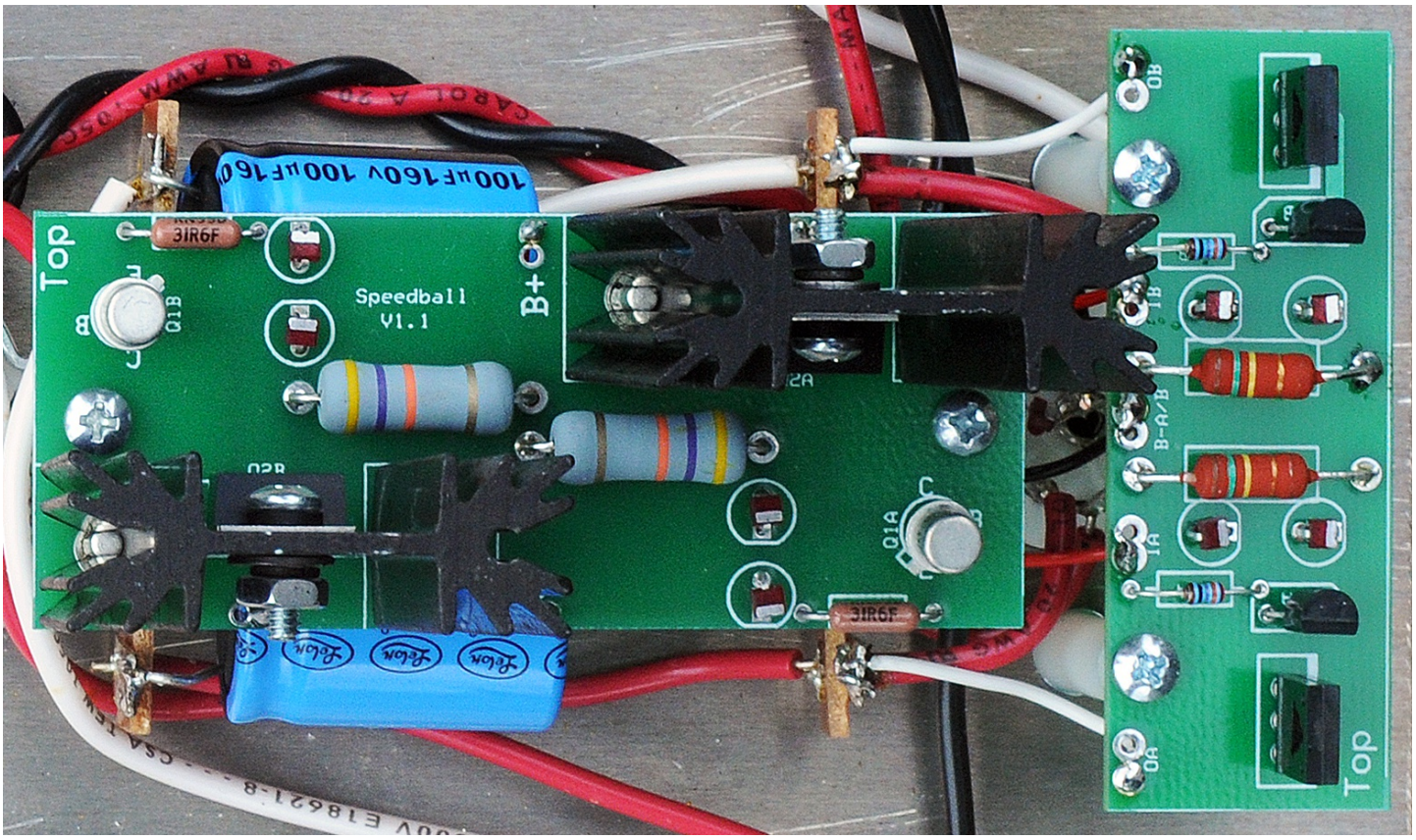


Speedball 1.1 Manual

A guide to constructing the Speedball upgrade to the Bottlehead Crack Headphone Amplifier kit

Table of Contents

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

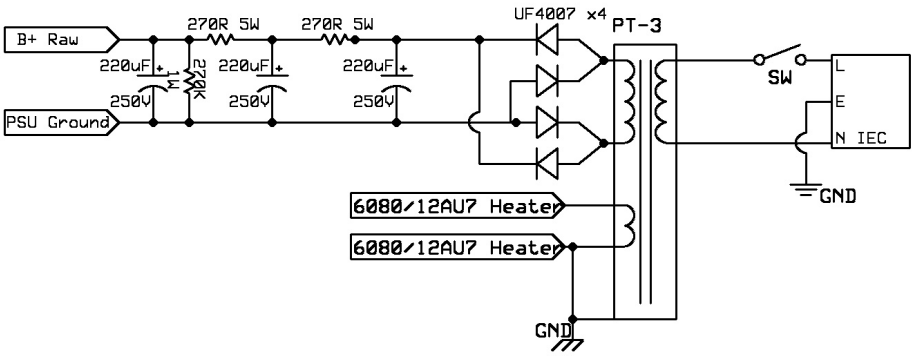
The Speedball kit is an application of the Camille Cascode Constant Current Sources that have been used throughout the Bottlehead product line, to the Crack Output Transformer-Less (OTL) headphone amplifier. It is employed to reduce distortion and further reduce the already exceptionally low noise floor by increasing power supply ripple rejection (PSRR). The audible result is a sense of better dynamics, tighter bass, and more defined imaging.

A Camille Cascode Constant Current Source is applied to each triode—both halves of the 12AU7 voltage amplifiers and both halves of the 6080 cathode followers.
By loading a triode voltage amplifier with a high impedance, such as an active current source, it operates in a more linear region and produces less distortion. A second advantage, not as widely appreciated, is that the current source provides a great deal of isolation from the power supply. A good current source will provide a high impedance over a wide range of frequencies including radio frequency interference. It is otherwise extremely difficult to stop RFI that is carried on the power line, because power supply chokes have a leakage capacitance and the large capacitors used will also have some inductance at high frequencies. Isolation from the power supply also removes the power supply capacitors from the signal current loop.

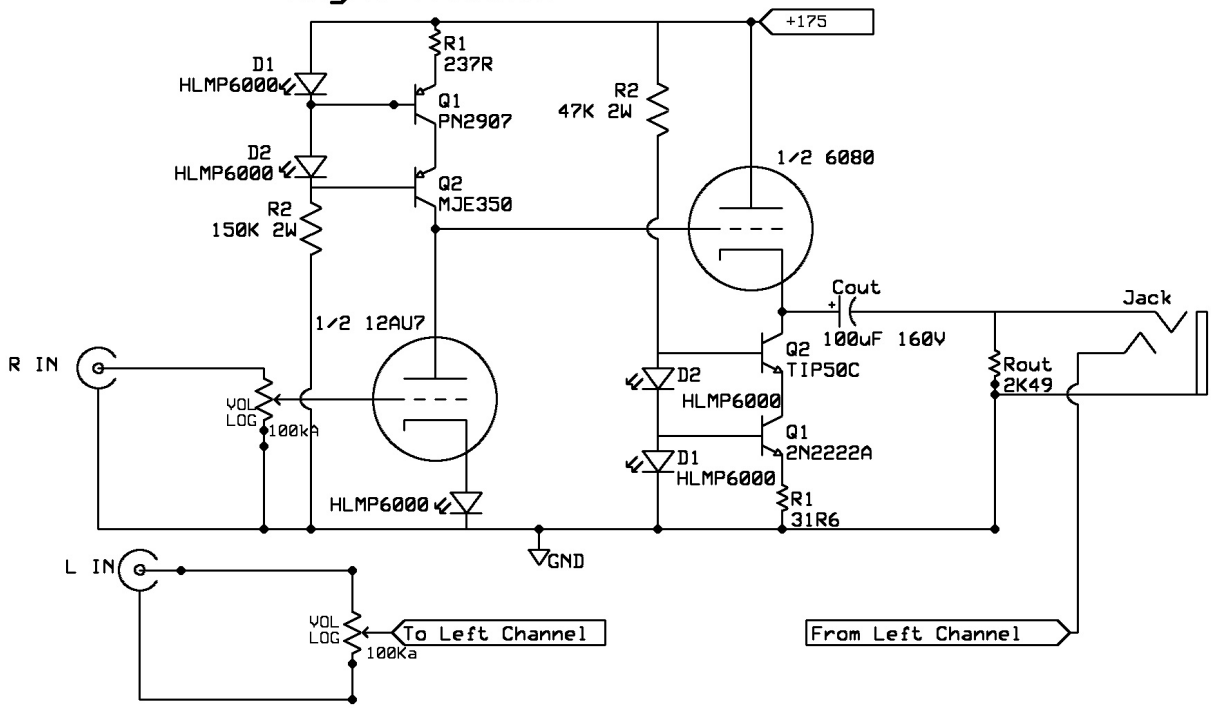
Maximum output is about 10V rms (28V pk-pk) before clipping into a 300Ω load. Gain is about 15 dB into a 300Ωload. Output impedance is about 120Ω - recommended headphone load is 100Ω or greater. Frequency response is +/- 0.5 dB from 10Hz to 50kHz into a 300Ω load. Phase is inverted.

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 11/12/2015	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 12ga. and smaller wire
- soldering iron, 40W is fine. An inexpensive solder station is much, much better
- volt-ohm meter - we suggest a 'pocket DMM'
- masking tape
- 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

Speedball 1.1 Upgrade Kit Parts List

( ) 1 — Speedball 1.1 manual CD-ROM
(or previous download)

( ) 1 — Narrow Profile C4S circuit board
( ) 1 — Speedball 1.1 circuit board

( ) 2 — #6 round lockwashers
( ) 4 — #4x1" nylon standoffs
( ) 6 — 4-40x¼" screws

( ) 1 foot black solid core wire
( ) 1 foot red solid core wire
( ) 1 foot white solid core wire

( ) 2 — 31.6Ω ⅛W resistors (31R6F)
( ) 2 — 237Ω ⅛W resistors (red, orange, violet, black, brown)
( ) 2 — 47KΩ 2W resistors (yellow, violet, orange, gold)
( ) 2 — 150KΩ 2W resistors (brown, green, yellow, gold)

( ) 8 — HLMP-6000 LEDs
( ) 2 — PN2907A transistors
( ) 2 — 2N2222A transistors
( ) 2 — MJE-350 transistors
( ) 2 — TIP-50 transistors

( ) 2 — PC mount heat sinks
( ) 2 — transistor heat sink mounting kits

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.

The first step, and *by far the most important,* is to make sure you have a functional Crack Headphone Amplifier before going any further.

This means that your Crack has passed all resistance and voltage checks and you have used it in your audio system for some time. You should go back to the Crack manual and repeat the resistance and voltage checks (following ALL safety guidlines) to confirm its funtionality.

DO NOT for *ANY REASON* attempt to integrate this upgrade as you build a Crack. There are several reasons for this requirement:

1) If something goes wrong with the build, it will be much easier to diagnose and fix the simpler stock circuit.

2) Likewise, if it doesn't work when the upgrade is applied, then you know that the base kit was working, so it limits the possible locations of errors.

3) From an audio hobby perspective, if you never hear the stock circuit, you will not know how the Speedball is improving the sound. You might even be one of the people who prefers the stock unit.

This is based on years of providing technical support on Speedballs.

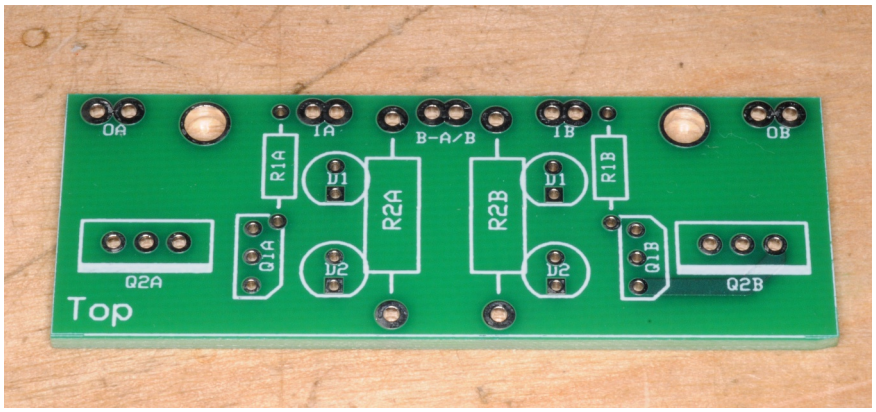
If you firmly believe that you will save time by ignoring this requirement, pick up your wire cutters.

Squeeze them together seven times...

That is the ammount of time you could potentially save. You will never save time by rushing any electronics build. You will end up spending hours, sometimes days, fixing a mistake that was so avoidable you will want to scream. The first step in your debugging process will be to remove the Speedball and find out where the fault lies. Save yourself the frustration and

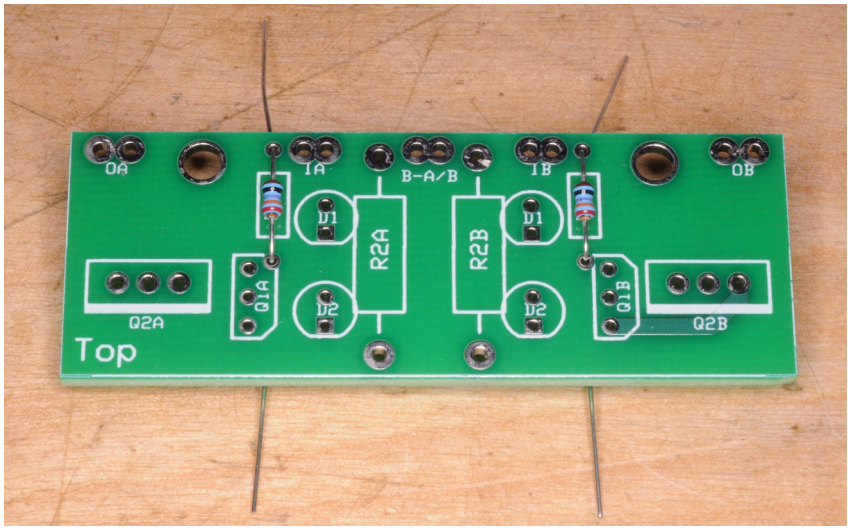
FOLLOW THIS REQUIREMENT!!

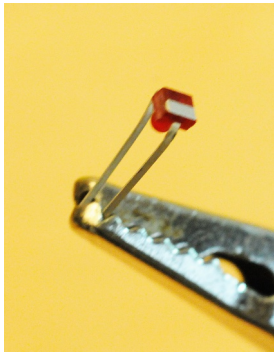
Assembly Part One - Wiring the Small Circuit Board



First, take a moment to look at the board and its layout. Notice the white text that says "Top"; this is the top side of the board. All components will be on this side of the board. All components will be installed on this side of the board, with only leads on the bottom side of the board. **DO NOT** install components on the bottom side of the board.

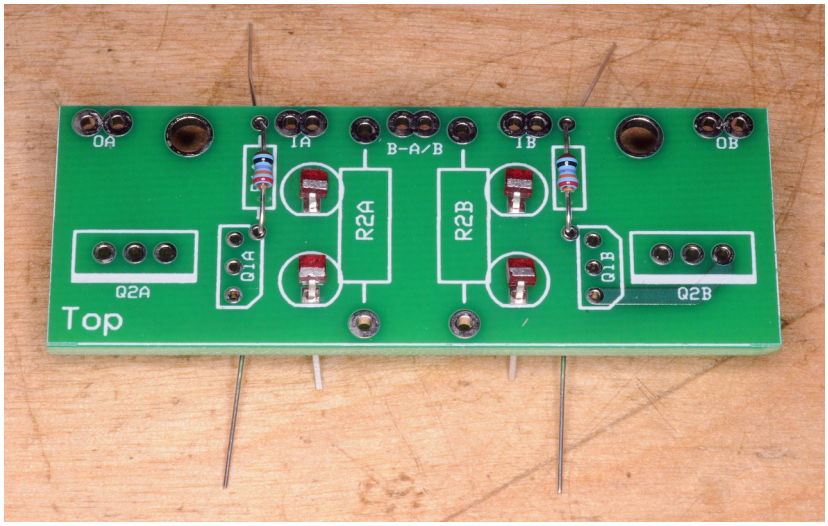
( ) Insert the leads of a 237Ω ⅛W (red, orange, violet, black, brown) resistor into the R1A and R1B positions.

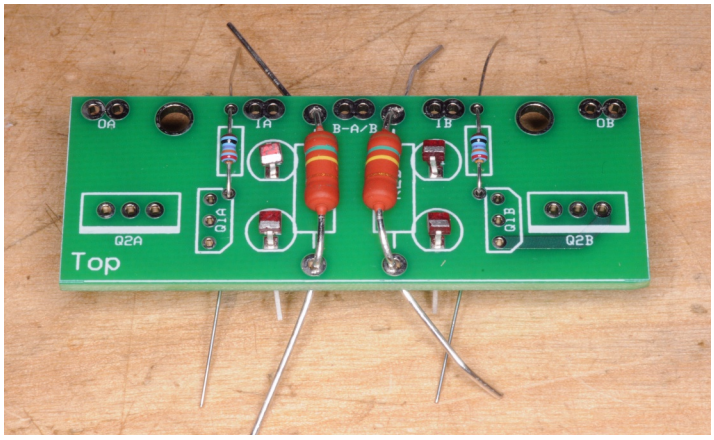




( ) Locate four HLMP-6000 LEDs and bend the leads "up" as shown. Pay close attention to the silver band that identifies the cathode; these parts are directional and it is crucial that you orient them properly. Preparing the LEDs in this way will confirm the correct installation to anyone who looks at your board. The illumination from the LED will still be visible.

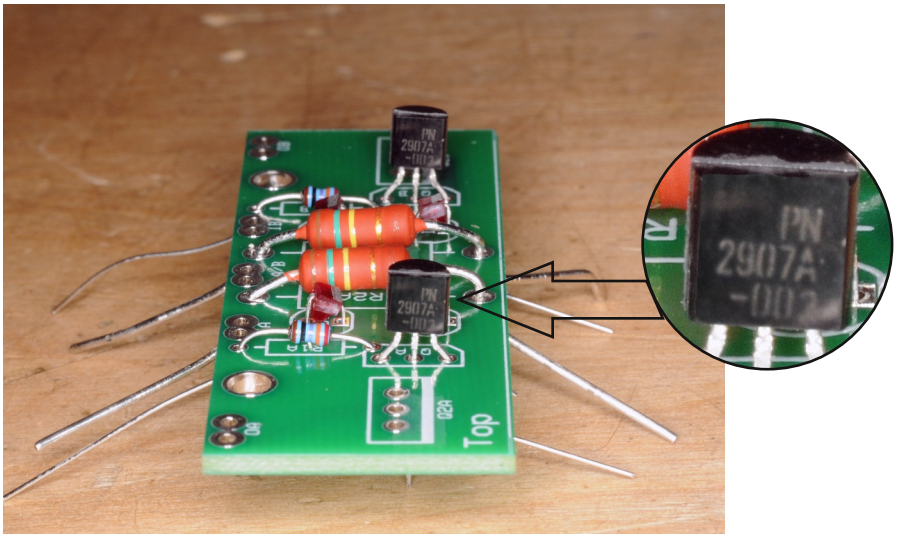
( ) Insert the LEDs into positions D1 and D2 on both the A and B sides. The banded end goes into the terminal with the square pad. Pay close attention to the picture and confirm the correct orientation of these diodes.

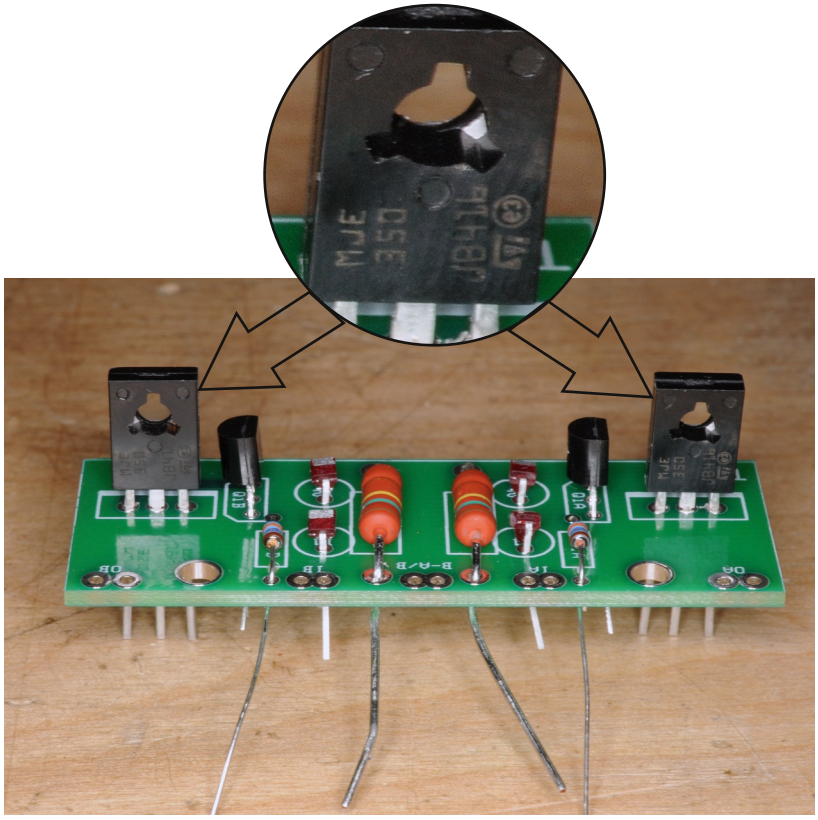




( ) Insert the leads of a 150KΩ 2W resistor (brown, green, yellow, gold) into the R2A and R2B positions.

( ) Insert the leads of a PN2907A transistor into the Q1A and Q1B positions on both the A and B Orient the transistors so their flat sides align with the flat side of the part outline.





( ) Insert the leads of a MJE350 transistor into the Q2A and Q2B positions. Orient the transistors so the sides with the printed text faces the the narrow line of the part outline (towards the center of the PC board).

WHOA!! PC Board Soldering lesson!

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...)

Here's the scoop on soldering PC boards:

- A "third hand" tool is very useful for this, supporting the PC board while you hold the iron in one hand and the solder in the other.

- 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.

- Solder on the back, or bottom side of the PC board, where the component leads come out. Apply the tip of the iron to contact both the solder pad and the lead attached, and let it rest against the joint long enough to heat both thoroughly.

- Flow enough solder onto the joint to fill the joint between the pad and the lead threaded through 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 only to 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.

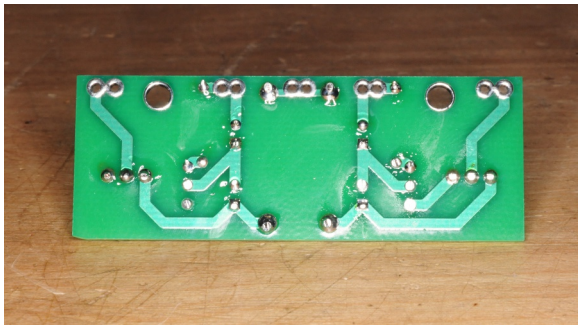
- Keep the tip of the soldering iron clean. A slightly damp sponge is the tip cleaning tool of choice.

- If you have a temperature adjustable soldering station, try setting the tip temperature to about 650 to 700 degrees for PC board work.

- Watch for "solder bridges," places where the solder has bridged across a gap, joining two pads that should not be joined. Remove any solder bridges with solder braid, a braided copper tape that absorbs molten solder and wicks it away from the solder joint. A spring or suction type desoldering tool may also be used.

If you have middle aged eyes, don't be proud! For those of us with presbyopia, reading glasses can make a seemingly tough job quite simple. Use them in place of your safety glasses.

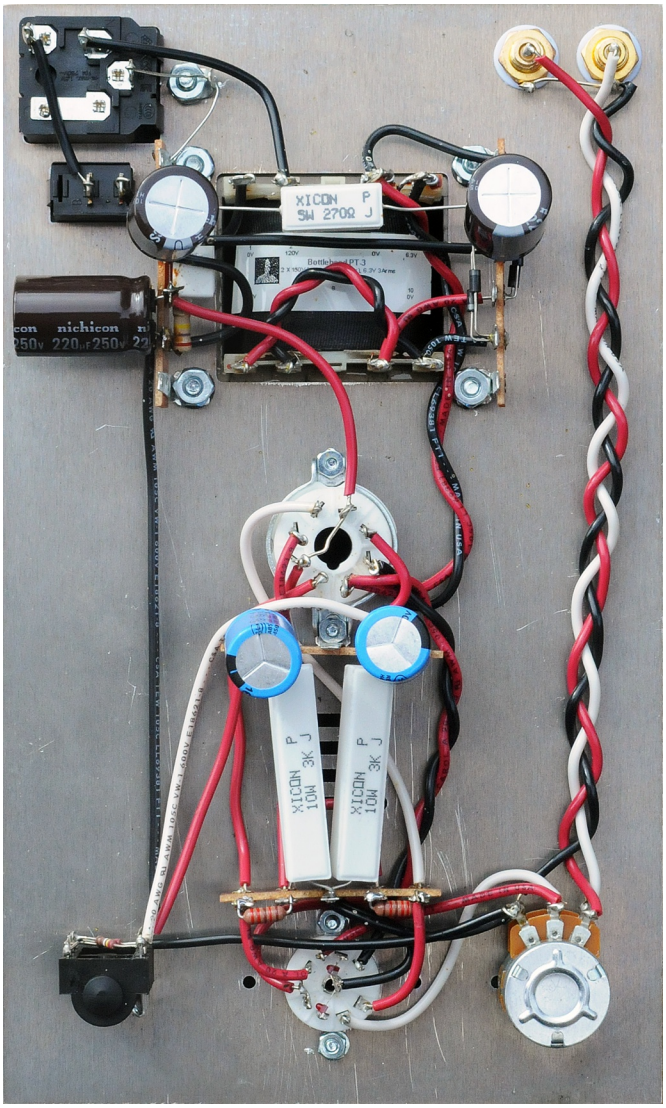
You are wearing safety glasses when you solder, right?



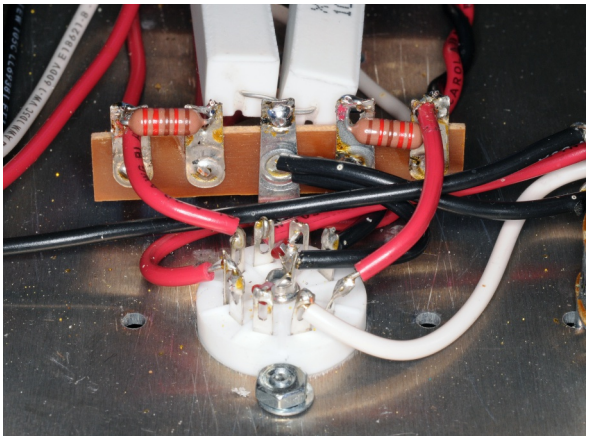
( ) Flip the board over, solder all connections, and trim the leads close to the board. Please note that the middle leg of the MJE350 transistors absorb more heat than other leads, and will require more time with the soldering iron to get the solder to properly flow.

Assembly Part Two - Installing the Small Circuit Board

Before proceeding, look closely at this picture. This is the state that your amplifier **MUST** be in to perform the following steps.

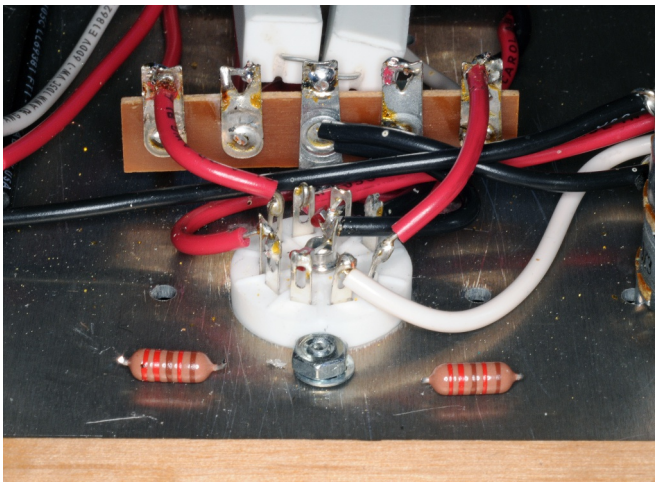


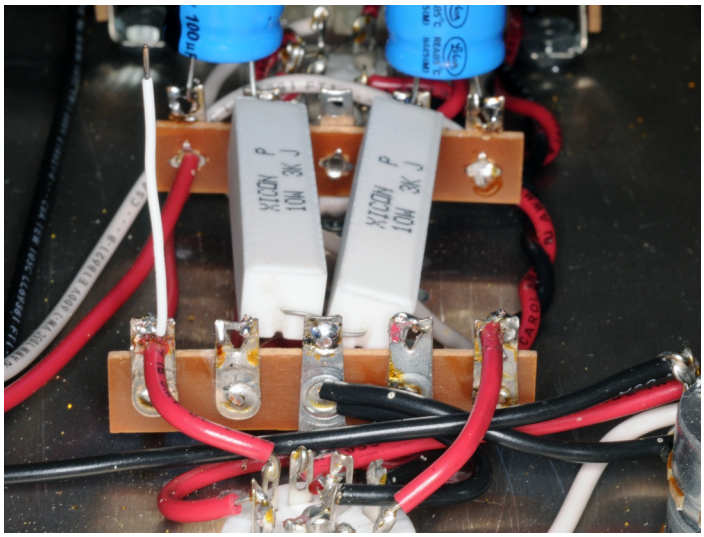
If your amplifier does not resemble this picture, please refer to page 10 of this manual.



( ) Locate the 22.1KΩ resistors (red, red, brown, red, brown) connecting 1U to 2U and 4U to 5U.

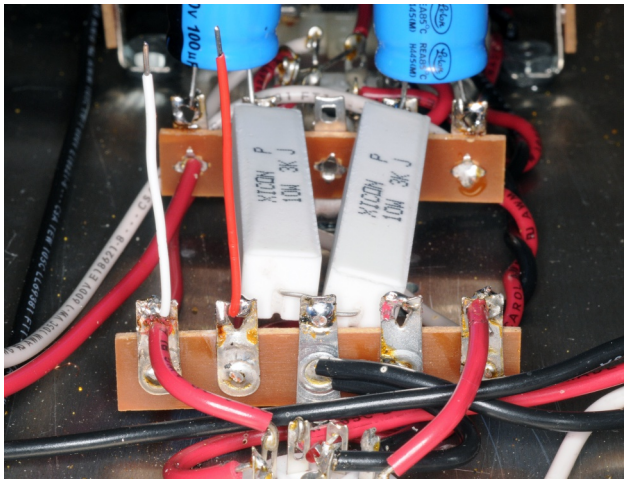
( ) Clip the leads of the 22.1KΩ resistors close to the terminals.

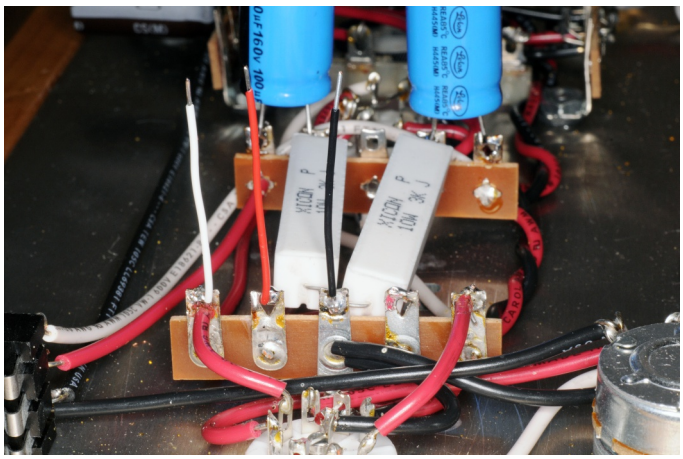




( ) Cut a 1½" (38mm) piece of white wire and strip both ends ¼" (7mm). Attach and solder one end to 1U.

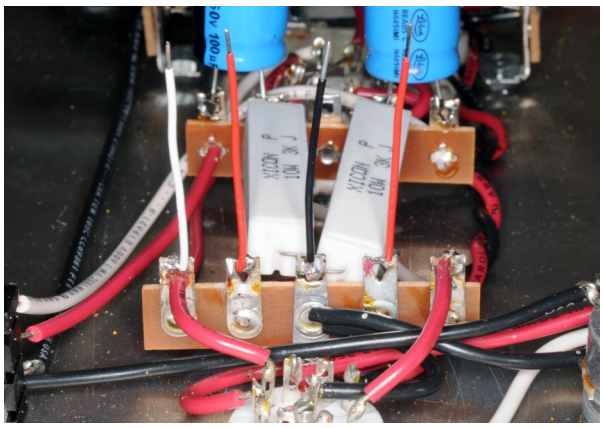
( ) Cut a 1½" (38mm) piece of red wire and strip both ends ¼" (7mm). Attach and solder one end to 2U.

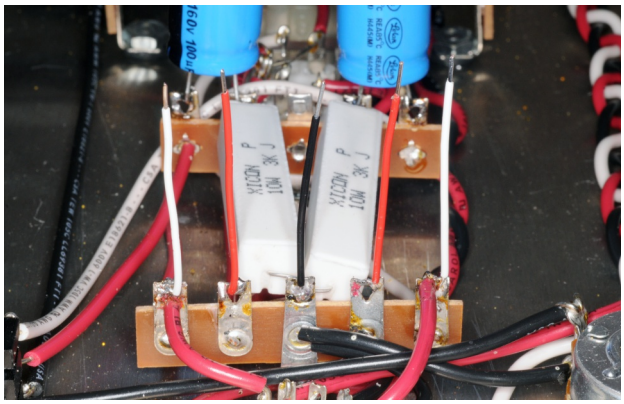




( ) Cut a 1½" (38mm) piece of black wire and strip both ends ¼" (7mm). Attach and solder one end to 3U.

( ) Cut a 1½" (38mm) piece of red wire and strip both ends ¼" (7mm). Attach and solder one end to 4U.

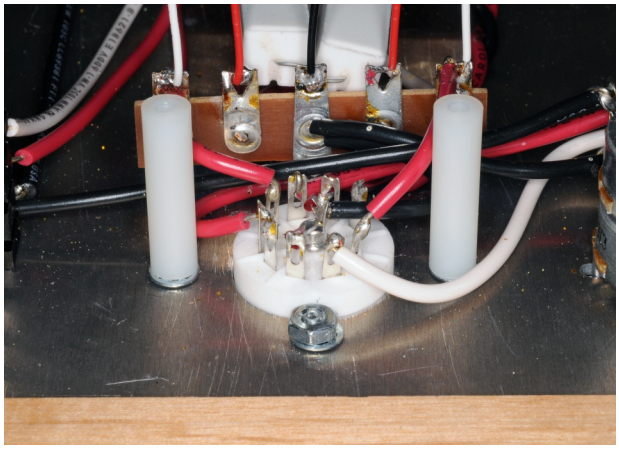


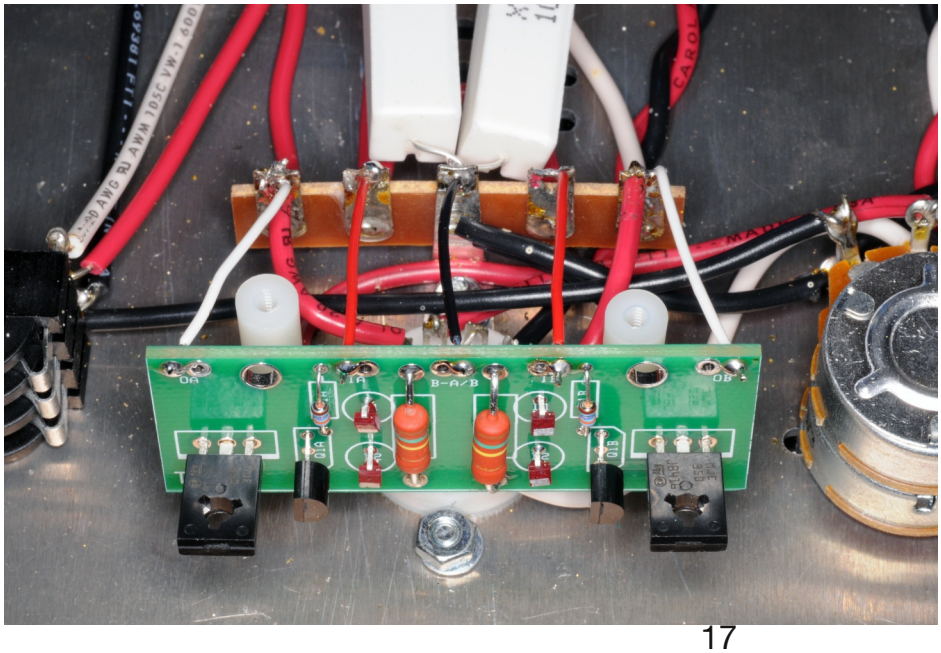


( ) Cut a 1½" (38mm) piece of white wire and strip both ends ¼" (7mm). Attach and solder one end to 5U.

( ) Insert a 4-40x¼" screw from the top side of the chassis through the hole to the left of the 9-pin socket. Slip a #6 lockwasher over the screw and secure into a #4x1" nylon standoff.

( ) Insert a 4-40x¼" screw from the top side of the chassis through the hole to the right of the 9-pin socket. Slip a #6 lockwasher over the screw and secure into a #4x1" nylon standoff.





( ) Attach the white wire connected to 1U to OA.

( ) Attach the red wire connected to 2U to IA.

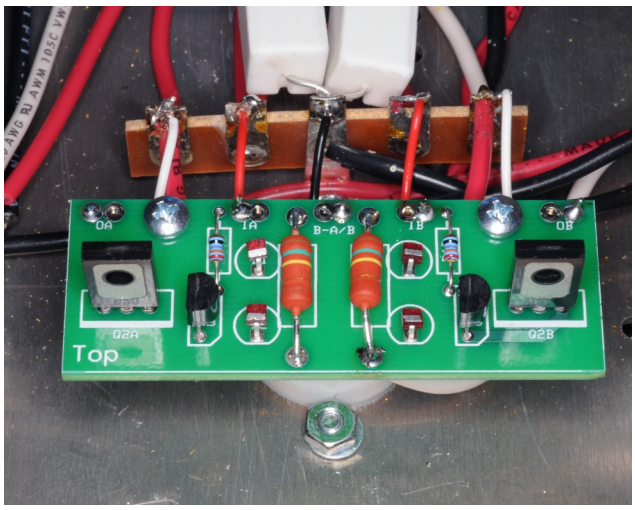
( ) Attach the black wire connected to 3U to B-A/B.

( ) Attach the red wire connected to 4U to IB.

( ) Attach the white wire connected to 5U to OB.

( ) Solder all connections.

( ) Secure the board to the standoffs with 4-40x¼" screws.



Small Board Voltage Check

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

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

( ) Confirm that the 1A fuse is still in the fuse holder.

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

( ) Turn on the power switch.

( ) Turn the chassis over and connect the black negative lead of the volt-ohm meter to terminal 12U. Using a clip lead to connect the black test lead to the ground will free one hand, which makes testing much easier and safer. Switch the meter to read DC volts (on a 200V 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%:

Please note: these tests are being performed on the circuit boards, which is easier than trying to reach underneath the boards to probe terminals. This does require your utmost care to not short your probe across multiple terminals.

Terminal	**Voltage (DC)**
OA	60-90V
IA	170-270V
B-A/B	0V
IB	170-270V
OB	60-90V

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.

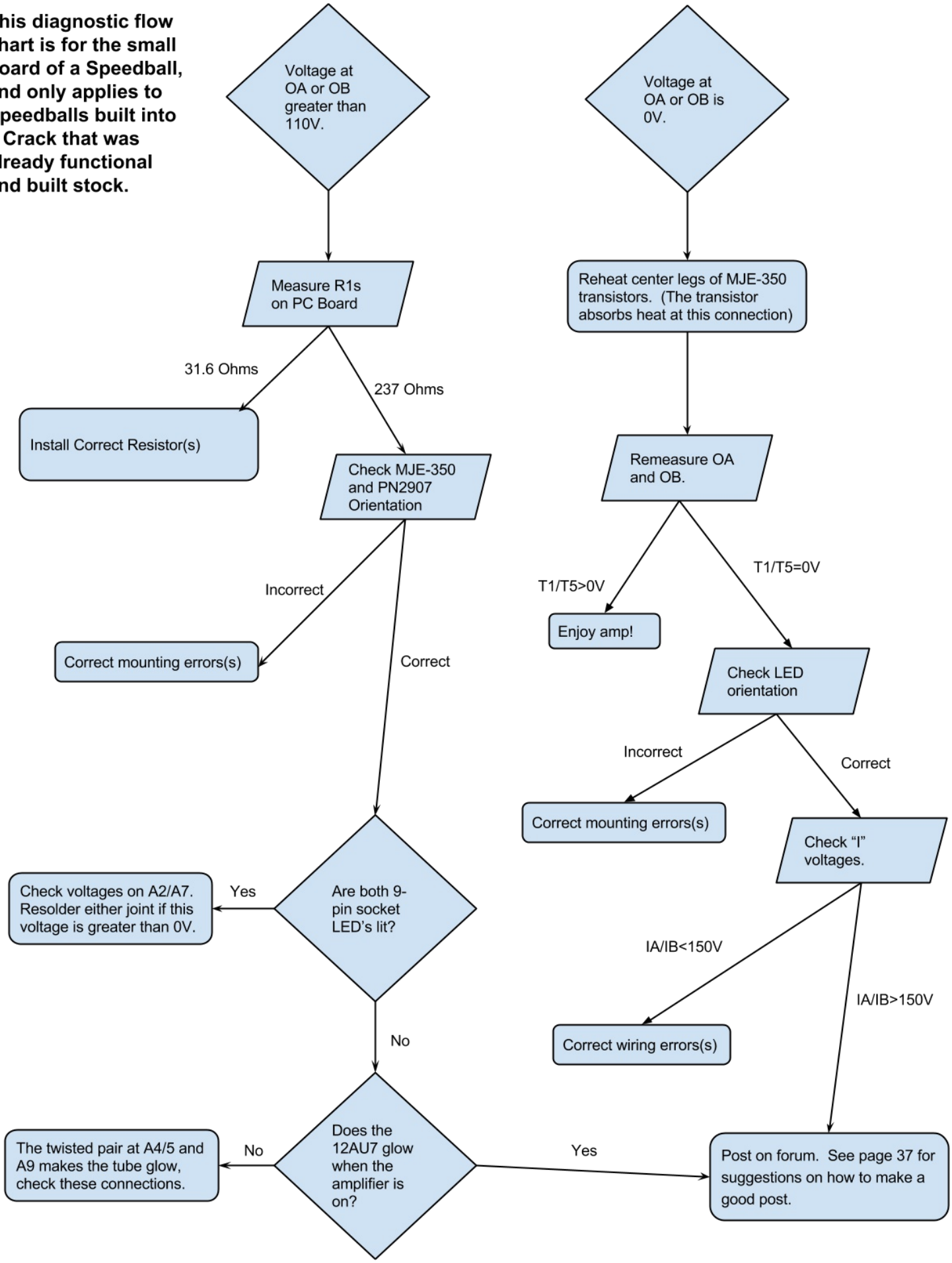
Don't worry if your voltages are not exactly these figures. Tube tolerance variations can change them by a few percent. If you run into any hitches, refer to the diagnostic flow chart on the next page which will guide you through the most common errors. If you still cannot find the root of your problem, you can always get help on the Bottlehead Forum. It's a wonderful tech support resource: http://www.bottlehead.com/smf/index.php.

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.

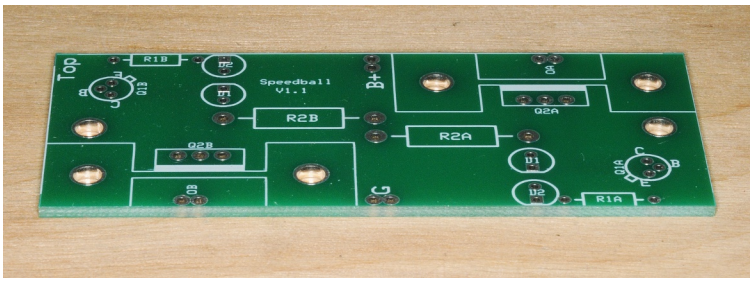
OK, if everything checks out, unplug the power cable from the wall and disconnect the meter.

You can resume use of your Crack at this time and listen to the benefits of the upgrade, or you can continue and complete the second half of the kit.

This diagnostic flow chart is for the small board of a Speedball, and only applies to Speedballs built into a Crack that was already functional and built stock.

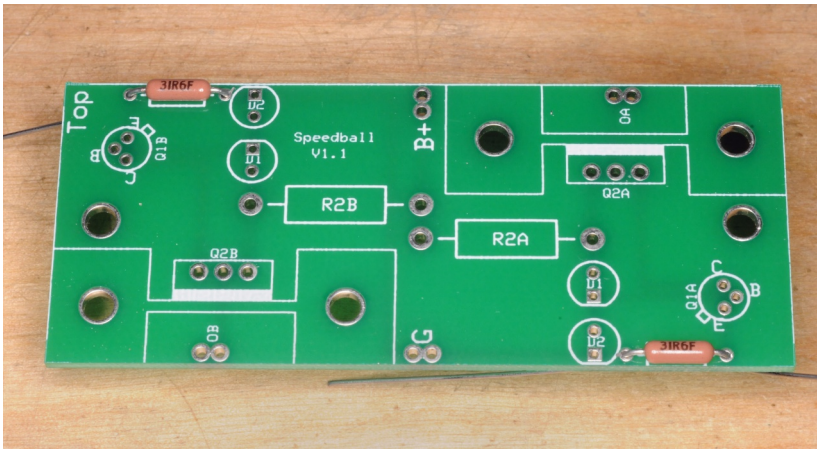


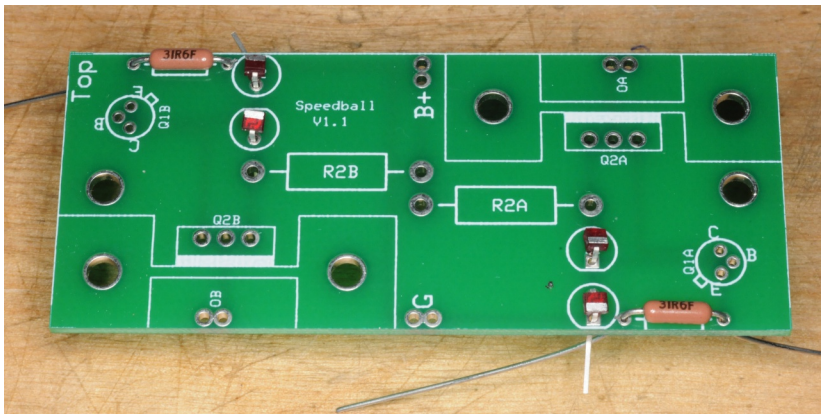
Assembly Part Three - Assembly Part Three - Wiring the Large Circuit Board



First, take a moment to look at the board and its layout. Notice the white text that says "Top"; this is the top side of the board. All components will be on this side of the board. All components will be installed on this side of the board, with only leads on the bottom side of the board. **DO NOT** install components on the bottom side of the board.

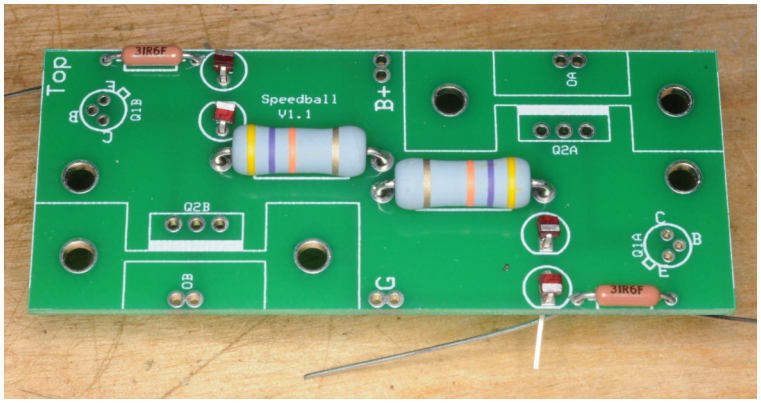
( ) Insert the leads of a 31.6Ω ⅛W resistor (31R6F) into the R1A and R1B positions.

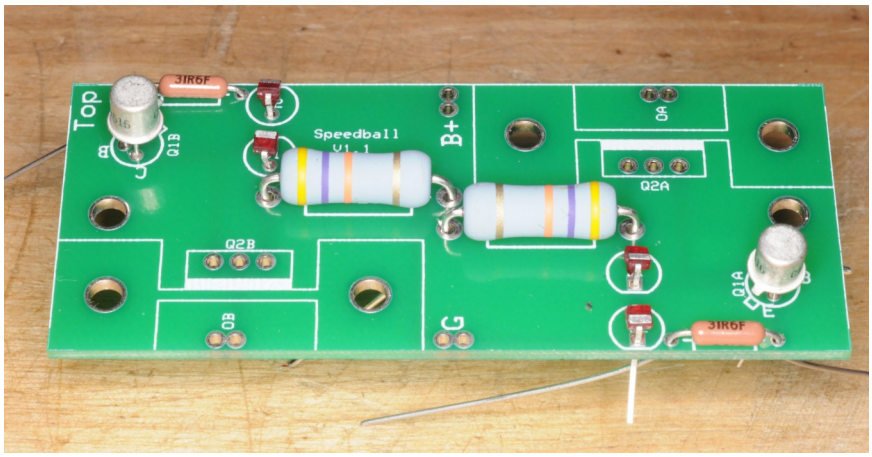




( ) Locate four HLMP 6000 LEDs and bend the leads "up" as before. Insert the LEDs into positions D1 and D2 on both the A and B sides. The banded end goes into the terminal with the square pad. Pay close attention to the picture and confirm the correct orientation of these diodes.

( ) Insert the leads of a 47KΩ 2W resistor (yellow, violet, orange, gold) into the R2A and R2B positions.

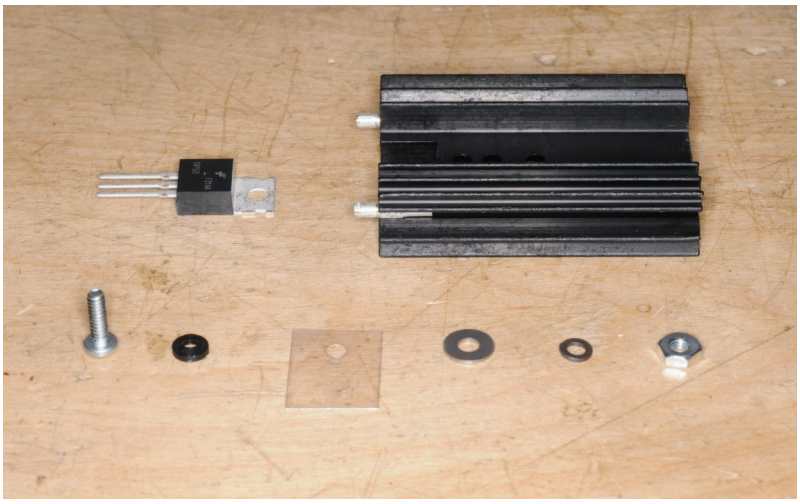


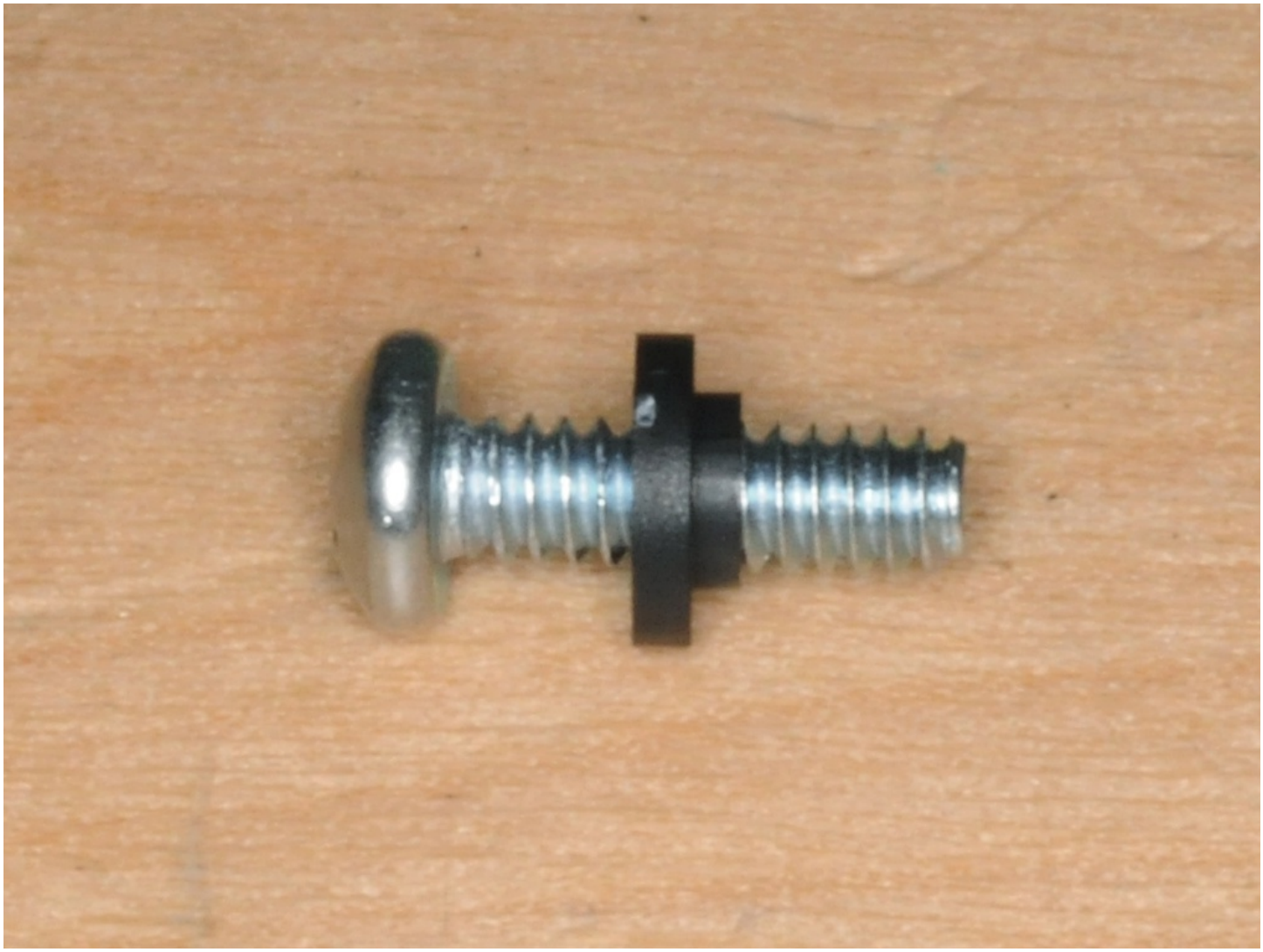


( ) Insert the leads of a 2N2222A transistor into position Q1 on the B side. Make sure that the tab on the side of the transistor aligns with the tab on the part outline. The body of the transistor should sit a bit above the surface of the board, as shown.

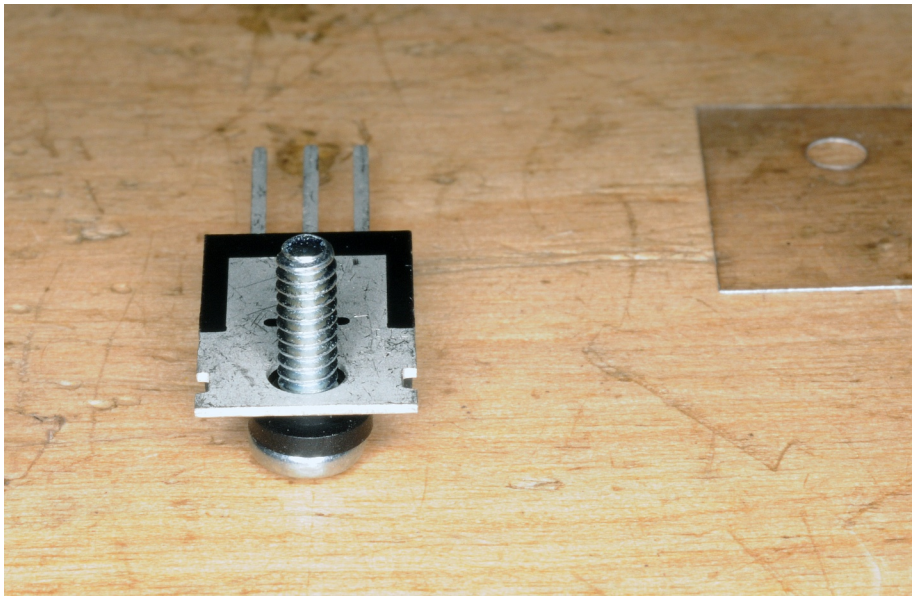
Note that the following instructions are absolutely essential and must be followed **exactly!** Failure to do so will damage your amplifier and possibly destroy your power transformer. Replacement power transformers are **$100** plus shipping. There is also a video covering these steps that can be viewed here.

The front row of this picture shows the parts contained in the heat sink mounting kit in the order they will be used. A transistor and heat sink are shown in the back row



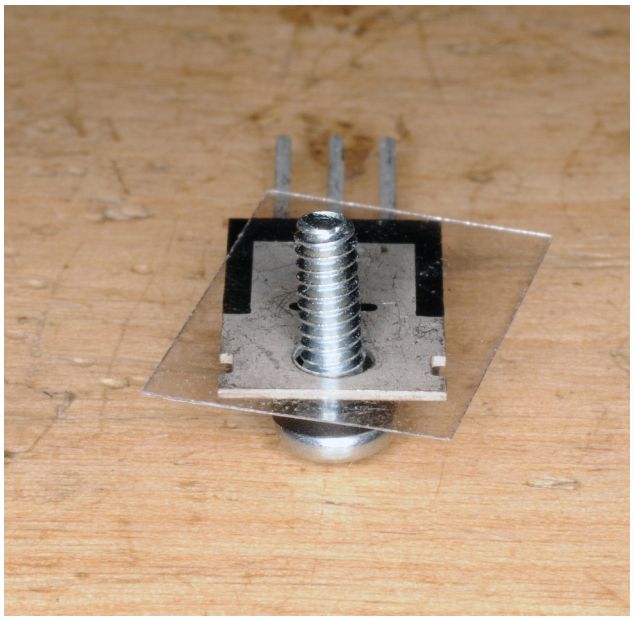


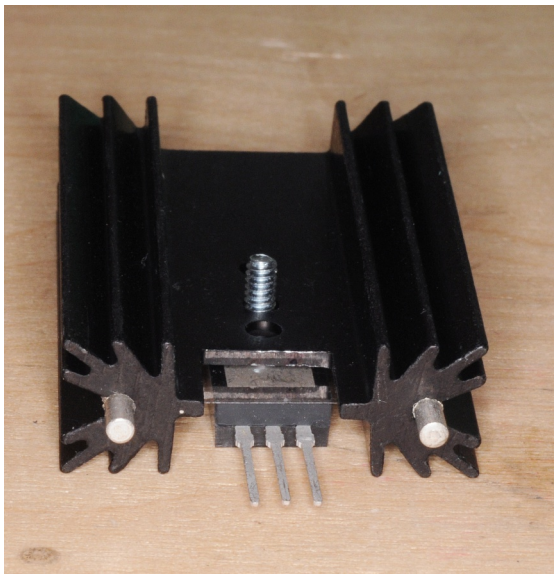
( ) Slide the insulating shoulder washer onto the screw. Note that the ridge of the washer faces **away** from the head of the screw.



( ) Slide a TIP-50 transistor onto the screw so the screwhead is over the black side of the transistor and the ridge of the shoulder washer sits in the hole of the transistor.

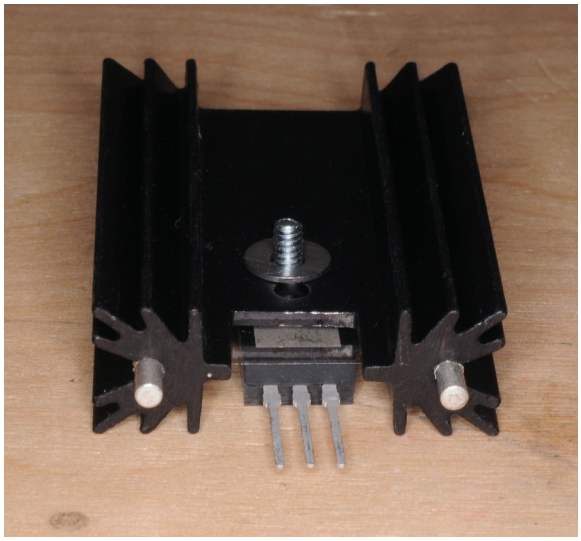
( ) Slide the insulator onto the screw so it rests on the metal tab of the transistor.

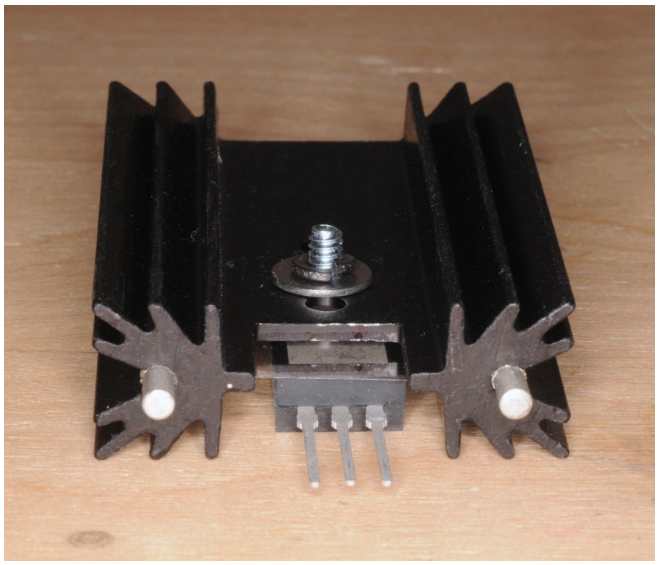




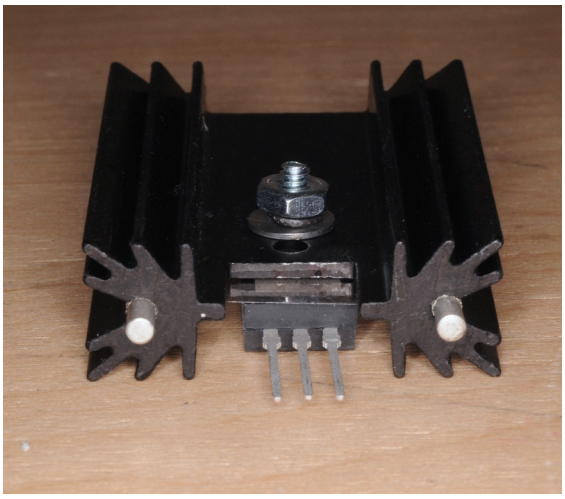
( ) Place the heat sink over the screw, so the screw passes through the middle hole of the heat sink.

( ) Slide the flat washer onto the screw so it rests on the heat sink.



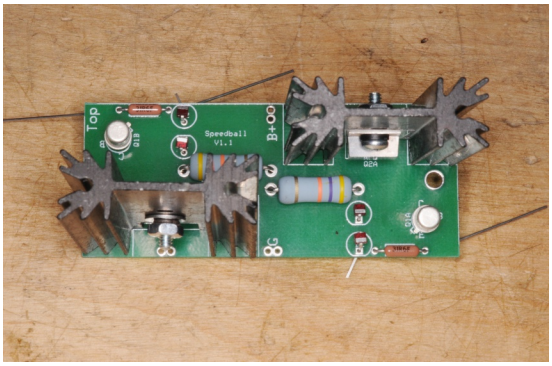


( ) Slide the lock washer onto the screw so it rests on the flat washer.



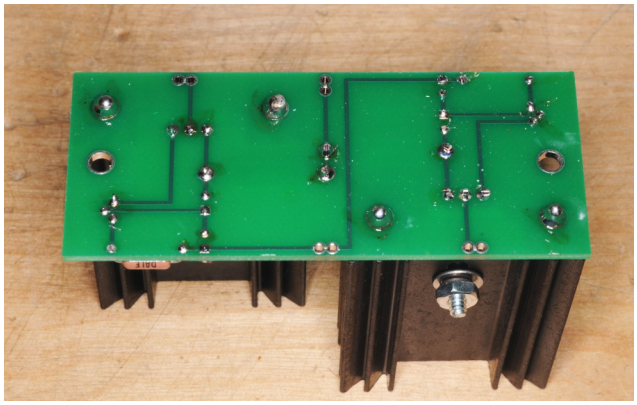
( ) Loosely secure the screw with the provided nut. Do not fully tighten the nut yet, but make certain the nut is tight enough to keep the shoulder washer seated in the transistor hole.

( ) Repeat this process to mount a second TIP-50 transistor onto another heat sink.



( ) Insert the leads of a mounted TIP-50 transistor into positions Q2A and Q2B. Line up the heat sink to the outline around the transistor, and snap the posts of the heat sink into the coresponding holes

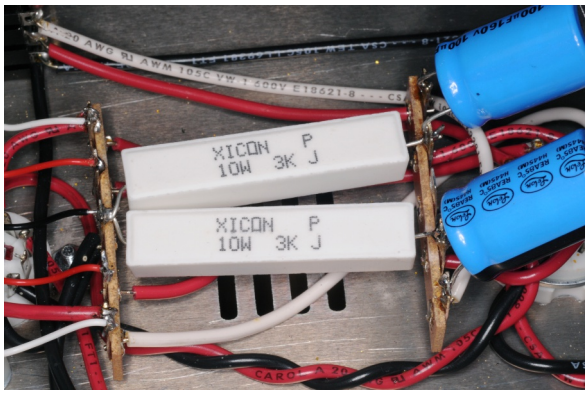
( ) Solder around the legs of the heat sinks; this may take some time depending on the output of your soldering iron. Soldering the legs is primarily to prevent the heat sink from falling off the board and does not need to be a perfect solder joint. Fully tighten the nuts on the heat sinks at this time.



Solder the leads of the TIP-50 transistors next. *Please note* that the middle leg of the TIP-50 transistors absorb more heat than other leads, and will require more time with the soldering iron to get the solder to properly flow.

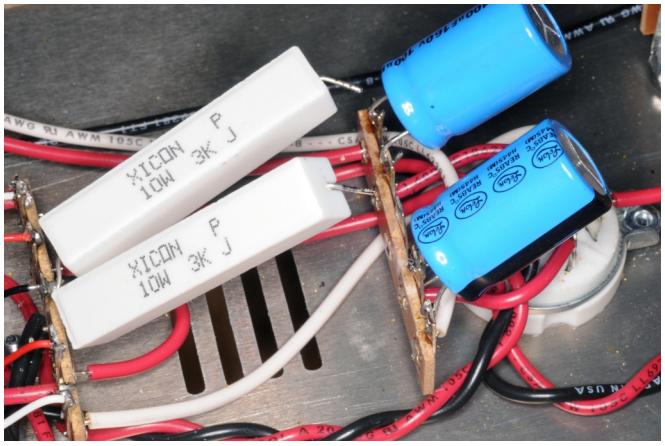
Solder all remaining leads. Trim the soldered leads close to the board.

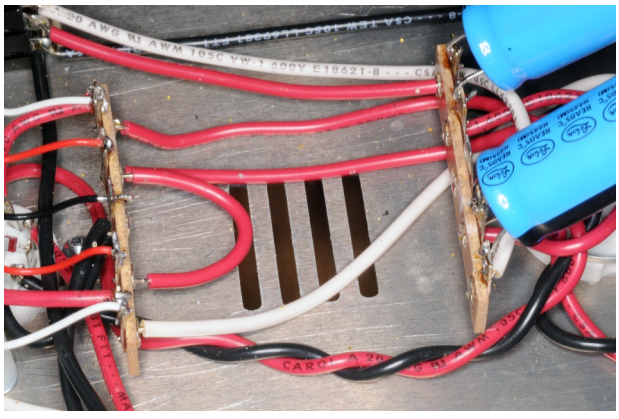
Assembly Part Four - Installing the Large Circuit Board



( ) Locate the 3KΩ 10W resistors connecting 3U to 7U and 9U.

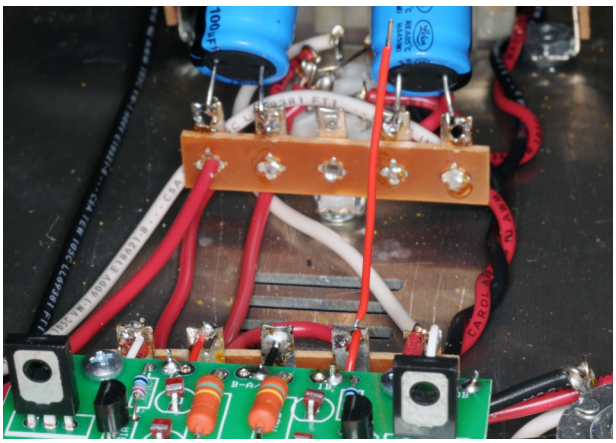
( ) Clip the leads of the 3KΩ resistors close to terminals 7U and 9U. Gently bend the leads to move capacitors out of your way, if necessary.

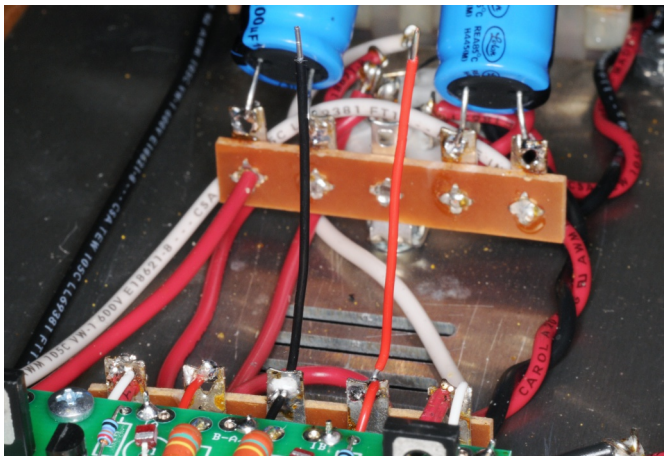




( ) Clip the twisted leads of the 3KΩ resistors close to terminal 3U and remove the resistors.

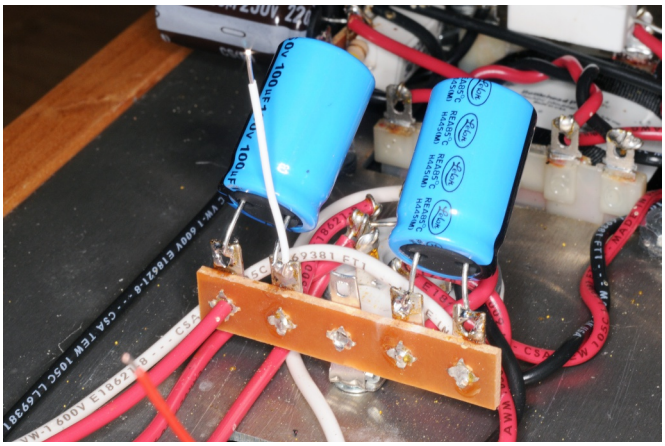
( ) Cut a 2" (51mm) piece of red wire and strip both ends ¼" (7mm). Attach and solder one end to 4U.

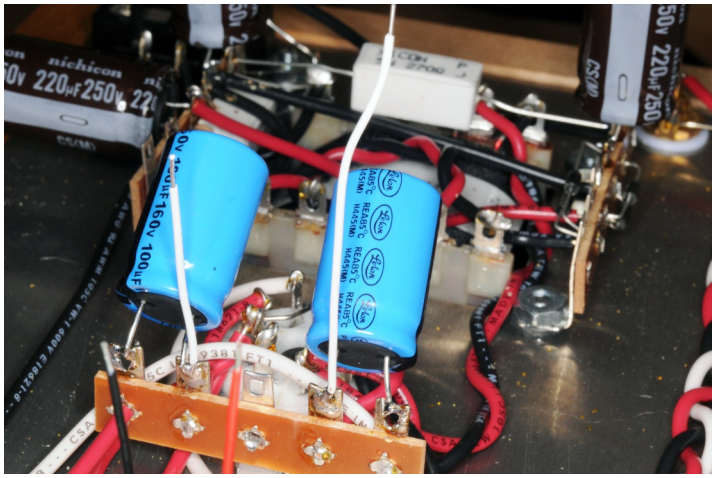




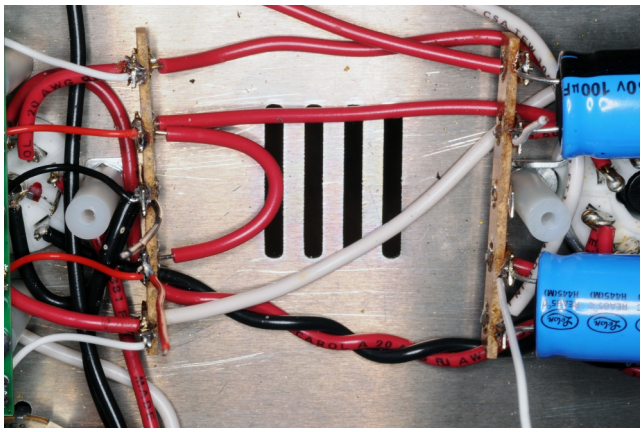
( ) Cut a 2" (51mm) piece of black wire and strip both ends ¼" (7mm). Attach and solder one end to 3U.

( ) Cut a 1½" (38mm) piece of white wire and strip both ends ¼" (7mm). Attach and solder one end to 7U.



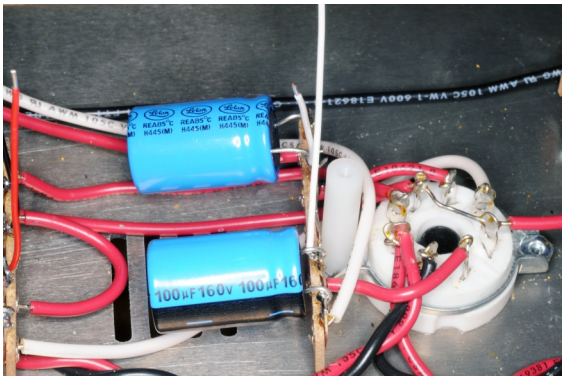


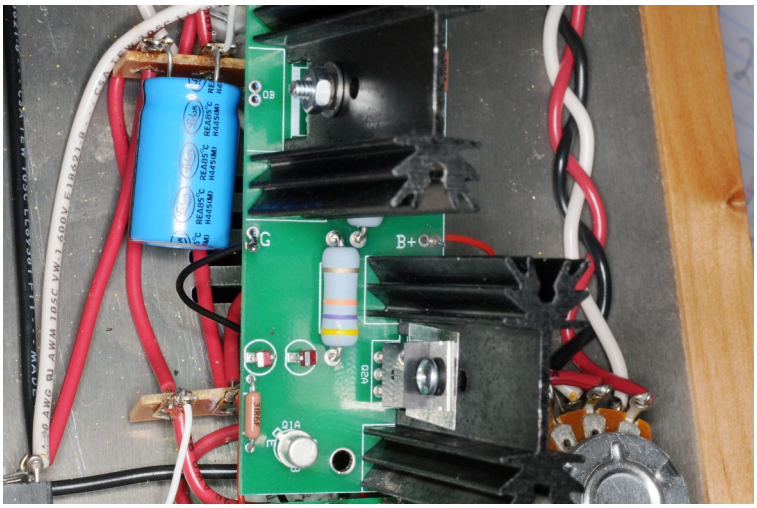
( ) Cut a 2¾" (70mm) piece of white wire and strip both ends ¼" (7mm). Attach and solder one end to 9U.



( ) Mount a #4x1" nylon standoff onto each screw holding a 5-lug terminal strip. **DO NOT** remove the nuts securing the strips to do this.

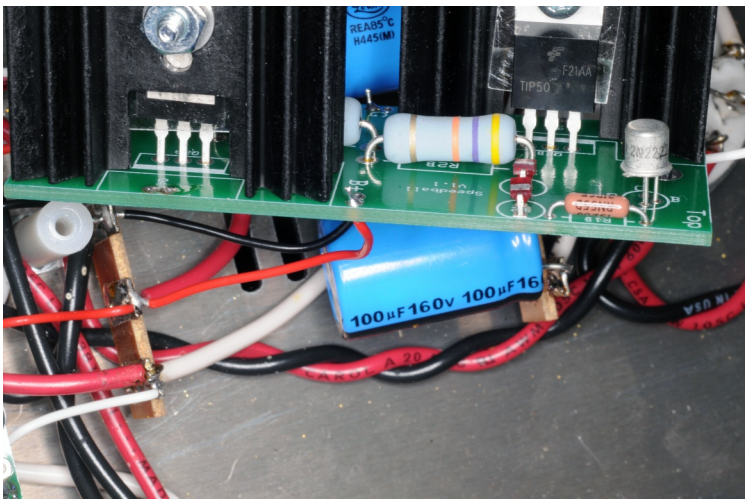
( ) Gently bend the leads of the output capacitors so the capacitors float in the space where the 3KΩ resistors used to be.



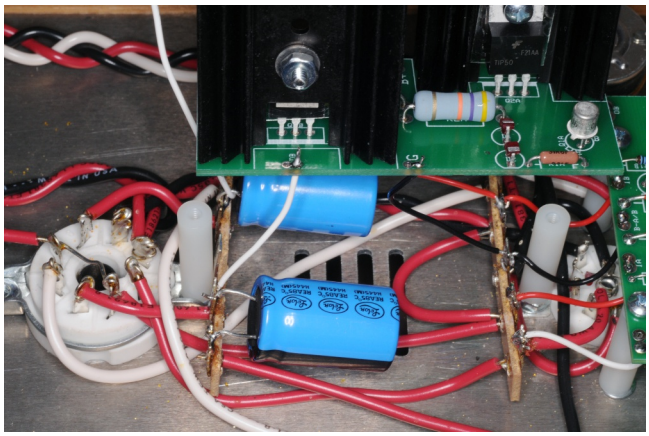


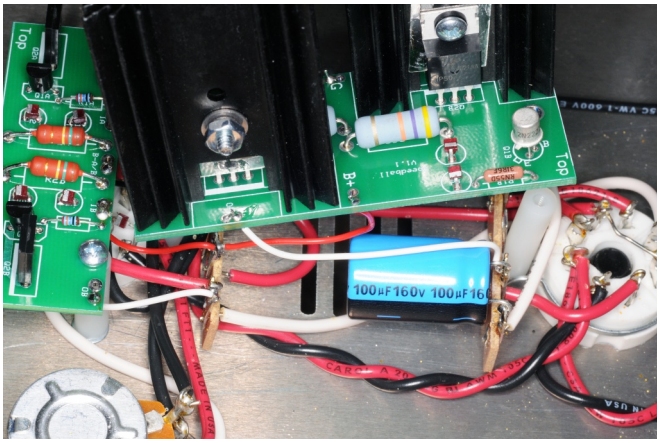
( ) Attachand solder the black wire connected to 3U to the G solder pad.

( ) Attach and solder the red wire connected to 4U to the B+ solder pad.

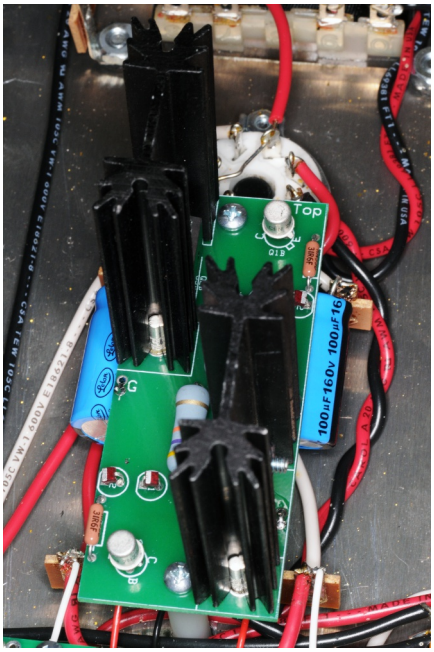


( ) Attach the white wire connected to 7U to OB. Solder OB.





( ) Attach the white wire connected to 9U to OA. Solder OA.



( ) Secure the board to the standoffs with 4-40x¼" screws.

Resistance Check

Attach the black probe to terminal 12U.

Measure the resistance at OB and OA on the large board. They should read very high, in the hundreds of KΩ (it could be over the limit of your meter. Consult your meter's manual for how a description of how the meter will display over limit readings).

If either measures less than 100Ω, go back to page 22 and carefully examine the instructions. **UNDER NO CIRCUMSTANCES** should you continue if you do not get a very high resistance reading on these terminals.

Large Board Voltage Check

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

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

( ) Confirm that the 1A fuse is still in the fuse holder.

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

( ) Turn on the power switch.

( ) Turn the chassis over and connect the black negative lead of the volt-ohm meter to terminal 12U. Using a clip lead to connect the black test lead to the ground will free one hand, which makes testing much easier and safer. Switch the meter to read DC volts (on a 200V 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%:

Please note: these tests are being performed on the circuit boards, which is easier than trying to reach underneath the boards to probe terminals. This does require your utmost care to not short your probe across multiple terminals.

Terminal	Voltage (DC)
OA	75-100V
OB	75-100V
G	0V
B+	170-195V

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.

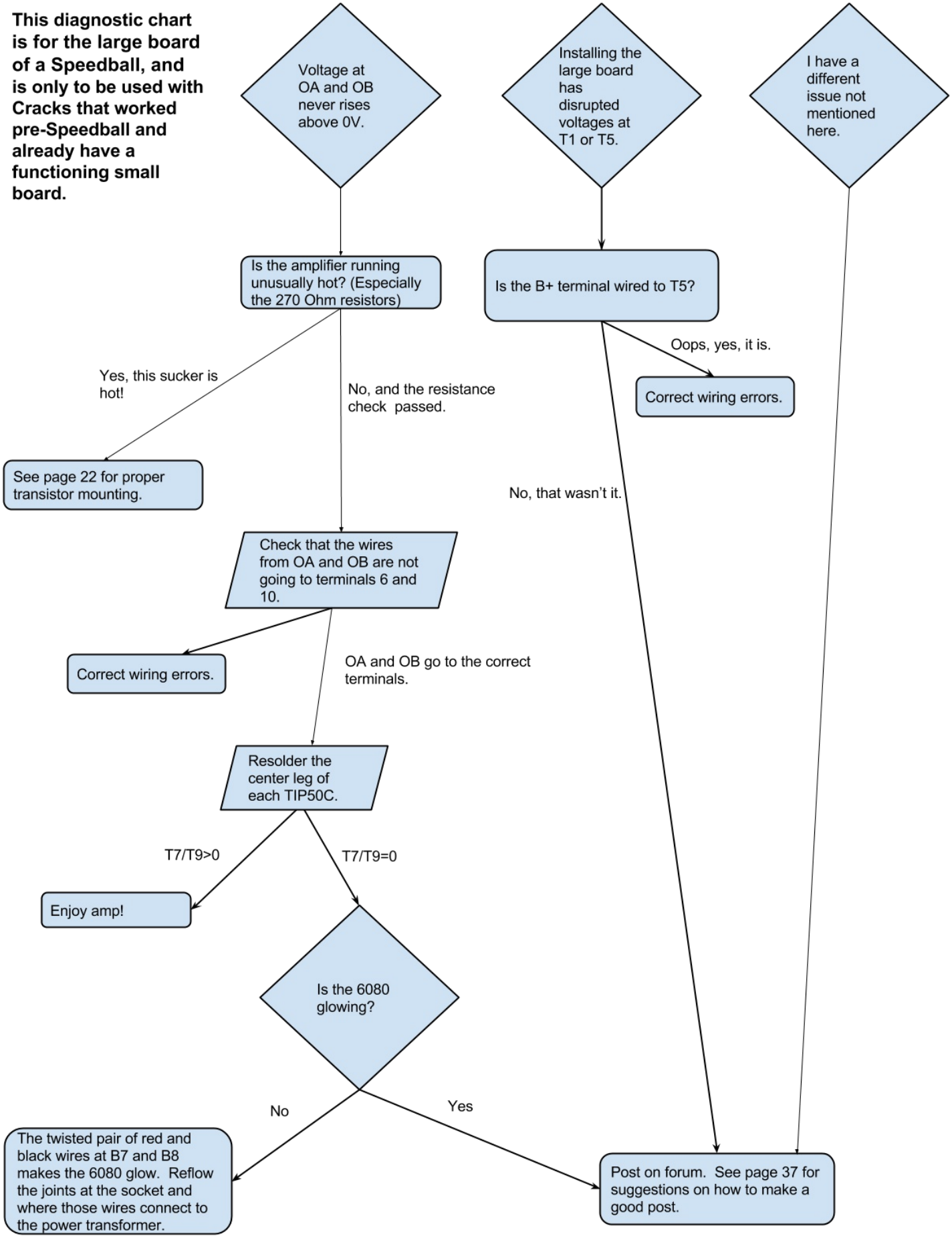
Don't worry if your voltages are not exactly these figures. Tube tolerance variations can change them by a few percent. If you run into any hitches, refer to the diagnostic flow chart on the next page which will guide you through the most common errors. If you still cannot find the root of your problem, you can always get help on the Bottlehead Forum. It's a wonderful tech support resource: http://www.bottlehead.com/smf/index.php

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.

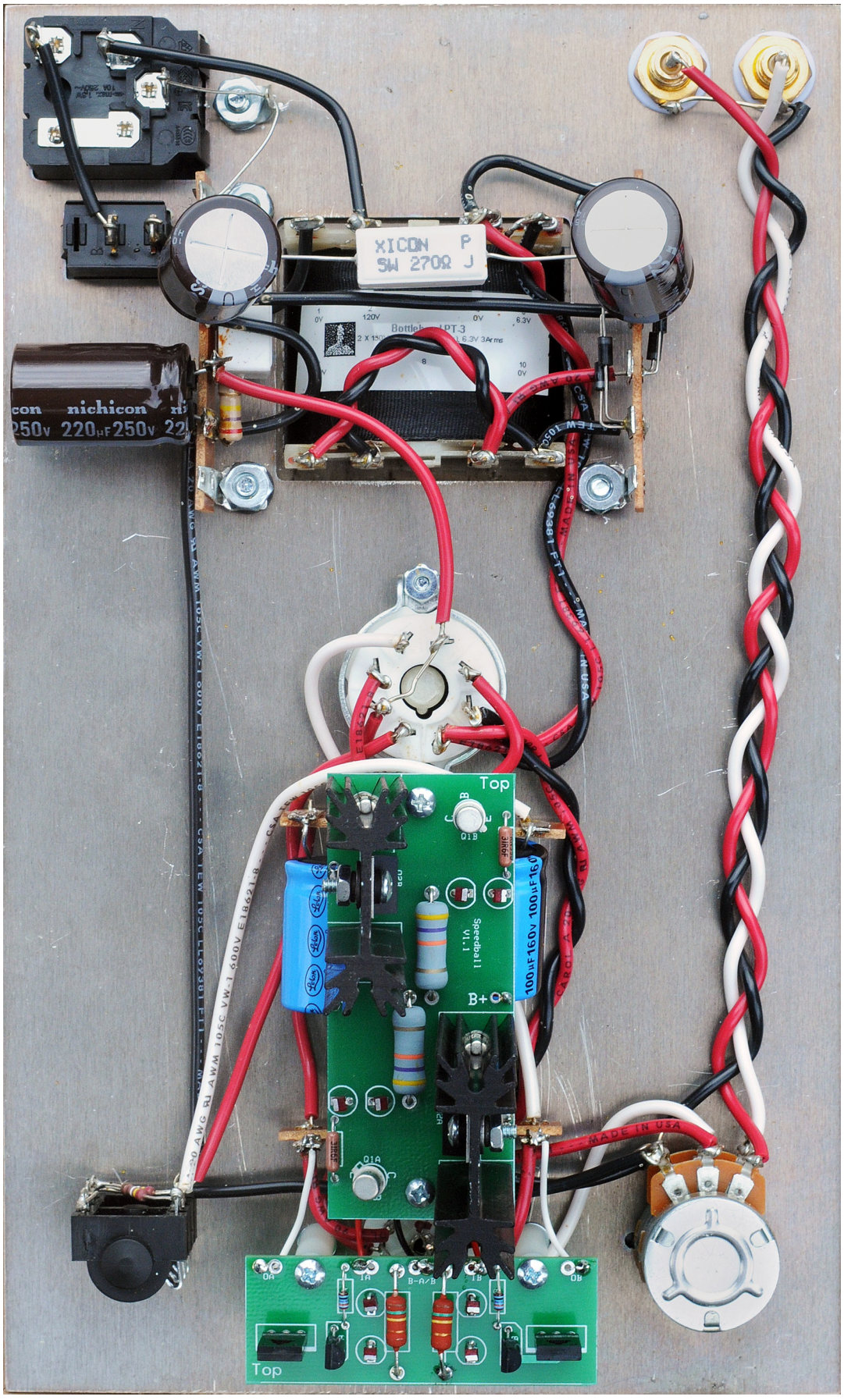
OK, if everything checks out, unplug the power cable from the wall and disconnect the meter.

You can resume use of your Crack at this time and listen to the benefits of the upgrade.

This diagnostic chart is for the large board of a Speedball, and is only to be used with Cracks that worked pre-Speedball and already have a functioning small board.



The Completed Speedball Upgrade



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.

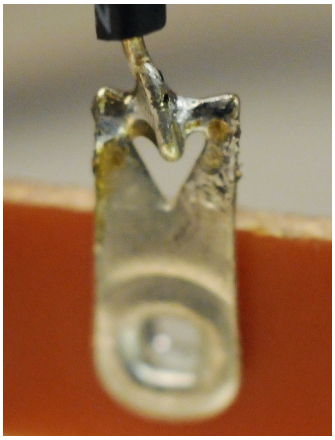
The Big Three

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!

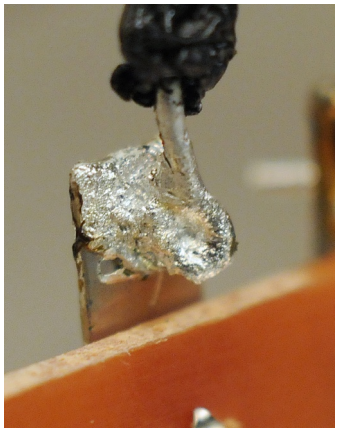
Bad solder joints



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. Contact us for a replacement switch.

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.

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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