Crack 1.1 Manual

A guide to constructing the
Bottlehead Crack OTL Headphone Amplifier kit

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HEY! You gotta read this first!

This kit contains parts which operate at high, ***potentially deadly,*** voltages. In constructing, operating, and modifying this kit you agree to assume liability for any damage or injury resulting from exposing yourself or others to this high voltage, high temperature hazard. This kit contains only a partial enclosure and thus has not been designed to be shockproof or thermally isolated. The builder must have, or must acquire the knowledge to construct an enclosure which properly isolates this high voltage and high temperature from anyone coming in contact with the kit if deemed necessary.

The kit contains many small parts. None of them are edible.

PLEASE NOTE! If you do not feel that you possess the skills, knowledge, or common sense necessary to safely construct and operate this electronic kit, do not attempt its construction! Contact us to enquire about a refund or for a recommendation of a qualified builder if you decide that you cannot safely execute its construction.

Above all else:

- ***Never leave the kit operating in the presence of unattended children. Along with the shock hazard, there is also a potential for serious burns from touching hot vacuum tubes.***
- ***Never leave out the fuses, power switches or power supply bleeder resistors***
- ***Never assume that the shock or high temperature hazards are neutralized, even when the unit is unplugged!***
- ***Never turn on a kit that has not passed resistance checks. Never use a kit that has not passed voltage checks.***

Safety and the Bottlehead

The current state of electronic technology is such that do it yourself electronics construction is a lost art. A lot of the safety knowledge that goes along with it has been lost too.

The basics

Tube audio gear tends to operate at much higher voltages than the current day solid state audio equipment. Let's consider a single ended 300B amp like the Bottlehead Kaiju. We have a power supply that can supply 450 volts, and it may be able to push out 160 mA of current. That is enough to make you curse uncontrollably if you errantly touch a live terminal.

OK, so how to stay safe?

Rubber soles
Always wear shoes when working with electronic gear, preferably rubber soled, and particularly when standing on concrete floors. This is because the high voltage potential will want to find its way to ground potential. The rubber soles will insulate you from ground. It won't completely insulate you from getting shocked, but it can reduce the effect of the shock from fatal to merely teaching you a lesson.

Only one hand
If you grab the chassis of an amp or preamp with one hand, and touch a live terminal with the other, guess where the current will flow. Right through you! The old time technicians figured out a good way to avoid absent mindedly performing this shocking display - train yourself to always keep one hand in your pocket when reaching into live gear.

A heart stopper

The reason these paths (hand to foot, hand to hand) are two of the most critical is because they cross through one of the more electrically sensitive organs in your body - the heart. Because the heart is slightly to the left side of the chest cavity, it is actually slightly safer to use your right hand than your left hand when reaching into or touching a probe to live circuits, as the path to ground through your feet does not pass quite so directly through your heart as current passing through the left hand would.

Other things to remember

It is a good practice to only work on high voltage equipment when someone else is present, in case you are accidentally hurt. This can be tough for some of us - all the more reason to practice meticulous safety habits.

Wear safety glasses when building and testing.

Make sure you stay away from mains wiring! Remember that the power cord is live even if the equipment is switched off. So are the exposed terminals on the power entry socket and the power switch if the cord is attached. AC mains usually supply 15-20A before the circuit breaker will trip. That’s way too much current to disrespect. If you don't need a piece of gear plugged into the wall to test it (say you need to check a resistance), do not leave it plugged in. If it must be plugged in for voltage testing, consider use of an isolation transformer between the wall socket and the equipment to be tested, which will create a current limit on what the AC mains can supply.

Use clip leads on your meter test probes whenever it is possible. Clipping the probe to the test point will avoid shorts caused by test probes slipping off of terminals, a common cause of shorted components (and not covered by warranty). If you can’t use a clip lead, ask someone to give you the meter reading rather than taking your eyes off of the terminal you are testing to look at the meter. NEVER lean over live equipment or put probes in where you can't see them.

Remember that it takes several seconds to a minute or two for the high voltage to drain off of the power supply components after the power is switched off. Practice waiting 30 seconds to a minute after powering down your gear before probing around inside it.

Tubes get hot

This should be obvious, but we hear from many first time builders who are surprised to find that a tube with a glowing filament inside gets very hot, and stays hot for some time after the gear is turned off. Be sure to let tubes cool before removing them from a socket. And always switch off and unplug the gear before you remove tubes.
Other components get hot too. Resistors, power transformers, even the chassis plate will get very warm. This is normal.

Doc B.

Introduction

As headphone listening becomes more and more a dominant form of high fidelity listening Bottlehead has wanted to offer a product to that group of listeners that offers the same bang for the buck as our speaker-oriented kits. The Crack Output Transformer-Less (OTL) headphone amplifier has been designed as a relatively simple, highly cost effective, great sounding headphone amp kit for higher impedance headphones (200Ω or higher) .

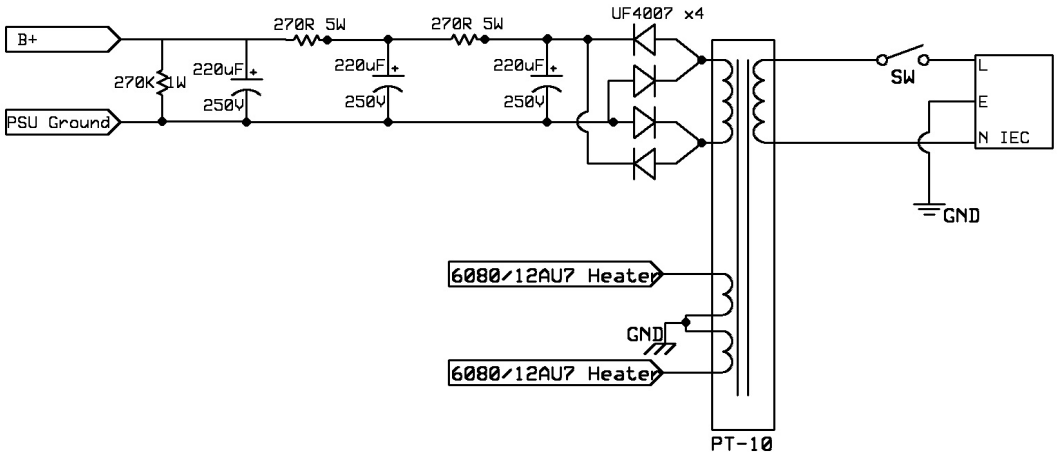
Brief circuit theory

The amplifier circuit consists of two channels, each using half of a 12AU7 tube voltage amplifier direct coupled to half of a 6080 tube as a cathode follower output. Only one output coupling capacitor is in the signal path of each channel. The high voltage power supply is an efficient solid state ultrafast soft recovery full wave bridge feeding a C-R-C-R-C filter.

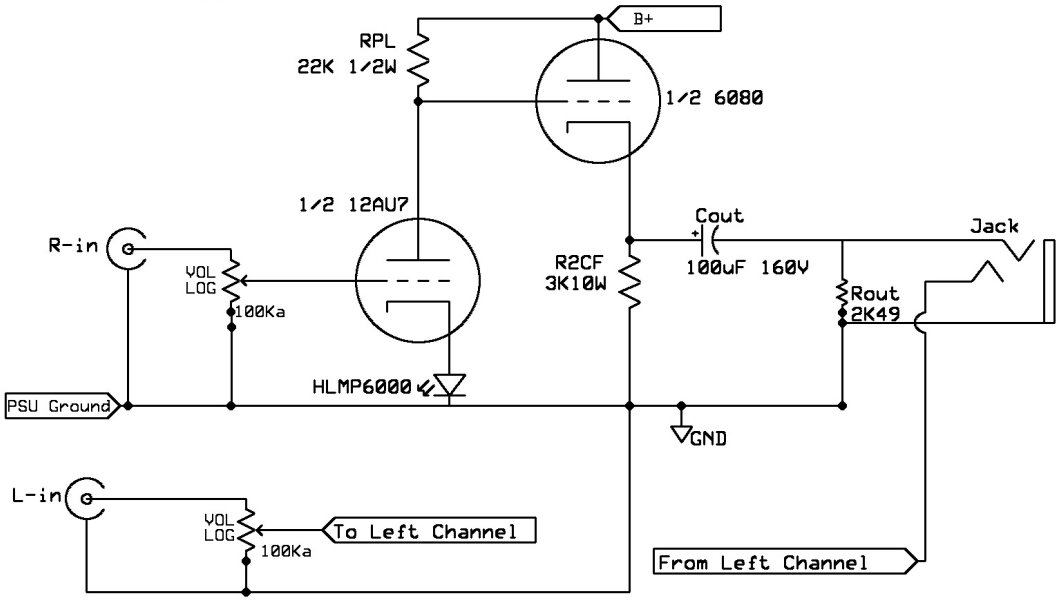
Maximum output is about 10V rms (28V pk-pk) before clipping into a 300Ω load.
Gain is about 15 dB into a 300Ω load.
Output impedance is about 120Ω - recommended headphone load is 200Ω or greater.
Frequency response is ±0.5 dB from 10Hz to 50kHz into a 300Ω load.

Acknowledgements
This manual was written, edited, and laid out by Joshua Harris with additional writing, photographic, and editing contributions by Dan "Doc" Schmalle. Photographs by Joshua Harris while Paul "PB" Birkeland assembled. Circuit design by Paul Birkeland. Thanks to Paul "Braniac" Joppa for his sage wisdom. Thanks to John "Buddha" Camille for all his mentoring in proper grounding techniques through the years. We miss you, boss. Thanks also to Queen Eileen Schmalle for putting up with yet another of Dr. Bottlehead's cockamamie schemes.

Power Supply



Right Channel



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Paul Birkeland	Rev 1.1 8/11/2016	Page 1

Tools and Additional Materials You Will Need

- eye protection
- slotted tip screwdriver
- phillips head screwdriver
- needle nose pliers
- wire cutters
- wire stripper for 18 gauge and smaller wire
- soldering iron, 40W is fine. An inexpensive solder station is much, much better
- volt-ohm meter - we suggest a 'pocket DMM'
- clip on attachments for your meter probes, OR a set of "alligator" clip leads
- masking tape (the blue kind is MUCH better than the white)
- a good light source
- a ruler
- a soft towel or placemat to rest the amp on while working on the underside

Solder — we recommend standard 60/40 or 63/37 tin/lead solder as the easiest to work with. 2% silver solder is OK, but stay away from 4% silver solder. It does not flow well. If you are using an adjustable solder station you will want to set the temperature to about 650-700 degrees. Whatever solder you choose, **MAKE ABSOLUTELY CERTAIN** it is rosin core, and intended for electronics use. Plumbing and other types of solder **WILL RUIN YOUR KIT.**

Other tools that are nice to have:

- desoldering tool or desoldering braid
- magnifying glass for parts identification

My technicians have asked me to emphasize that a lot of the issues they see in customer amps are due to miswires or bad solder joints that are easily visible with a little magnification. Don't be proud, if you need reading glasses to work on these tiny parts, use them. See the first item above—you need to wear some kind of safety glasses when soldering and clipping leads anyway.

- A set of small sockets and a socket wrench for tightening the mounting hardware
- A "third hand" tool can be useful for situations where you need support the parts you are working on while keeping both hands free to solder

Wood Finishing Supplies — you will need, at minimum, wood glue and masking tape. 220 grit sandpaper and some kind of finish are recommended if you want a completed look to your project. Water based polymer finishes are available at any hardware store and are great for first timers.

Paint —you may want to protect the transformer end bell with paint or a clear coat to prevent rust from appearing on the top surface (it *will* rust if left untreated). You may also wish to paint the chassis panel for aesthetic reasons. Make sure to allow for plenty of drying time to any painted metal, as installing the hardware may damage finishes on paint that has not fully cured (the time listed on the can is rarely enough). Also take the time to remove any paint from the underside of the chassis or end bell.

Crack OTL Headphone Amplifer Parts List

( ) 1 — wood base kit
( ) 1 — PT-10 power transformer
( ) 1 — N. American terminated power cord
( ) 1 — 6080 vacuum tube (or equivalent)
( ) 1 — 12AU7 vacuum tube (or equivalent)
( ) 1 — Crack chassis plate
( ) 1 — Crack manual CD-ROM
(or previous download)

( ) 4 — 8-32x2" screws
( ) 2 — 4-40x¼" screws
( ) 2 — 4-40x⅜" screws
( ) 1 — 8-32x⅜" screw
( ) 1 — 8-32 self-tapping screw
( ) 2 — #6 round lockwashers
( ) 5 — #8 round lockwasher
( ) 4 — #8 star lockwashers
( ) 4 — #8 fiber shoulder washers
( ) 4 — #8 nylon transformer washers
( ) 1 — #8 solder tab
( ) 4 — #4 hex nuts
( ) 5 — #8 locknuts

( ) 1 — 1A fuse
( ) 1 — IEC power entry module
( ) 1 — rocker power switch
( ) 2 — 5-lug terminal strips
( ) 2 — 6-lug terminal strip
( ) 1 — red RCA jack
( ) 1 — black RCA jack
( ) 1 — TRS headphone jack
( ) 1 — knob
( ) 1 — 100KΩ logarithmic potentiometer (A100K)
( ) 1 — octal tube socket
( ) 1 — octal socket clamp
( ) 1 — 9-pin tube socket
( ) 1 — 9-pin socket clamp
( ) 4 — rubber feet

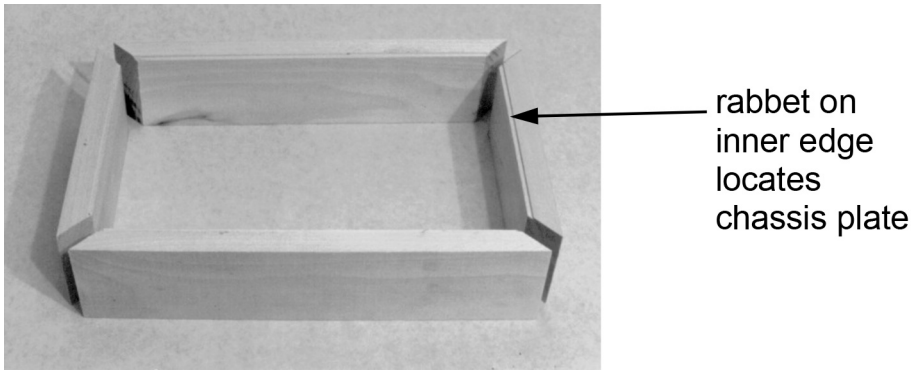
( ) 5 feet black solid core wire
( ) 5 feet red solid core wire
( ) 3 feet white solid core wire
( ) 3 feet green solid core wire
( ) 6 inches bare buss wire

( ) 2 — 270Ω 5W wirewound resistors
( ) 2 — 3KΩ 10W wirewound resistors
( ) 2 — 100µF 160V electrolytic capacitors
( ) 3 — 220µF 250V electrolytic capacitors
( ) 2 — HLMP 6000 LEDs
( ) 4 — UF4007 rectifier diodes
( ) 2 — 2.49KΩ ¼W resistors (red, yellow, white, brown, brown)
( ) 2 — 22.1KΩ ½W resistors (red, red, brown, red, brown)
( ) 1 — 270KΩ 1W resistor (red, violet, yellow, gold)

Some of the parts included in your kit my vary slightly from the descriptions here. Occasionally parts can be mis-packed, so e-mail replacementparts@bottlehead.com if you have problems finding all the correct parts in your kit.

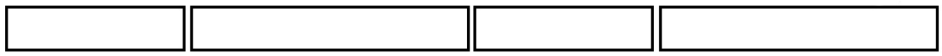
Assembly Part One — The Wood Base

It is useful to assemble the wood base at this point so that it may be used as a convenient cradle for the inverted chassis plate while you work on the assembly.



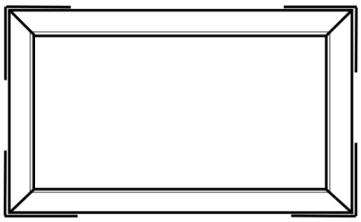
The base is composed of two 6" and two 10" pieces of 1"x4" alder, miter cut and rabbeted for support of the aluminum chassis plate.
Additionally, you will need wood glue, masking tape, 220 grit sandpaper, stain and the finish of your choice.
We strongly urge you to do a dry run of the assembly instructions, following all directions excepting the application of glue, before attempting the final, glued assembly.

Begin assembly by laying the four pieces in a line, with their inner (mitered) faces down:



Be sure to butt each end evenly against the next, and be sure all the rabbeted edges are oriented the same way. Now place a three to four inch piece of masking tape across each joint:

Now carefully flip the entire assembly over. When ready for final asssembly apply a small amount of wood glue evenly to each mitered surface, including the two end miters. For the first dry run, leave the glue out until you are sure all pieces are properly oriented and aligned. Next, set the assembly on edge, with the rabbeted face up, and form the four pieces into a box:



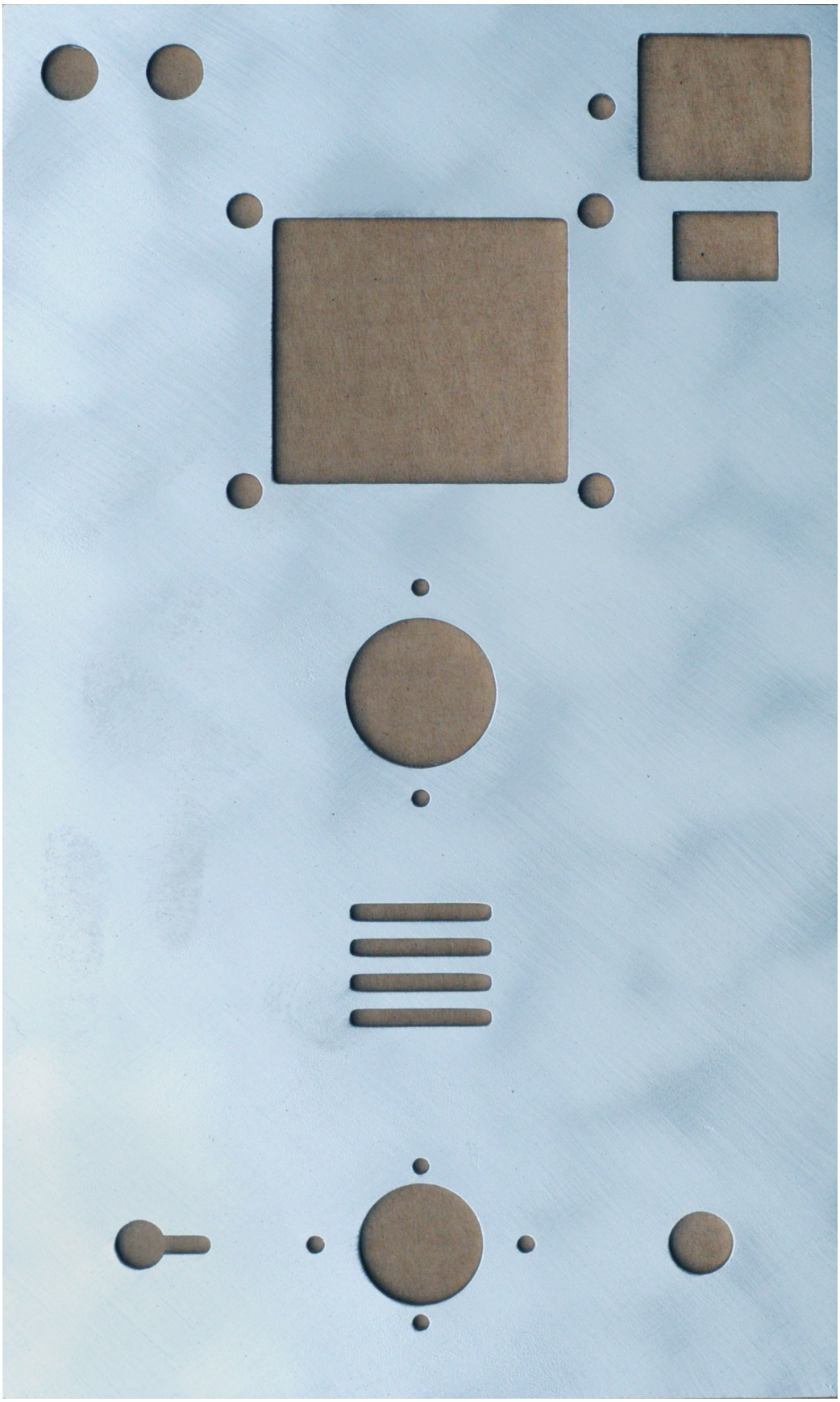
Place one more 3"-4" piece of tape on the one corner that is untaped. The box will have pulled into a squared shaped. Place the chassis plate into the rabbeted inner edge to assure that it fits properly, and let the glue dry for a few hours. Remove the tape from each corner, lift away the chassis plate, and sand, stain, and finish to taste.

You may secure the assembled chassis to the base with polyurethane glue or epoxy for a permanent mounting or use silicone sealer or adhesive foam strips for a removable mounting. Most builders leave the chassis plate unattached for ease in modification of the circuit.

Please Note: the feet are **NOT OPTIONAL**. They provide ventilation **VITAL** for your amplifier!

YOU MUST INSTALL THE FEET!!!

Chassis Orientation



Orient the chassis as shown in the photograph. The top side is shown, with the rear of the chassis at the top of the image.

Every step of this manual has been carefully considered for high quality sound, low noise, and above all safety. This starts with the hardware mounting, and continues to the last solder joint. Disregarding instructions in this manual will result in poor performance, including the chance of creating unsafe conditions. Almost every build we have seen with problems stem from either disregard of instructions, a rushed build, or a combination of the two. Take your time, aim to make your build look like the pictures, and if you do not understand something, ASK! The Bottlehead Forum is there to help.

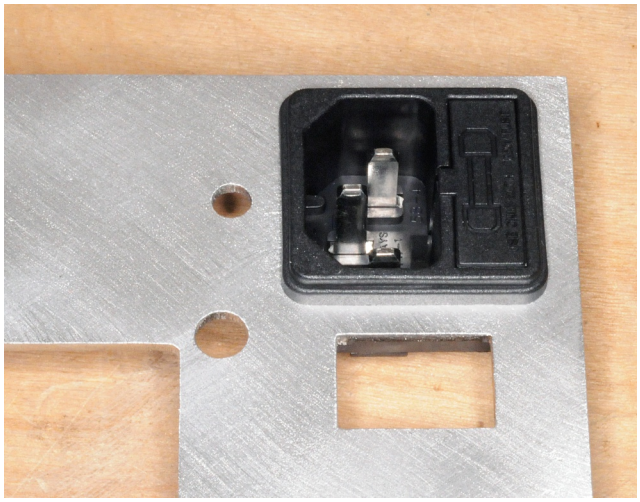
Painting:
If you paint your chassis and/or transformer end bell, you must leave the underside bare. The bare metal contact provides a ground path vital for audio and safety reasons.

Parts selection:
The parts included in this kit have been selected for reliability and repeatability.
If you wish to use upgrade parts, first build your kit with the parts provided and upgrade later. We cannot provide support when we do not know the parts selected. Anyone who tells you that your amplifier will only sound good with brand X capacitors, or some power supply mod, or whatever, bear in mind that this is their *subjective* opinion and not a fact. The stock parts work and sound very good. If your upgrade is really an upgrade, you will need to hear it stock first to hear what it does.

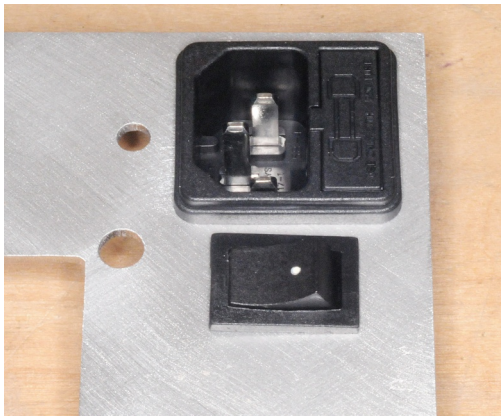
This should be an enjoyable project, take your time and remember:

THERE IS NO PRIZE FOR FASTEST ASSEMBLY!!!

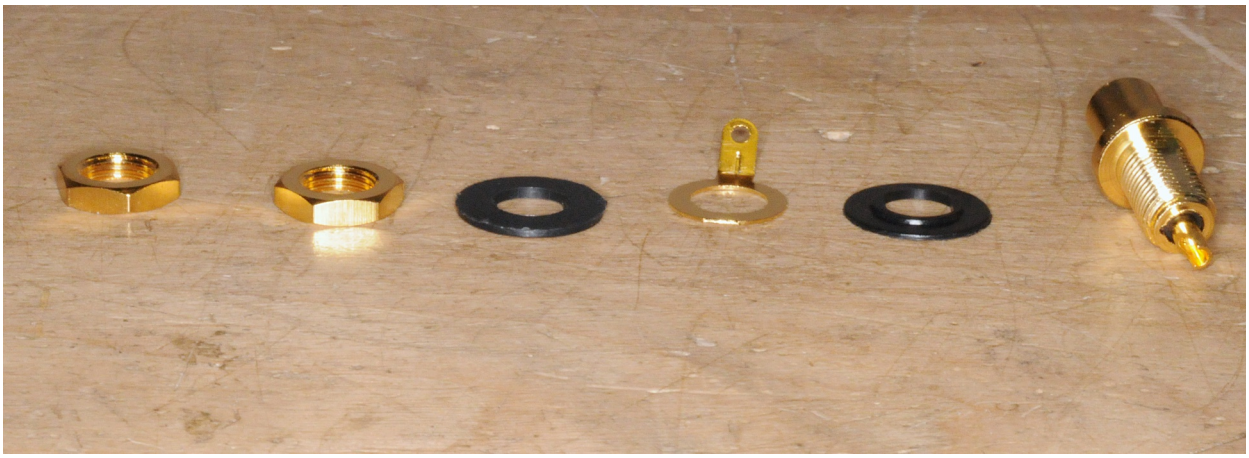
Assembly Part Two — Building up the Chassis



( ) Insert the IEC power inlet into the rectangular hole in the back-right corner of the chassis. Note that the pins should face the inside of the chassis. Insert the inlet from the top side and push until it clicks into place.

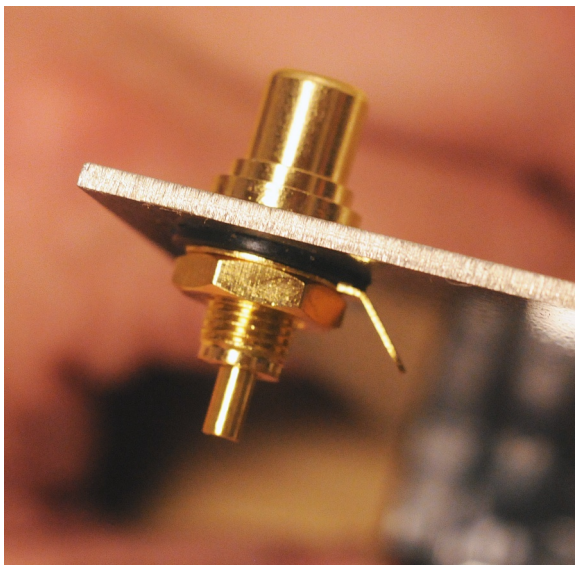


( ) Insert the power switch into rectangular hole in front of the power inlet. Make sure the power on indicator (either a white dot or a 1) faces the edge of the chassis as shown. Insert the switch from the top side and push until it clicks into place.



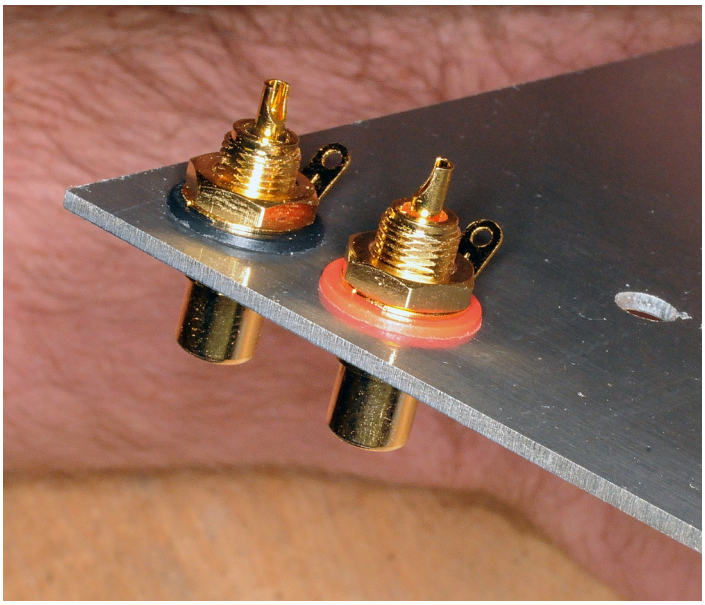
The RCA jacks provided have hardware to isolate the body of the jack from the chassis. It is a crucial detail to mount them correctly; failure to do so will have a negative impact on the sound of your amplifier. The hardware provided is shown here.
From left to right: a nut, a second nut, a flat washer, a solder tab, a shoulder washer (note the ridge!), and the jack itself. The jacks provided may vary visibly from the ones shown, but they will have the same functional parts.

( ) Disassemble the hardware of the black RCA jack, then place the shoulder washer on the body of the jack with the ridge facing up towards the threaded portion of the jack.

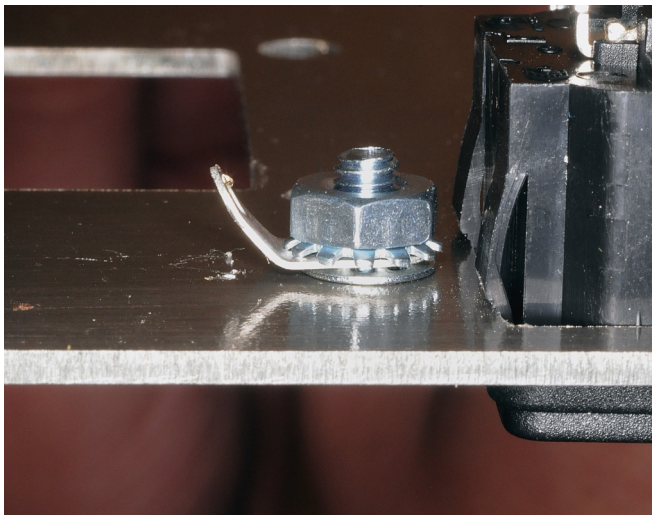


( ) Insert the jack and shoulder washer from the top side of the hole in the corner furthest from the power inlet at the back edge of the chassis (making certain the ridge of the shoulder washer sits in the hole and the flat portion rests flat against the surface of the chassis). On the bottom side, place the flat washer over the jack, then the solder tab, and secure with the nut (if there is a second nut, its use is optional). Orient the solder tab to point towards the front of the chassis and bent up, as shown.

( ) Disassemble the hardware of the red RCA jack, then place the shoulder washer on the body of the jack with the ridge facing up towards the threaded portion of the jack. Insert the jack and shoulder washer from the top side of the hole next to the black jack at back edge of the chassis (making certain the ridge of the shoulder washer sits in the hole and the flat portion rests flat against the surface of the chassis). On the bottom side, place the flat washer over the jack, then the solder tab, and secure with the nut (if there is a second nut, its use is optional). Orient the solder tab to point towards the front of the chassis and bent up, as shown.

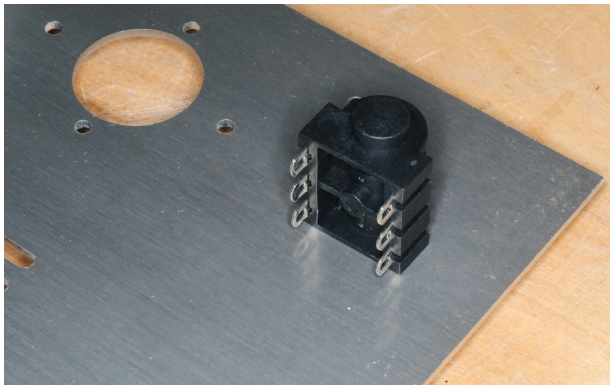


The safety ground lug provides a safe path should high voltage accidentally contact the chassis. It is vital that it is built correctly and is not isolated from the chassis by paint or any other means. It consists of 4 parts, shown here in a row from left to right: a 8-32x⅜" (10mm) screw (which is different from the self-tapping 8-32 screw used later shown below. Note the tapering and ridges at the tip of the self-tapping screw. Pay close attention to your parts selection here), a #8 round lockwasher (**not** the star shaped lockwasher), a #8 solder lug, and a #8 locknut.



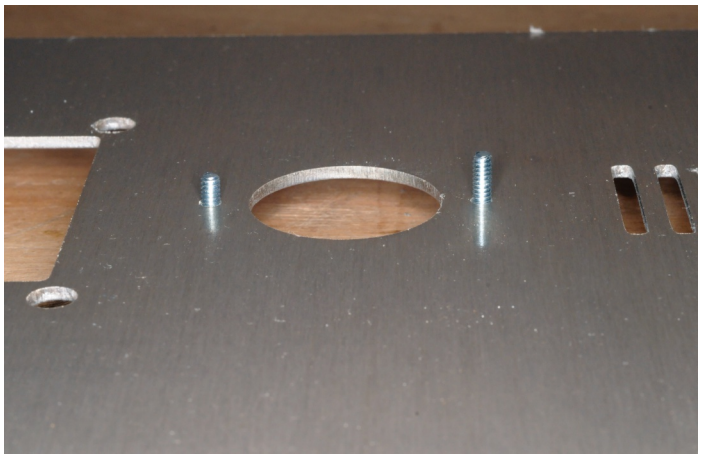
( ) Insert the 8-32x⅜" screw from the top side of the chassis through the hole closest to the IEC power inlet. On the bottom side of the chassis, slip a #8 round lockwasher over the screw, followed by a #8 solder lug, then secure with a #8 locknut. The teeth of the locknut must face the solder lug, as shown. The solder lug should point away from the inlet and be bent up, as shown.

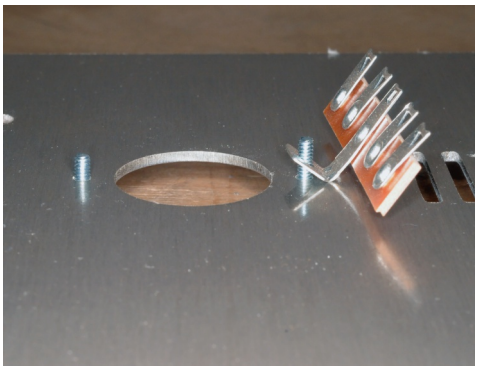
( ) Mount the volume potentiometer with the provided hardware in the hole at the front of the chassis on the same side as the input jacks. The lugs will face towards the rear of the chassis, and the indexing pin of the potentiometer will sit in the notch extending off the hole.



( ) Mount the headphone jack with the provided hardware in the hole at the front of the chassis on the same side as the IEC inlet. The lugs will face towards the rear of the chassis as shown.

( ) Insert a 4-40x⅜" (10mm) screw from the top side of the chassis through the hole between the large circular hole in the center of the chassis and the narrow vent holes. Insert a 4-40x¼" (7mm) screw from the top side of the chassis through the hole between the large circular hole in the center of the chassis and the large square hole at the rear of the chassis.





( ) Place the mounting tab of a 5-lug terminal strip on the ⅜" (10mm) screw between the large circular hole in the center of the chassis and the narrow vent holes. Align the tag strip towards the vent holes as shown.

( ) Insert the octal socket into the large circular hole from the bottom side of the chassis. Make **absolutely certain** that the notch in the center hole faces the front of the chassis. Place the socket clamp over the socket.

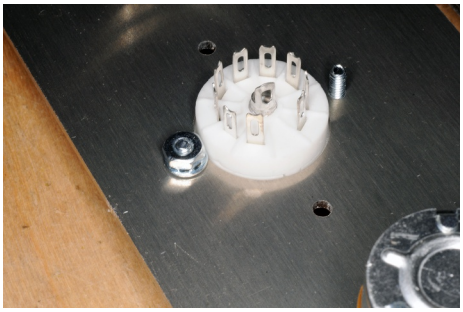
( ) Insert a #4 nut into the rearmost set of prongs of the socket clamp. Partially tighten the 4-40x¼" screw into the nut. Insert a #4 nut into the forward set of prongs of the socket clamp. Partially tighten the 4-40x⅜" screw into the nut.

( ) Confirm **beyond all doubt** the following:
- The indexing notch of the octal socket points towards the front of the chassis
- The longer screw is on the mounting hole of the octal socket closer to the front of the chassis.
- The 5-lug terminal strip is mounted on the longer screw, closer to the front of the chassis.

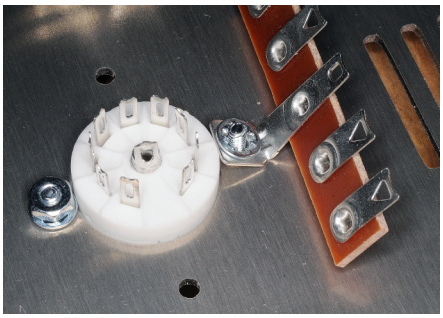
Once all of these details have been confirmed, securely tighten the mounting screws of the octal socket.

( ) Insert the 9-pin socket in the hole at the front of the chassis. Insert the socket from the top side, making sure the gap in the pins faces the volume potentiometer. Place the socket clamp over the socket on the top side of the chassis.

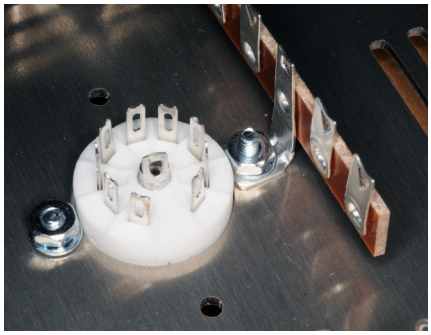
( ) Insert a 4-40x⅜" (10mm) screw from the top side of the chassis through the mounting hole of the 9-pin socket clamp closer to the rear of the chassis. Insert a 4-40x¼" (7mm) screw from the top side of the chassis through the mounting hole of the 9-pin socket clamp closer to the front of the chassis.



( ) Place a #6 lockwasher over the end of the 4-40x¼" screw at the front of the 9-pin socket. Loosely secure the screw with a #4 nut.



( ) Place the mounting tab of a 5-lug terminal strip on the ⅜" screw behind the 9-pin socket. Align the tag strip towards the vent holes as shown. Slip a #6 lockwasher over the end of the screw.

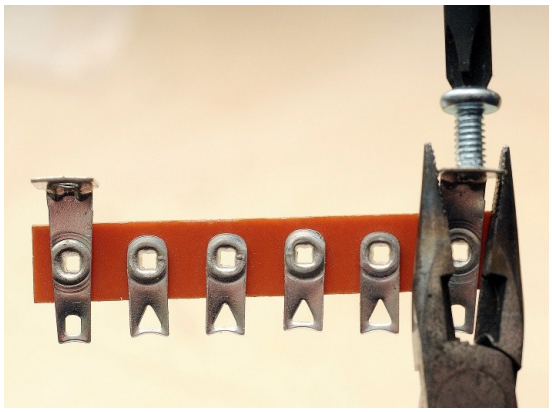


( ) Loosely secure the ⅜" screw with a #4 nut.

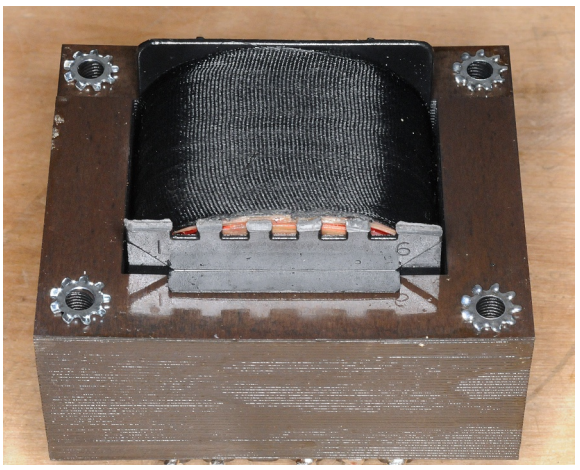
( ) Confirm **beyond all doubt** the following:

- The gap in the pins of the 9-pin socket points towards the volume potentiometer.
- The longer screw is on the mounting hole of the 9-pin socket closer to the rear of the chassis.
- The 5-lug terminal strip is mounted on the longer screw, closer to the rear of the chassis.

Once all of these details have been confirmed, securely tighten the mounting screws of the 9-pin socket.

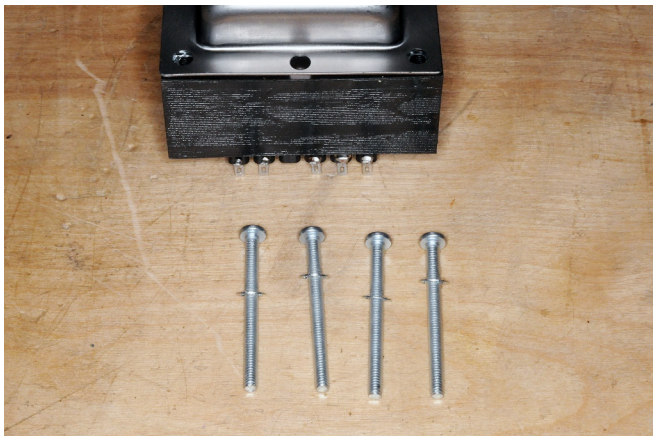


( ) Grasp the mounting tabs of each 6-lug terminal strip firmly in some pliers and slowly thread the #8-32 x ½" self tapping screw into each mounting tab to cut a thread. Remove the screw and set the terminal strips aside. You will not need to use the self tapping screw during the rest of the assembly.

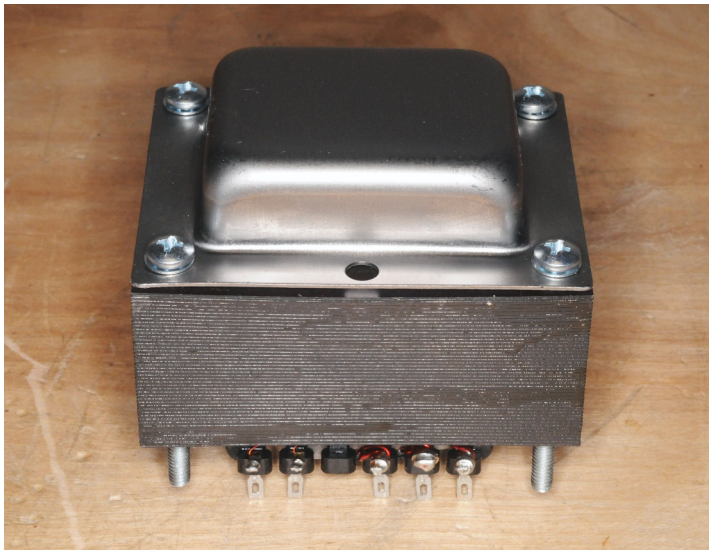


( ) Set the PT-10 power transformer on its lugs on your workbench. Place a #8 star lockwasher over each of the mounting holes.

( ) Place the end bell on the top of the transformer.

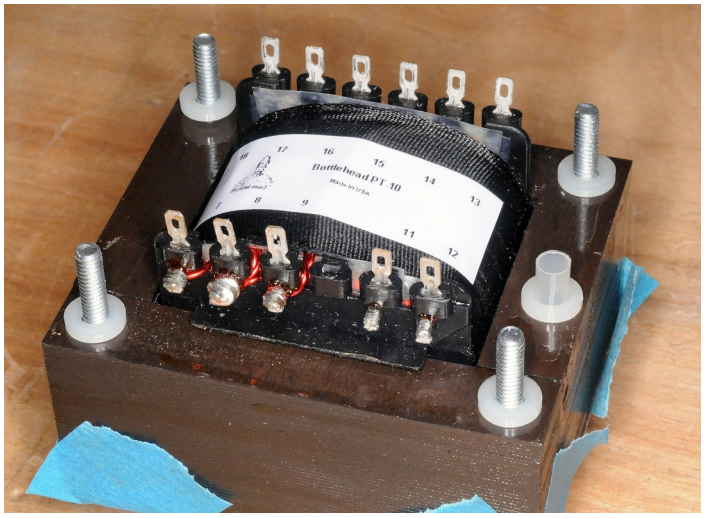


( ) Slip a #8 round lockwasher over each of the four 8-32x2" (51mm) screws.



( ) Insert an 8-32x2" screw through each of the transformer mounting holes.

( ) Cover each of the screws with masking tape to temporarily hold the screws in place.

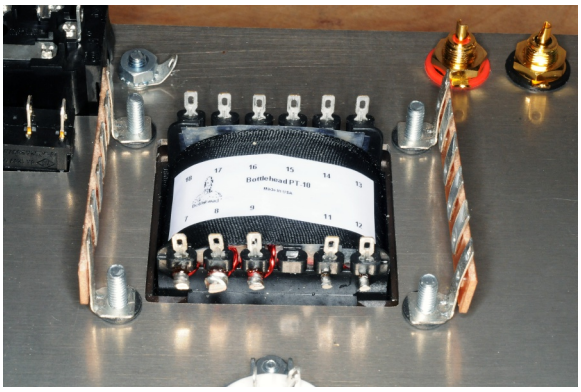


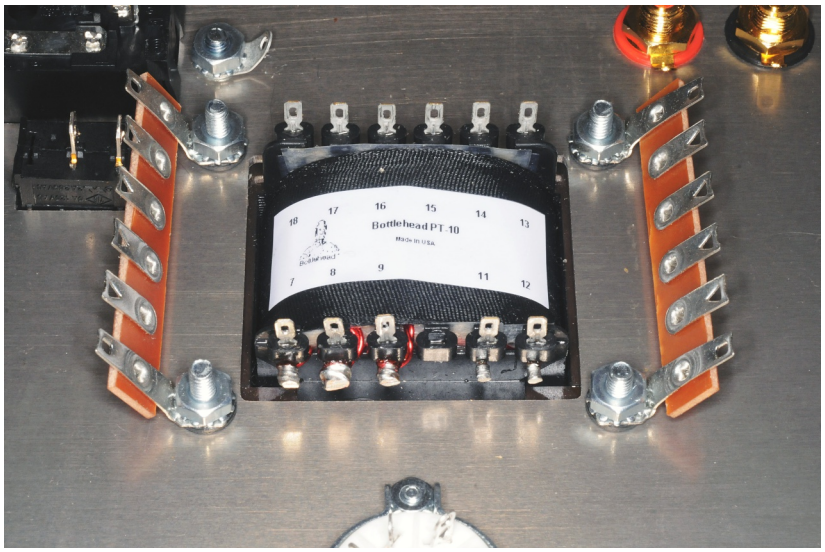
( ) Flip the PT-10 power transformer over so it rests on its end bell and place a #8 nylon shoulder washer over each screw. The ridges of the shoulder washers **must** sit in the holes of the transformer. An additional nylon washer is shown to demonstrate how the ridge would appear in the incorrect position.

( ) Set the chassis topside down on the PT-10 power transformer so terminal 18 of the transformer is closest to the IEC inlet.

( ) Place a #8 fiber shoulder washer over each of the power transformer mounting screws. Make sure the ridges of the shoulder washers sit in the holes and the flat portions rest flat against the surface of the chassis. An additional fiber washer is shown to demonstrate how the ridge would appear in the incorrect position.

( ) Align the prepared 6-lug terminal strips over the screws at the sides of the transformer. Remove the tape off each screw one by one to tighten each screw into the threaded mounting tabs.

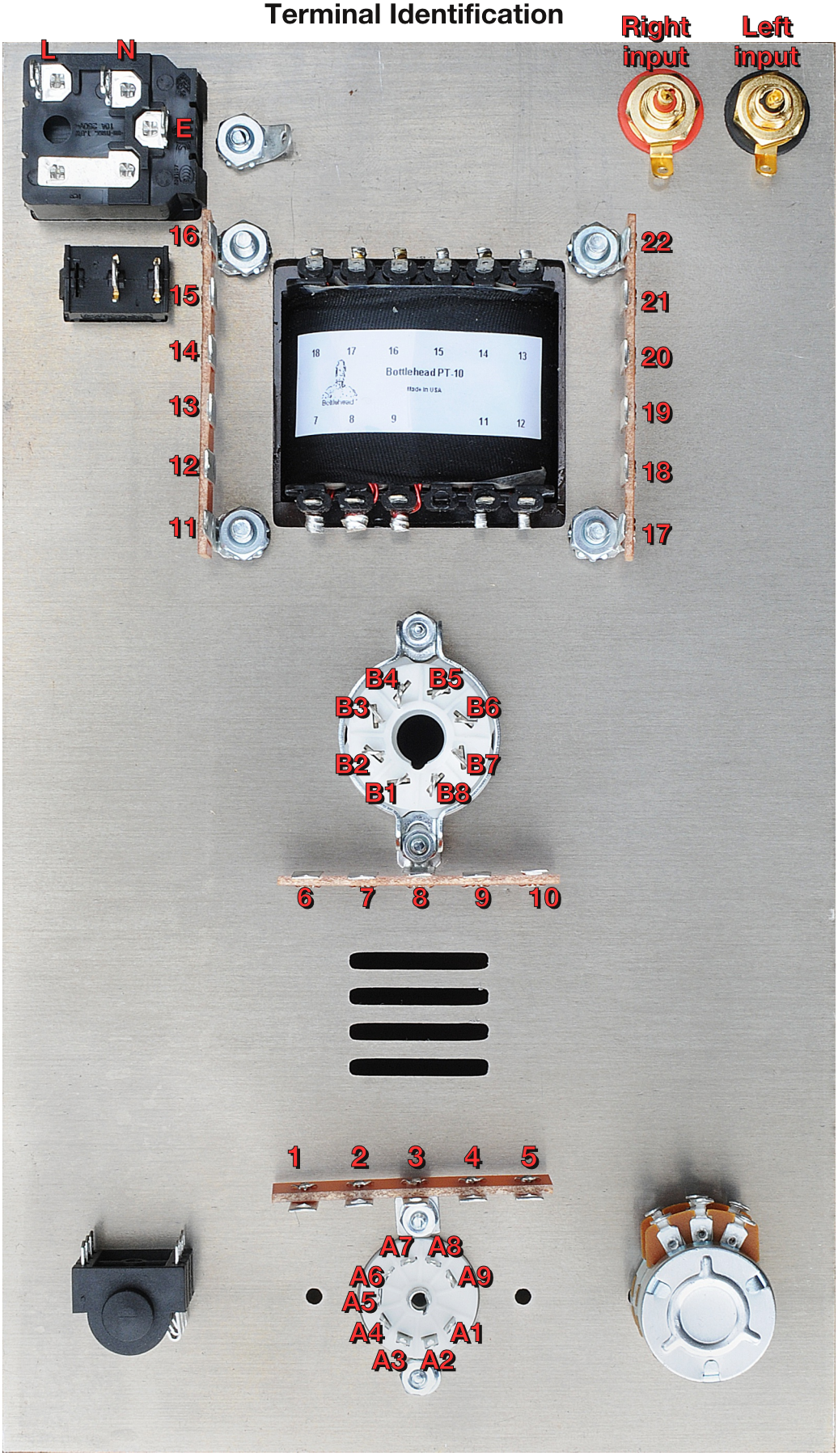




( ) Fold back the terminal strips to secure each screw with a locknut using pliers or a wrench. The teeth of the locknuts must face the terminal strip tabs, as shown. Tighten securely, but take care to not overtighten, and make sure that a flat side of the nut will face the terminal strip.

( ) Fold the terminal strips up once the nuts are secure.

Terminal Identification



It is recommended that you write the terminal numbers on your chassis. The terminal strips each have two rows of holes, when the manual refers to 4U, that would be the top hole of 4 and 4L would be the bottom hole. When the manual says "attach" that refers to wrapping the lead or wire around a terminal. Do not solder terminals until explicitly instructed to do so, as some terminals will be used by more than one component.

OK, time to fire up your soldering iron!

WHOA! Soldering lesson!

When you read the word "attach" in this manual, it means to insert a wire lead through a terminal strip hole, and wrap it around the outside of the terminal. Needlenose pliers are the trick here. The idea is to create a mechanically sound connection. If you can't wrap the wire completely around the solder point, at least bend it so that it will hold its position while being soldered. **Don't solder the connection until instructed to in the manual, as other leads may attach to the terminal later.**

Most of all, remember that the soldering iron is a hot item! The tip temperature can approach 800 degrees, and won't feel too good if you absent mindedly touch it! (Think of a steak hitting the hot grill of your BBQ...)

When the instruction is given to solder the terminal use the following procedure:

- Apply the tip of the iron to contact both the terminal and the lead(s) attached, and let it rest against the joint long enough to heat the terminal thoroughly.

- Flow enough solder onto the joint to fill the joint between the terminal and every lead attached to it. Look for a concave fillet of solder at each junction rather than a convex blob of solder.

- Be sure to touch the solder to the hot joint, not the tip of the iron.

- Remove the iron and let the joint cool unassisted (don't blow on it!). A joint which cools too quickly or moves will become "cold," it will crystallize and cool to a dull finish. A cold joint will not function structurally, nor will it conduct properly. Reheat any cold joints, applying a small additional amount of solder, and make sure that it cools to the proper shiny finish.

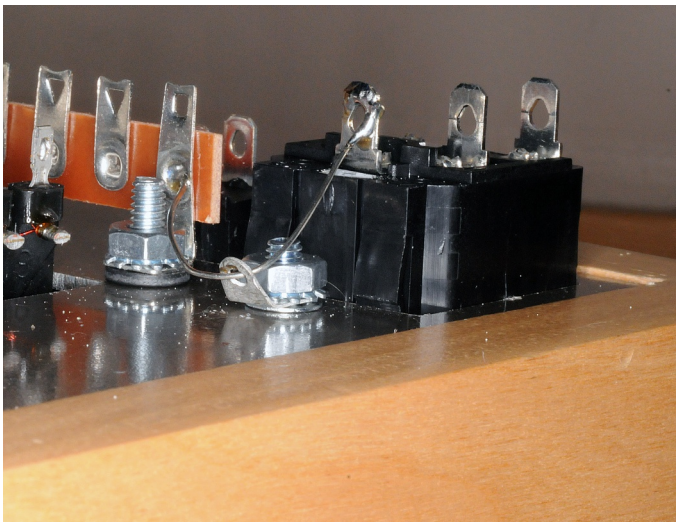
- Keep the tip of the soldering iron clean. A slightly damp sponge is the tip cleaning tool of choice.

- Under **NO CIRCUMSTANCES** should you use acid core or copper bearing solder. These products are for plumbing, not electronics use. Using this type of solder will ruin your amplifier.

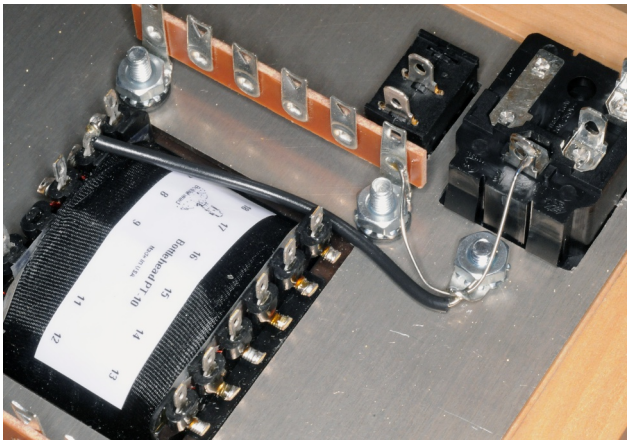
- We highly recommend not using using lead-free solder. Lead-free solder is much harder to work with, especially for beginners. Likewise, silver bearing solder (even when specified for electronics use) presents unnecessary challenges to getting good results.

If this is your first time using a soldering iron, we **HIGHLY** recommend getting used to the process on a lower stakes project. Make a cable, or even just buy some resistors and try soldering them together.

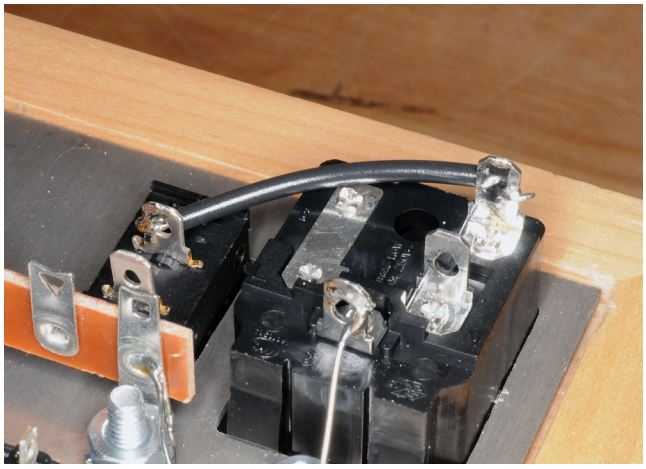
Power Input Wiring



( ) Cut a 2½" (64mm) piece of bare buss wire. Attach and solder one end to the E tab of the IEC inlet. Pass the other end through the safety ground lug, then attach the end to 16L. Solder 16L. Do not solder the ground lug.



( ) Cut a 3¼" (83mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to the safety ground lug. Attach and solder the other end to terminal 8 of the PT-10 power transformer.



( ) Cut a 2" (51mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to L tab of the IEC inlet. Attach the other end to the lug of the power switch closer to the edge of the chassis.

Follow this link to watch a video on the technique to safely and properly solder the power switch terminals.

Solder the terminal of the power switch closer to the edge of the chassis.

Use your meter to test the switch. It should read low resistance in the "on" position, and overlimit in the "off" position. If it measures the same in both positions, it is damaged and must be replaced. Follow this link to order a replacement.

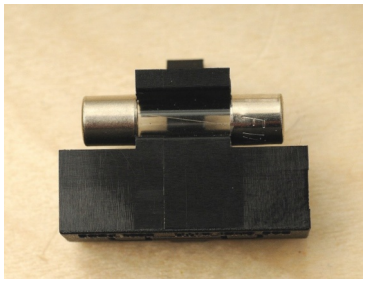
Powerline Voltage Test
The PT-10 power transformer can be configured for different incoming voltages. You will now test the incoming voltage to determine how to configure the transformer.

WHOA! SAFETY CHECK!

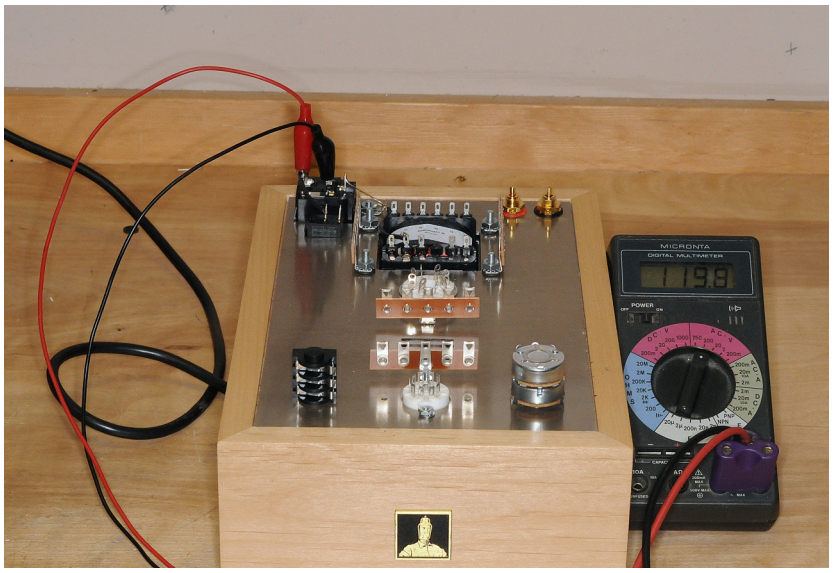
ALWAYS USE EXTREME CAUTION WHEN MAKING VOLTAGE MEASUREMENTS ON A LIVE PIECE OF ELECTRONIC GEAR. Always wear rubber soled shoes when working on electronic gear, particularly if you are working on a concrete floor. Don't work in socks or bare feet. A circuit can be created from the live amplifier to ground through your feet.

NEVER, REPEAT, ***NEVER*** TOUCH THE LIVE AMPLIFIER WITH BOTH HANDS WHEN TESTING. IF YOU CREATE A CLOSED CIRCUIT THROUGH YOUR HANDS AND ARMS, THE VOLTAGE AND CURRENT CAN STOP YOUR HEART. The old timers would keep one hand in their pocket when working with live gear to avoid a fatal slip up. Also, it is a bit safer to use your right hand than your left to touch the chassis, as any current passing through your hand to the ground would be less likely to pass through your heart. OK, now that you are sufficiently scared, let's begin:

( ) Check that the power switch is in the "on" position(white dot (or 1) side of rocker down, black (or 0) side up). Insert the 1A fuse into the fuse holder. Plug the power cord into the power entry module. Do not plug the power cord into the wall outlet yet! Turn the chassis upside down.



( ) **We strongly urge you to use alligator style clip-on probe tips or test leads when testing voltages so that you do not have to hold the test leads in your hands.**



Clip the black lead of your Digital Multi Meter to N on the IEC inlet. Clip the red lead of your DMM to L on the IEC inlet. Make sure that the metal ends of the two test leads cannot touch each other. Set your DMM to AC volts in the appropriate range.

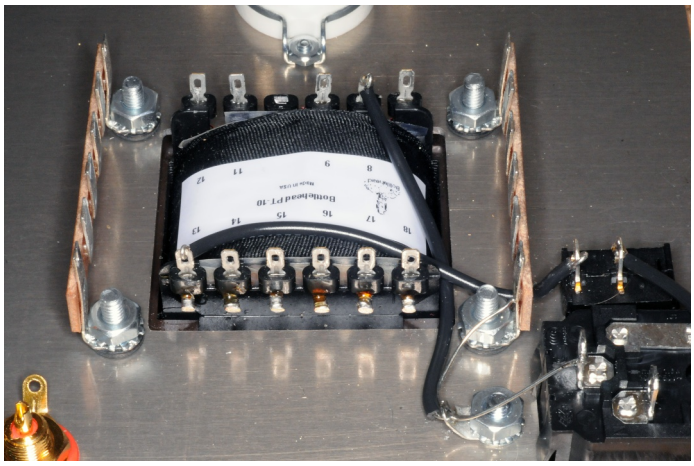
( ) Do not touch the terminals on the power entry socket or power switch as they will become "hot" at this step. Now you can plug the power cord into the wall outlet. The voltage you read is your incoming voltage. Unplug the power cord from the wall before removing the test leads and the power cord from the amplifier.

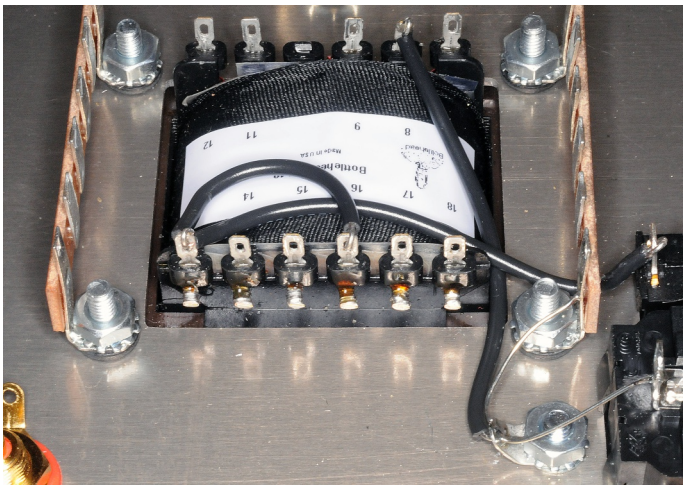
DO NOT CONTINUE until you have removed the power cord.

Power Transformer Input Wiring

IF your voltage is LESS *than* 115V AC:

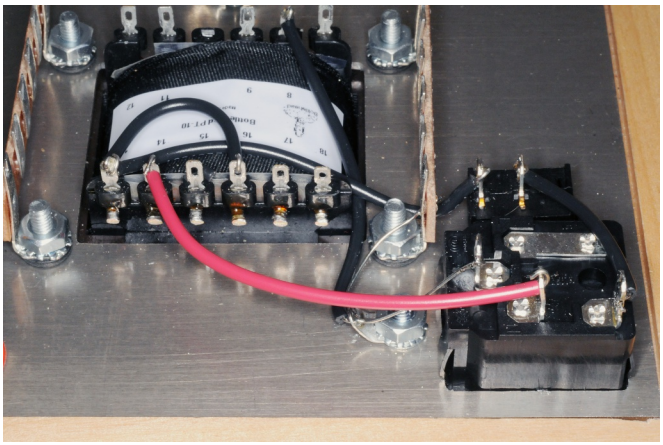
( ) Cut a 3½" (89mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach one end to terminal 13 of the PT-10 power transformer. Attach and solder the other end to the lug of the power switch closer to the center of the chassis.

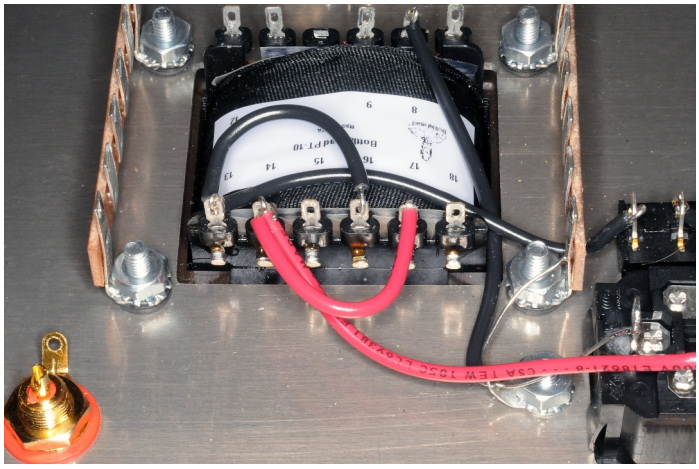




( ) Cut a 2¼" (57mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 16 of the PT-10 power transformer. Attach and solder the other end to terminal 13 of the PT-10 power transformer.

( ) Cut a 3¾" (95mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach one end to terminal 14 of the PT-10 power transformer. Attach and solder the other end to the N tab of the IEC inlet.

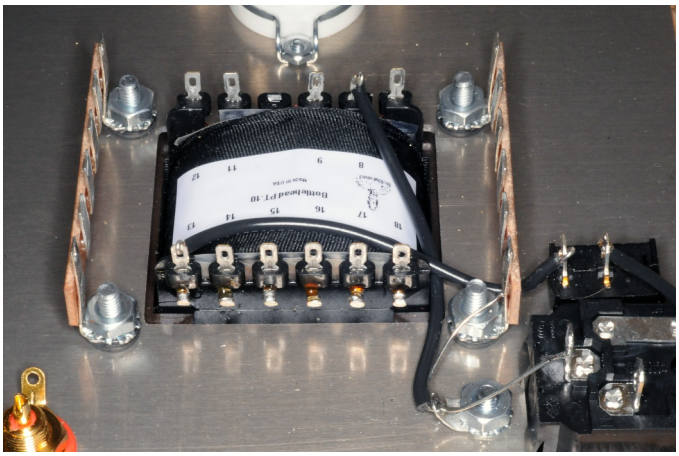




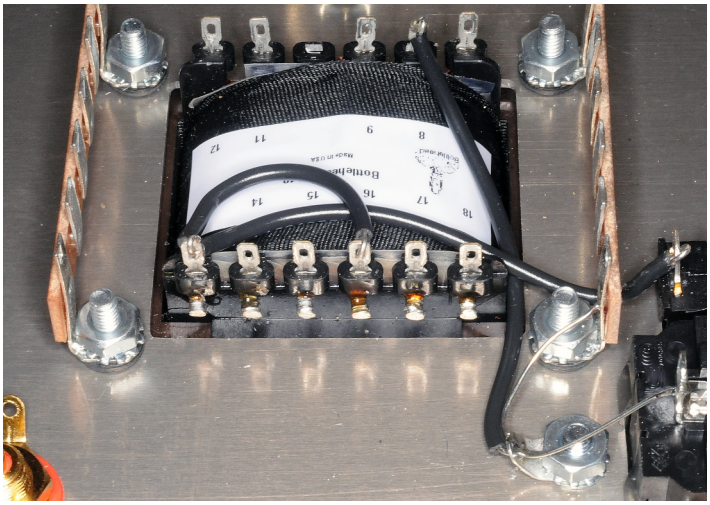
( ) Cut a 2½" (64mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 14 of the PT-10 power transformer. Attach and solder the other end to terminal 17 of the PT-10 power transformer.

Continue on Page 29.

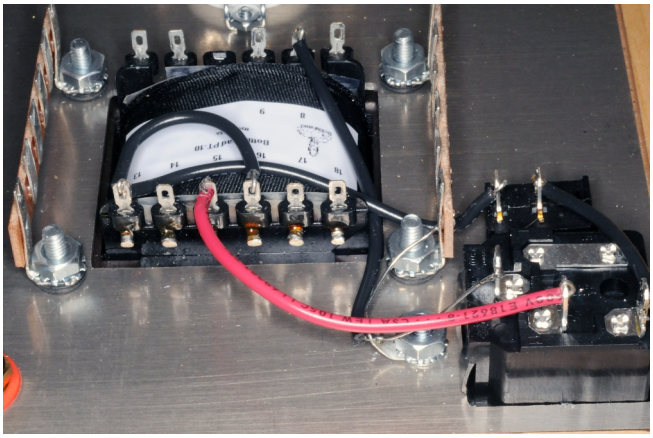
IF your voltage is GREATER *than* 115V AC *and* LESS *than* 130V AC:



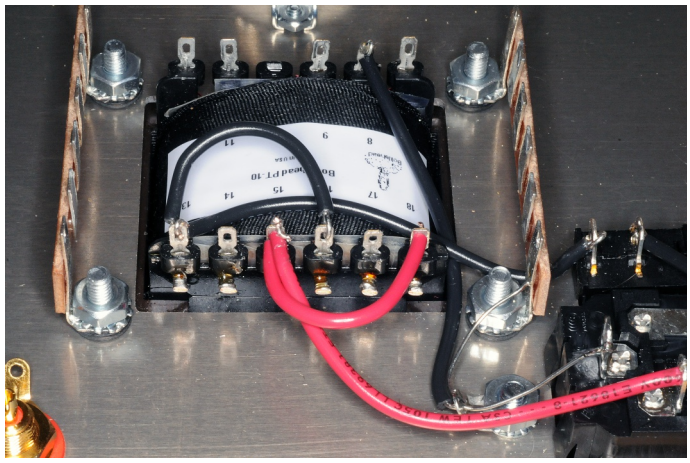
( ) Cut a 3½" (89mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach one end to terminal 13 of the PT-10 power transformer. Attach and solder the other end to the lug of the power switch closer to the center of the chassis.



( ) Cut a 2¼" (57mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 16 of the PT-10 power transformer. Attach and solder the other end to terminal 13 of the PT-10 power transformer.



( ) Cut a 3¾" (95mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach one end to terminal 15 of the PT-10 power transformer. Attach and solder the other end to the N tab of the IEC inlet.

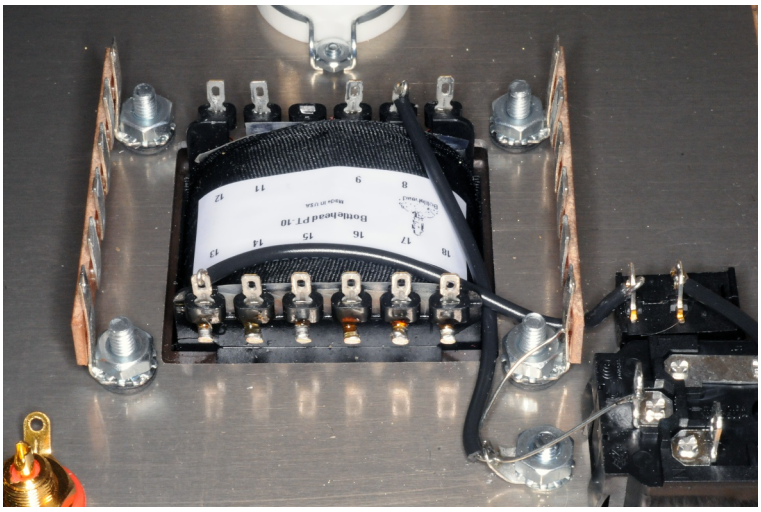


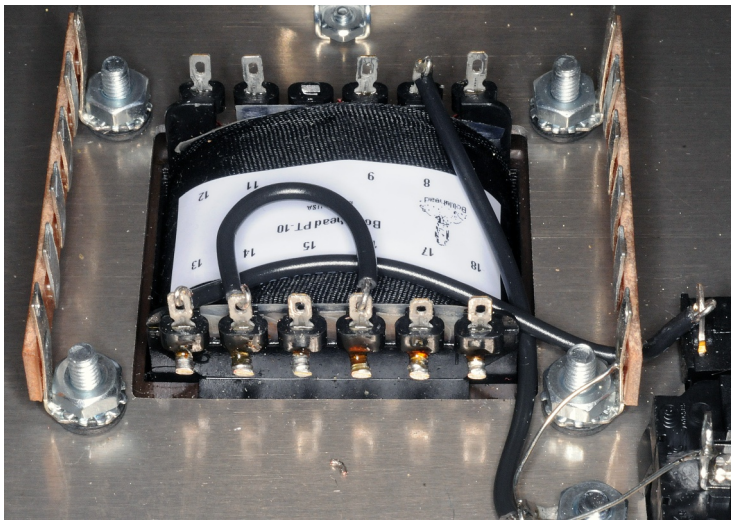
( ) Cut a 2½" (64mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 15 of the PT-10 power transformer. Attach and solder the other end to terminal 18 of the PT-10 power transformer

Continue on Page 29.

IF your voltage is GREATER *than* 210V AC *and* LESS *than* 225V AC:

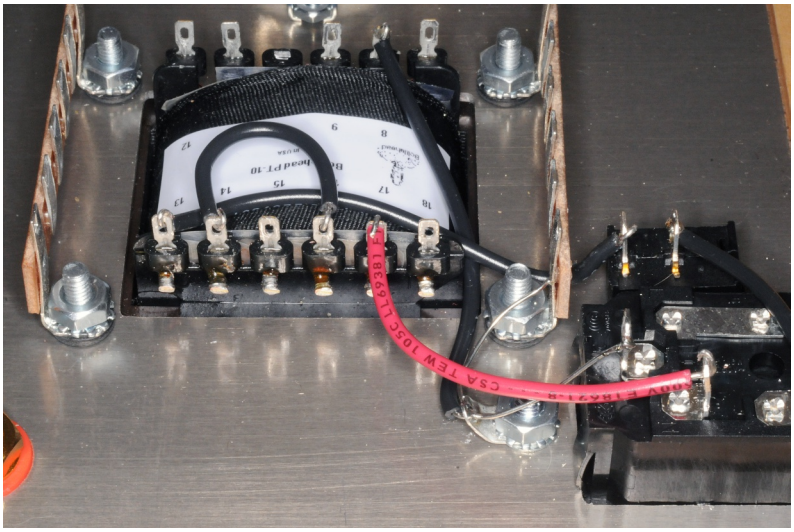
( ) Cut a 3½" (89mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 13 of the PT-10 power transformer. Attach and solder the other end to the lug of the power switch closer to the center of the chassis.





( ) Cut a 2¼" (57mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 16 of the PT-10 power transformer. Attach and solder the other end to terminal 14 of the PT-10 power transformer.

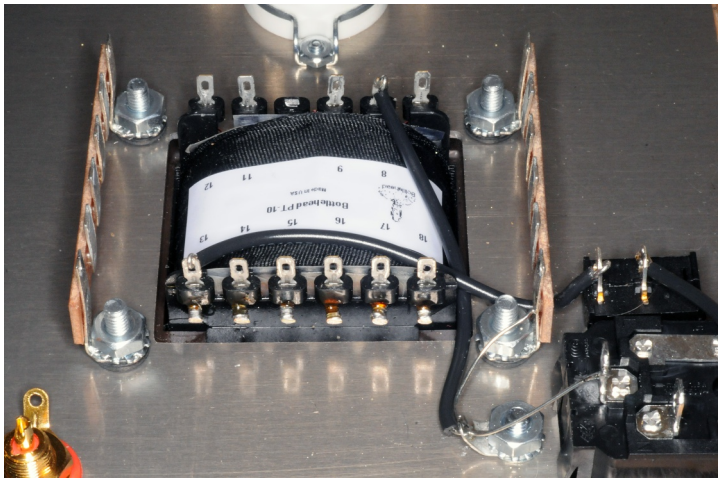
( ) Cut a 3" (76mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 17 of the PT-10 power transformer. Attach and solder the other end to the N tab of the IEC inlet.

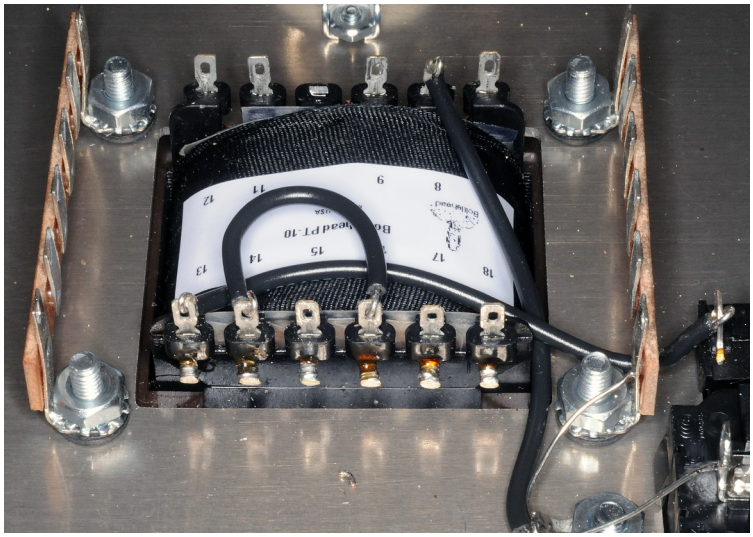


Continue on Page 29.

IF your voltage is GREATER *than* 225V AC *and* LESS *than* 235V AC:

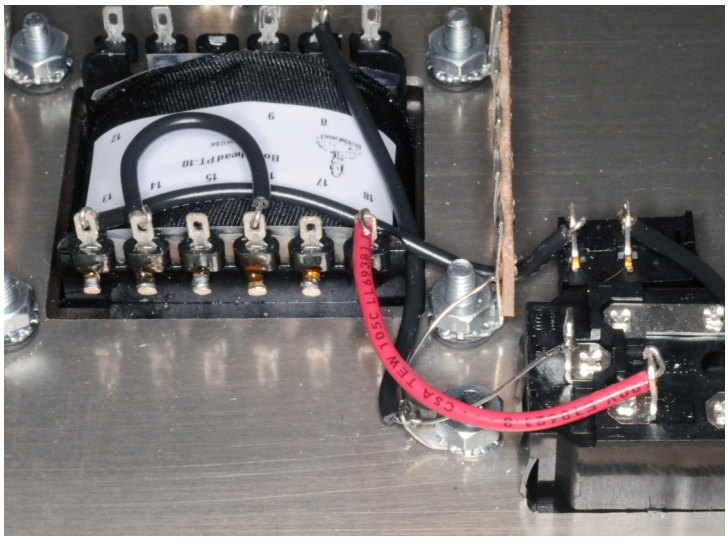
( ) Cut a 3½" (89mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 13 of the PT-10 power transformer. Attach and solder the other end to the lug of the power switch closer to the center of the chassis.





( ) Cut a 2¼" (57mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 16 of the PT-10 power transformer. Attach and solder the other end to terminal 14 of the PT-10 power transformer.

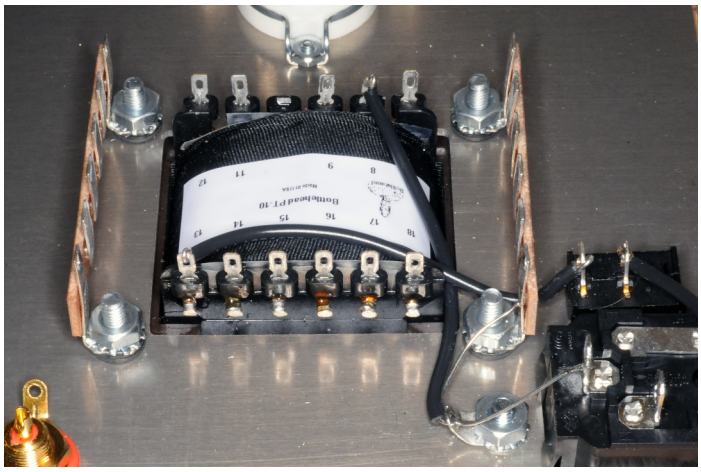
( ) Cut a 3" (76mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 18 of the PT-10 power transformer. Attach and solder the other end to the N tab of the IEC inlet.

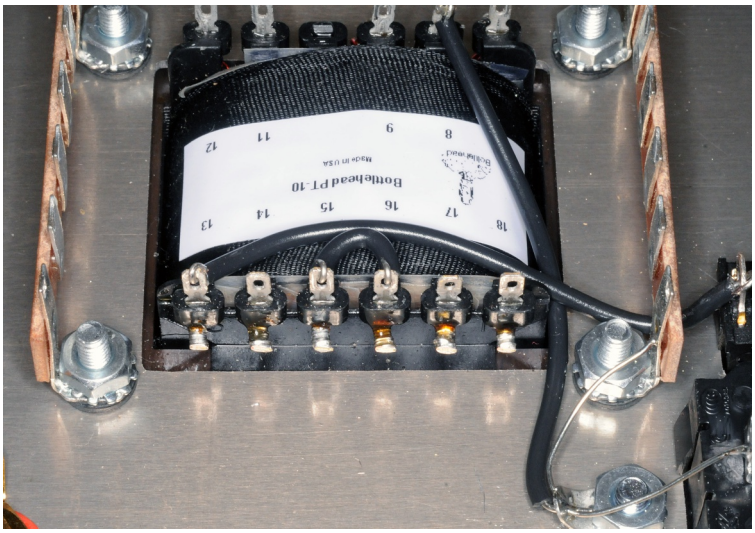


Continue on Page 29.

IF your voltage is GREATER *than* 235V AC *and* LESS *than* 245V AC:

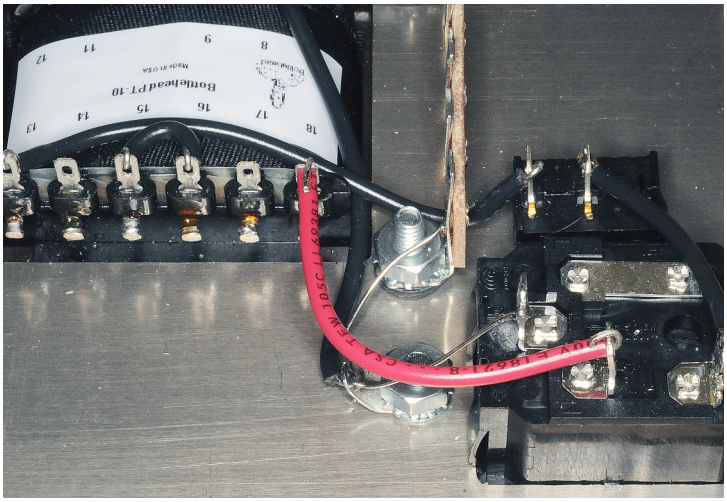
( ) Cut a 3½" (89mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solderone end to terminal 13 of the PT-10 power transformer. Attach and solder the other end to the lug of the power switch closer to the center of the chassis.





( ) Cut a 1" (25mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 16 of the PT-10 power transformer. Attach and solder the other end to terminal 15 of the PT-10 power transformer.

( ) Cut a 3" (76mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 18 of the PT-10 power transformer. Attach and solder the other end to the N tab of the IEC inlet.



Continue on Page 29.

Power Transformer Secondary Test

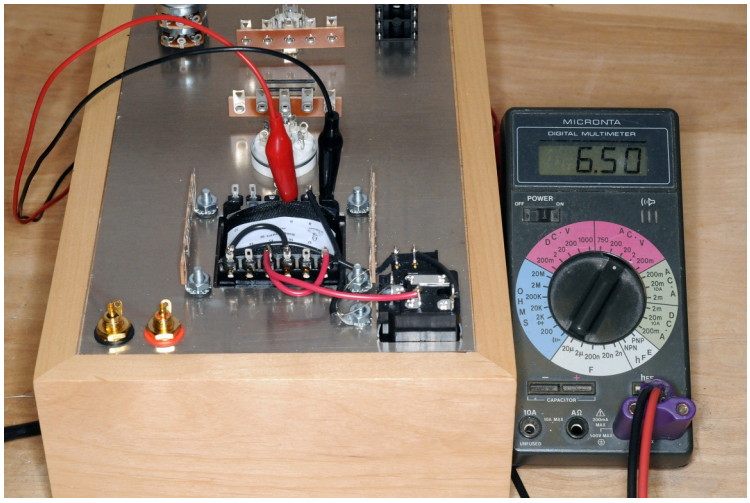
We have found over the years that it is common for the novice builder to have difficulties measuring the AC voltage of a power transformer with an inexpensive meter once the kit is assembled and running. We have incorporated a series of test procedures that will confirm proper function of the power transformer and power supply as each part of the assembly is complete. If you find a discrepancy from these voltage figures you will know that you need to examine your wiring on the most recently completed step before continuing.

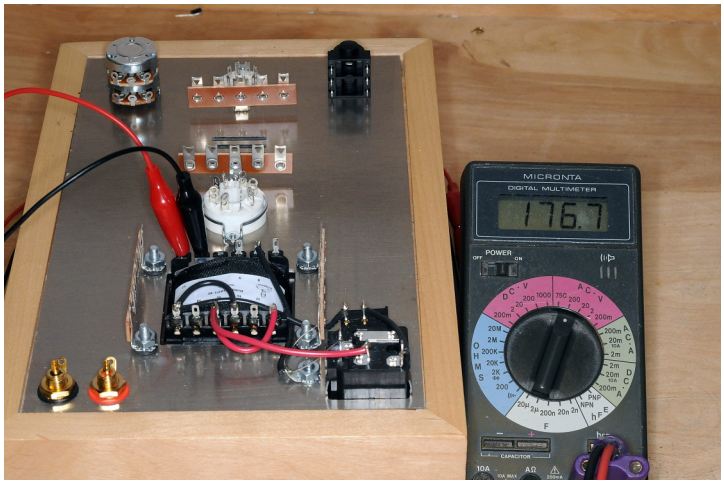
( ) Check that the power switch is in the "on" position, (white dot (or 1) side of rocker down, black (or 0) side up).. Make sure the 1A fuse is in the fuse holder. Plug the power cord into the power entry module. Do not plug the power cord into the wall outlet yet! Turn the chassis upside down.

( ) **We strongly urge you to use alligator style clip-on probe tips or test leads when testing voltages so that you do not have to hold the test leads in your hands.**

Clip the black lead of your Digital Multi Meter to power transformer terminal 7. Clip the red lead of your DMM to power transformer terminal 9. Make sure that the metal ends of the two test leads to not touch each other. Set your DMM to AC volts in the appropriate range.

( ) Do not touch the terminals on the power entry socket or power switch as they will become “hot” at this step. Now you can plug the power cord into the wall outlet. You should read 6.5V AC ± 20%. Unplug the power cord from the wall before removing the test leads, then remove the test leads.





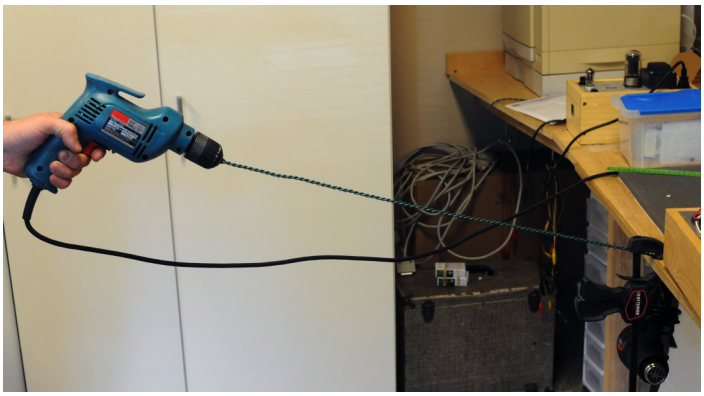
( ) Attach the red lead to terminal 12, and the black lead to terminal 11.

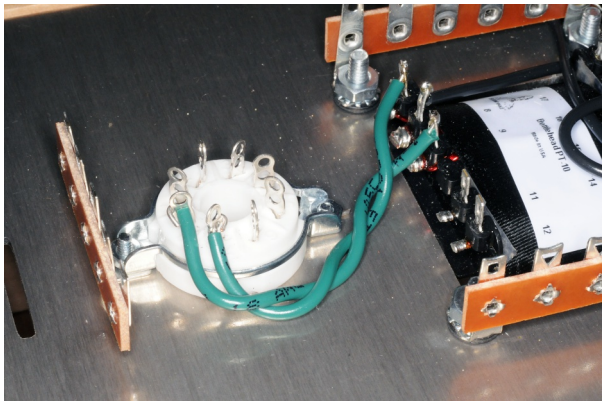
( ) Do not touch the terminals on the power entry socket or power switch as they will become “hot” at this step. Now you can plug the power cord into the wall outlet. You should read 175V AC ± 20%. Unplug the power cord from the wall before removing the test leads, then remove the test leads.

DO NOT CONTINUE until you have removed the power cord.

Heater Wiring

( ) Cut the green wire into two equal length pieces. Twist the wires together. This can be done by hand, but you will get more consistent results with the following technique. Either clamp one end of each piece to a solid work surface or have an assistant hold them in a pair of pliers. Put the other ends in a drill chuck, stretch the wire out its full length and turn the drill slowly to twist the wires together. The ideal is approximately 3 turns per inch (6 turns per 5cm).





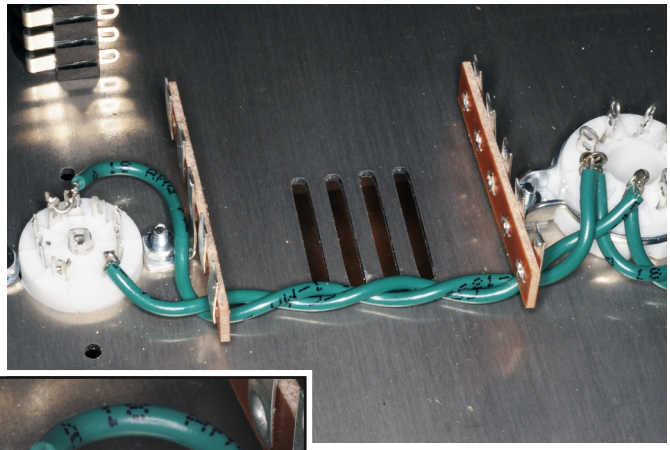
( ) Cut a 3½" (89mm) piece of green twisted pair wire. Strip all ends ¼" (7mm). Attach and solder one wire to terminal 7 of the PT-10 power transformer. Attach and solder the other wire to terminal 9 of the PT-10 power transformer. Route the wires towards the front of the octal socket on the input jack side of the chassis. Keeping the twisted wires close to the chassis, attach one wire to B7 and the other wire to B8.

Note: *The octal socket may or may not have two holes on each lug. This manual will refer to all octal connections as if there is only one hole. If you use both holes, make certain that you solder* **both** *holes when instructed to solder an octal terminal.*

( ) Cut a 6" (153mm) piece of green twisted pair wire. On one end, strip both wires ¼" (7mm).

On the other end, untwist 2" (51mm), then trim 1½" (38mm) off one wire. Strip the trimmed wire ¼" (7mm). Strip the untrimmed wire ½" (13mm).

Using the untrimmed end, attach and solder one wire to B7 and the other wire to B8.



Route the wires towards the 9-pin socket on the input jack side of the chassis. Keeping the twisted wires close to the chassis, attach and solder the trimmed wire to A9. Insert the untrimmed wire through A5 and into A4. Solder A4 and A5.

Glow Test

( ) Set the chassis on the base topside up. Insert the 6080 (or equivalent) tube into the octal socket. Insert the 12AU7 (or equivalent) tube into the 9 pin socket. Make sure the fuse is in the fuse holder. Plug the power cable into the power inlet, then plug the power cable into the wall outlet. Turn on the power switch and check both tubes for glow, making certain both halves of the 12AU7 glow. Please note that tube glow can be hard to see in bright light.

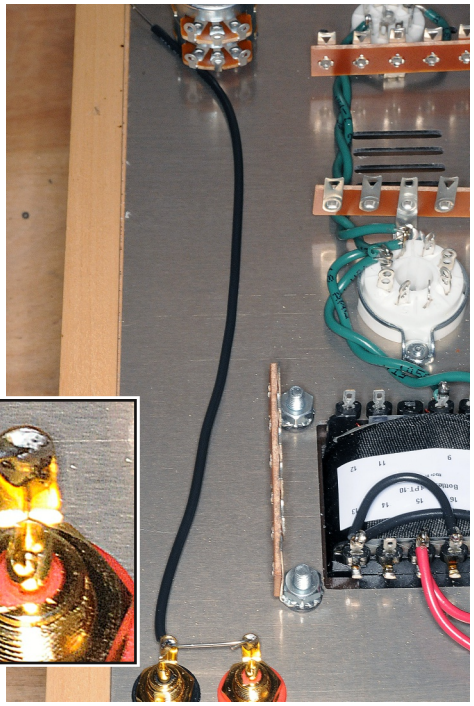
( ) Turn off the switch and remove the power cable from the wall and the power inlet to resume wiring.

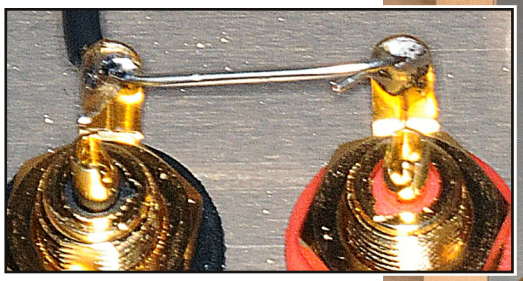
Remove the tubes from their sockets.

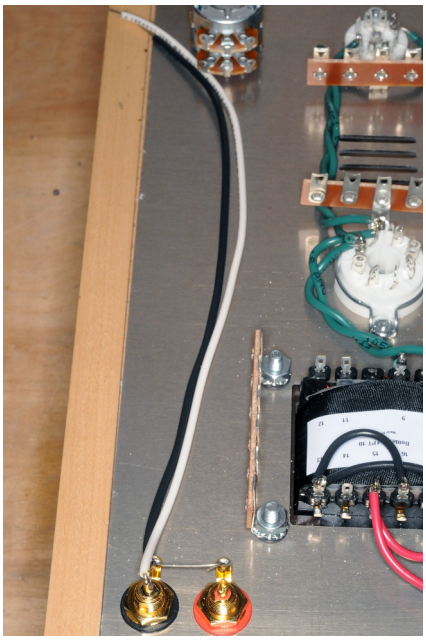
If neither tube glowed, check the solder joints of the green wires between the octal socket and the power transformer. If only the 12AU7 did not glow, the problem lies in a solder joint on the wires between the 9-pin socket and the octal socket. Resolder and recheck until both tubes glow.

Input Wiring

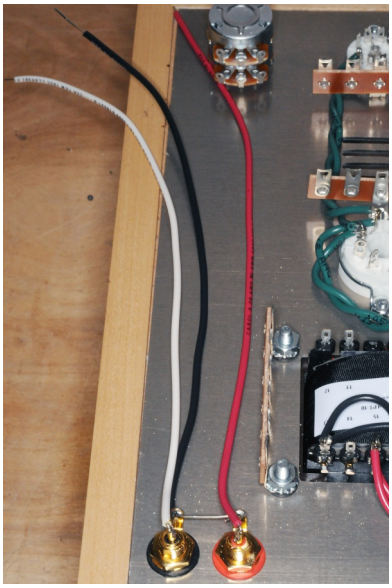
( ) Cut a 10" (254mm) piece of black solid core wire. Strip one end 1" (25mm); strip the other end ½" (13mm). Insert the 1" through the solder tab of the black RCA jack and into the solder tab of the red RCA jack. Solder the solder tabs on both RCA jacks.



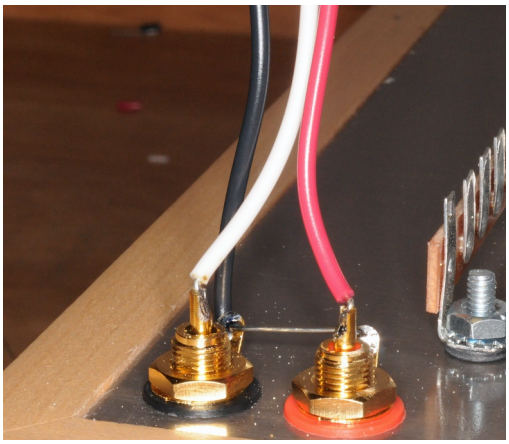




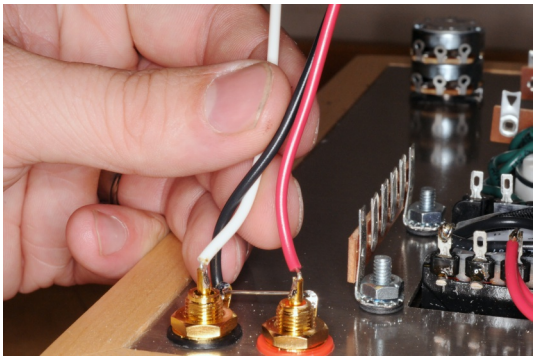
( ) Cut a 9½" (242mm) piece of white solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to the solder cup of the black RCA jack.



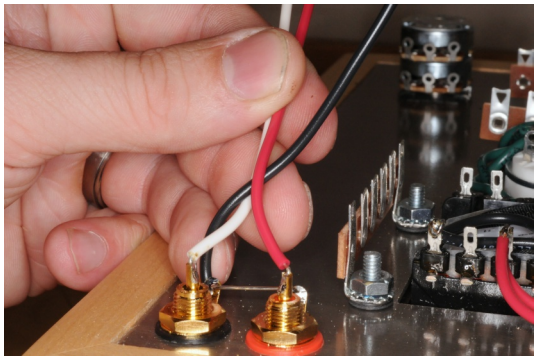
( ) Cut a 9½" (242mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to the solder cup of the red RCA jack.



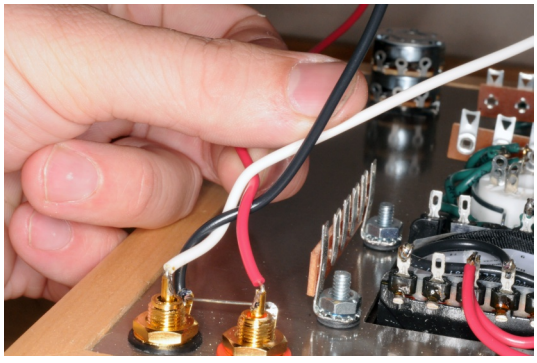
( ) Braid the input wiring. Begin by putting the black wire on the left, the white wire in the middle, and the red wire on the right.



( ) Pass the black wire over the white wire so it sits between the white and red wires.

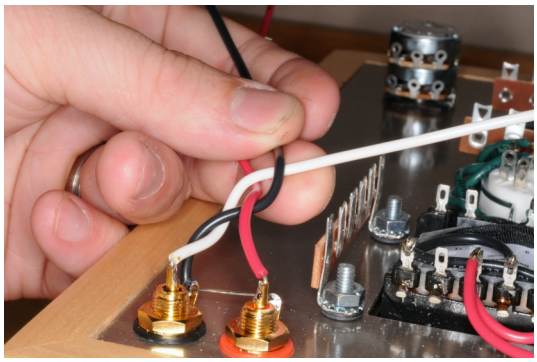


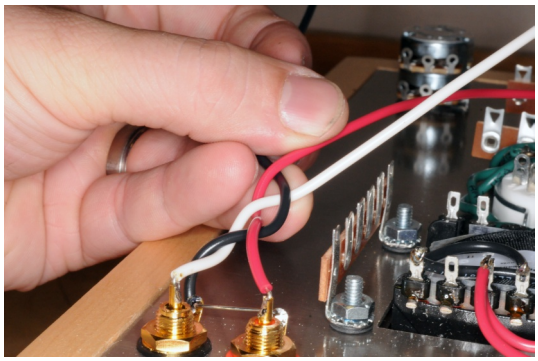
( ) Pass the red wire over black wire so it sits between the white and black wires.



( ) Pass the white wire over the red wire so it sits between the red and black wires.

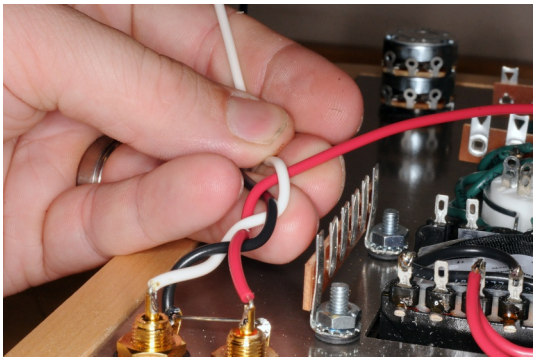
( ) Pass the black wire over the white wire so it sits between the red and white wires.

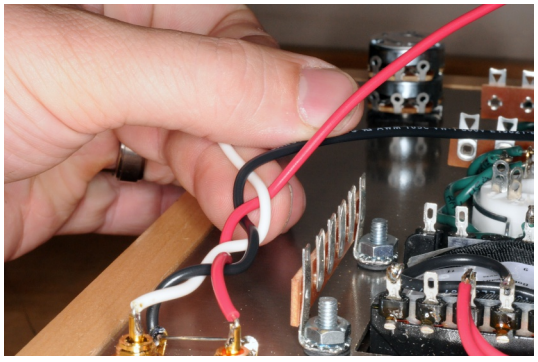




( ) Pass the red wire over black wire so it sits between the black and white wires.

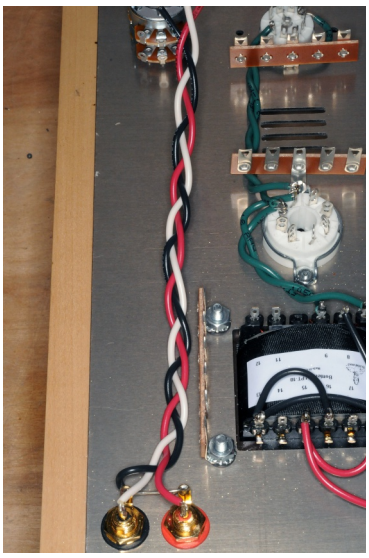
( ) Pass the white wire over the red wire so it sits between the black and red wires.

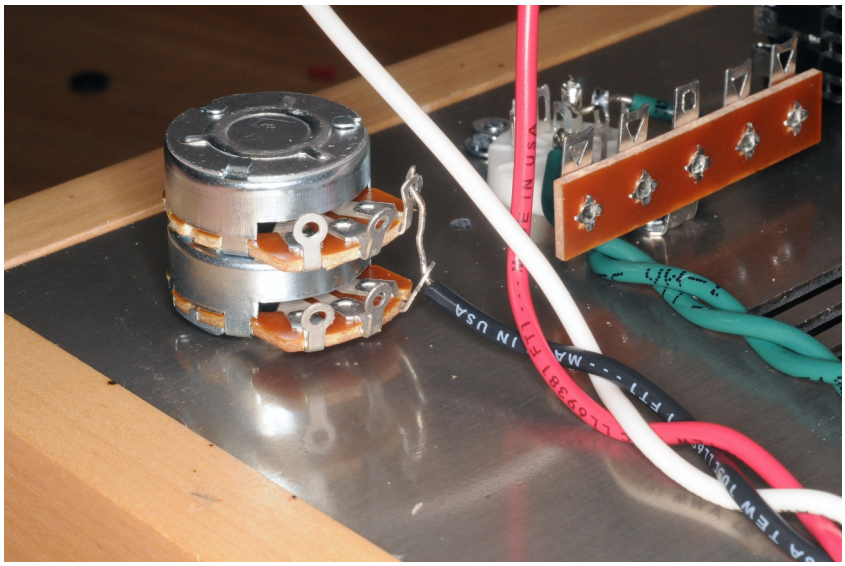




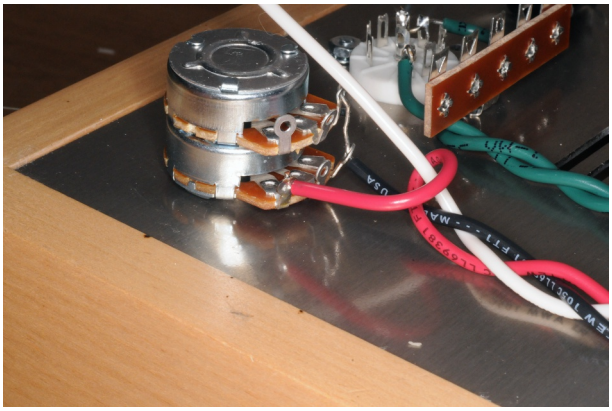
( ) Pass the black wire over the white wire so it sits between the white and red wires.

( ) Continue this process until the full length of all three wires are braided together.



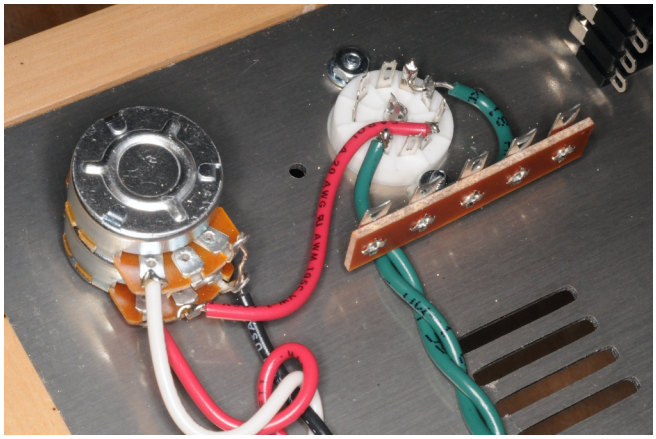


( ) Insert the black wire though the lower lug of the volume potentiometer closest to the 9-pin socket. Attach the end of the wire to the upper lug of the volume potentiometer closest to the 9-pin socket.

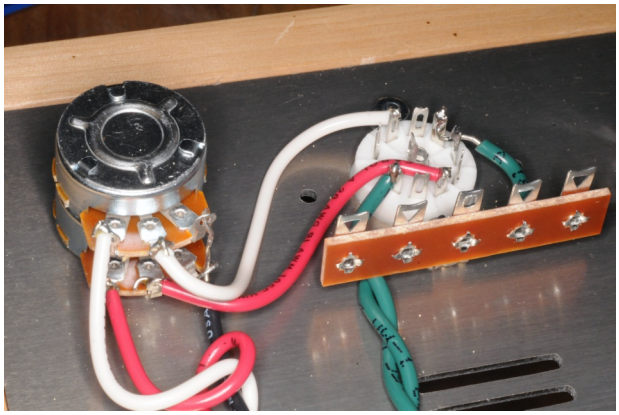


( ) Attach and solder the red wire to the lower lug of the volume potentiometer furthest from the 9-pin socket.

( ) Attach and solder the white wire to the upper lug of the volume potentiometer furthest from the 9-pin socket.

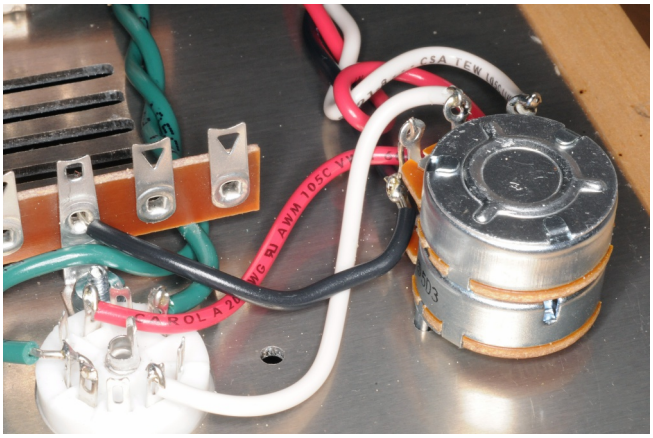


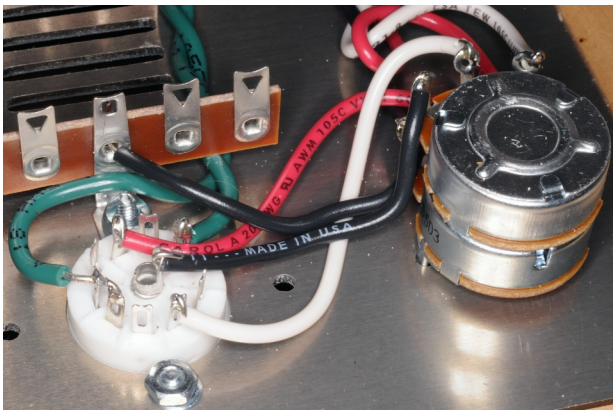
( ) Cut a 2¾" (70mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to the center lug of the lower row of the volume potentiometer. Pass the free end through the gap in the pins of the 9-pin socket as shown, then attach and solder the other end to A7.



( ) Cut a 3½" (89mm) piece of white solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to the center lug of the upper row of the volume potentiometer. Attach and solder the other end to A2.

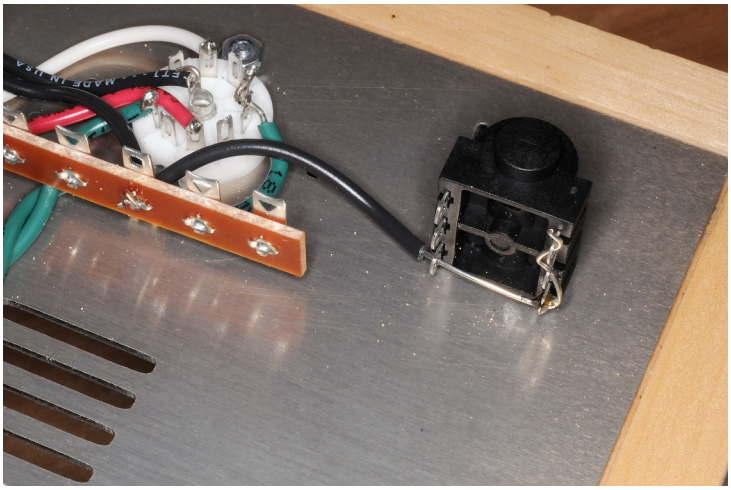
( ) Cut a 2¼" (57mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to the lower lug of the volume potentiometer closest to the 9-pin socket. Attach the other end to 3L.





( ) Cut a 2½" (64mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to the upper lug of the volume potentiometer closest to the 9-pin socket. Attach the other end to the center pin of the 9-pin socket.

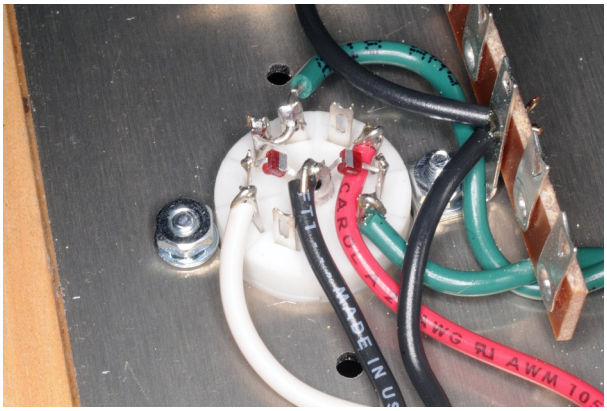
( ) Cut a 3¾" (95mm) piece of black solid core wire. Strip one end ¼" (7mm), strip the other end 1½" (38mm). Attach and solder the ¼" end to 3L. Insert the other end through both lower lugs of the headphone jack, going through the one closest to the 9-pin socket first. After passing through the second lower lug, route the wire up to the middle lug furthest from the 9-pin socket and pull the wire back through the lug. Then route the wire up to the lug directly above and attach the end. Solder the oower lug furthest from the 9-pin socket. Do not solder any of the other headphone jack connections.



9-pin Socket Wiring

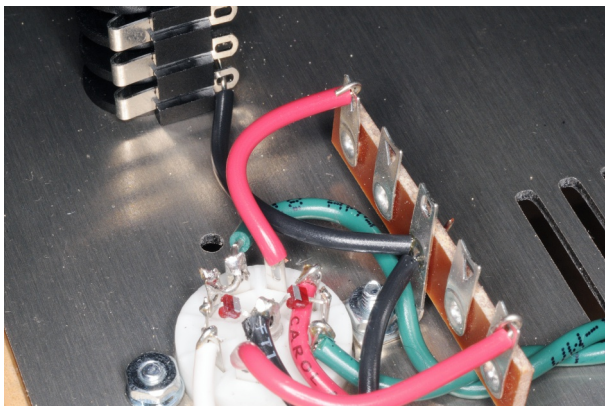
( ) Attach the banded lead of an HLMP-6000 LED to the center pin of the 9 pin socket.
MAKE **ABSOLUTELY** certain that you have attached the banded lead, and that the flat side of the LED body faces up away from the socket as shown. Leave some slack in the LED lead to allow for the flexing that occurs when a tube is inserted into the socket.
Attach and solder the un-banded lead to A3.

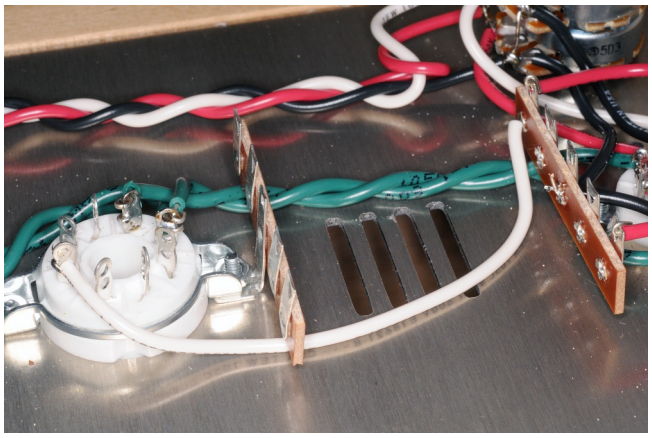
( ) Attach the banded lead of an HLMP-6000 LED to the center pin of the 9 pin socket.
MAKE **ABSOLUTELY** certain that you have attached the banded lead, and that the flat side of the LED body faces up away from the socket as shown. Solder the center pin of the 9-pin socket. Leave some slack in the LED lead to allow for the flexing that occurs when a tube is inserted into the socket.
Attach and solder the un-banded lead to A8.



( ) Cut a 2" (51mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to A1. Attach the other end to 5U.

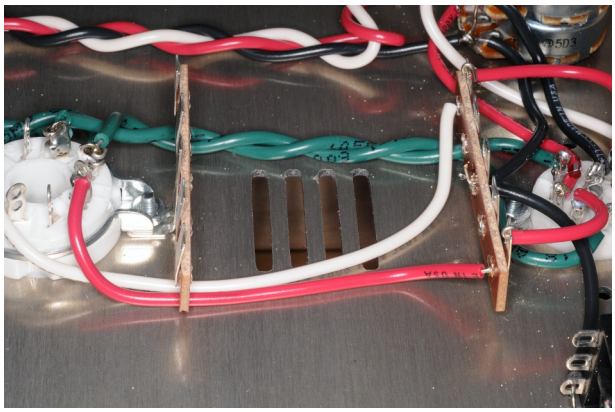
( ) Cut a 1½" (38mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to A6. Attach the other end to 1U.

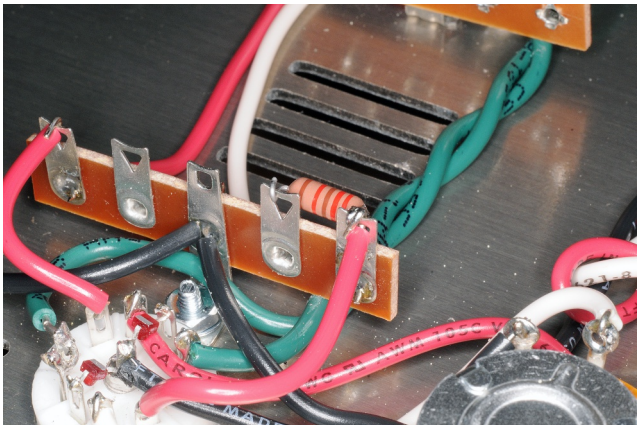




( ) Cut a 5" (127mm) piece of white solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to 5L. Attach and solder the other end to B4.

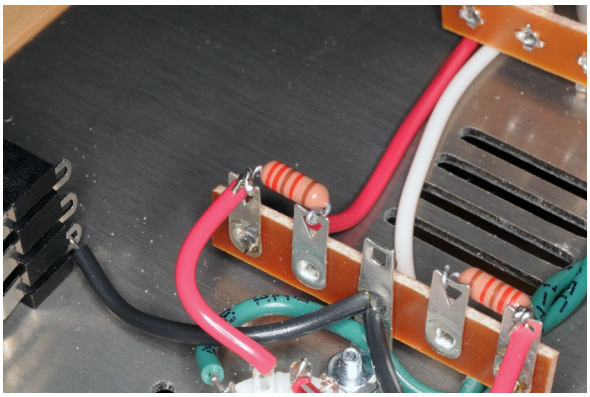
( ) Cut a 4" (101mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to 1L. Attach and solder the other end to B1.





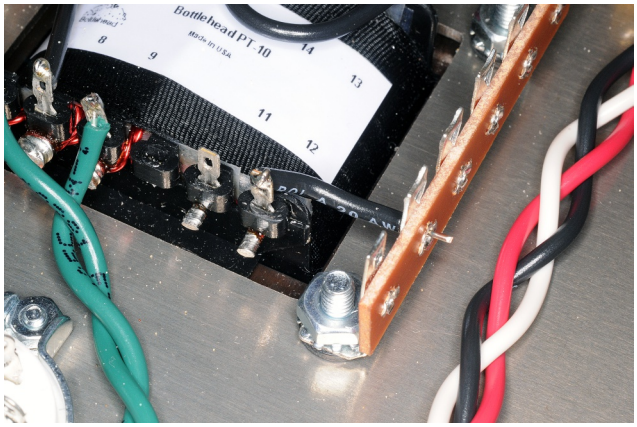
( ) Attach and solder one lead of a 22.1KΩ ½W resistor (red, red, brown, red, brown) to 4U. Attach and solder the other lead to 5U.

( ) Attach and solder one lead of a 22.1KΩ resistor ½W (red, red, brown, red, brown) to 1U. Attach and solder the other lead to 2U.



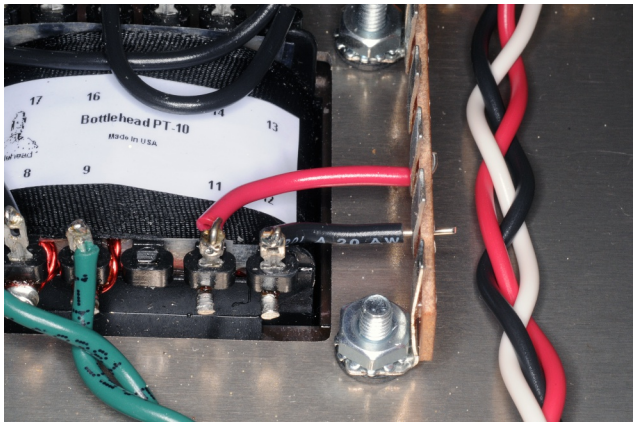
ATTENTION:

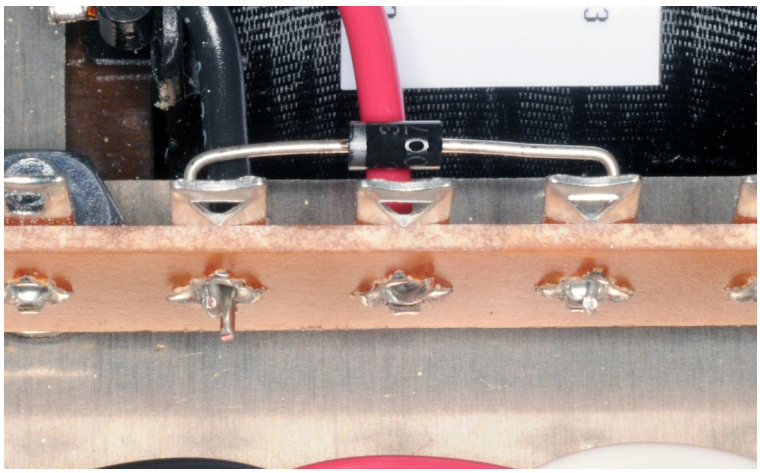
Failure to follow these instructions **EXACTLY** will damage your power transformer. A replacement power transformer will cost you $100 plus shipping (note that this cost may rise with metal costs). Wire lengths, component spacing, and component orientation MATTER! These instructions are here for your benefit, so follow them.



( ) Cut a 1¼" (32mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 12 on the PT-10 power transformer. Attach the other end to 18L.

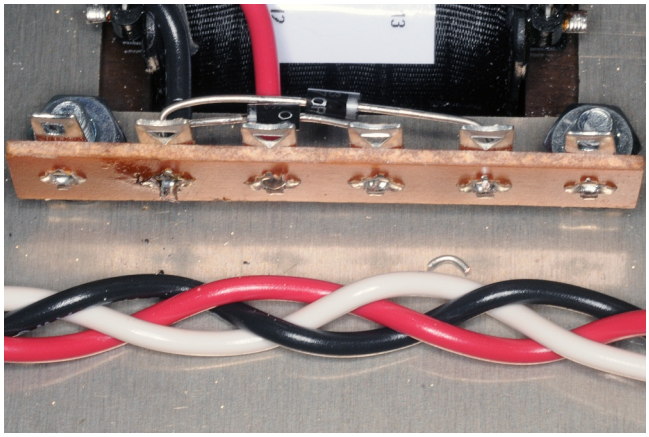
( ) Cut a 1¾" (45mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to terminal 11 on the PT-10 power transformer. Attach the other end to 19L.

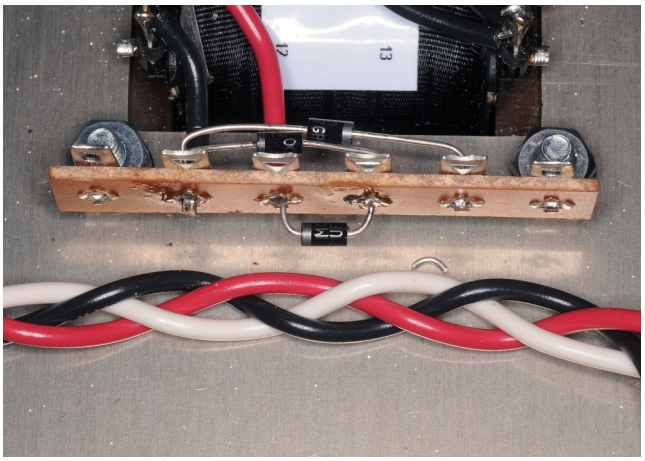




( ) Bend the leads of a UF4007 rectifier ⅜" (10mm) from the body. Attach the lead of the banded end to 18L. Attach the lead of the un-banded end to 20L.

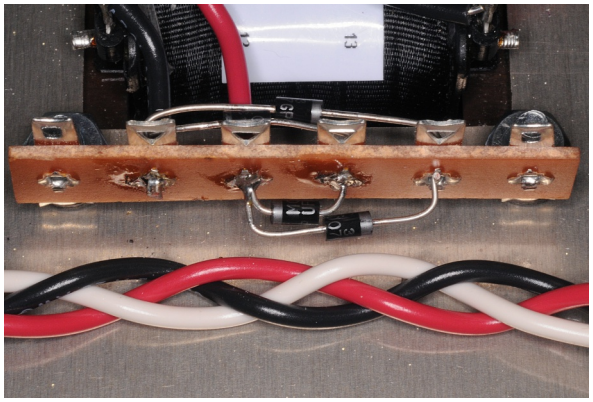
( ) Bend the leads of a UF4007 rectifier ½" (13mm) from the body. Attach the lead of the banded end to 21L. Attach the lead of the un-banded end to 18L. Make sure the body of the rectifier sits just behind the previously mounted rectifier, as shown.
Solder 18L.

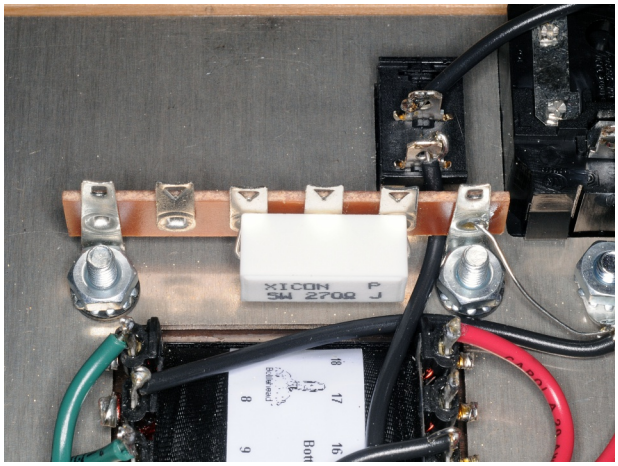




( ) Bend the leads of a UF4007 rectifier at the body and trim the leads so ¼" (7mm) remains of each lead past the bend. Attach the lead of the banded end to 19L. Attach the lead of the un-banded end to 20L.
Solder 20L.

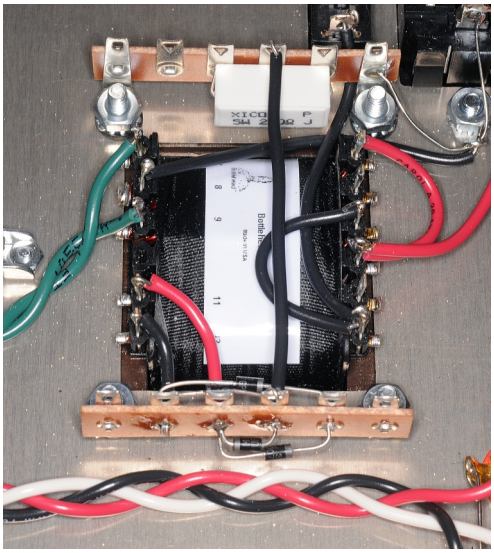
( ) Bend the leads of a UF4007 rectifier ⅝" (16mm) from the body and trim the leads so ¼" (7mm) remains of each lead past the bend. Attach the lead of the banded end to 21L. Attach the lead of the un-banded end to 19L. Make sure the body of the rectifier sits just behind the previously mounted rectifier, as shown.
Solder 19L and 21L.

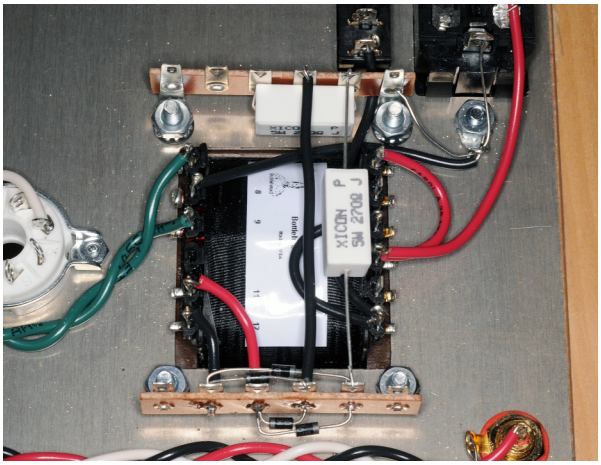




( ) Attach one lead of a 270Ω 5W wirewound resistor to 13L. Attach and solder the other lead to 15L.

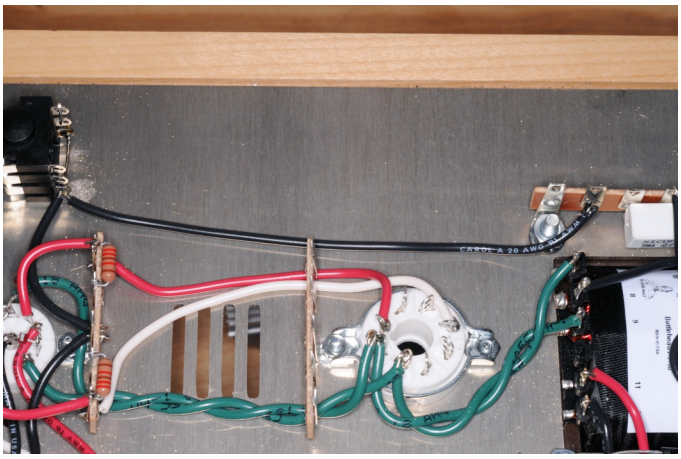
( ) Cut a 3¼" (83mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach one end to 14U. Attach the other end to 20U.

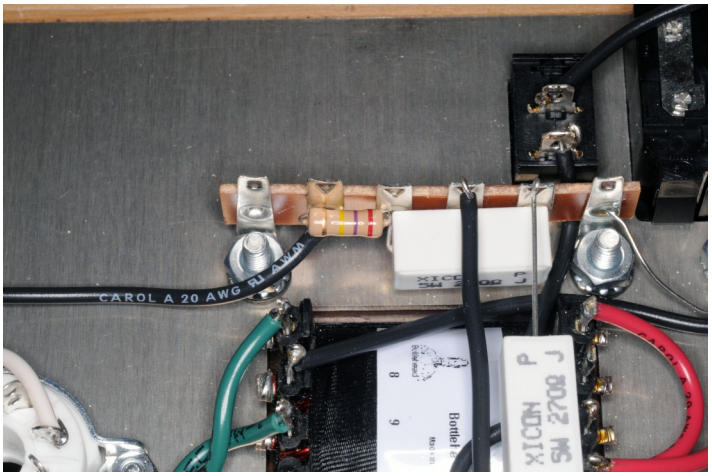




( ) Attach one lead of a 270Ω 5W wirewound resistor to 21U. Attach the other lead to 15U.

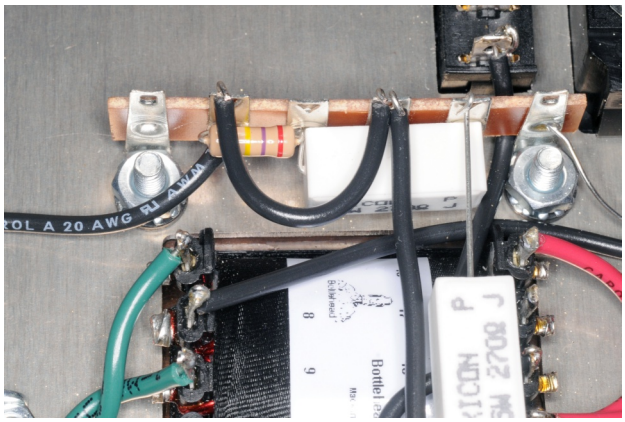
( ) Cut a 6" (153mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach one end to 12L. Attach and solder the other end to the lower lug of the headphone jack closest to the 9-pin socket.

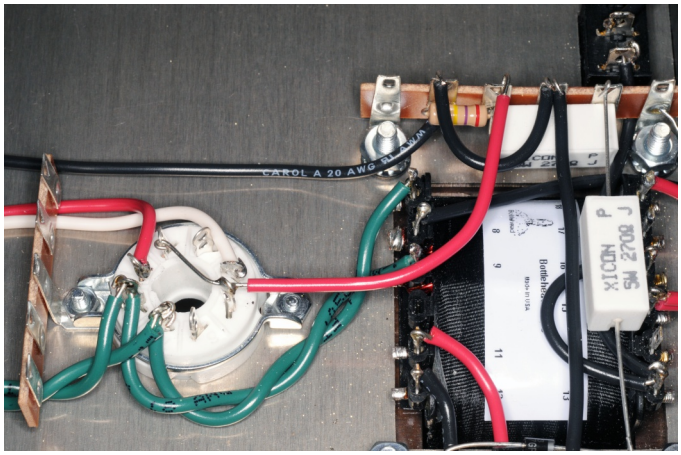




( ) Attach and solder one lead of a 270KΩ 1W (red, violet, yellow, gold) resistor to 12L. Attach and solder the other lead to 13L.

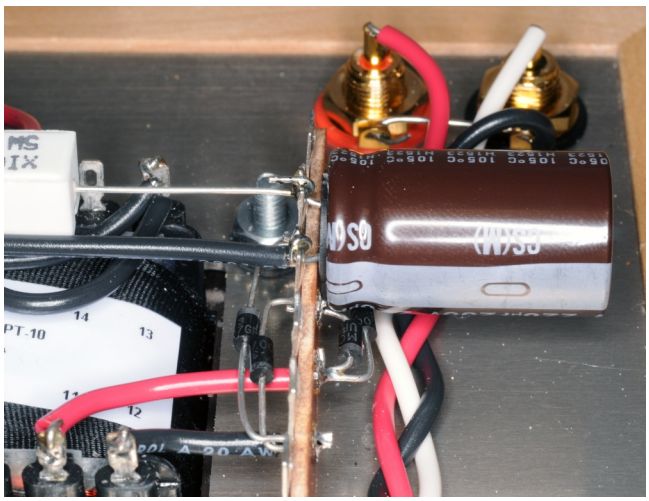
( ) Cut a 2" (51mm) piece of black solid core wire. Strip both ends ¼" (7mm). Attach one end to 12U. Attach the other end to 14U.

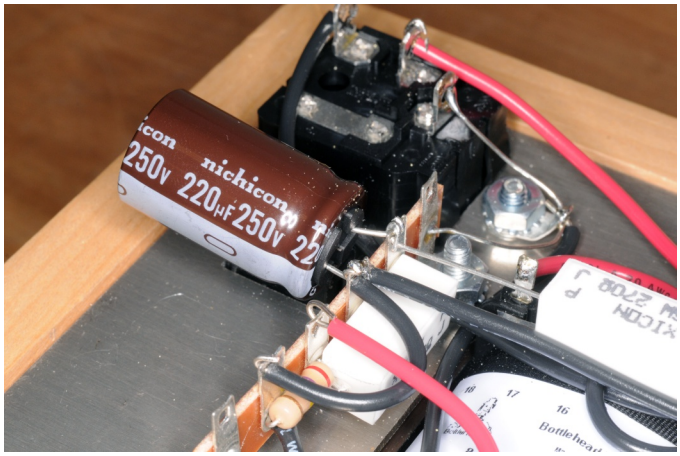




( ) Cut a 4" (101mm) piece of red solid core wire. Strip one end ¼" (7mm). Strip the other end 1" (25mm). Attach the ¼" end to 13U. Insert the 1" end through B5, then attach to B2. Solder B5.

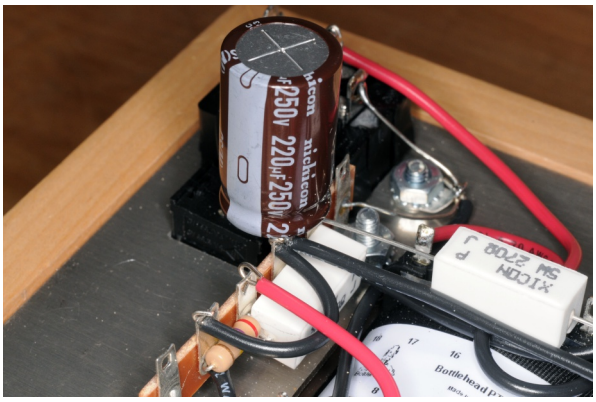
( ) Attach the banded lead of a 220µF 250V capacitor to 20U. Attach the un-banded lead to 21U. Confirm that the negative marked stripe of the capacitor faces the front of the chassis, as shown, then solder both 20U and 21U.





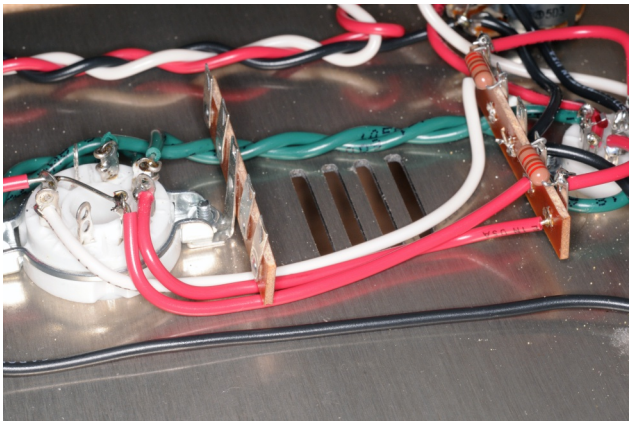
( ) Insert the banded lead of a 220µF 250V capacitor into 14U. Insert the un-banded lead into 15U, making sure to leave about ¼" (7mm) of space between the body of the capacitor and the terminal strip. Confirm that the negative marked stripe of the capacitor faces the front of the chassis, as shown, then firmly attach the leads and solder both 14U and 15U.

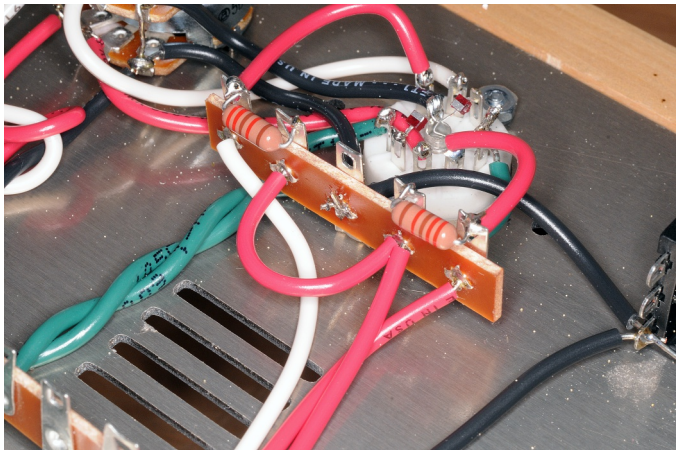
( ) Bend the leads so the capacitor sits "up" as shown.



( ) Attach the banded lead of a 220µF 250V capacitor to 12U. Attach the un-banded lead to 13U. Confirm that the negative marked stripe of the capacitor faces the front of the chassis, as shown, then solder both 12U and 13U.

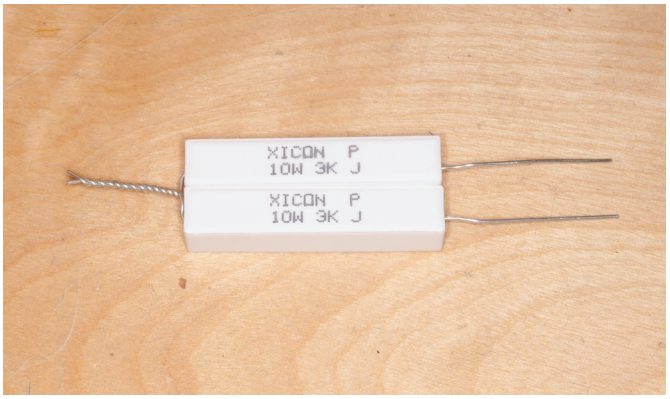
( ) Cut a 4" (101mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach one end to 2L. Attach and solder the other end to B2.

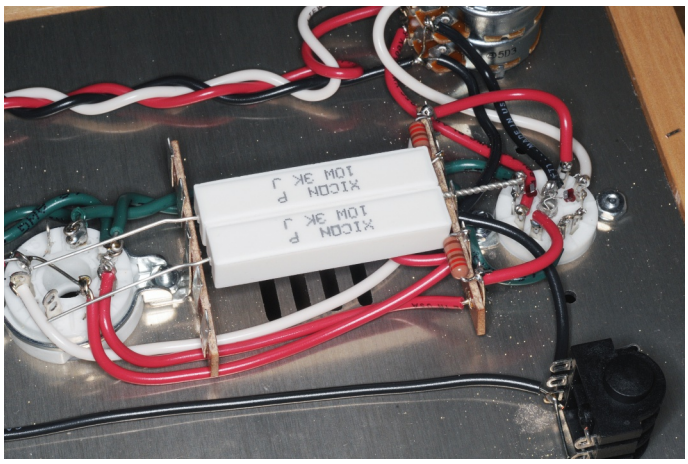




( ) Cut a 2" (51mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to 2L. Attach and solder the other end to 4L.

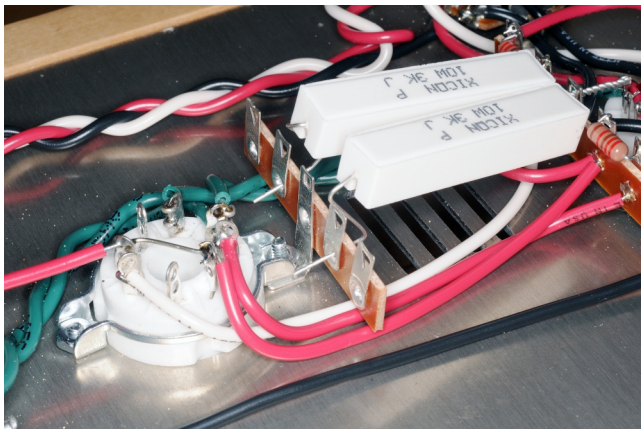
( ) Put the two 3K 10W wirewound resistors next to each other and twist the leads together at one end.

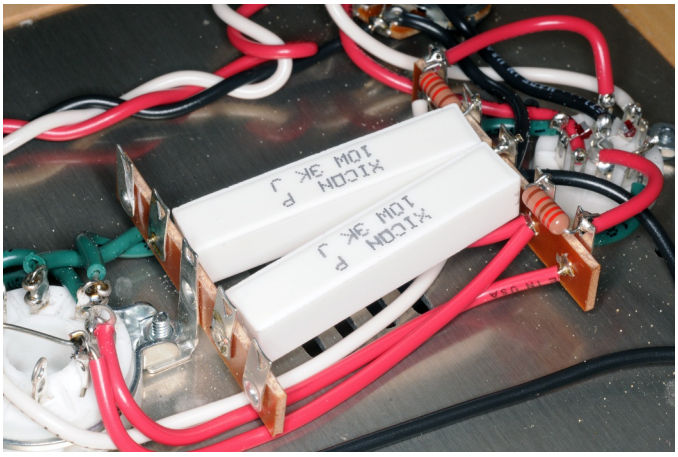




( ) Insert the twisted leads of the 3K 10W wirewound resistors through 3U.

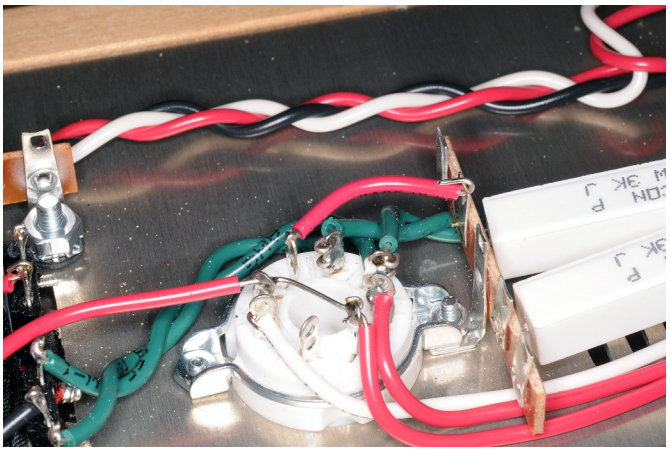
( ) Insert the untwisted lead of one of the 3K 10W wirewound resistors into 7L. Insert the other lead into 9L.

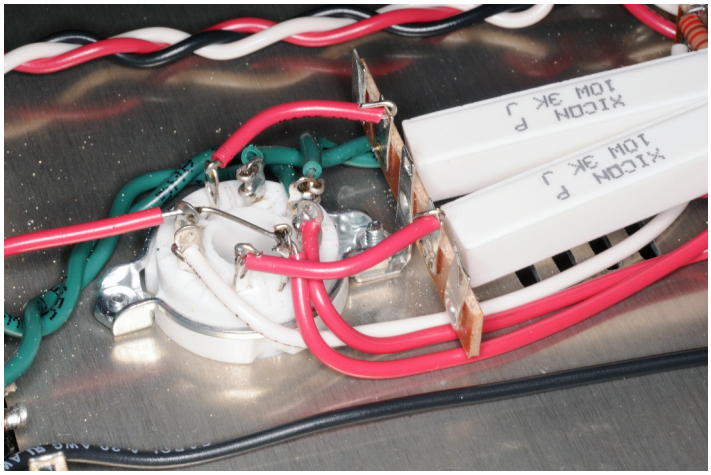




( ) Gently pull the leads inserted into 7L and 9L taught and crimp them into place on their terminals. Crimp the twisted wires to 3U, then solder 3U, 7L, and 9L.

( ) Cut a 1½" (38mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to B6. Attach the other end to 9U.

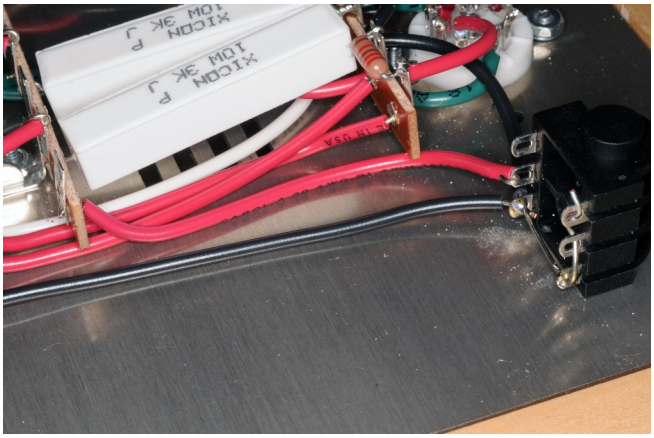


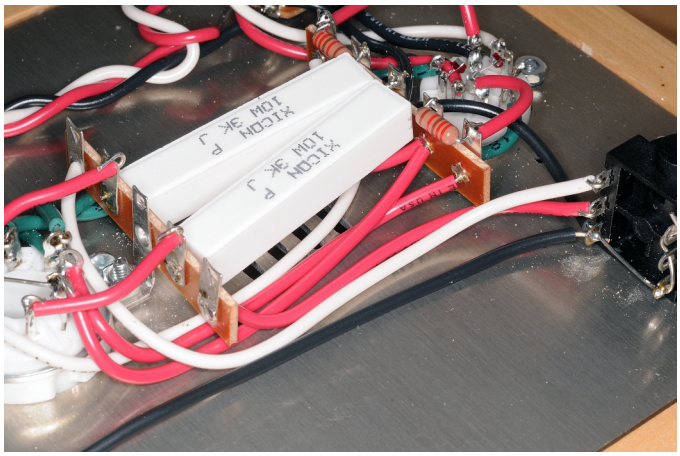


( ) Cut a 1½" (38mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to B3. Attach the other end to 7U.

Output Wiring

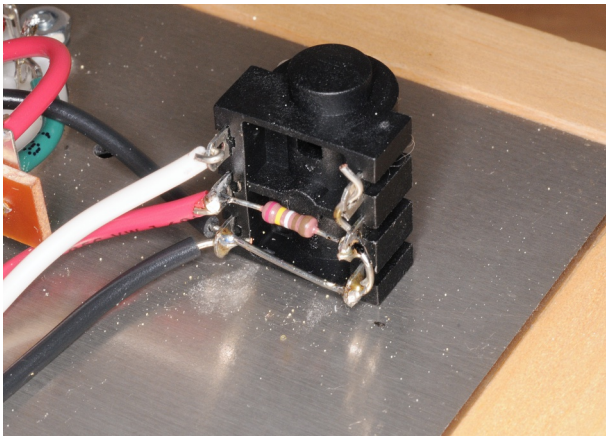
( ) Cut a 3½" (89mm) piece of red solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to 6L. Attach the other end to the middle lug of the headphone jack closest to the 9-pin socket.

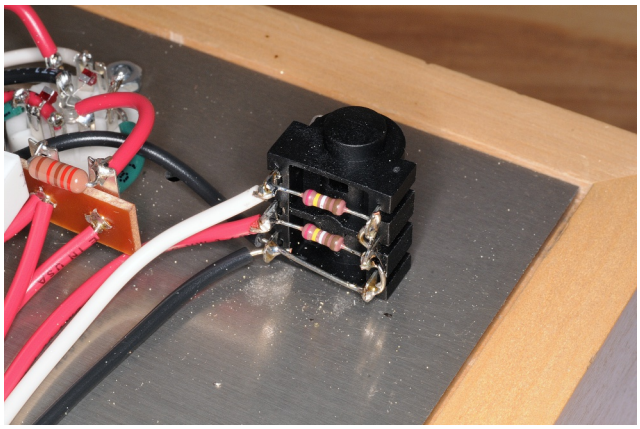




( ) Cut a 5½" (140mm) piece of white solid core wire. Strip both ends ¼" (7mm). Attach and solder one end to 10L. Attach the other end to the upper lug of the headphone jack closest to the 9-pin socket.

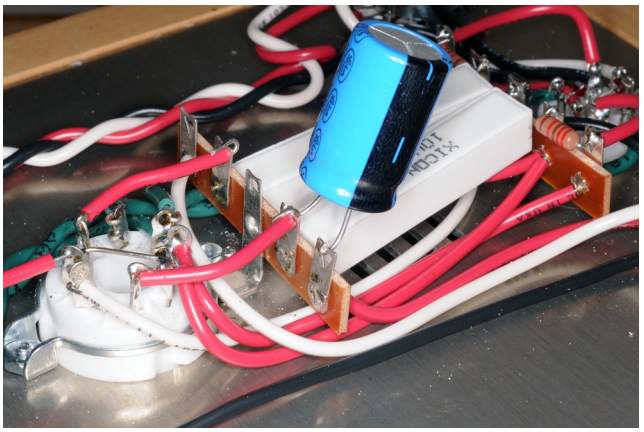
( ) Attach and solder one lead of a 2.49KΩ resistor (red, yellow, white, brown, brown) to the middle lug of the headphone jack closest to the 9-pin socket. Attach and solder the other lead to the middle lug of the headphone jack furthest from the 9-pin socket.

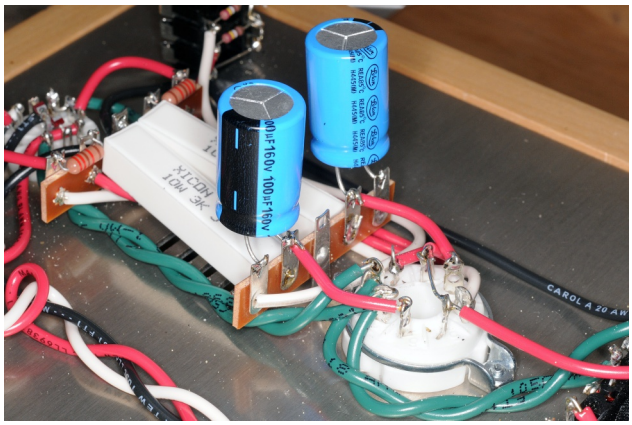




( ) Attach and solder one lead of a 2.49KΩ resistor (red, yellow, white, brown, brown) to the upper lug of the headphone jack closest to the 9-pin socket. Attach and solder the other lead to the upper lug of the headphone jack furthest from the 9-pin socket.

( ) Insert the banded lead of a 100µF 160V capacitor into 6U. Attach the un-banded lead into 7U, making sure to leave about ½" (13mm) of space between the body of the capacitor and the terminal strip. Confirm that the negative marked stripe of the capacitor faces the left side of the chassis, as shown, then firmly attach the leads and solder both 6U and 7U.

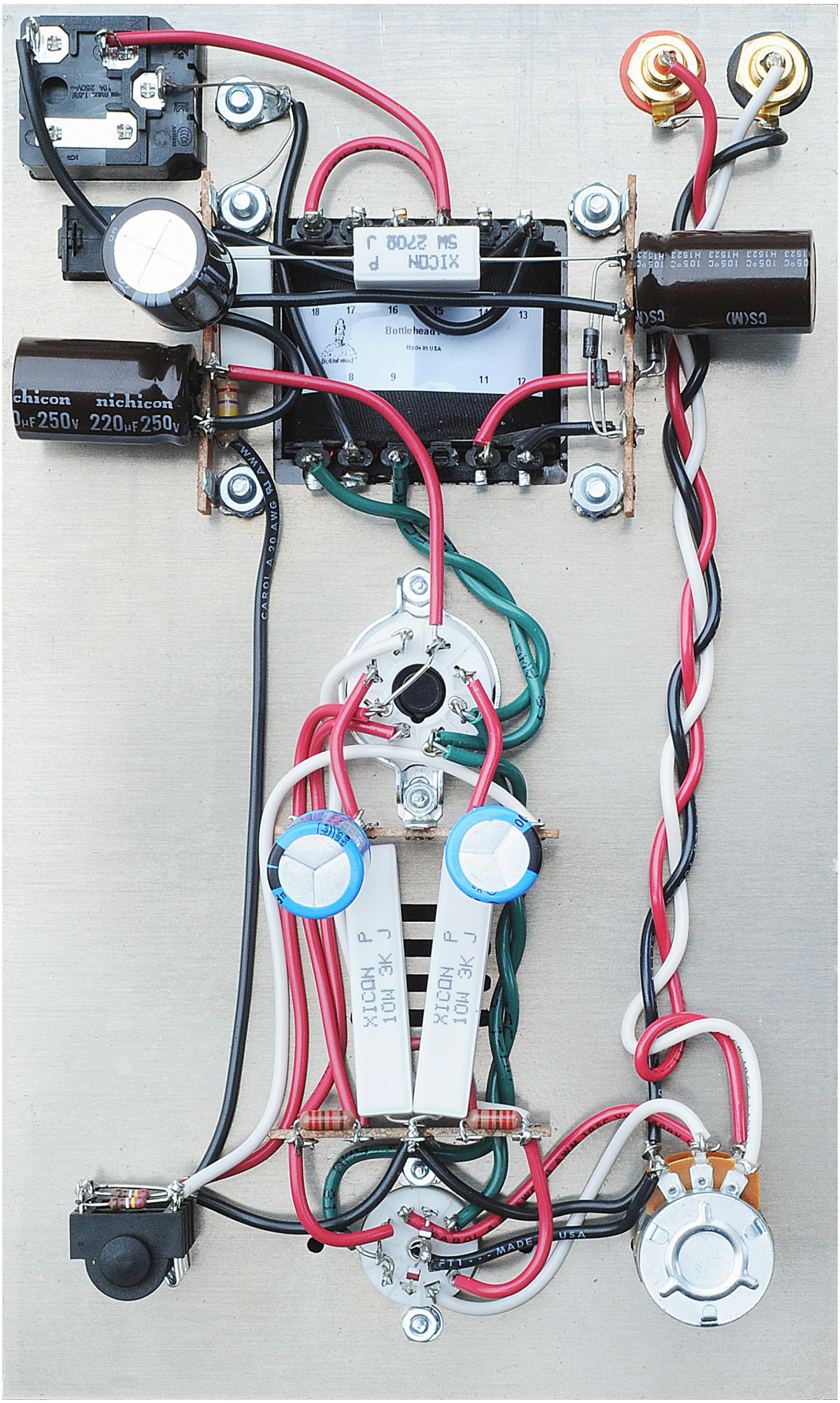




( ) Insert the banded lead of a 100µF 160V capacitor into 10U. Attach the un-banded lead into 9U, making sure to leave about ½" (13mm) of space between the body of the capacitor and the terminal strip. Confirm that the negative marked stripe of the capacitor faces the right side of the chassis, as shown, then firmly attach the leads and solder both 9U and 10U.

This completes the assembly of the Crack OTL headphone amplifier. ***Before continuing***, turn the chassis over and give a good shake to ensure no trimmed leads are still present. Carefully inspect **every** joint to make sure they are all soldered and that the components and wires specified in the manual are connected properly.

The Completed Crack OTL Headphone Amplifier



Resistance Check
Once you have completed a visual inspection of the circuit, the next step is to perform a resistance check of the circuit. This will help to assure that parts have been connected to the proper terminals and soldered properly before any voltage is applied to the circuit.

( ) Attach the negative lead (typically black) of a volt-ohm meter to the ground buss at terminal 12U. Use of a clip lead to connect the black test lead to the ground buss will free one hand, making testing much easier and safer. Using the positive lead (typically red) of the volt-ohm meter, check the resistance of the following terminals. Before you begin, put your red lead on the ground tab next to the power transformer and see what your meter reads (most likely a fraction of an ohm); consider any readings you get near this value as being 0Ω.

The term K denotes x1000, and the term Ω denotes ohms, so 1KΩ equals 1000Ω. 1MΩ equals 1,000,000Ω. **Not all meters read exactly the same in certain conditions***—the meter we use on the prototype is very sensitive in the higher resistance ranges. Where we have published a high resistance reading, your meter may instead read infinity. Also, the values signified with a * are going to vary from ohmmeter to ohmmeter because these terminals are connected to the filter capacitors, which try to charge themselves off the battery in the meter, causing a fluctuating reading. If the circuit is connected properly these readings will wander in the tens or hundreds of KΩ or higher range. What you want to watch out for is a zero reading at one of these terminals, which would indicate that something is mis-wired.*

Terminal	**Resistance**
1.	*
2.	*
3.	0Ω
4.	*
5.	*
6.	0Ω
7.	2.9KΩ
8.	0Ω
9.	2.9KΩ
10.	0Ω
12.	0Ω
13.	*
14.	0Ω
20.	0Ω
22.	0Ω
B3	2.9KΩ
B6	2.9KΩ
RCA Jacks	
Center Pin	90KΩ-115KΩ
Ground tab	0Ω

If you find resistances that are not within 10%-15% of the listed value, carefully inspect the wiring connected to any terminals with the deviations.

DO NOT PROCEED

if you have not successfully passed all of your resistance checks.

If a terminal was listed as 0Ω, and measured greater than 1Ω,

DO NOT PROCEED.

If a terminal was **not** listed as 0Ω, and measured less than 1Ω,

DO NOT PROCEED.

This is both for your own safety and and the safety of the amplifier.

DO NOT APPLY VOLTAGE TO AN AMPLIFIER WITH FAULTY WIRING!!!

Voltage Check

( ) Insert the 6080 (or equivalent) tube into the octal socket.

( ) Insert the 12AU7 (or equivalent) tube into the 9 pin socket.

( ) Plug the IEC power cord into the power entry module. Turn on the power switch. Do not plug the cord into the wall yet.

( ) Turn the chassis over and reconnect the black negative lead of the volt-ohm meter to terminal 12U. Switch the meter to read DC volts (on a 400V or higher scale if your meter doesn't auto-range).

WHOA! SAFETY CHECK!

ALWAYS USE EXTREME CAUTION WHEN MAKING VOLTAGE MEASUREMENTS ON A LIVE PIECE OF ELECTRONIC GEAR.
Always wear rubber soled shoes when working on electronic gear, particularly if you are working on a concrete floor. Don't work in socks or bare feet. A circuit can be created from the live amplifier to ground through your feet.

NEVER, REPEAT, **NEVER** TOUCH THE LIVE AMPLIFIER WITH BOTH HANDS WHEN TESTING. IF YOU CREATE A CLOSED CIRCUIT THROUGH YOUR HANDS AND ARMS, THE VOLTAGE AND CURRENT CAN STOP YOUR HEART. The old timers would keep one hand in their pocket when working with live gear to avoid a fatal slip up. Also, it is a bit safer to use your right hand than your left to touch the chassis, as any current passing through your hand to the ground would be less likely to pass through your heart.

( ) When you are ready, plug the power cord into the wall, always being mindful of the live power. If the tube filaments do not glow after a few seconds, remove the power cord from the wall, and check the fuse. If it is blown, recheck your wiring one more time. Correct mis-wires, replace the fuse and try again. The following voltages have been made with an AC mains voltage of 120VAC, your voltages may vary up or down by about 10%:

Terminal	Voltage (DC)
1.	50-100V
2.	170V
3.	0V
4.	170V
5.	50-100V
6.	0V
7.	90-115V
8.	0V
9.	90-115V
10.	0V

If one, or several LEDs do not light, the problem is **NOT** the LED itself. Post you voltages on the forum and your problems will be resolved

Don’t worry if your voltages are not exactly these figures. Tube tolerance variations can change them by a few percent. If you run into any hitches, try asking for help on the Bottlehead Forum. It’s a wonderful tech support resource: http://www.bottlehead.com/smf/index.php

OK, if everything checks out, shut it down and disconnect the meter.

Turn the amplifier over and set it on the base. Connect the your source to the pair of input RCA jacks and connect your headphones to the headphone jack.

So what are you waiting for? Pump up the jams!

Bottlehead Kit General Troubleshooting Technique

The techniques described here assume that you have properly executed the resistance and voltage tests as instructed in the assembly manual. If you have not completed those tests you must go back and do them before going any further.

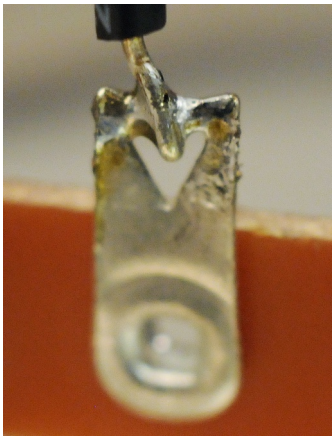
The Big Three

A kit that fails to operate properly usually has one or more of the following issues:
- Bad solder joints
- Miswired connections
- Electrolytic capacitors, rectifiers, transistors or diodes installed backwards

If you are having an issue with your kit these are the first things to double check against the instructions and photos in the assembly manual.

Be sure that you have unplugged the kit from the AC mains before proceeding with these troubleshooting measures!

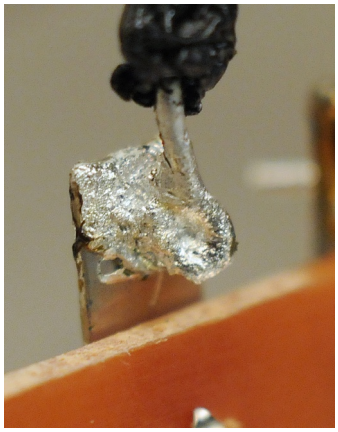
Bad solder joints



A good solder joint should encapsulate the terminal (or solder pad) and all the wires connected to the terminal. This begins with a firm mechanical connection between the wire and the terminal. The solder should be shiny in appearance and it should have flowed into the joint well enough to create fillets in the 'corners' where the wire and terminal meet.

A joint does not have enough solder if there are attached wires with no solder on them, or if wires can be pulled from the joint. It should be reheated and a tiny bit more solder should be added to the joint.

A joint has too much solder if it has run down the terminal and cooled off as a drip below the attachment point. It is best to reheat these joints and remove some excess solder with solder wick or a desoldering pump.



A cold joint is also a common error. Cold joints are where the components being soldered did not get hot enough to allow the solder to flow well enough to properly penetrate the joint. A cold joint will usually appear as a convex blob and be dull or even crystallized in appearance. It should be reheated (aka reflowed) until the solder draws into the joint and cools to a shiny finish.

When soldering always be sure to make the tip of the soldering iron contacts all terminals, pads and wires that need the solder to flow over them. Also note that these illustrations are extreme examples of soldering issues; the problems in the real world can be harder to see.

If your kit has run perfectly well for days weeks or months and suddenly cuts out or makes crackling sounds it is most likely that you have cold or completely missed solder joint that has finally worked loose through thermal cycling over time.

Miswired connections

The most common symptom of miswired connections is strange resistance and/or voltage readings. If you see a high voltage where it should be zero or vice versa it is likely that a wire has been attached to the wrong terminal or pad or some connection has been missed altogether. The other possibility is two bare wires touching that should not be touching. Untrimmed leads can also lead to this issue. The best approach here is to refer to the assembly instructions very methodically and compare your work to the written instructions and photos in the manual. Asking someone else to compare your work to the photos in the manual can be helpful. A second pair of eyes that have not been staring at the kit during its construction can often pick out an error you may have missed.

A more dramatic symptom that can sometimes be due to miswiring is seeing smoke, hearing a pop, blowing a fuse or seeing/feeling/smelling a component get very hot. If this occurs shut the kit off immediately and do not turn it back on until you have the issue resolved. Repeated powering on in this condition can ruin components.

Components installed backwards

The assembly manual will be explicit in its directions for the mounting of all electrolytic capacitors, transistors, rectifiers and diodes (including LEDs). As with miswires the common symptoms of backwards components are blown fuses, snapping or popping sounds, hot smelling parts, and bad voltages. Capacitors installed backwards may bulge and if run too long may even vent.

As with miswires the best way to resolve these issues is to refer to the assembly manual written instructions and photos and compare your work, looking for capacitor and rectifier stripes on the wrong end of the component, transistor tabs, flats or printing facing the wrong way, and the silver stripe painted on the body of the LED at the wrong end. If you find any of these components installed backwards do not turn the kit back on until you have the issue resolved. Repeated powering on in this condition can ruin components.

Other issues

LEDs don't light

One of the most common and most misunderstood symptoms posted on the Bottlehead tech support forum is LEDs not lighting. This is a symptom, not a cause. It is almost never a fault of the LED itself and you will need to investigate other parts of the circuit to fix it.

Repeat, *this is almost never a fault of the LED.*

If one or more LEDS are not lighting the best place to start is to check for bad solder joints and miswires as described above. If you reflow any joints or move any connections and the LEDs still do not light up, go back to taking resistance and voltage measurements again and note any changes. Then go back and look for more cold joints and miswires. Note here that not all LEDs in Bottlehead kits will glow at the same brightness. Some may be a little dimmer in some circuits and lowering your room lighting might help to see the glow in some situations.

Blown fuse

Stop! Don't just put another fuse in and try again. The fuse is blowing to protect the kit and is not a cause but rather a symptom. If you just keep sticking fuses in and powering up component damage can occur. It is most likely that there is a shorted connection somewhere in the circuit. First check carefully for miswires by comparing the written instructions and photos in the manual with your kit. Next check for components installed backwards, particularly electrolytic capacitors, rectifiers and transistors. If you find a fault and fix it redo your resistance checks first before you power the kit up again.

Power switch doesn't turn off when I switch it

Oops, you overheated it when you soldered it and melted it. Follow this link to order a replacement.

Noise

This is a subject worthy of its own book! Here we will attempt to cover the most common issues and their resolution.

Really loud buzz

Turn it off! You probably have a miswire or crossed wires that is putting high voltage somewhere it shouldn't be. Unplug the amp and go over your connections, comparing with the manual. Use the resistance measurements to determine if you are safe to power it up after you change what you think caused the problem. Do not plug it in again until you rectify the problem.

Buzzy hum

This is almost always due to a bad ground connection. That is often due to bad solder joints or a miswire.
However –
First you will need to confirm that the noise is not coming in from cables or gear ahead of your kit. This can be confirmed by disconnecting any cables connected to the input jack(s) and inserting a shorting plug into both the right and left jacks. An input shorting plug is simply an RCA plug that has the outer "-" shell electrically connected to the inner "+" pin. You can make one from a standard RCA plug by connecting the two together.

If the hum or buzz goes away when you use the shorting jack the kit is fine and the noise is coming from the cables or other gear ahead of the kit. If the buzz does not go away proceed with the search for a miswire or cold solder joint.

If the buzzy hum persists with the inputs shorted, check that you have installed the power transformer washers in exactly the order prescribed in the assembly manual. If you have painted or powder coated your chassis panel make sure that any star washers that are in direct contact with the panel are penetrating that coating and making contact with the aluminum underneath. The continuity test setting on your DMM will be helpful in determining if you have a good low resistance connection from the transformer end bell to the safety ground screw on the chassis.

Hum in one channel
That tells you that the issue is located somewhere in the part of the circuit that is dedicated to that channel. If your kit has separate tubes for each channel, try swapping the tubes. If you still hear the noise only in the left channel, carefully examine the components and connections around the left channel tube(s).
Soft deep hum
If you hear a low soft 60Hz hum in high gain kits like the Eros and Reduction phono preamps it may be coming from transformers in some of your other audio gear. Try moving any other gear farther away from your kit.

Beep-dadabeep-dabeep
Your cell phone is searching for a cell tower connection. Take your cell phone out of your pocket and set it across the room.

Other electronic hash
Wifi routers are notorious noise sources. Keep them as far from audio equipment as possible. Large electric appliances can put noise onto the power lines that feed your gear.

Hissing or low hum noise is not there at low levels, can hear it when I turn the volume up to max
That's normal and you will probably find the listening level deafening at that loudest volume setting.

Voltages measure OK, no sound on one channel
The most common issue is that excess solder has run down from the center pin of an RCA input jack or output jack, and shorted it to that jack's outer shell. Reheat the connection and remove enough solder with solder wick or a desoldering pump to clear the shorted solder bridge.

Headphone only plays mono
You haven't pushed the headphone plug in all the way, or possibly you have wires touching on the jack that need to be adjusted.

Now what?
If you have tried the techniques here and still haven't resolved your issue, try posting your issue on the Bottlehead Forum in the appropriate kit category. Check the sticky posts at the top of that forum, as there may be some info that addresses your issue. When you post be as specific as possible about the problem and be sure to list any resistance and or voltage readings that are not what the manual lists. Crisp photos from different angles that clearly show terminal connections are a huge help. Fuzzy overhead photos are pretty much useless. Also be sure to post your real name in case we need to send you any replacement parts. It's very difficult to ship parts to a forum username.

Guarantee

Bottlehead Corp. guarantees prompt replacement of any parts which may be missing from the kit upon receipt. E-mail replacementparts@bottlehead.com to receive replacements for missing parts. If any parts have been damaged in shipment, replacements will be sent to the purchaser upon return of the damaged parts.

Bottlehead Corp. is unable to accept for refund any kit upon which assembly has begun. Returns of unbuilt kits require prior authorization and must be returned within two weeks of receipt. The price of any parts damaged or missing from a returned unbuilt kit will be subtracted from the refund amount

If you wish to have the kit assembled for you, contact us at 206-451-4275 and we will refer you to a factory authorized assembly technician.

If you have technical questions regarding assembly of the kit please visit the Bottlehead Forum at http://www.bottlehead.com/smf/index.php

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