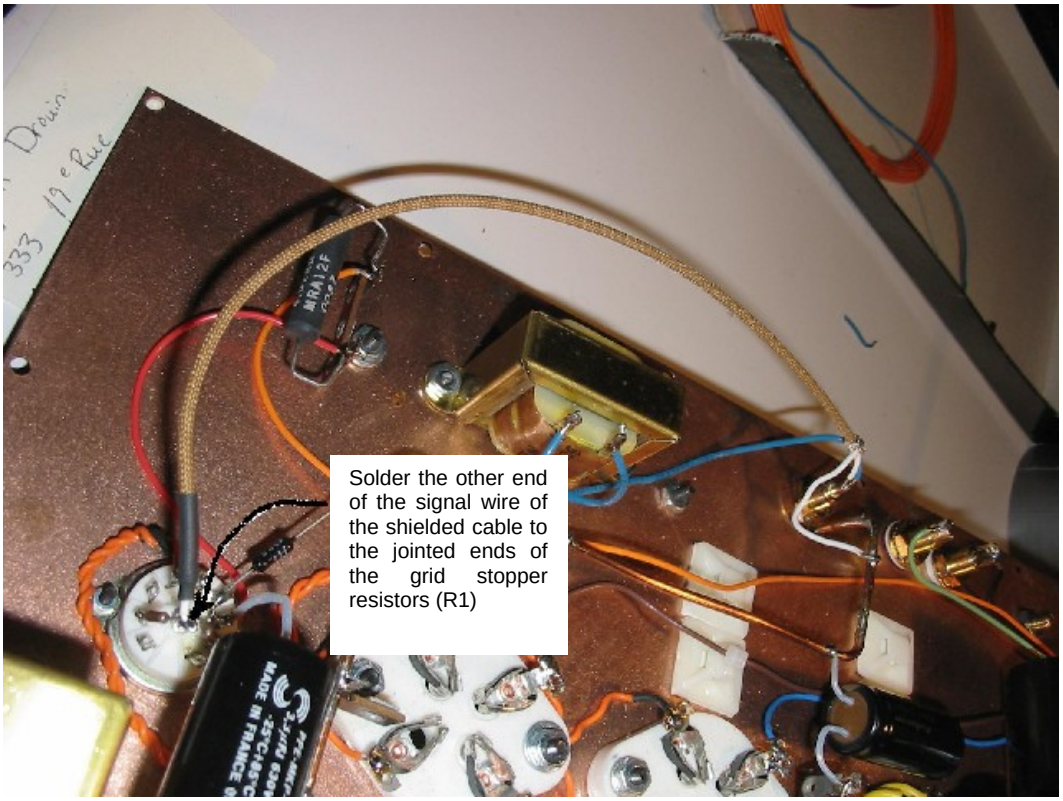


Figure 40. Soldering the input cable to the grid resistors (R_1)

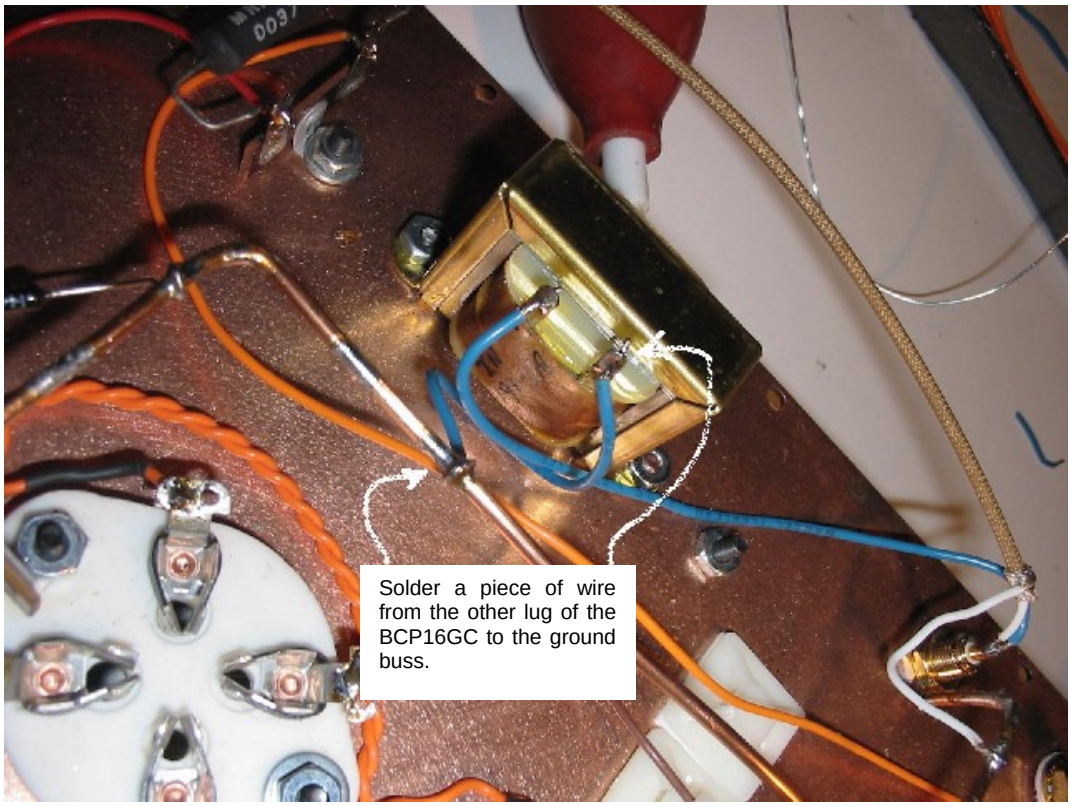


Figure 41. Final wiring of L_1.

Final wiring of the PSU and audio circuits

Good news! Time to put the copper plate on the wood chassis right now. Hopefully you were careful when bending the ground buss so it won't be in the way of the PSU filtering chokes. You can now finish wiring the PSU and the audio circuit as shown in Figures 42 to 46.

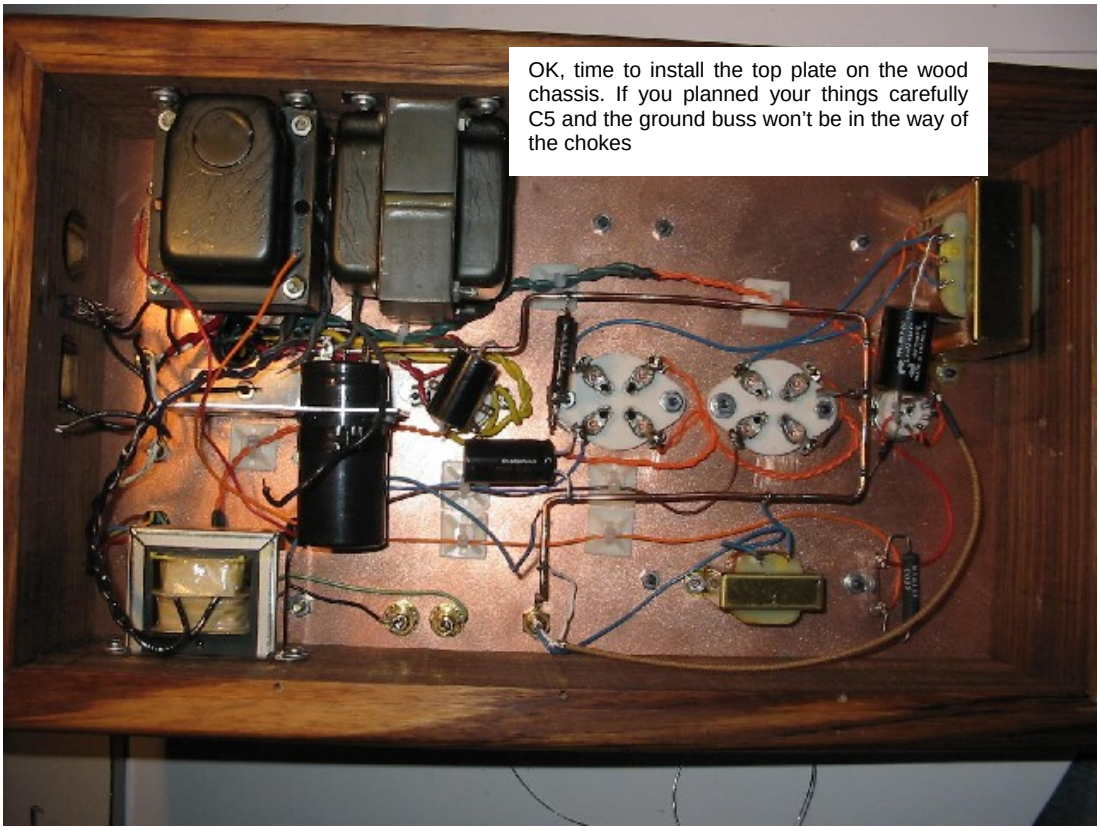


Figure 42. Installing the top plate on the chassis.

Figure 43. Soldering the secondary winding of T_3 to the rearmost 2A3 socket.

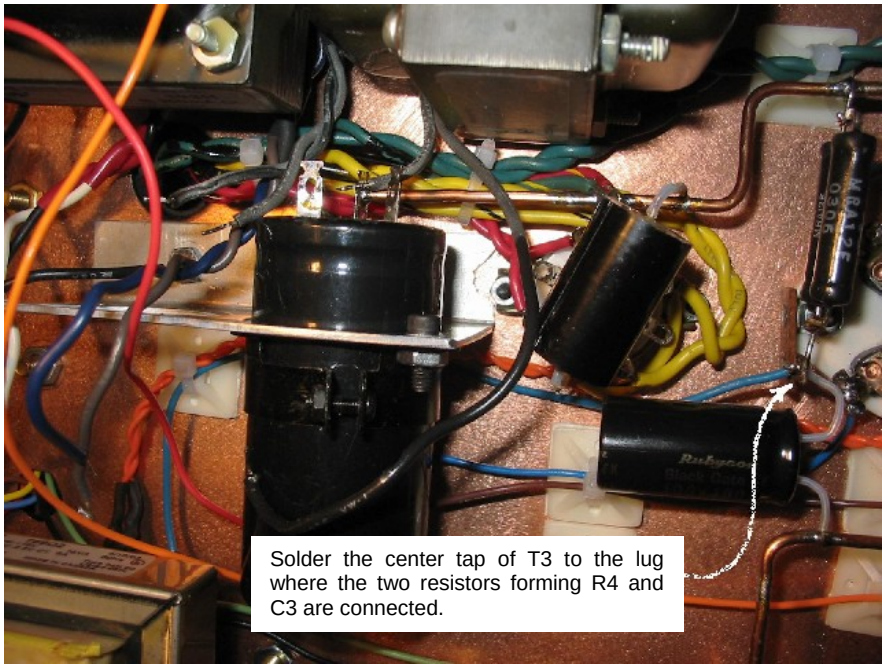


Figure 44. Connecting the center tap of T_3 to R_4.

Figure 45. Wiring the B+ (C_{5b}).

Figure 46. Wiring C_{5a}.

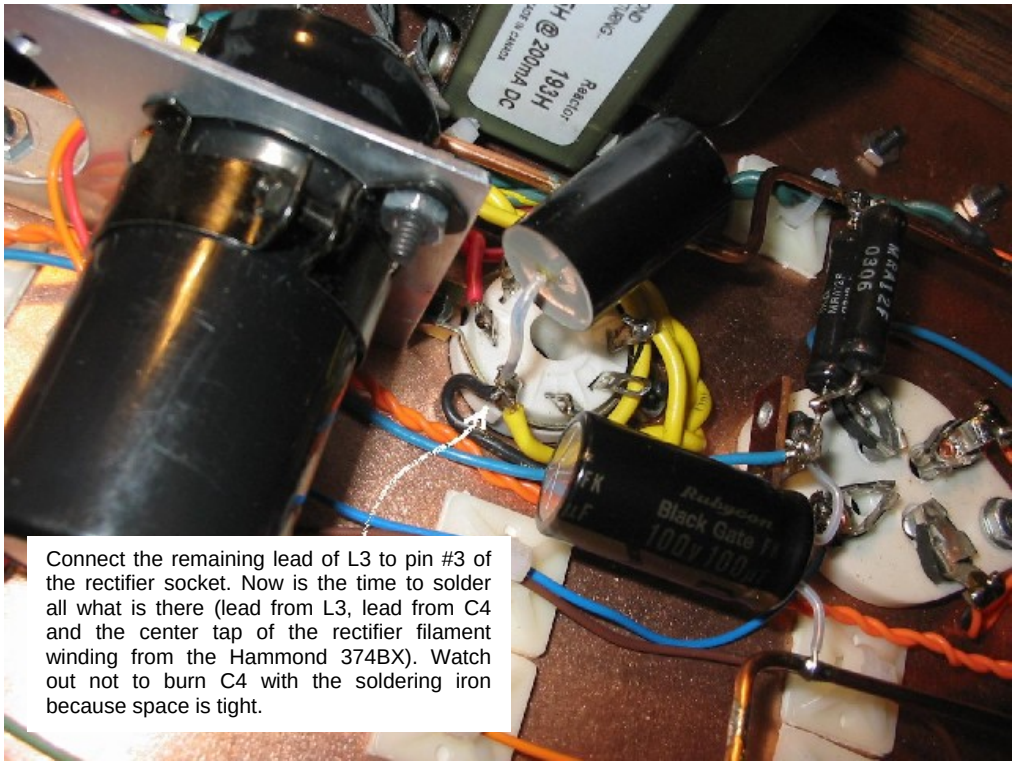


Figure 47. Final wiring of the rectifier socket.

Final wiring of the AC.

Patience, amp is nearly done. All you have to do now is finalise the AC wiring. **It is important you understand that the method I show here might be illegal in your area.** This is your responsibility to make sure your amp is safe and "legal" to use. Most electronic technician will be able to help you on this. I am not. Figure 48 to 52 will show you how I did do it.

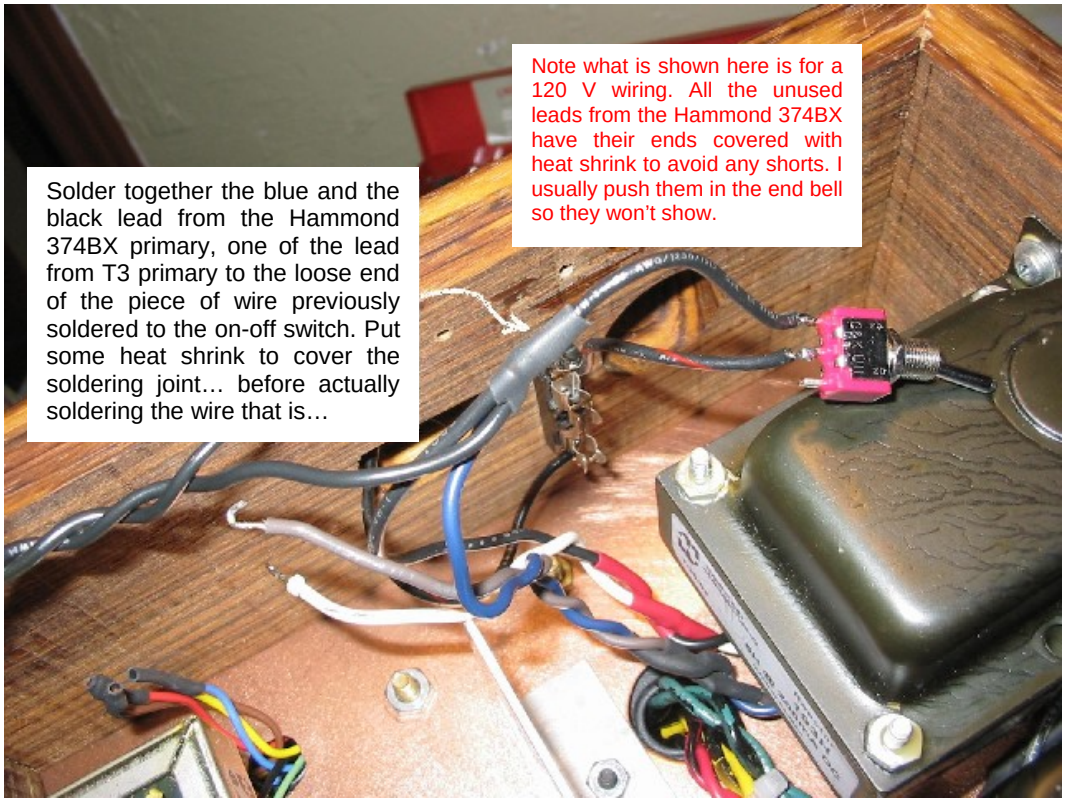


Figure 48. Final wiring of the on-off switch.

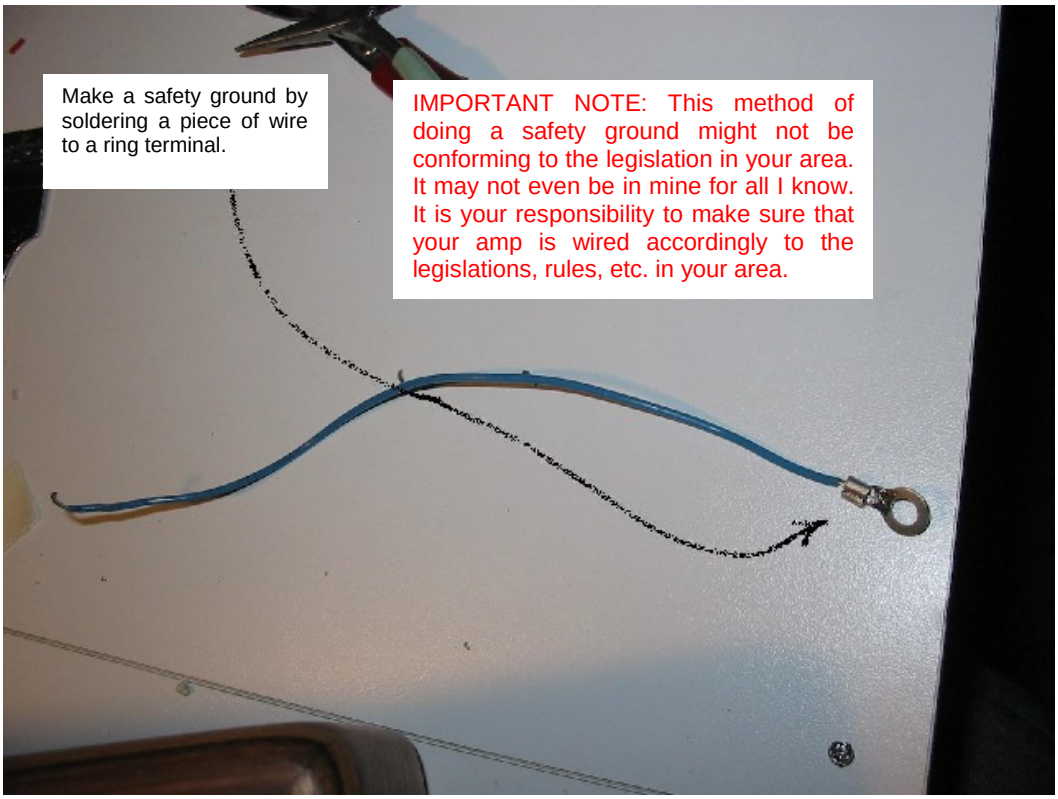


Figure 49. Preparing the safety ground.

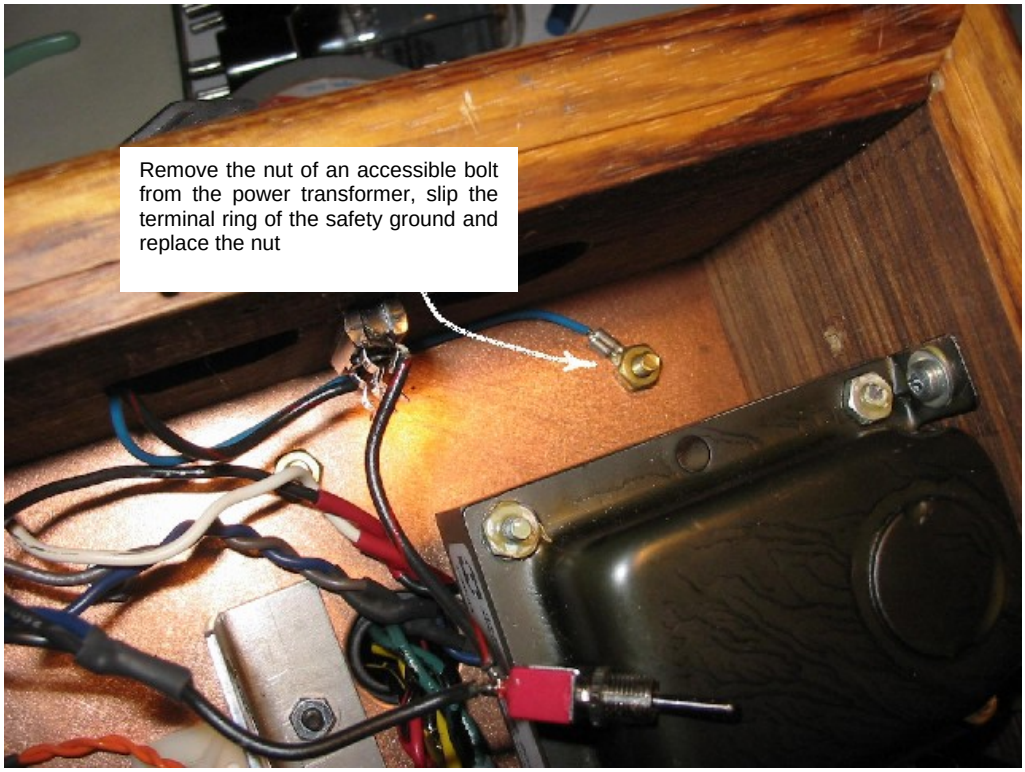


Figure 50. Wiring the safety ground (part 1).

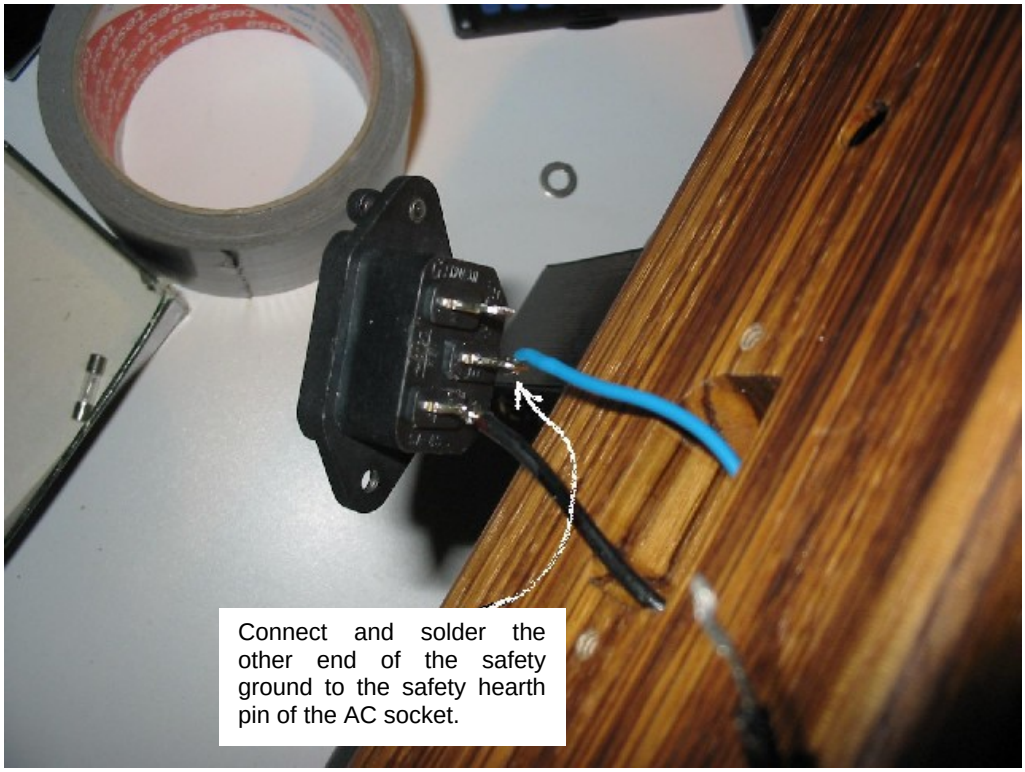


Figure 51. Wiring the safety ground (part 2).

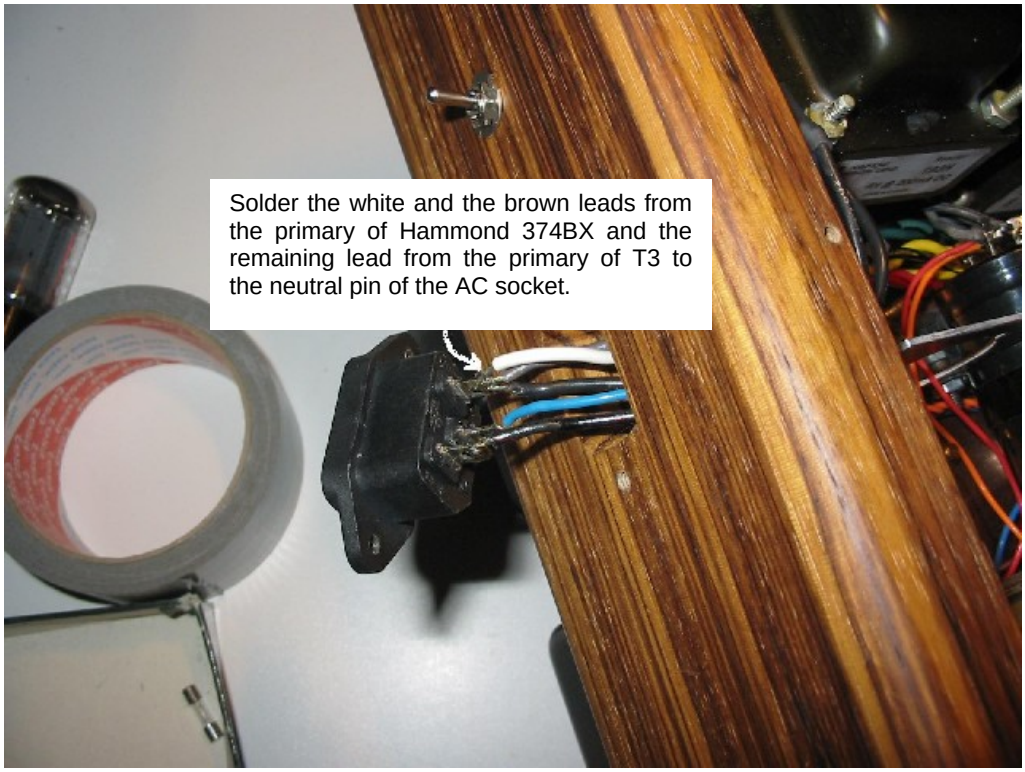


Figure 52. Wiring the neutral pin of the AC socket. Amp is now done! Congratulation!

If everything went fine, the amp should look like what is shown in Figure 53.

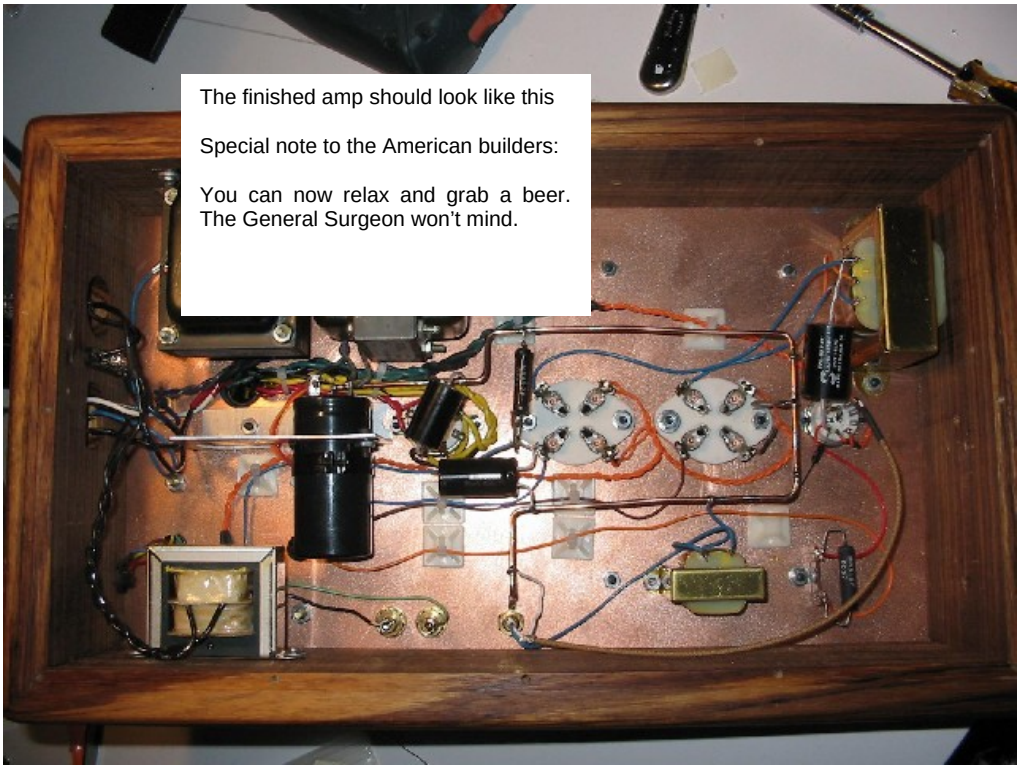


Figure 53. Done!

Testing the amp.

OK, time to do the smoke test. First put a 3A fuse in the fuse holder. Make sure the on-off switch is on the off position. Put a AC cord in the AC socket (duh!) and the wall outlet (re-duh!). Put all the tubes in.

Put the amp firmly seated on the side and turn on the amp. Check for any smoking components. Check also if any of the tube plates are glowing red (not the filaments, it is normal they'll glow red…).

Glowing plates? Signs of smoke?

No? Gooood!

Yes? Turn off the amp and recheck all of your wiring. Something must be wrong or you used a lower wattage resistor at some place. Correct any mistake and re-test again.

Assuming everything went well, it is now time to check the voltage.

Now watch out here because you now are doing the most dangerous part of this trip so far. First advice, ALWAYS BE AFRAID OF ELECTRICITY. Electricity ain't your friend. It will kill you it you get intimately acquainted. Second advise, get leads for your voltmeter that have self retaining clips so you won't have to hold the leads but clip it where you want to take the voltage. Third advice, ALWAYS WORK WITH ONE HAND IN YOUR POCKET. If you get zapped with only one hand while the other one is in your pocket, you increase your chance of living for another day. Take this seriously. I've turn my DVM into a spot welding machine in a couple of occasion and let me tell you it ain't fun.

Put your DVM on DC position and you will firmly clip the black lead on the ground buss. Then you will check the voltage at the various points shown in Table 1.

Table 1. DC Voltage reading.

Voltage that is read	Where to take the reading	Supposed reading
B+	C_{5b} B+ lug	330 V
Voltage on the plate of the first 2A3	Pin #2 of the first 2A3 socket	320 V
Voltage on the plate of the second 2A3	Pin #2 of the second 2A3 socket	320 V
Bias voltage of the 2A3	Lead of R_4 that is located on the single lug strip.	48 V
Plate voltage of the 6C45-Pi	Pin #7 of the 6C45-Pi socket	170 V
Bias voltage of the 6C45-Pi	Pin #6 of the 6C45-Pi socket	1.6 V

You can have slightly different reading. Don't loose your sleep for anything within 10%. This being said, if your 2A3s are well matched, the plate voltage read on each pin #2

should be pretty much the same thing. If you see a difference greater than 2-3 V between the two 2A3 plate voltage, the matching of your tube leaves to be desired.

So if you got those reading, the amp is operational.

Build the other one now…

Conclusion.

Well look in front of you to your creations and be proud. How's that for a conclusion! Listen to the amps for a while, play it at least for a 100 hours breaking period before getting the upgrade bug! Hopefully you enjoyed building it. I did…