Standard Upgrade

Mercury™ Upgrade Kit

Epiphone®

VALVE JUNIOR

Transformer Demonstration Project

Featuring custom Axiom® Power Transformer, Choke & Output Transformer!

MERCURY UPGRADE ASSEMBLY MANUAL

VERSION 012011

VALVE Junior

Mercury Upgrade Kit

This manual is for the Valve Jr.
PCB VERSION 2 or 3 ONLY!
(Please see the identification notes in this manual to determine which version you have.)

Circuitry modifications and design by
Sergio Hamernik and Alan Cyr

Manual written and designed by
Paul H. Smith

The Heart & Soul of Your Amp
Mercury MAGNETICS

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If you do not know how to read a schematic, we strongly recommend that you take this project to a qualified technician for installation.

All ***Mercury Magnetics*** products are 100% handmade by us in California, USA.

Mercury Magnetics products are UL (Underwriters Laboratories Inc.) recognized components for the USA and Canada. OBJY2 component systems, electrical insulation, E120568. UL Recognition, class 130(b) – Class 200(n). OBJY8 component systems, electrical insulation, certified for Canada, class 130(b) – Class 200(n).

Mercury Magnetics transformers and other products are in compliance with the European Union RoHS Directive 2020/95/EC with respect to the following substances: lead (Pb), mercury (Hg), cadmium (Cd, hexavalent chromium (CR (VI)), polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE).

Attention: Modifying your Epiphone Valve Jr. amp voids the factory warranty!

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CAUTION! The voltages in your amplifier can be dangerous. Transformers and chokes are not user servicable parts. Installation of these components should always be performed by an experienced technician. The simple ability to use a soldering iron is not enough to qualify a "do-it-yourself person." Those who are inexperienced in working with electronic circuits should never attempt to service their amplifiers. Household line currents can be deadly!! Transformers, chokes and large filter capacitors can store dangerous charges for several days, or longer, after the amplifier has been unplugged. Never touch the terminals of these components without being certain of their charge status. Risk of shock and damage to equipment may result from mishandling and/or improper use of these components. Please use common sense and always think safety first. After all, great tone is most enjoyed when you are alive to hear it.

SOLDERING NOTE: Depending upon the version your ***Valve Jr.*** may be assembled using *RoHS* compliant, lead-free solder. Working with lead-free solder is different than standard solder. Generally a hotter iron is necessary. For more information we recommend doing a web-earch for "lead-free soldering techniques."

CAPACITOR DISCHARGE WARNING: Safe discharging of *filter* capacitors matters. It is essential for your safety and to prevent damage to the amp's circuitry, that large or high voltage capacitors be fully discharged before measurements are made, soldering is attempted, or the circuitry is touched in any way. For information on how to do this, web-search "capacitor discharging." Also see the appendix for additional information.

CAPACITOR POLARITY: Note that many capacitors have positive and negative polarity, and are stamped accordingly. Be sure that their polarity is correct when soldering to a PCB.

BRAIDING, TWISTING AND COILING LEADS: Do not braid, twist or coil the power transformer's B+ lead wire. Check our reference illustrations and photos to see which leads are twisted together. Typically only the filament leads of the power transformer. Other positioning of leads may be necessary to minimize amp noise. Follow are diagrams and instructs for optimal performance.

TRIMMING TRANSFORMER LEADS: To minimize noise, measure and trim the solderable lead lengths of the transformers and ***Mini-Choke***™. Route all wires cleaning around the tubes, chassis, *etc.*

CLIPPING *vs.* UNSOLDERING PCB COMPONENTS: To make this ***Upgrade*** it will be necessary to remove several components from the Main PCB of the amp. Due to quality issues with modern off-shore PCB manufacturing, it can be difficult to unsolder an item without creating other problems, the most typical of which is an eyelet detaching from the PCB. Therefore we've indicated which components should be clipped vs. unsoldered. To unsolder heat your iron to 800ºF, then very quickly heating up one side of the existing solder connection while pulling it through on the other. If the iron is not hot enough, or you linger too long, the eyelet will get damaged (or fall off). If this happens you'll have to fabricate a repair, or created a jumper to a trace. See this manual's appendices for tips.

POWERING UP A GUITAR AMP: After making any modifications to an amp's circuit (e.g. this ***Upgrade***) use a *Variac* along with an current meter (some have both) to slowly apply power to the amp while checking for warning signs of circuitry errors or shorts. See the section on "Using a Variac" at the end of this manual.

LOADING OUTPUT TRANSFORMERS: You must connect a speaker or speaker cab to your amp before powering it up. Without a load the output transformer will blow.

MINI-CHOKE FACTOID: A ***Mercury Mini-Choke***™ replaces a resistor and adds a disernable amount of tonal dimension to the circuit.

TRANSFORMER BREAK IN PERIOD: As a general rule, transformers require approximately 30 hours of ***playing time*** to be fully broken in. Please refer to ***Mercury's*** website for more information.

BE SAFE! ALWAYS USE PROTECTIVE EYEWEAR!

READ THIS FIRST! Identifying which verion of the amp you own.

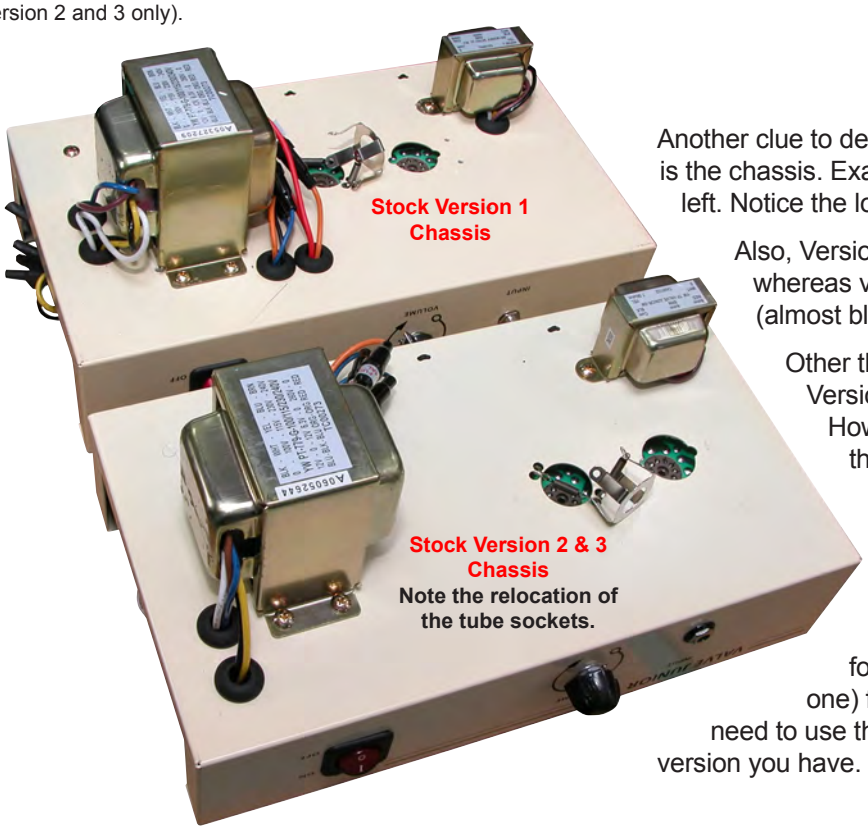
There are currently at least 3 different versions of the ***Valve Junior's*** PCB (printed circuit board) in circulation. Before you can begin the ***Upgrade*** you must identify which version you have so that you can use the correct ***Upgrade*** instruction manual and parts. Use the following as a guide.

2 Basic Flavors and 3 Versions

The ***Valve Jr.*** comes in 2 flavors: Head or combo. Both amps are fundamentally the same, using the same components. However, the original Version 1 ***Valve Jrs.*** came with a single 4 ohm output, whereas the later Versions 2 and 3 were given 4, 8 and 16 ohm outputs.

Valve Jr. Head
With 4, 8 & 16 ohm outputs
(Version 2 and 3 only).

Valve Jr. Combo
Version 1, 2 and the original 3s are 4 ohm output only. Now all Version 3s are 4, 8 and 16 ohm.



Stock Version 1 Chassis

Stock Version 2 & 3 Chassis
Note the relocation of the tube sockets.

Another clue to determining which version you have is the chassis. Examine the chassis photos on the left. Notice the location of the tube sockets.

Also, Version 1 and 2 PCBs were green, whereas version 3 PCBs are dark brown (almost black).

Other than the color of the PCBs, Versions 2 and 3 are nearly identical. However, Epiphone did change the values of some of the minor components from Version 2 to 3 (which are indicated in the illustrations in this manual).

Note: There are 2 tutorials on the CD-ROM; one specifically for Version 1 and the other (this one) for Versions 2 and 3 PCBs. You'll need to use the appropriate tutorial for the PCB version you have.

The Story Behind *Mercury's* First Transformer Demonstration Project

Way back in '06 your friends at ***Mercury*** set out to create a basic demonstration to show exactly what quality ***transformers*** could do for your tone. Our goal was to reveal the sonic capabilities of high quality magnetics – *i.e.* properly designed *vs*. generic ***transformers***.

What started out as a simple educational demo ended up blowing the minds of virtually everyone who heard it. There was no denying how extraordinary our little test amp sounded after the ***Mercury trannys*** were installed....

The guinea pig

For the experiment we chose ***Epiphone's*** remarkable value, the all-tube ***Valve Jr:***

- 5 watts
- Single-ended, class A design
- One generic 12AX7 preamp tube
- One generic EL84 power tube
- Generic ***power*** & ***output transformers***
- No choke

Epiphone's Valve Jr. is an ideal demonstration platform for our purposes because it is such a fundamental, stripped-down tube amp. With no digital components, no tone knobs, no added f/x circuits, nothin'... you just can't get any more elementary and still have a playable tube amp!

All this for around $100.00–$150.00 retail? Yes, but as you might expect, the stock amp is rather dull and anemic-sounding.

The *Mercury Upgrades*

The ***Mercury*** team spent about 3 months working on the little amp before deciding upon the best sounding combination of ***Upgrades*** and adaptations.

The project was headed by *Sergio Hamernik*, of ***Mercury Magnetics***, and Los Angeles-based amp wizard, *Alan Cyr.* After examining the original circuitry several custom ***Axiom***-series ***transformers*** and ***Mini-Choke*** sets were designed and tested. Alan was then able to clean up the circuit, effectively opening up the amp's sound because much of the original circuit was designed to get around and reduce noise generated from the original trannys – no longer necessary by the ***Mercury Upgrades***.

The result is a remarkably toneful little amp that runs quiet and sounds B-I-G.

If you are an experimenter you may want to try different speaker and/or tube configurations, but oddly enough, those components deliver relatively minor tonal changes compared to the absolutely H-U-G-E improvement of the ***Mercury trannys***.

Here in Los Angeles, the ***Mercury Upgraded Valve Jr.*** is one of the hottest, most in-demand insider amps around. Those who've heard it immediately want one – and at such low cost to make the mods, who can afford NOT too!

With this kit you'll be able to transform your bland little ***Valve Jr.*** into a keeper.

Continued on next page ➔

Factoid: A ***Mercury Mini-Choke***™ replaces a resistor and adds a discernable amount of tonal dimension to the circuit.

Perform your own experiment when working on your ***Valve Jr.***—try it with and without the ***choke*** mod to the circuit. You'll have no difficulty hearing how much better it sounds with the ***choke***. ***Chokes*** were originally used in vintage amps but seldom are now due to the economics of amp building (a cost issue, not a tonal one!). ***Chokes*** extend the life of the ***power transformer*** and rectifier. A choke is much more than a simple inductor. It can also store energy like a capacitor. Better voltage regulation results from using a ***choke*** that puts less stress on your ***power transformer*** helping it to live longer. ***Chokes*** permit higher load currents to be drawn from vacuum tube rectifiers without exceeding their peak current rating. This means life extension for your tube rectifier! Solid state rectifiers run happier as well. If that's not enough, the tone of your amp will noticeably improve with a "peaked and tweaked" hand-tuned ***choke*** from ***Mercury***.

"State-of-the-Art" Studio Samples

Follow these links to a selection of undoctored MP3 samples of the prototype Mercury Upgraded Valve Jr. Just for the fun of it these samples were made under primitive conditions (see the photo to the right).

A special "Thank you!" goes out to LA musician Phil Woodward for his guitar work on these tracks:

Mercury Upgrade Sample 1
Mercury Upgrade Sample 2
Mercury Upgrade Sample 3
Mercury Upgrade Sample 4
Mercury Upgrade Sample 5

You've made the *Mercury Upgrade* – *now* you're ready to play!

VALVE Junior

Mercury Upgrade Kit

Parts List

Your ***Mercury Upgrade Kit*** for the ***Epiphone Valve Jr.*** (Version 2 or 3 PCBs) includes these components.

Transformers:
- ***Mercury* Axiom** Power Transformer (part #: EPJR-P) 1
- ***Mercury* Axiom** Output Transformer (part #: EPJR-OM) 4, 8 & 16Ω outputs 1
- ***Mercury* Axiom** Mini-Choke (part #: EPJR-C-3H) 1

Capacitors:
- 10μF 25V or 50V electrolytic (radial) 1
- 22μF 40V electrolytic (axial) 1
- 22μF 450V electrolytic (axial) 2
- 22μF 450V electrolytic (radial) 2
- 270ρF silver mica 1
- 680ρF silver mica 1

Resistors:
- 100KΩ ½W carbon film 2
- 220KΩ ½W carbon film 1
- 470KΩ ½W carbon film 1
- 1.5KΩ ½W carbon film 2
- 1MΩ ½W carbon film 1
- 470Ω 2W flame proof 1
- 3.3KΩ 2W flame proof 1

Misc. Components:
- CD-ROM with photographic instructions (with schematics) 1
- Jack insulators to isolate input jack 2
- Stand-off connector, nut, washer & bolt ..... 1 set
- 8-pin tube socket 1
- 8-32—1/4” bolts, washers, locking washers & nuts (for mounting the choke to the chassis) ..... 2 sets
- 8-32—1/2” bolts, washers, locking washers & nuts (for mounting PT and OT) ..... 6 sets
- 6” coil of UNSHIELDIED buss wire ..... 1 coil
- 6” coil of wire insulation “spaghetti” ..... 1 coil
- 12” coils of insulated black, white, yellow, red and blue wire ..... 5 coils
- ***Mercury*** metal badge 1
- ***Mercury*** guitar case sticker 1

Alan’s 6V6 option components: In addition to the standard ***Mercury Upgrade***, you may also want to install ***Alan’s 6V6 option***. It’s fairly simple to do, but requires adding a socket to the circuit (another hole inthe chassis). There is a special section of this manual dedicated to making ***Alan’s 6V6 option***. Here is the list of components included with this kit (6V6 tube NOT included) –
- 220KΩ ½W resistor (carbon film) 1

Anti-squeal option: Owners of some, but not all, Version 3 PCB amps have reported an unusual “squeal” emitting from their amps. This random noise seems to be related to the quality of the Chinese components. We recommend that you DO NOT install this option unless you experience this phenomenon. There is a special section of the manual dedicated to installing this option. Here is the list of components (included with the kit) –
- 220KΩ ½W resistor (carbon film) 1
- 47ρF capacitor (ceramic disk) 1

Extra components note: Each kit includes components for all 3 versions of the ***Valve Junior’s*** PCB. However, only the components you need for a Version 2 and 3 PCBs ***Upgrade*** are listed above (and on the next page).

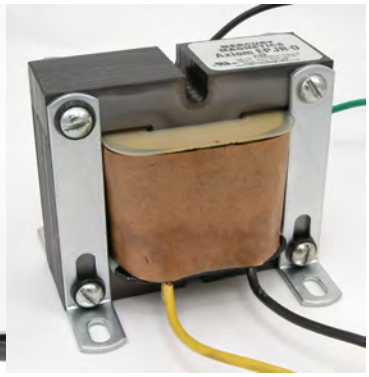
IMPORTANT NOTE REGARDING VERSION 3 AMP ON/OFF SWITCHES: Do not attempt to disconnect the leads from the ON/OFF switch of your amp. We have received numerous kit-builder reports that any of the ON/OFF switches literally fall apart with any attempt to disconnect their leads! Instead, cut the wires so that you can use wire connectors. We’re working on a better solution. But for now, just cut the leads so that they can be reconnected with wire connectors.

Component Identification

Use these photos to identify the components needed to make your *Version 2* or *3* PCB ***Upgrade***:

Axiom
EPJR-P
(power transformer)

Axiom
EPJR-C-3H
(***Mini-Choke***™)



Axiom
EPJR-O 4Ω & EPJR-OM 4, 8 & 16Ω
(output transformer)

RESISTORS (carbon film)

2x 100KΩ 1/2W (brown/black/yellow)

1x 220KΩ 1/2W (red/red/yellow)

1x 470KΩ 1/2W (yellow/violet/yellow)

2x 1.5KΩ 1/2W (brown/green/red)

1x 2.2KΩ 1/2W (red/red/red)

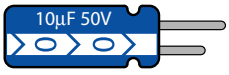
1x 1MΩ 1/2W (brown/black/green(

RESISTORS (flame-proof)

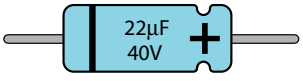
1x 470Ω 2W (yellow/violet/brown(

1x 3.3KΩ 2W (orange/orange/red)

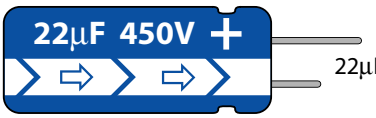
CAPACITORS (electrolytic)

1x 

10µF 25V or 50V (radial)

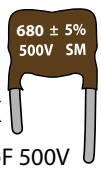
1x 

22µF 40V axial

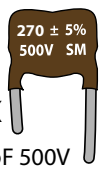
1x 

22µF 450V (radial)

CAPACITORS (silver mica)

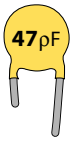


1x 680pF 500V



1x 270pF 500V

CAPACITORS (ceramic disk)

1x 

47pF

NUTS 'N BOLTS

2x 
8-32, 1/4" bolt, nut, washer & lock washer for attaching the ***Mini-Choke*** to the chassis.

6x 
8-32, 1/2" bolt, nut, washer & lock washer for attaching the output & power transformers to the chassis.

2x 
4-40, 1/4" bolt, nut & lock washer for attaching the 8-pin tube socket to the chassis.

OTHER COMPONENTS


~6 in. UNSHIELDED buss wire


~6 in. wire insulation "spaghetti"

~12 in. coils

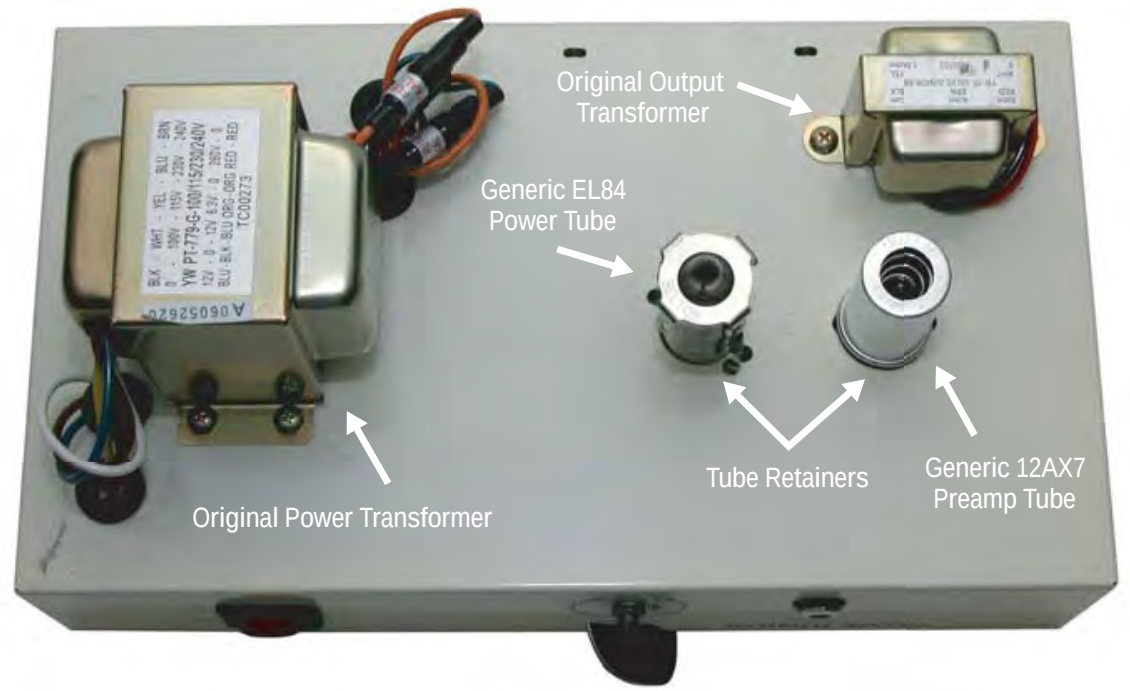
Shielded ORANGE, RED, BLUE, BLACK & YELLOW wire


8-pin tube socket


Stand-off connector with nut, washer & bolt

Mercury nameplate

Note that most capacitors have +/- polarity. Be sure to study the schematics for the correct directions when ***Upgrading*** your amp.



Reference photo of a stock Version 2 or 3 Valve Jr. chassis. Photo shows external chassis layout of transformers and tubes. Note that hte EL84 and 12AX7 tube (or valve) sockets are identical. Be careful NOT to accidentally switch these tubes!

Recommended tools for this project:

- Set of Phillips screwdrivers
- Wire strippers
- Good quality solder iron (capable of temps at > 800ºF)
- Electronics grade solder
- Solder sucker and/or wick
- *Dremel Tool* with polishing and carbide cutting tips*
- *Exacto* knife for cutting and scraping PCB traces*
- Small needle-nose plyers
- Small ratchet set (American and Metric)
- Sharp knife for scraping insulation layer from traces
- Electric drill with 1/16" and 11/64" bits
- 1" and 9/16" Varibit or stepped drill bit
- Silicon goo
- *Loctite 290* (green)
- Pure isopropyl alcohol and Q-tips
- *Variac* and current meter

**Dremel Tool* can be used to cut traces and drill holes in PCB.

Synopsis of *Upgrade* Sequence:

1. Disconnect chassis from amp and discharge the caps.
2. Remove old transformers.
3. Disconnect Main and Output PCBs and remove/ desolder components that will be changed.
4. Drill new transformers and choke mounting holes. If you'll be adding Alan's 6V6 option, drill the socket and mounting screw holes for that.
5. Mount transformers and choke. Install 6V6 socket and stand-off connector bracket if you are adding Alan's 6V6 option.
6. Drill holes for filament wires and enlarge holes for other connections into the main PCB.
7. Cut traces on the main PCB.
8. Solder buss wire jumpers to the main PCB.
9. Solder in upgrade's resistors and capacitors onto the main PCB.
10. Make and solder in filament supply leads between V1 and V2 (EL84 and 12AX7) sockets.
11. For the 6V6 option, install 8-pin socket's components and connecting leads.
12. Solder OT's leads to the output's mini PCB and reconnect to the chassis.
13. Complete connections to the 6V6 option.
14. Solder remaining leads for the PT, choke and the OT to the main PCB and the On/Off switch.
15. Reattach main PCB to chassis.
16. Using the supplied diagrams, triple-check your work to ensure that all connections are made and are correct.
17. Power up using a variac and amp meter. **CAUTION: DO NOT POWER UP THE AMP WITHOUT THE SPEAKER CONNECTED!!!!**
18. Arrange leads to minimize RF and noise.

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Epiphone Valve Jr. • Version 2 & 3 Chassis

Locations of ***Mercury Magnetics*** transformers & choke mounting hole modifications

Back of chassis

6V6 Mod (only!)
Hole location:
6-1/2" x 5-1/4" from the front
left-hand corner of the chassis
1" dia. From the center of the 1" dia. hole
drill 2 mounting screw holes
exactly 1-1/2" apart.

Enlarge existing hole →

3/16" dia. hole

1/8" dia. hole

1/8" dia. hole

Mercury's
Axiom EPJR-O
OUTPUT TRANSFORMER
mounting hole locations
2.5" x 2" sq.
3/16" dia. holes

Hole location:
9-1/8" x 4-1/4" from the front
left-hand corner of the chassis

3/16" dia. hole

3-1/2"

Mercury's
Axiom EPJR-P
POWER
TRANSFORMER
mounting
hole
locations

2"

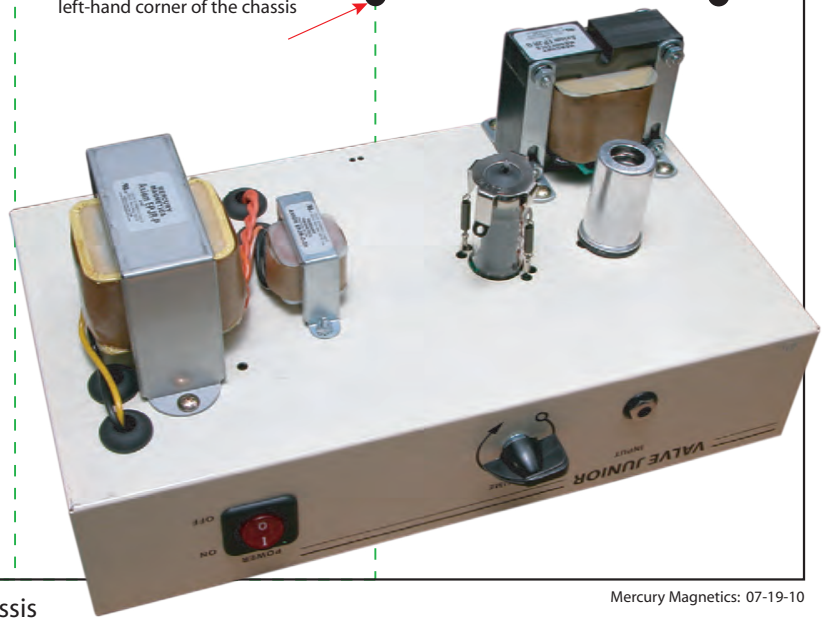
Mercury's
Axiom EPJR-C-3H
CHOKE
mounting
hole
locations

3/16" dia. hole

3/16" dia. hole

Hole location:
4" x 2-3/16" from the front
left-hand corner of the chassis

Hole location:
2-1/16" x 2" from the front
left-hand corner of the chassis



(Outside chassis: 12-1/4" x 7")

Front of chassis

Mercury Magnetics: 07-19-10

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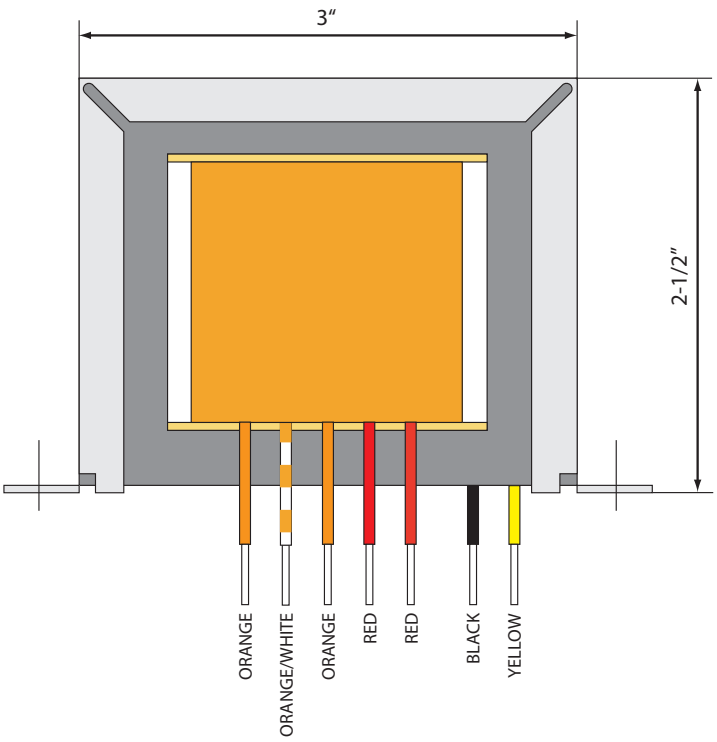
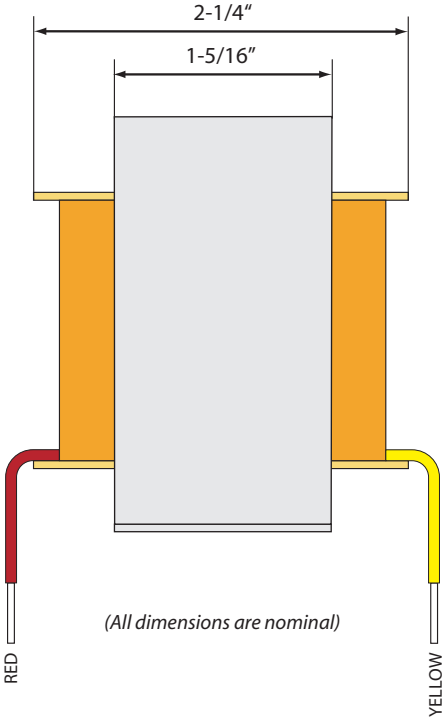
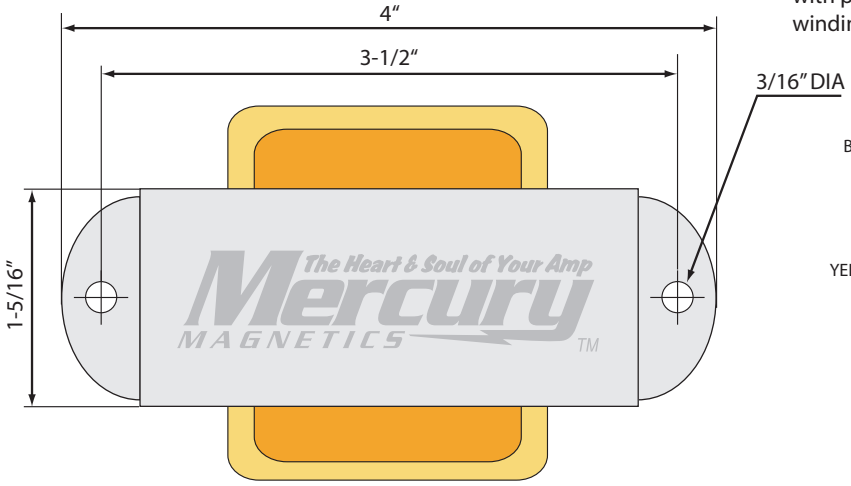
EPJR-P

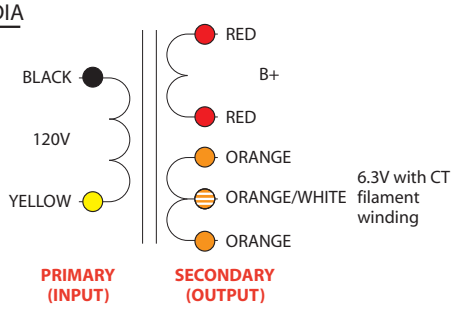




(All dimensions are nominal)

Low flux/high impedance inductance design with primary to secondary humbucking winding configuration.





VALVE Junior
Mercury Upgrade Kit

Epiphone Valve Jr.
Origin: Stock Valve Jr. purchased in April 2005 specifically for modification purposes.

CLASS: Axiom®
TYPE: Power Transformer
PART NO.: EPJR-P
ORIGINAL EPIPHONE PART NO: TC00273
MOUNTING: Horizontal A-Frame
VA RATING: 30VA
DATE: 03-30-06

EPJR-P

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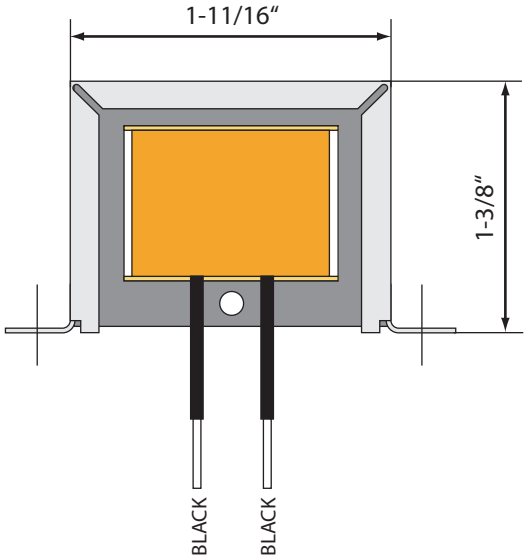
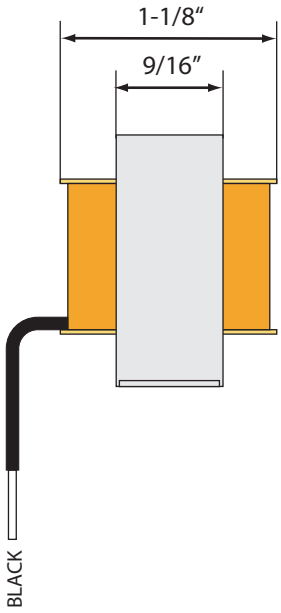
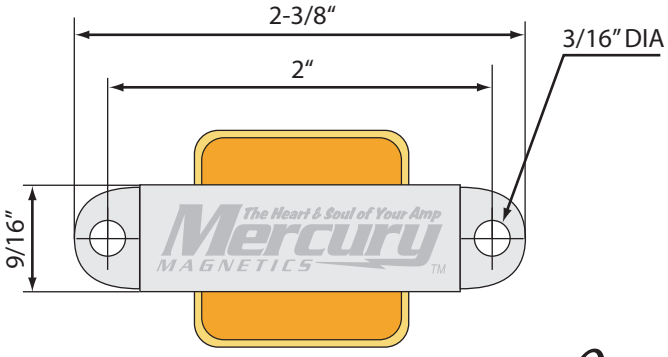
100% of our products are designed & handmade in So. California, USA. • Established in 1954

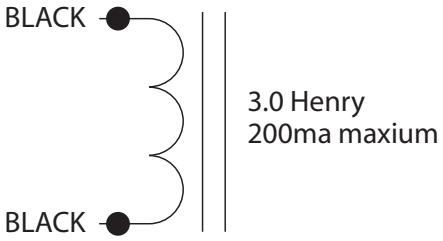
EPJR-C-3H





(All dimensions are nominal)





VALVE Junior
Mercury Upgrade Kit
Epiphone Valve Jr.

Origin: Stock Valve Jr. purchased in April 2005 specifically for modification purposes.

CLASS: **Axiom®**
TYPE: **Mini-Choke™**
PART NO.: **EPJR-C-3H**
ORIGINAL EPIPHONE PART NO.: **N/A**
MOUNTING: **Horizontal A-Frame**
POWER RANGE: **3 Henry / 200ma max.**
DATE: **03-27-06**

NOTE: The introduction of the first Mini-Choke™. This choke was specially designed by ***Mercury Magnetics*** for the **Valve Jr.** but may also be used in almost any amp style. (Call for more information.)

EPJR-C-3H

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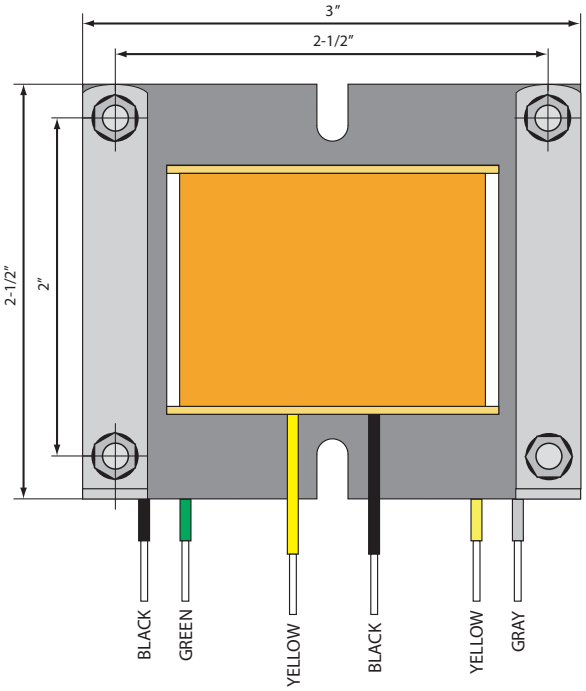
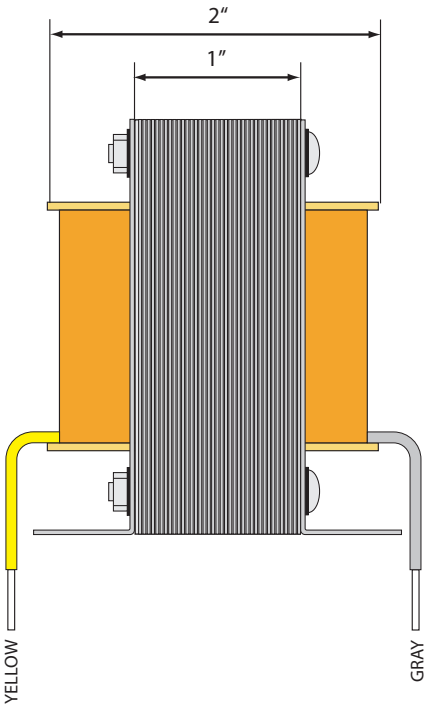
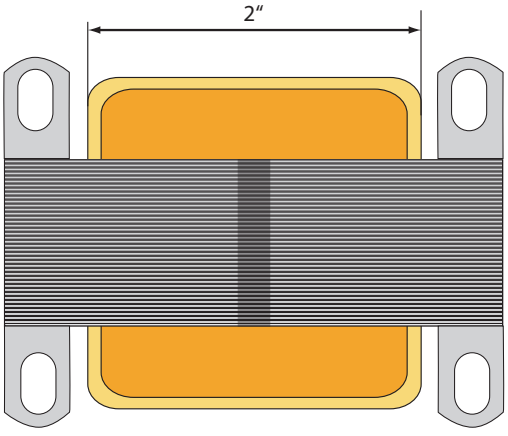
100% of our products are designed & handmade in So. California, USA. • Established in 1954

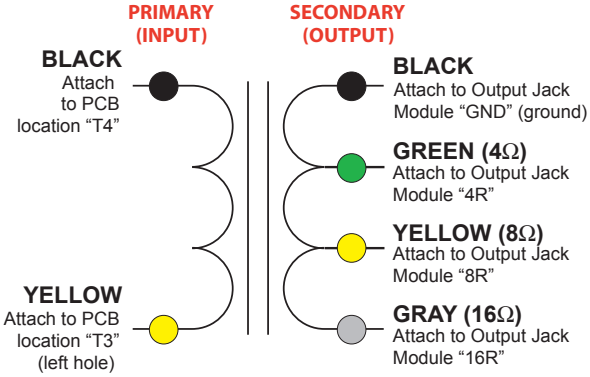
EPJR-OM
MULTI-TAP VERSION

(All dimensions are nominal)









VALVE Junior
Mercury Upgrade Kit

Epiphone Valve Jr.
Origin: Stock Valve Jr. purchased in April 2005 specifically for modification purposes.

CLASS: Axiom®
TYPE: Output Transformer
PART NO.: EPJR-OM
ORIGINAL EPIPHONE PART NO.: YW TF-VALVE JUNIOR-5W

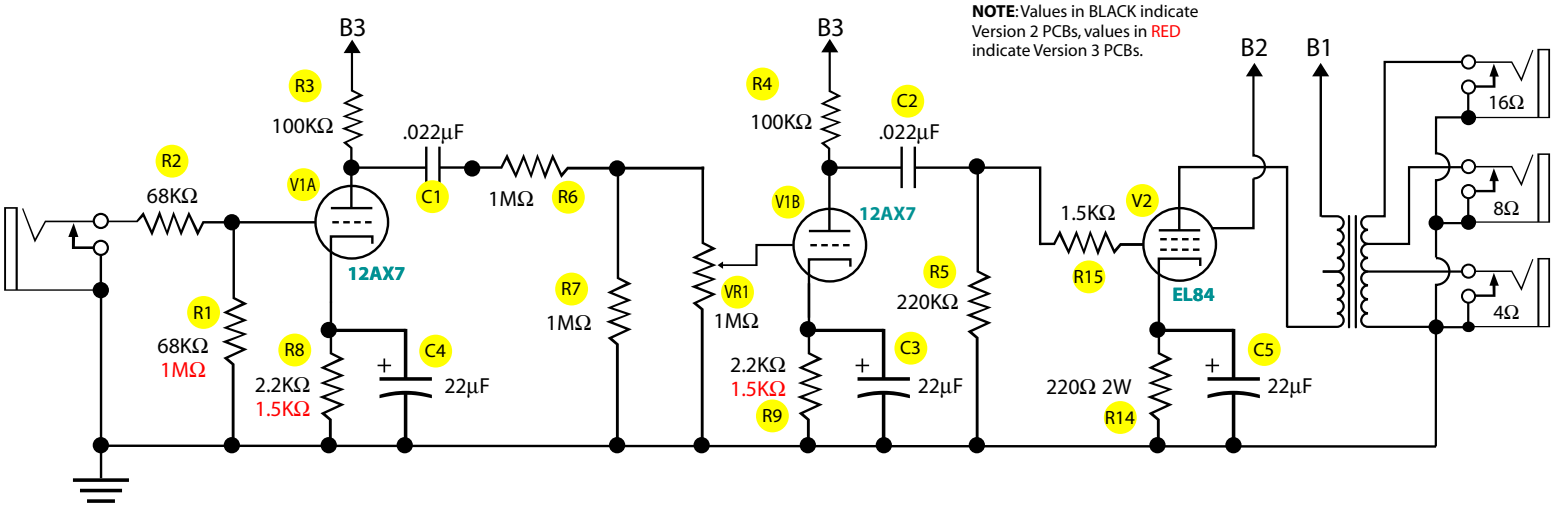
MOUNTING: Horizontal L-Bracket
POWER RANGE: Our OTs are rated to handle up to 50% more power than the original manufacturer spec.
DATE: 04-24-07

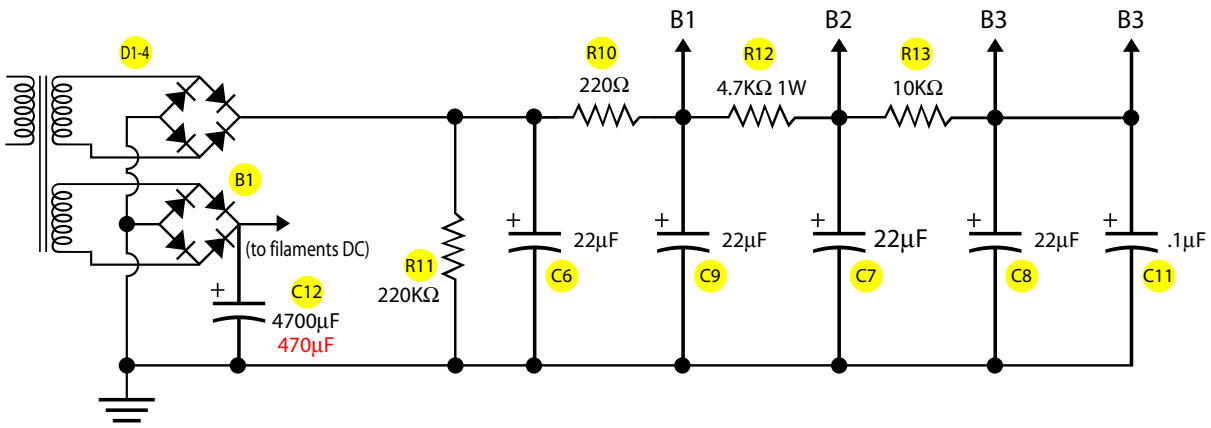
EPJR-OM
MULTI-TAP VERSION

Valve Junior Head

(Unmodified stock version • "Version 2 & 3" PCBs)

NOTE: Values in BLACK indicate Version 2 PCBs, values in RED indicate Version 3 PCBs.





DRAWN BY MERCURY MAGNETICS
08-03-07
REV. 04-09-10

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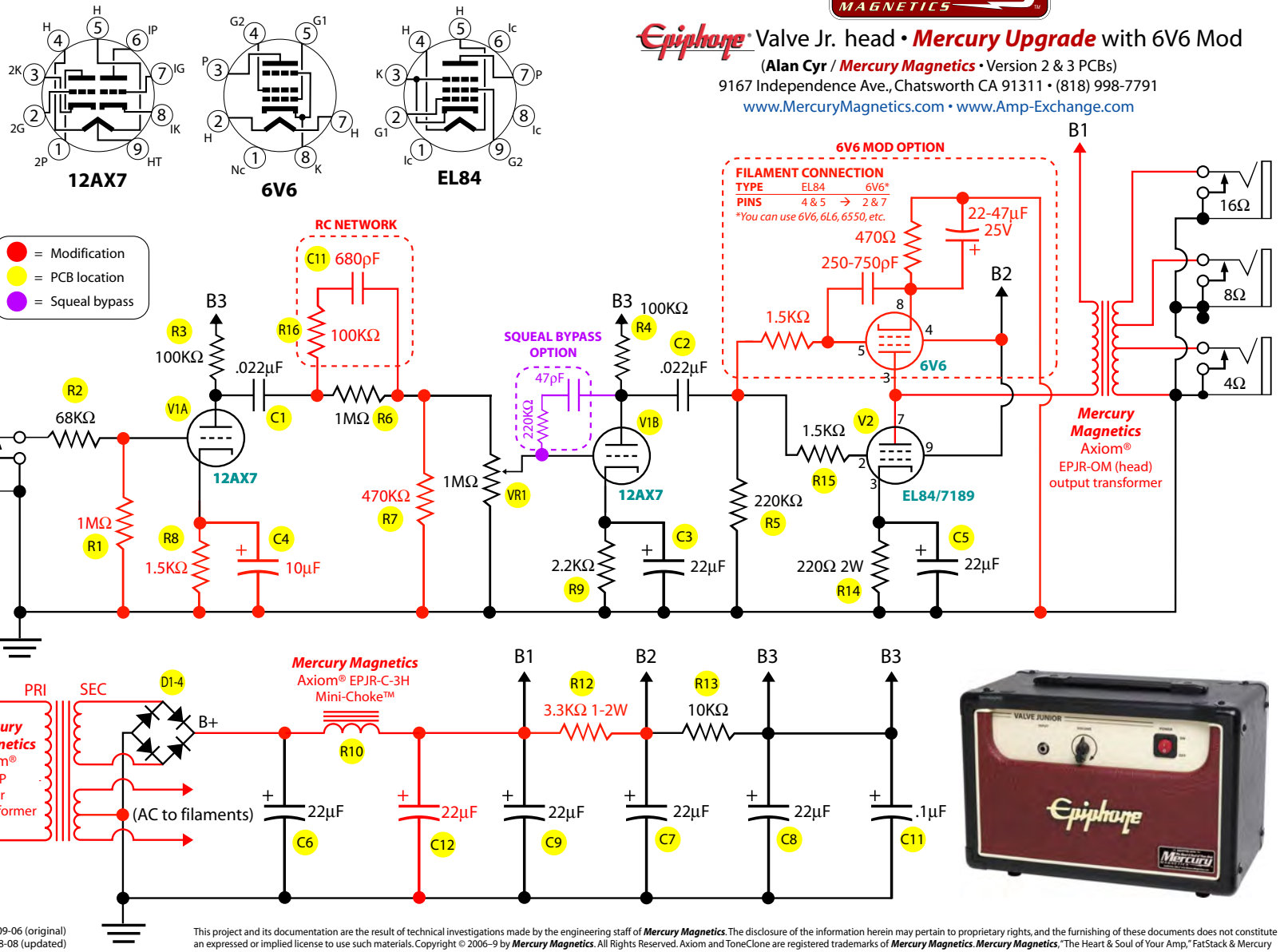
www.Amp-Exchange.com

Epiphone Valve Jr. head • *Mercury Upgrade* with 6V6 Mod

(**Alan Cyr** / *Mercury Magnetics* • Version 2 & 3 PCBs)
9167 Independence Ave., Chatsworth CA 91311 • (818) 998-7791
www.MercuryMagnetics.com • www.Amp-Exchange.com



VERSION: 05-09-06 (original)
6V6 REV. 07-28-08 (updated)
REV. 12-02-10

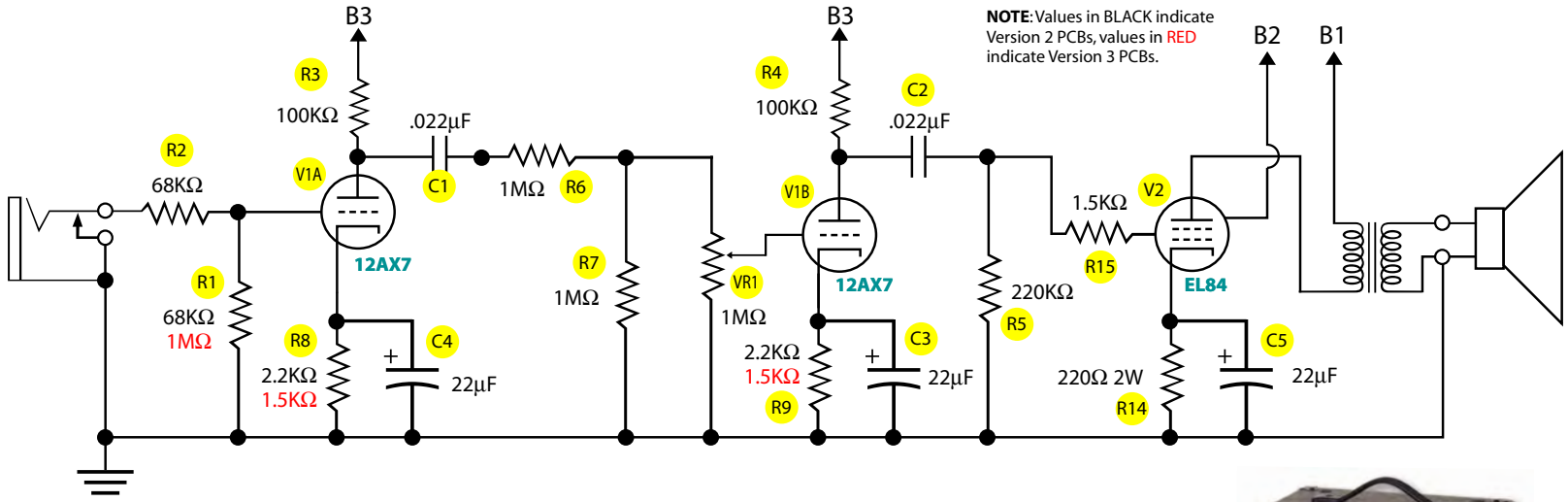
Epiphone

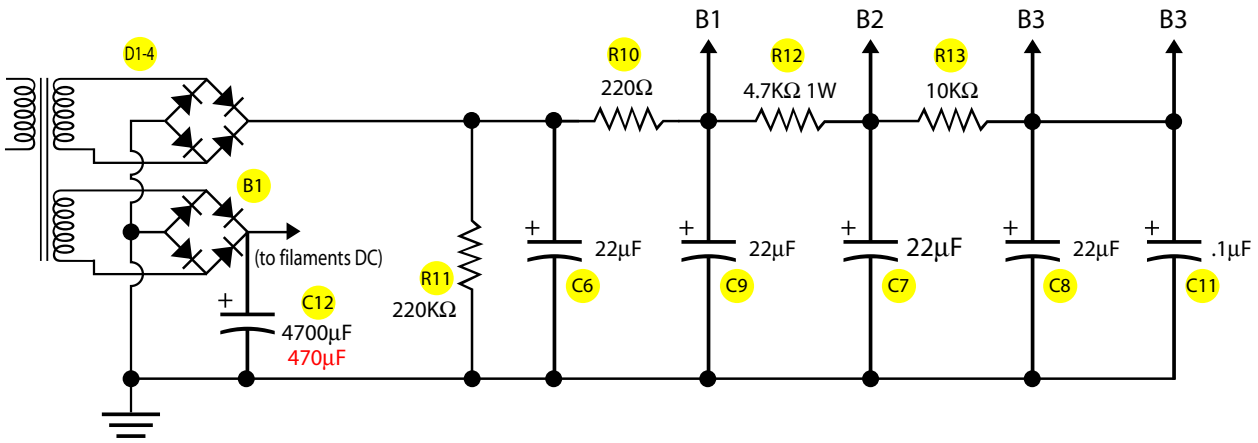
Valve Junior Combo

(Unmodified stock version • "Version 2 & 3" PCBs)

NOTE: Version 3 EVJ Combos are now appearing with 4, 8 & 16Ω outputs. See the head version of the schematic if you have one of these amps.

NOTE: Values in BLACK indicate Version 2 PCBs, values in RED indicate Version 3 PCBs.





DRAWN BY MERCURY MAGNETICS
05-09-06
REV. 04-09-10

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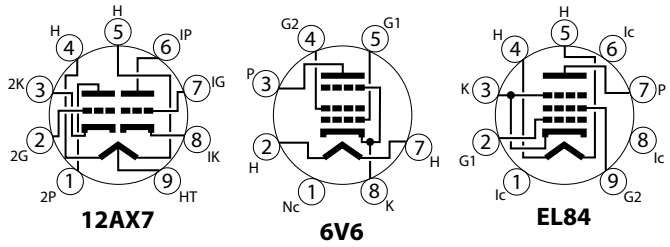

Epiphone Valve Jr. head • Mercury Upgrade with 6V6 Mod

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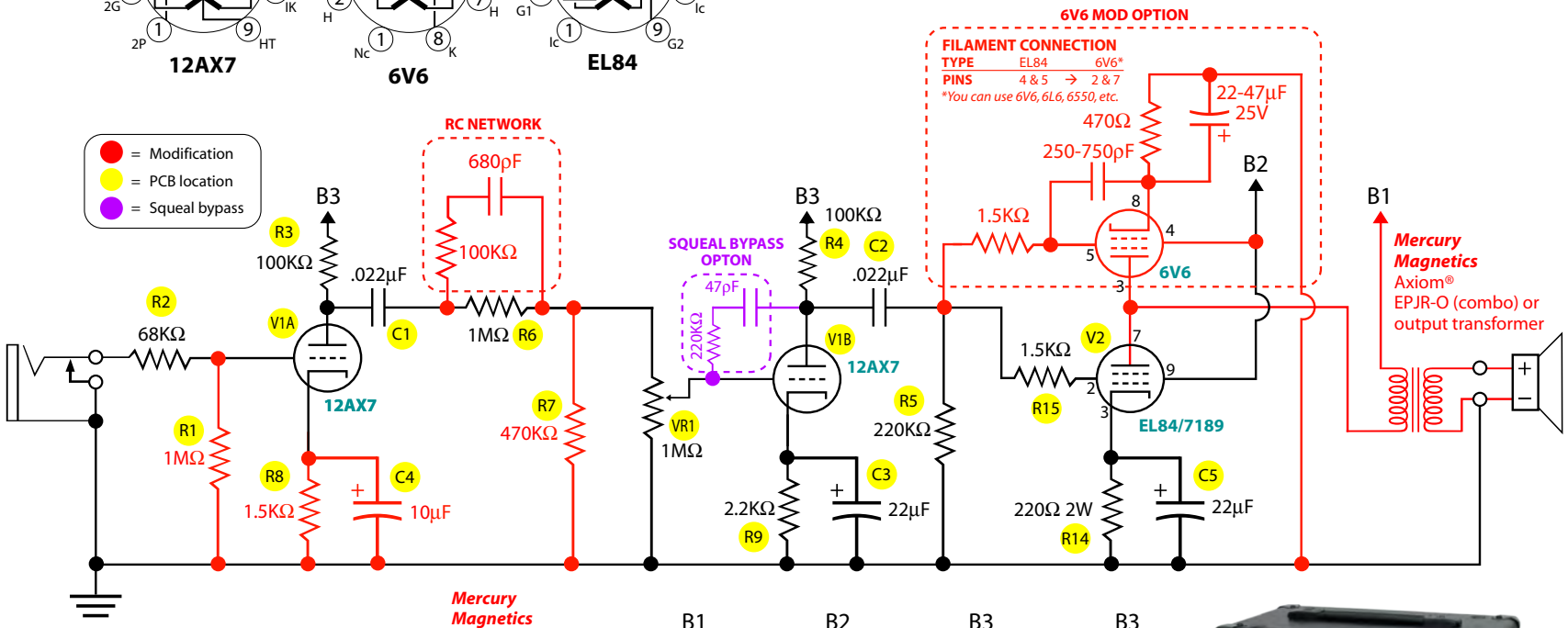


VERSION: 05-09-06 (original)
6V6 REV. 07-28-08 (updated)
REV. 04-09-10

VALVE Junior

Mercury Upgrade Kit

VERSION 2 & 3 PCBs ONLY!

An Overview of the *Upgrading* Process

Read the this manual BEFORE beginning the ***Upgrade***. In that way you'll be more aware of what's required and whether or not it is within your ability. Also, be sure to read through the various appendices for helpful hints and tips. If you have any questions, please do not hesitate to call us here at ***Mercury Magnetics***!

OUTLINE

You're about to strip your stock amp and prepare it for the ***Mercury Upgrade***. It's good practice to place all of the components you remove into holding containers so they are easy to locate and won't get lost. Most of the components you are stripping will not be used again. But hold onto everything for now until your ***Upgraded*** amp is up and running.

Let's get started:

1. Unplug the amp from the power source (AC).
2. Remove all chassis retaining screws from the back and the two on the top of the amp.
3. Remove the chassis from the amp – disconnect the two speaker wires first.
4. Discharge the capacitors.
5. Remove the following from the Main PCB (printed circuit board):
   a. Tubes
   b. Transformer clips
   c. Unbolt the main PCB.
   d. Unclip and/or unsolder all other direct connections to the main PCB.
   e. Unbolt and remove the stock output and power transformers

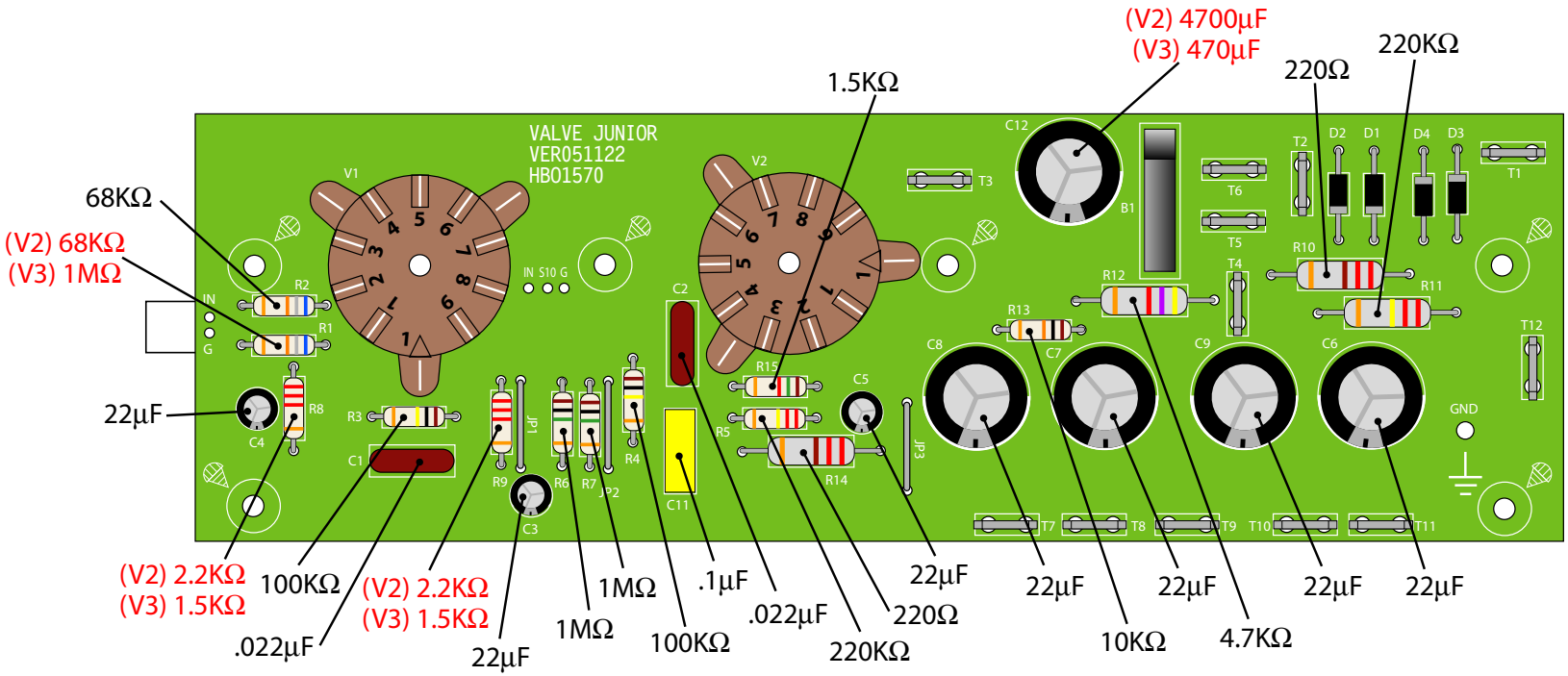
   Special note: The solder used in these amps is *RoHS* compliant – a term for a new industry standard that basically means the solder is lead-free. This also means that you'll need to use a good quality iron running hotter than traditional solder melting temperatures (set it for about 800° F) – *RoHS* compliant solder melts at higher temps than the original soldering alloys but it's likely you'll be using regular electronics solder for this project. You may also want to do a web search to study up on working with *RoHS* solder.

   For drilling or resizing holes we recommend that you use a *Dremel Tool* with a 1/16" bit. A hole reaming bit will also come in handy to enlarge existing holes. And a small grinding head will serve as a trace-cutter. A sharp pocket knife or *Exacto* is recommended for scraping away PCB insulation to reveal traces.

   See appendixes for special instructions regarding trace cutting, trace revealing, and adding jumpers.
6. Use the illustrations as a reference to strip the main PCB in this order:
   a. Unsolder items
   b. Hole drilling and enlarging
   c. Cut traces
   d. Reveal traces
   e. Add jumpers
7. Carefully compare your stripped and modified Main PCB so that it matches the illustrations in this Sequence. A missed step or mistake will bite you later on. Take your time to do a methodical and thorough approach.
8. The chassis needs to be modified to hold the ***Upgraded power*** and ***output transformer*** and the ***Mini-Choke***. If you will be adding the ***6V6 Mod***, you'll need to add the tube socket as well. Reference the chassis template, make the modifications and bolt on the transformers and Mini-Choke. If you'll be adding the 6V6 Mod, see the special section regarding how.

Epiphone Valve Jr. • STOCK MAIN PCB

(VERSIONS 2 & 3)



Note: This is a reference diagram. To date, *Epiphone* has released 3 versions of the *Valve Jr.* This diagram shows the Main PCB of Versions 2 & 3. The value changes from Version 2 to 3 are indicated in **RED**. Also note that Version 3's PCB is **DARK BROWN** and not **GREEN** in color.

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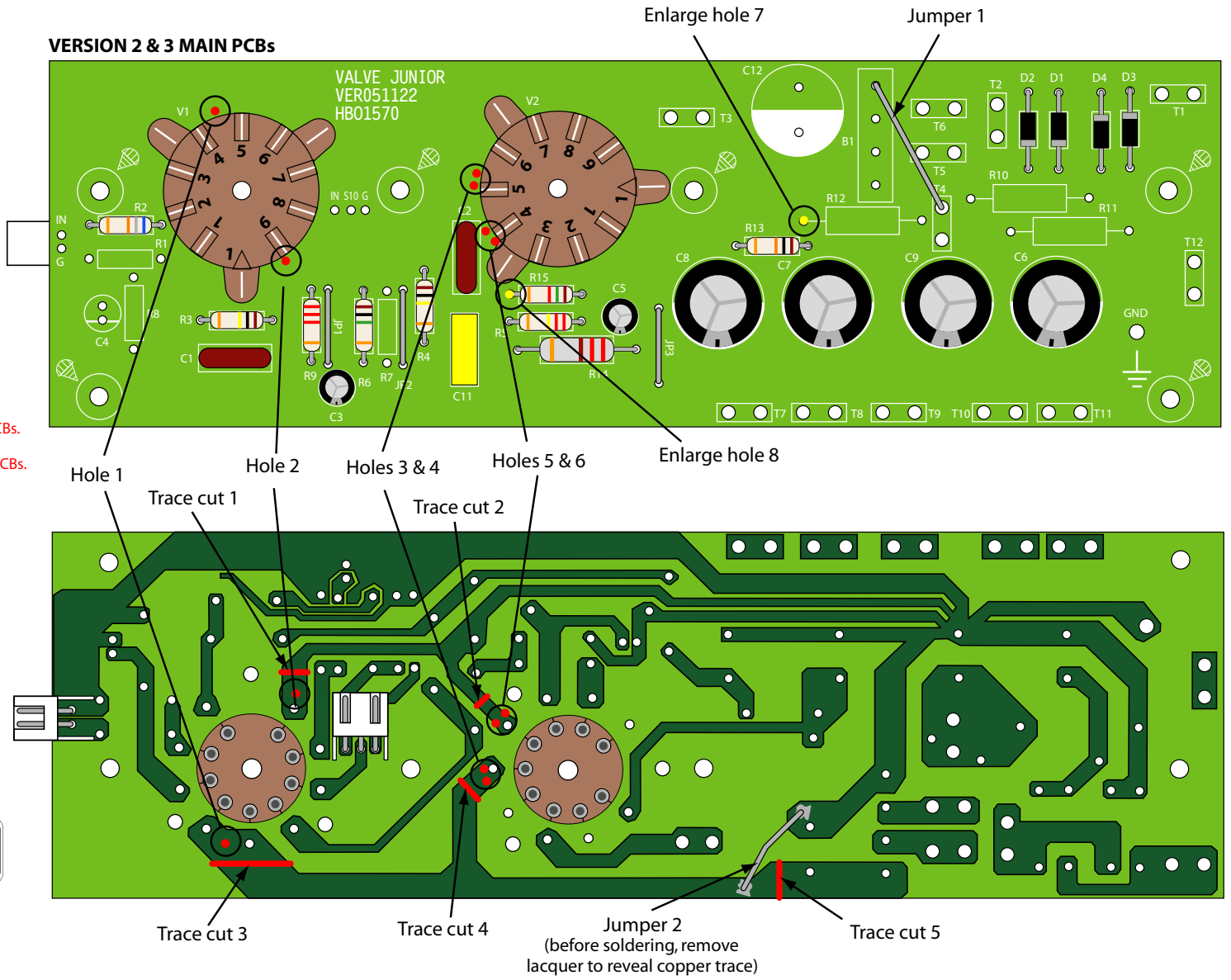
VERSION: 05-09-06 (original)
6V6 REV. 07-28-08 (updated)

Mercury Upgrade

Epiphone® Valve Jr.

VERSION 2 & 3 MAIN PCBs



MAIN PCB PREP SEQUENCE:

1. Remove clips (T1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 & 12).
2. Remove rectifier (B1).
3. Remove capacitors (C4 & 12).
4. Remove resistors (R1*, 7, 8*, 9**, 10, 11 & 12).
   *Remove for Version 2 PCBs. Do not remove for Version 3 PCBs.
   **Remove for Version 3 PCBs. Do not remove for Version 2 PCBs.
5. Make 5 trace cuts as indicated.
6. Drill new 5/64" holes as indicated (holes 1 to 6).
7. If you will be installing the *6V6 Mod* then enlarge holes 7 & 8 with 1/16" bit.
8. Add 2 buss wire jumpers as indicated.

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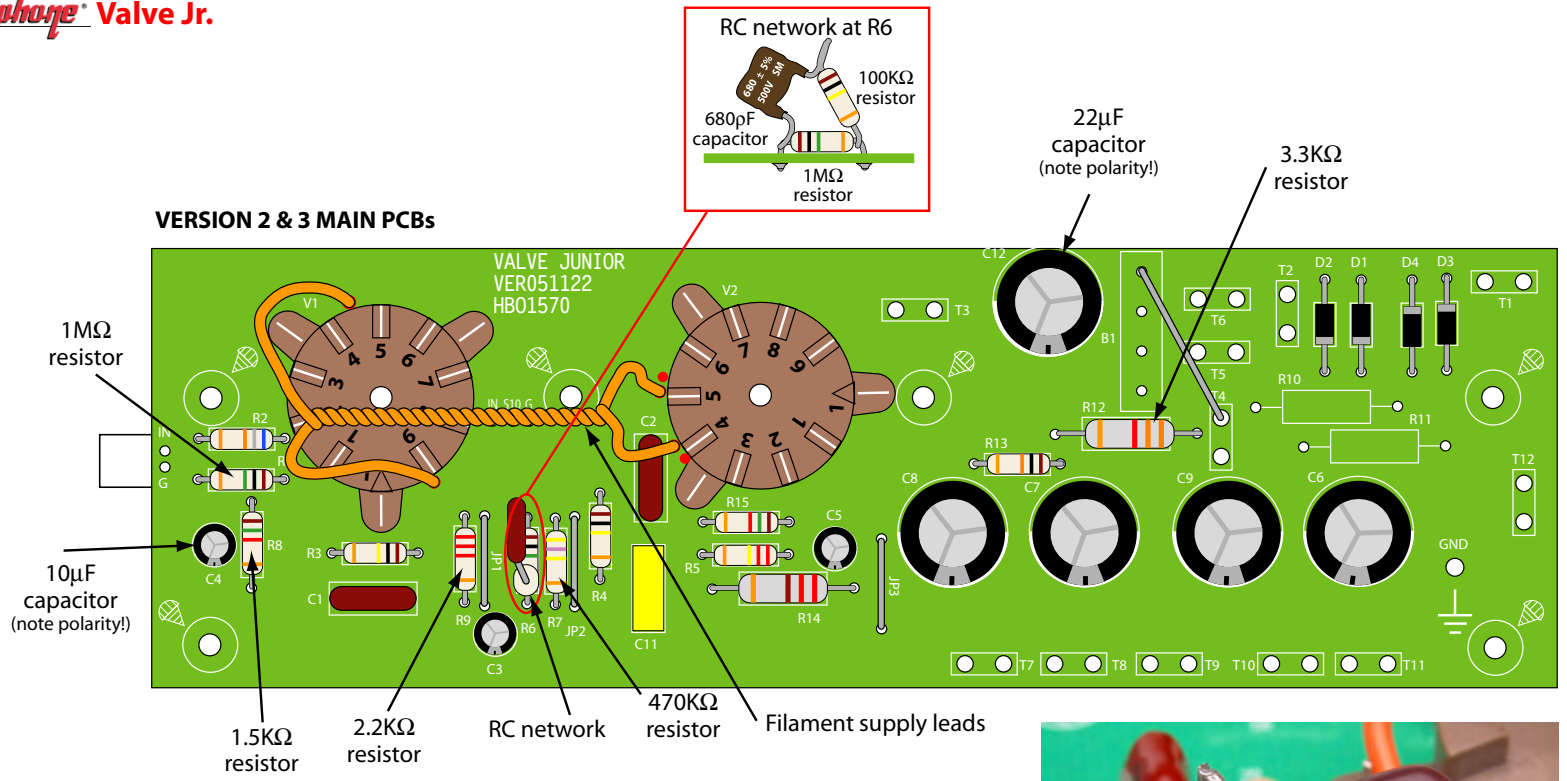
VERSION: 05-09-06 (original)
6V6 REV. 04-09-10 (updated)

Mercury Upgrade

Epiphone Valve Jr.



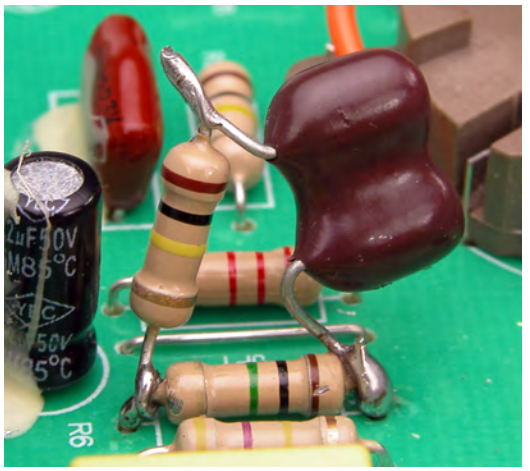
Tip: How to install resistors

Non-flame-proof resistors should be mounted flush to the PCB.

Flame-proof resistors should be mounted 2~3mm off the PCB.

MAIN PCB UPGRADE SEQUENCE:

1. If necessary, swap R1 with 1MΩ resistor.
2. If necessary swap R8 with 1.5KΩ resistor.
3. If necessary, swap R9 with 2.2KΩ resistor.
4. Replace R7 with 470KΩ resistor.
5. Replace R12 with 3.3KΩ resistor.
6. Replace C4 with 10µF capacitor.
7. Replace C12 with 22µF capacitor.
8. Build RC Network as indicated and solder into R6.
9. Build Filament Supply Leads as indicated and solder into position (use holes made in previous sequence).



RC network (R6)

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VERSION: 05-09-06 (original)
6V6 REV. 12-30-08 (updated)

Mercury Upgrade

Epiphone Valve Jr. head • *Mercury Upgrade*

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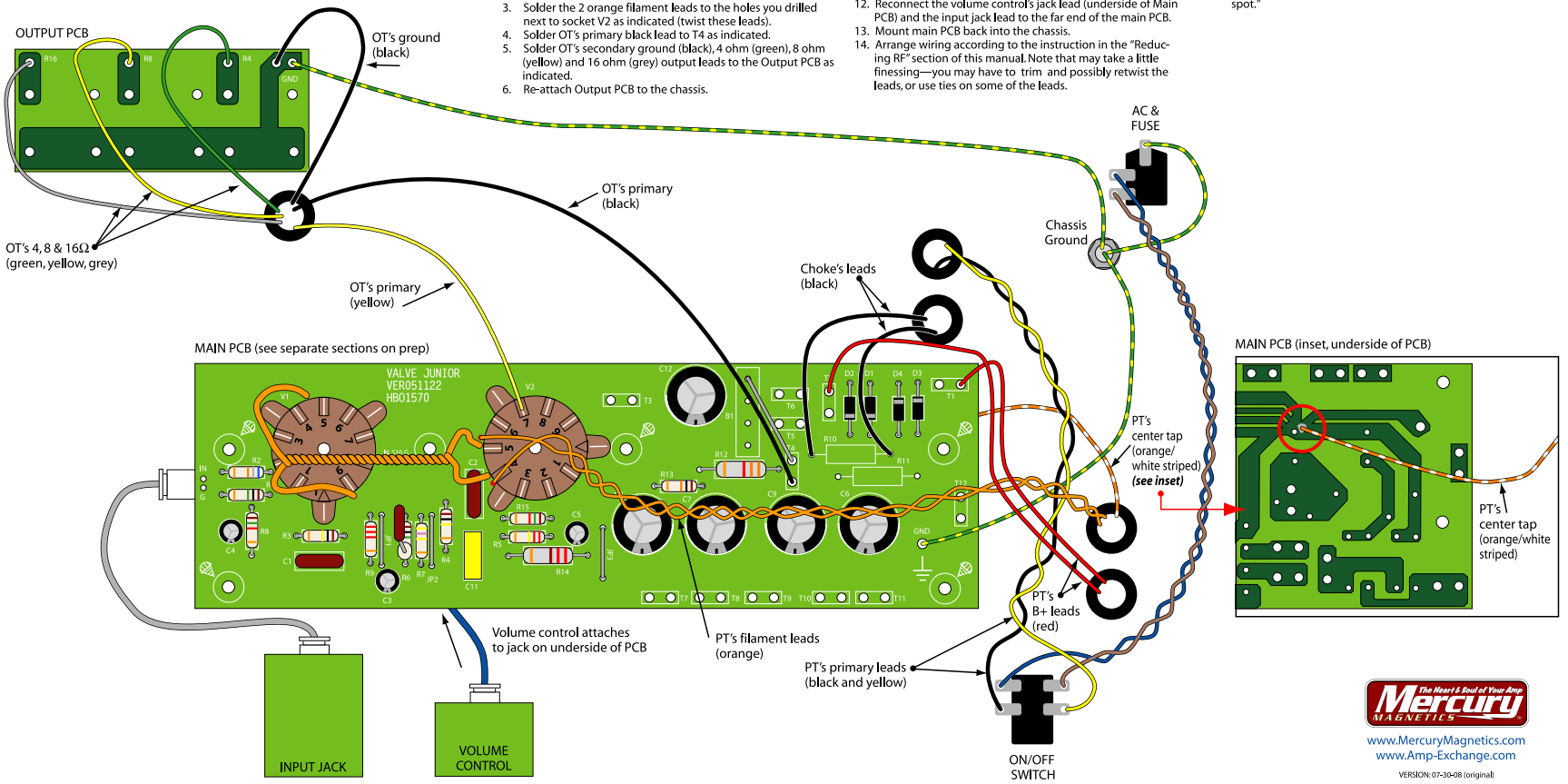
SEQUENCE WITHOUT 6V6 MOD:

Note: Do not attach either the Output PCB or the Main PCB to the chassis, yet. This schematic assumes that you have already modified the chassis (with mounted transformers), and Main PCB (see separate instructions).

1. Thread the various transformers and choke lead wires through the original chassis holes as indicated.
2. Attach yellow and black leads from PT's primary to the ON/OFF switch as indicated (twist these leads).
3. Solder the 2 orange filament leads to the holes you drilled next to socket V2 as indicated (twist these leads).
4. Solder OT's primary black lead to T4 as indicated.
5. Solder OT's secondary ground (black), 4 ohm (green), 8 ohm (yellow) and 16 ohm (grey) output leads to the Output PCB as indicated.
6. Re-attach Output PCB to the chassis.
7. Solder chokes 2 black leads to R10 as indicated.
8. Solder OT's primary yellow to V2's pin #7 as indicated.
9. Solder the PT's 2 B+ leads (red) to T1 and T2 of Main PCB (DO NOT TWIST THESE LEADS!) as indicated.
10. Re-solder original ground lead (green/yellow-striped) from the chassis ground to the GND of the Main PCB as indicated.
11. Solder the PT's center tap lead (orange/white-striped) to the underside of the Main PCB as indicated by the Inset diagram.
12. Reconnect the volume control's jack lead (underside of Main PCB) and the input jack lead to the far end of the main PCB.
13. Mount main PCB back into the chassis.
14. Arrange wiring according to the instruction in the "Reducing RF" section of this manual. Note that may take a little finessing—you may have to trim and possibly retwist the leads, or use ties on some of the leads.
15. Triple-check your work.
16. Reinstall the tubes.
17. Proceed to instructions on using the *variac* and amp meter to power the amp up. Debug if necessary and repeat this step.
18. Once operational, reassemble chassis in amp case, etc.
19. Note: New transformers require about 20 hours of *hard playing* to fully break-in—during this time you'll notice subtle improvements in the amp's tone. It takes about 20 hours of hard playing for the transformer set to achieve their "sweet spot."



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VERSION: 07-30-08 (original)

FINAL WIRING (*without* 6v6 Mod)

1. Thread the various transformer leads through the holes as indicated in the diagrams.
2. Solder the orange filament leads from the PT into positions at the V2 tube socket. Note that these leads must be tightly twisted (see appendix).
3. Solder onto T1 and T2 the red leads from the PT.
4. Solder the black and yellow PT leads onto the On/Off switch.
5. Solder the orange/white-striped center tap lead from the PT and the ground chassis lead to the back of the board (see special instruction page).
6. Solder the green and black secondary leads from the OT to the speaker jack as indicated.
7. Solder the black primary OT lead to T4.
8. Solder the yellow primary OT lead to T3.
9. Solder the Mini-Choke's leads to the locations designed on the Main PCB.
10. Bolt the Main PCB back into the chassis.
11. Connect the input jack and volume control leads to their jacks on the Main PCB.

Triple-check your modifications. If you have any questions the time to get them answered is now. Call ***Mercury*** if you are in doubt about anything.

Finish re-assembling the unit, including reinstalling the tubes, putting the chassis back in the case, hooking up the speaker, etc.

DO NOT BYPASS THIS NEXT STEP!

After triple-checking your assembly, connect the amp's power to a *Variac and amp meter*, or even better, a variable AC power supply, and follow the testing/start-up proceedure as outlined in this manual's appendix.

Debug if necessary and repeat this process until you are satisfied that the ***Upgraded*** amp is working correctly.

When the amp is working to your satisfaction use the cable ties (supplied) to group and hold the various wires away from the Main PCB (especially the tubes). In particular, gather up Filament Supply Leads tying them as close to the *power transformer* as possible. See final photographs for examples.

Apply *Loctite 290* (green) to the two retaining bolts and screws of the Main PCB.

Apply the ***Mercury*** metal place to properly I.D. your ***Mercury Upgraded*** amp. And you are done!

BONUS!!!

Valve Junior – and while you're at it, here's

Alan Cyr's 6V6 Option

A ***Mercury Upgraded Valve Jr.*** with Alan's 6V6 option installed. Note the additional tube socket.

Here's a simple additional mod you can make to your project amp from Alan Cyr. It adds a tube socket that gives you a lot more flexibility with the little amp's tone.

When we debuted the mod at the *LA Amp Show 2007* we demonstrated it with the EL84 and 6V6 in tandem (you can run either tube independently or at the same time) and it was the clear favorite of all who attended.

On the following pages are the schematics and accompanying photos to show you how the add-on fits into the circuit. To make the mod, you'll have to drill an additional hole in the chassis to support the new tube socket.

The provided schematics, illustrations and photos show the complete ***Mercury Upgrade***, including the parts needed to make the 6V6 option.

Enjoy!

"6V6 MOD" LAYOUT for the *MERCURY* VALVE JR. UPGRADE

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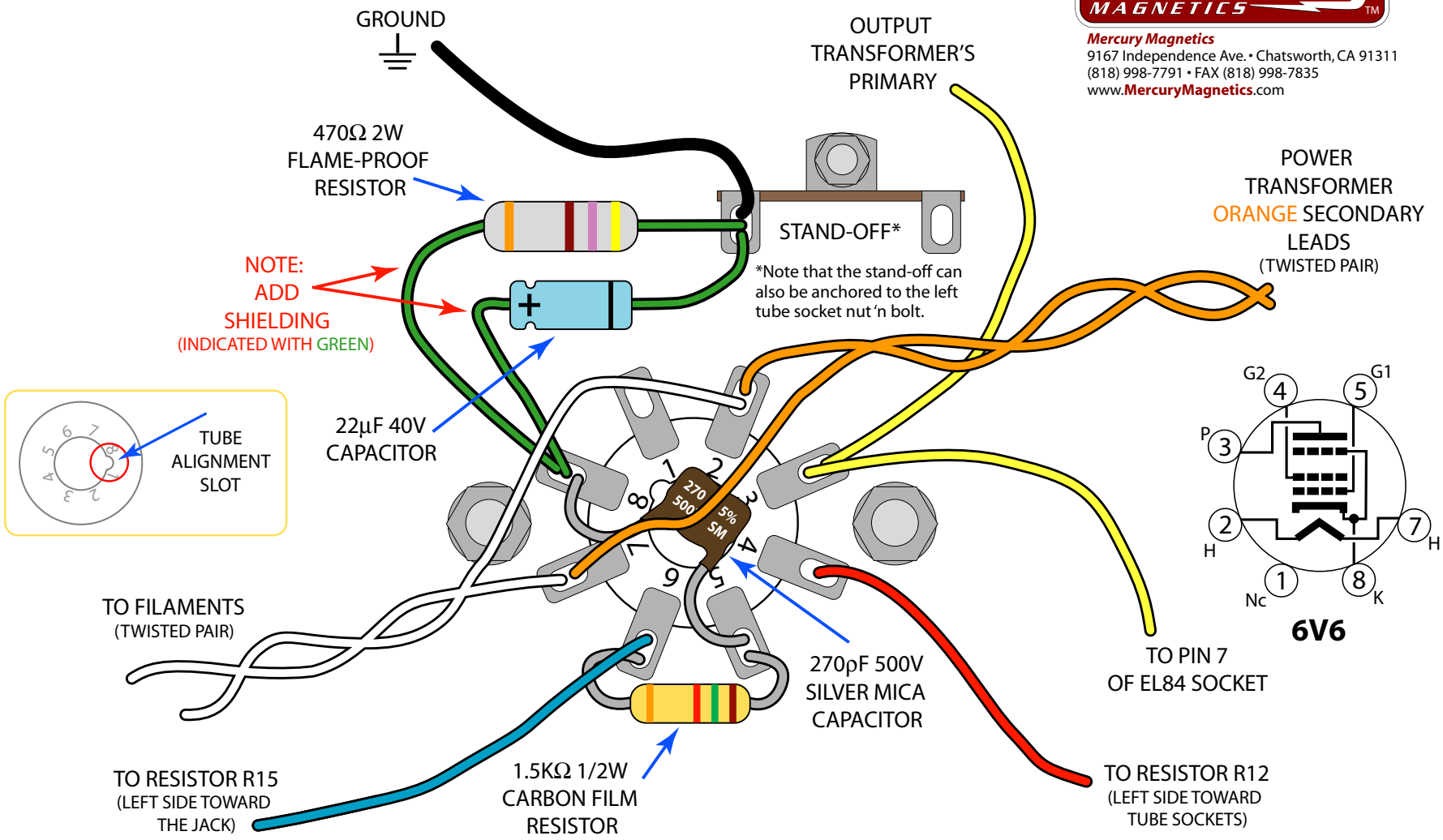

VERSION: 07-25-08
REVISED: 07-29-10

Mercury Upgrade

Epiphone Valve Jr. head • *Mercury Upgrade* with 6V6 Mod

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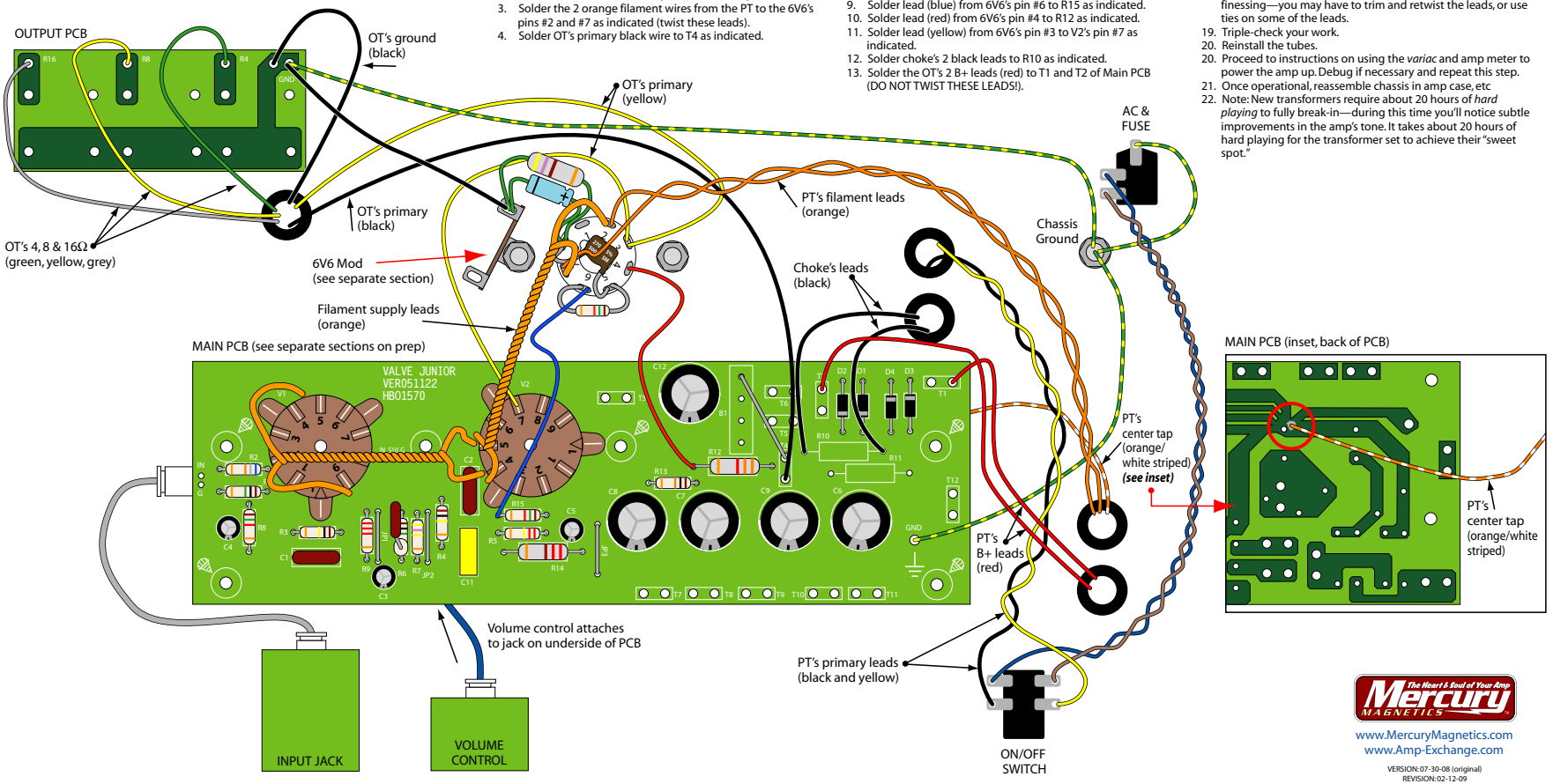
SEQUENCE:

Note: Do not attach either the Output PCB or the Main PCB to the chassis, yet. This schematic assumes that you have already modified the chassis (with mounted transformers), Main PCB, and setup the 6V6 Mod (see separate instructions).

1. Thread the various transformers and choke lead wires through the original chassis holes as indicated.
2. Solder yellow and black leads from PT's primary to the ON/OFF switch as indicated (twist these leads).
3. Solder the 2 orange filament wires from the PT to the 6V6's pins #2 and #7 as indicated (twist these leads).
4. Solder OT's primary black wire to T4 as indicated.
5. Solder OT's secondary ground (black), 4 ohm (green), 8 ohm (yellow) and 16 ohm (grey) output leads to the output PCB as indicated.
6. Solder ground lead (black) from the 6V6's standoff to the Output PCB's ground as indicated.
7. Re-attach Output PCB to the chassis.
8. Solder filament leads from 6V6 socket's pins #2 and #7 to the Main PCB holes at V2 you drilled earlier (twist these leads).
9. Solder lead (blue) from 6V6's pin #6 to R15 as indicated.
10. Solder lead (red) from 6V6's pin #4 to R12 as indicated.
11. Solder lead (yellow) from 6V6's pin #3 to V2's pin #7 as indicated.
12. Solder choke's 2 black leads to R10 as indicated.
13. Solder the OT's 2 B+ leads (red) to T1 and T2 of Main PCB (DO NOT TWIST THESE LEADS!).
14. Re-solder original ground lead (green/yellow-striped) from the chassis ground to the GND of the Main PCB.
15. Solder the OT's center tap lead (orange/white-striped) to the underside of the Main PCB as indicated by the Inset diagram.
16. Reconnect the volume control's jack lead (underside of Main PCB) and the input jack lead to the far end of the Main PCB.
17. Mount Main PCB back into the chassis.
18. Arrange wiring according to the instruction in the "Reducing RF" section of this manual. Note that may take a little finessing—you may have to trim and retwist the leads, or use ties on some of the leads.
19. Triple-check your work.
20. Reinstall the tubes.
20. Proceed to instructions on using the *variac* and amp meter to power the amp up. Debug if necessary and repeat this step.
21. Once operational, reassemble chassis in amp case, etc
22. Note: New transformers require about 20 hours of *hard playing* to fully break-in—during this time you'll notice subtle improvements in the amp's tone. It takes about 20 hours of hard playing for the transformer set to achieve their "sweet spot."



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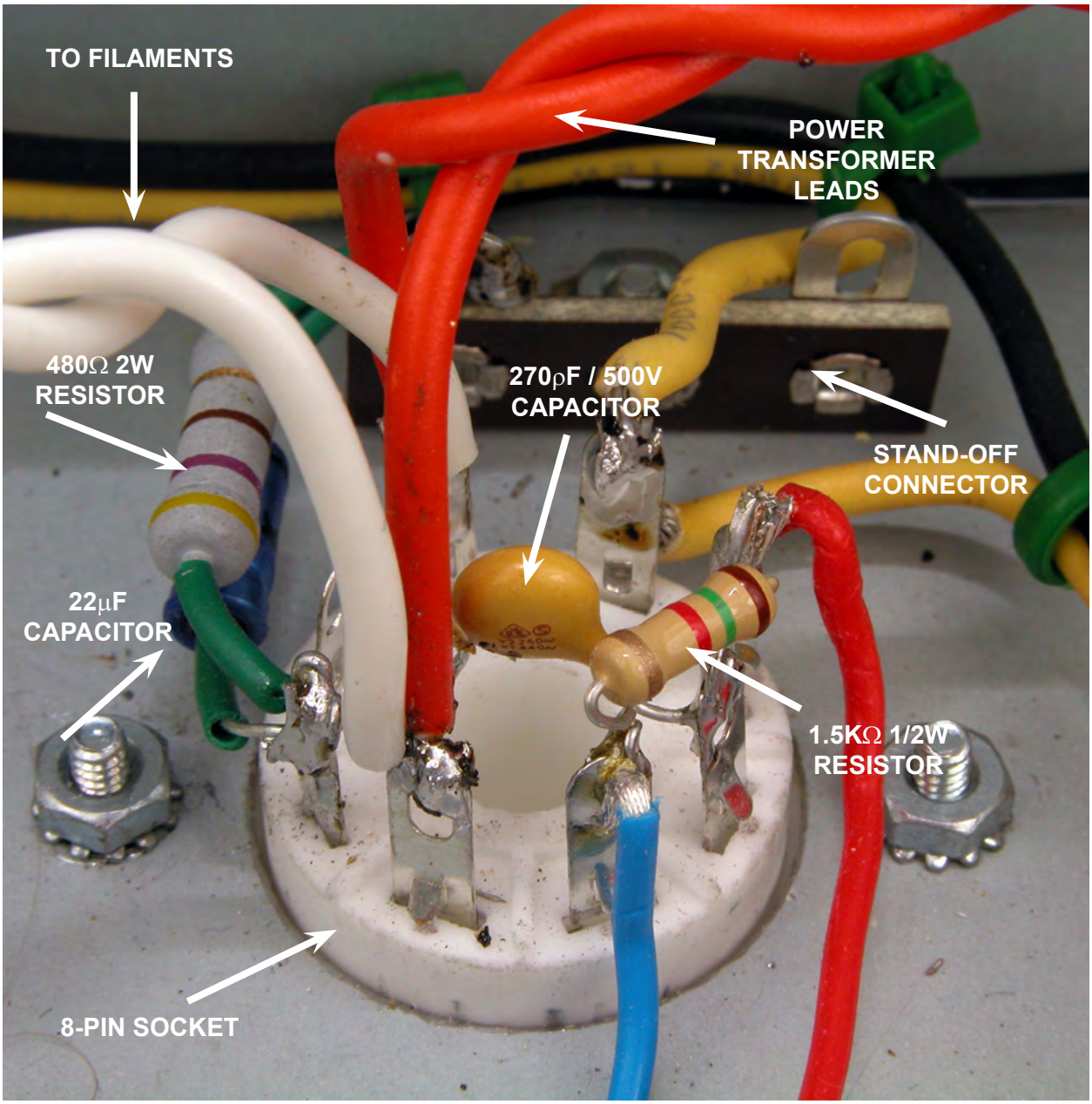
VERSION: 07-30-08 (original)
REVISION: 02-12-09

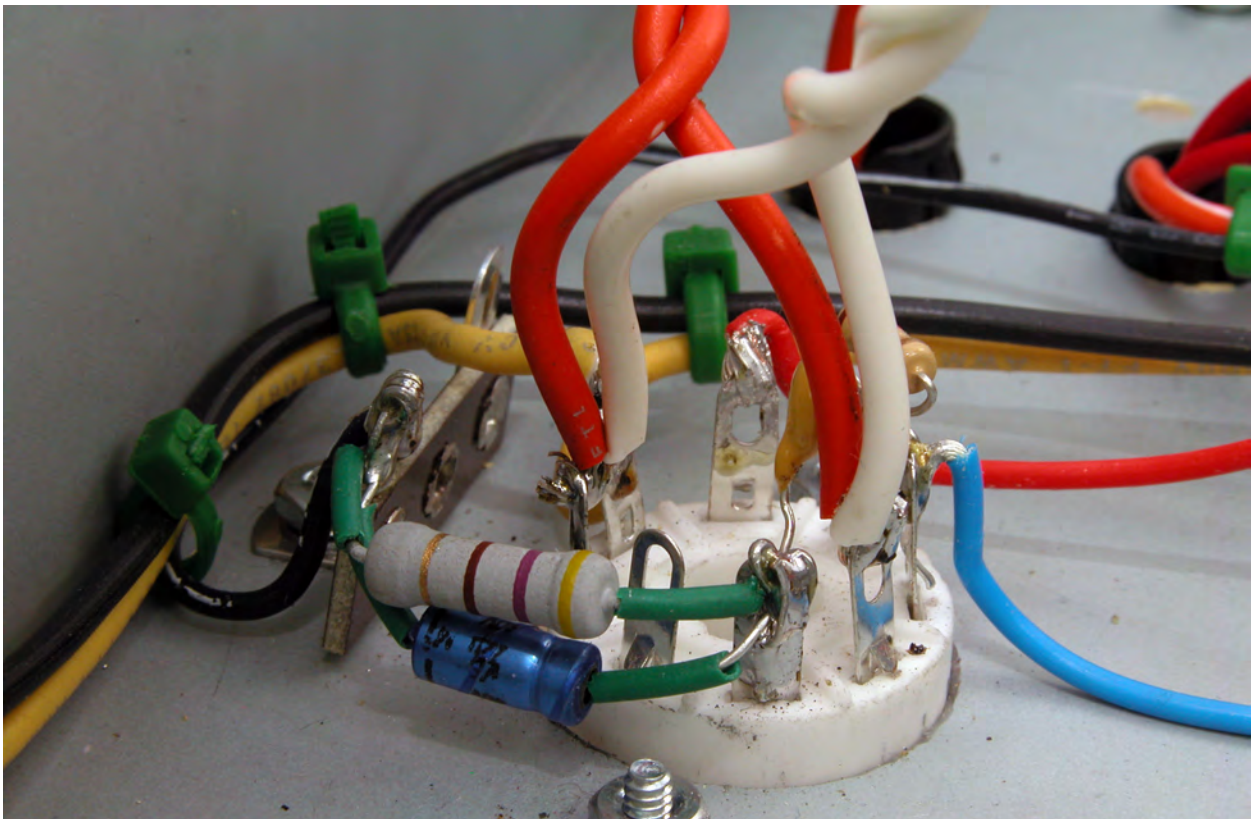


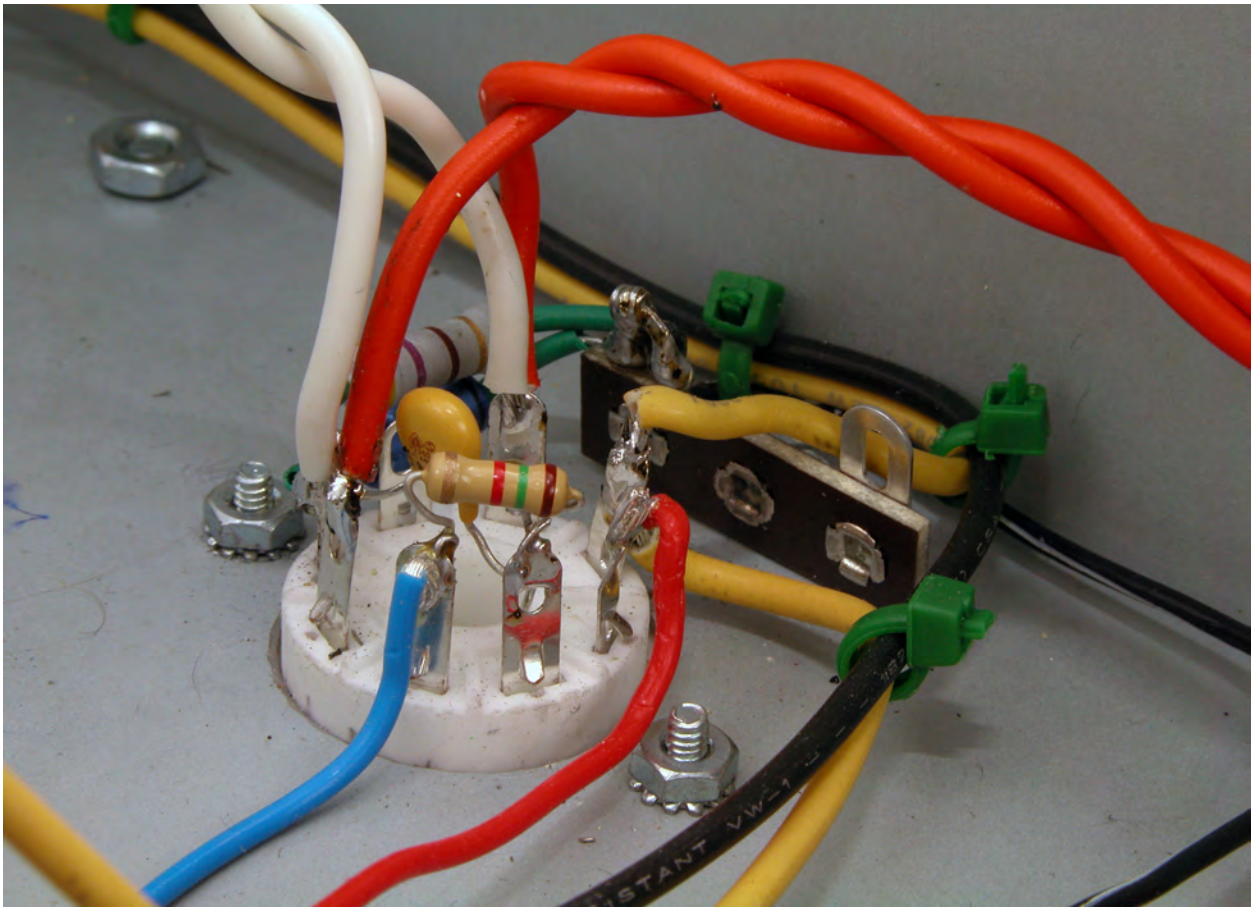
This sequence of photos shows the wiring and connections to the 6V6 socket.

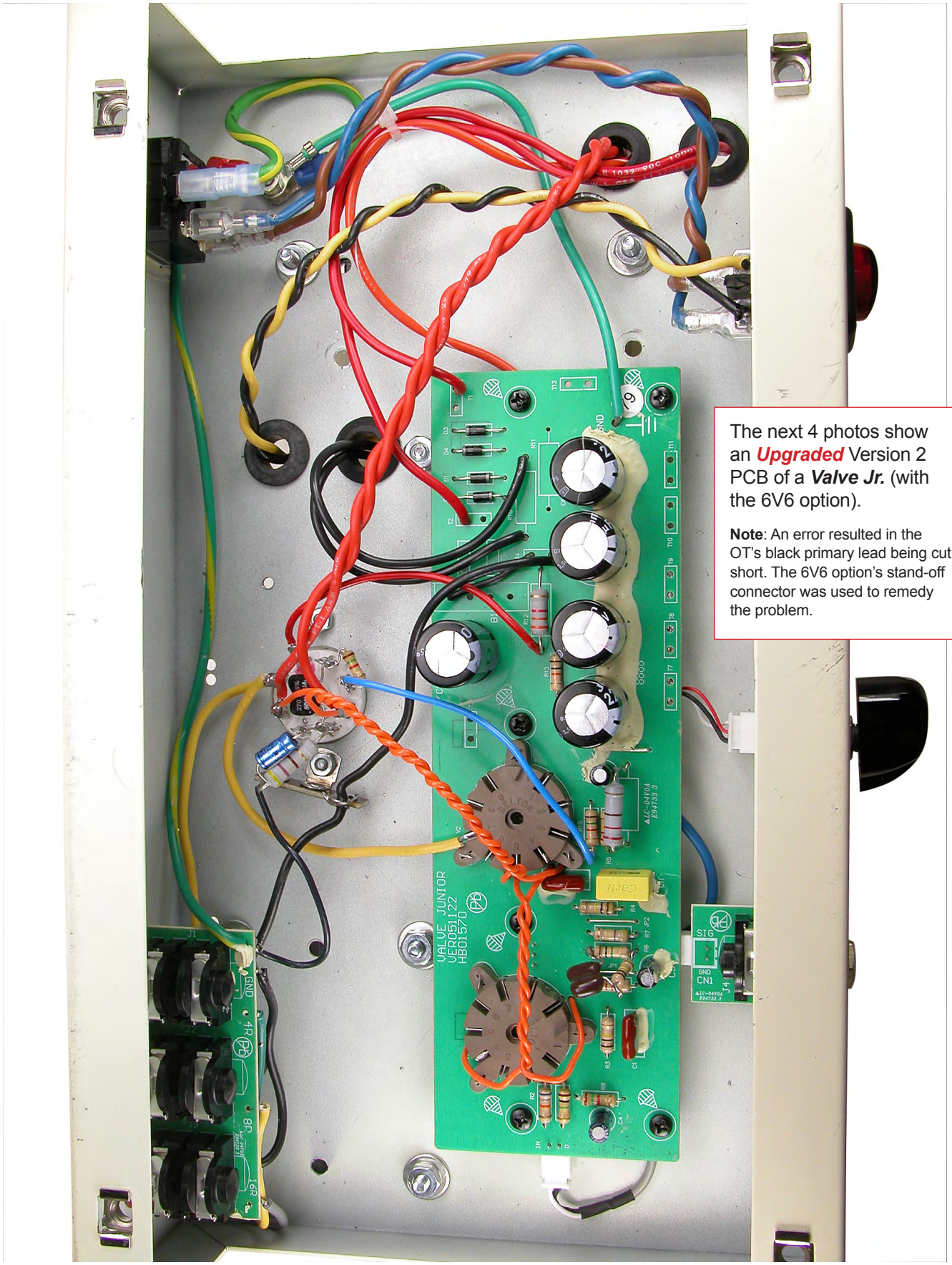
We suggest that you make the ***Mercury Upgrade*** first. Then run and fully test your amp. After you have tested, played in the amp and are accustomed to its new and improved tone, make the 6V6 option.

You can run the amp with both the 6V6 and EL84 in parallel, or remove either tube from the socket and run the amp on a solo tube.

Notes: The components of the current kit differ slightly from those shown in these photos. The 270ρF capacitor has been changed from a ceramic disk to a silver mica type. The white filament lead wires have been changed to orange. And, the green insulation shielding is now semi-transparent white.

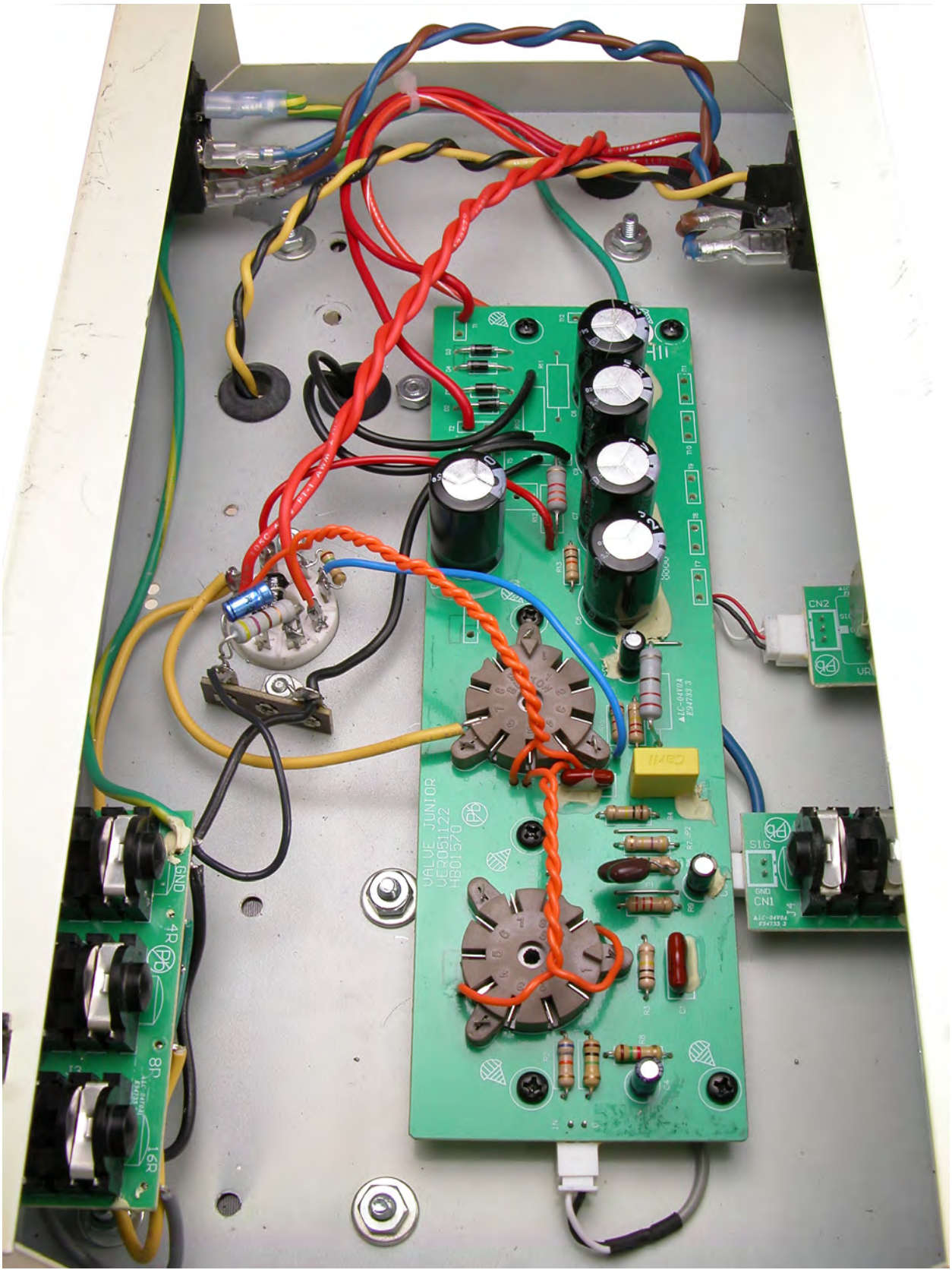


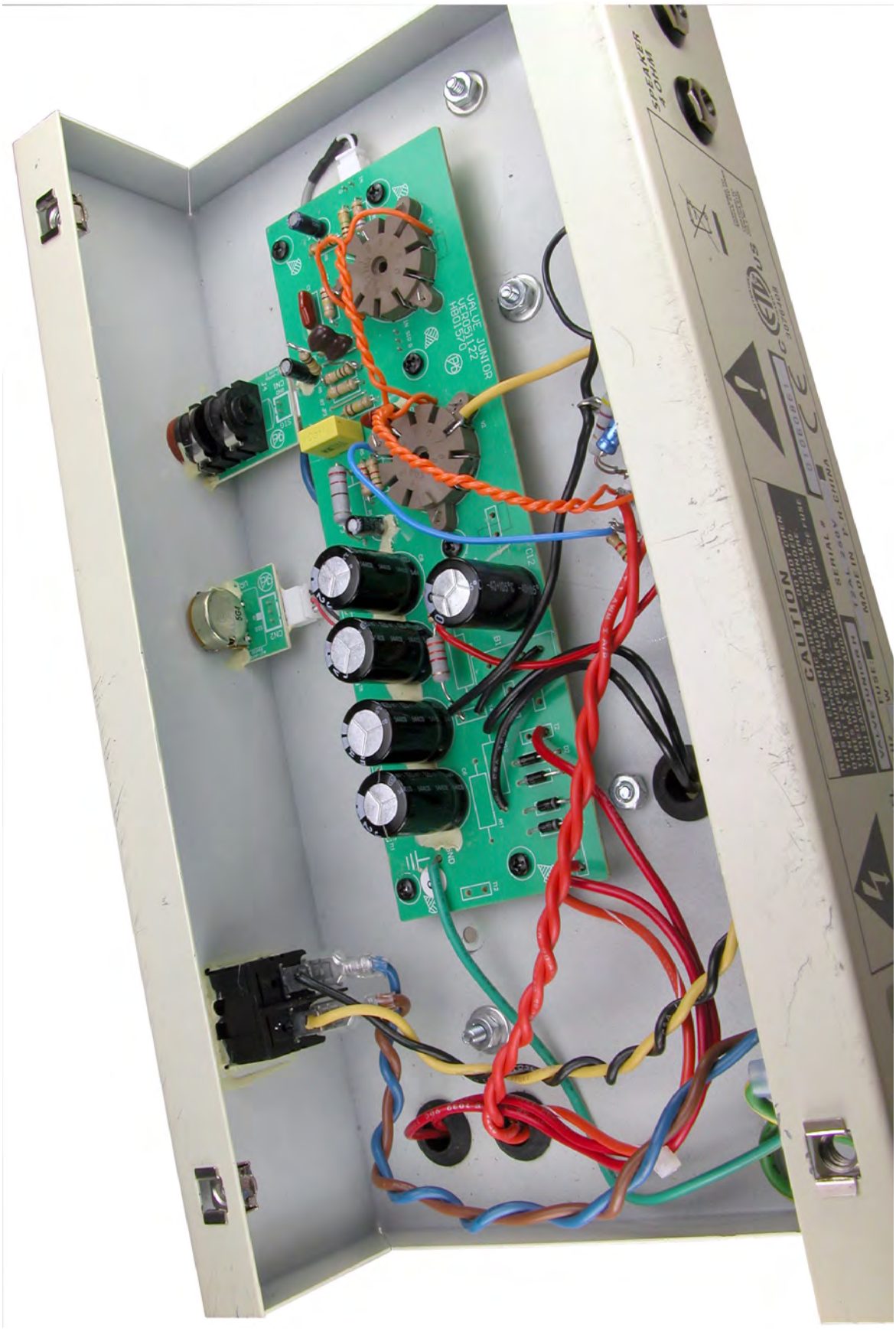




The next 4 photos show an ***Upgraded*** Version 2 PCB of a ***Valve Jr.*** (with the 6V6 option).

Note: An error resulted in the OT's black primary lead being cut short. The 6V6 option's stand-off connector was used to remedy the problem.





FINAL WIRING (with the 6V6 option)

With the 6V6 socket in place and wired up (but not connected to the Main PCB, let's wrap things up:

Thread the various transformer leads through the holes as indicated in the diagrams.

Solder the orange filament leads from the 6V6 into positions at the V2 tube socket. Note that these leads must be tightly twisted (see appendix).

Solder the red lead from the 6V6's pin 4 to the far left terminal of R12 (the side closest to the sockets).

Solder the blue lead form the 6V6's pin 6 to the far left terminal of R5 (the side closest to the sockets).

Solder the yellow wire from the 6V6's pin 3 to pin 7 of socket V2.

Solder the OT's yellow primary lead to pin 3 of the 6V6.

Solder the two orange filament leads of the PT into pins 2 and 7 of the 6V6 socket. Note that these leads should be tightly twisted (see appendix).

Solder the OT's secondary green and black leads to the speaker jack as indicated.

Solder the OT's primary black lead to T4 of the Main PCB.

Solder onto T1 and T2 the red leads from the PT.

Solder the black and yellow PT leads onto the On/Off switch.

Solder the orange/white-striped center tap lead from the PT and the ground chassis lead to the back of the board (see special instruction page).

Solder the Mini-Chokes leads to the locations designed on the Main PCB.

Connect the input jack and volume control leads to their jacks on the Main PCB.

Bolt the Main PCB back into the chassis.

Triple-check your modifications. If you have any questions the time to get them answered is now. Call ***Mercury*** if you are in doubt about anything.

Finish re-assembling the unit, including reinstalling the tubes, putting the chassis back in the case, hooking up the speaker, etc.

DO NOT BYPASS THIS NEXT STEP!

After triple-checking your assembly, connect the amp's power to a *Variac*, or even better, a variable AC power supply, and follow the testing/start-up proceedure as outlined in this manual's appendix.

Debug if necessary and repeat this process until you are satisfied that the ***Upgraded*** amp is working correctly.

When the amp is working to your satisfaction use the cable ties (supplied) to group and hold the various wires away from the Main PCB (especially the tubes). In particular, gather up Filament Supply Leads tying them as close to the *power transformer* as possible. See final photographs for examples.

Apply *Loctite 290* (green) to the two retaining bolts and screws of the Main PCB.

Apply the ***Mercury*** metal place to properly I.D. your ***Mercury Upgraded*** amp. And you are done!

BE FOREWARNED!

IF YOU BYPASS THIS STEP THERE IS A VERY REAL POSSIBILITY THAT YOU WILL CAUSE DAMAGE TO THE AMP AND/OR SERIOUS HARM TO YOURSELF!

Using a Variac & Current Meter

Don't power-up your amp without 'em!

NOTE: IF YOU ARE NOT A QUALIFIED AMP TECH, DO NOT ATTEMPT TO POWER UP YOUR MODIFIED AMPLIFER, YET. INSTEAD, ***Mercury*** RECOMMENDS THAT IT BE INSPECTED BY A QUALIFIED TECHNICIAN. AN AMP TECH WILL GO OVER YOUR WORK AND VERIFY THAT IT IS SAFE TO POWER IT UP.

After modifying your amp, the next step is to power it up using a *variac* and current meter.

The *Variac* and current meter allows you to slowly add voltage while checking the indicators to make sure that your handiwork is correct. Without a *variac* you run the *extreme* risk of frying your amp or some of its components, getting hurt, electrocuted, *etc*.

A *Variac* is a standard amp tech tool. No amp tech should be without one. They are available from many electronic stores or online, eBay, *etc*. Prices start at about $50 and go up from there. The better units (such as the *Tenma* isolated variable AC power supply shown in these photos) include output current metering. Consider that the cost of a *Variac* is free, because a single error without one can easily cost more than the *Variac* itself!

As the following instructions show, you'll need to monitor the output current while increasing power to the amp with the *Variac*. If your *Variac* doesn't have a self-contained current meter this can also be done with a separate amperes meter connected to the fuse-holder of the amp (with the fuse removed).

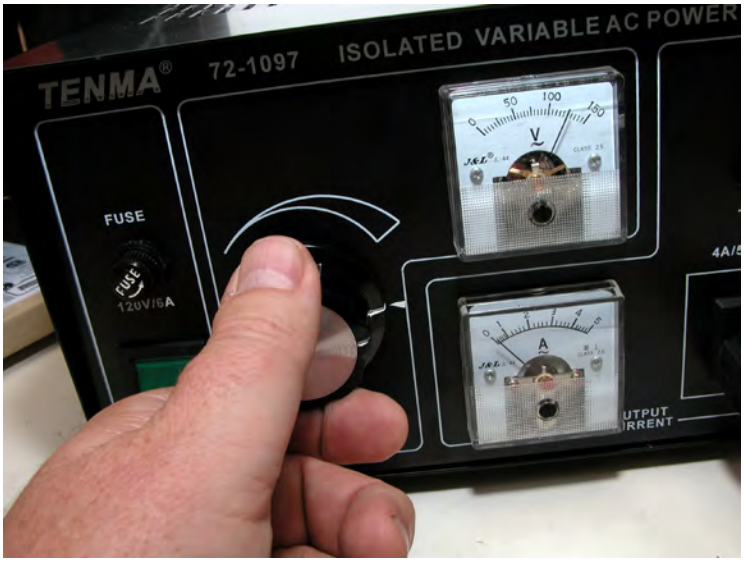
Specific instructions for how to use *Variacs* and current meters are beyond the scope of this manual. Check the web or owner manuals of the devices for specific methods.

STEP A: Make sure that your amp is OFF. Plug it into the *Variac*. The *Variac* is OFF with the output voltage knob set to zero (0). Turn on the *Variac's* power. Then, turn on the amp's power.

Variac: A variable transformer used to vary AC voltages. Also the tradename for a brand of variable AC transformer. There are other brands, but the term is generically used to describe all of them. A *variac* allows adjustment of the incoming AC mains voltage. The better quality units have meters for voltage and current, or both, and fuses for protection. *Variacs* come in many shapes and sizes. But their function is basically the same. If your *variac* does not have an amperes (current) meter, you'll need to use a separate meter.

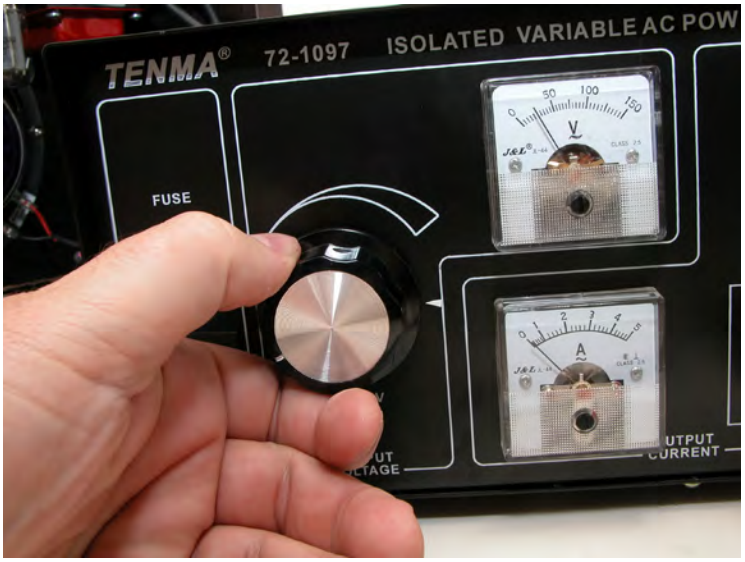
NOTE: The *Variac* in the photo to the left does not have an amperes meter whereas the *Tenma* model does.

STEP B: Turn on the amp's power.



STEP C: While watching the current (amp) meter, slowly roll on the *Variac's* output voltage knob. The amp should turn on at about 45 volts.

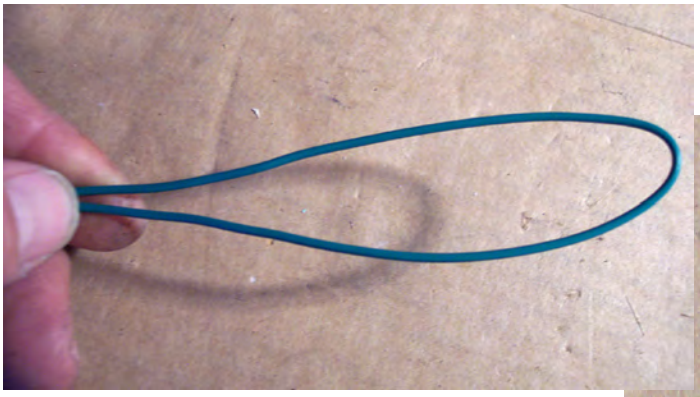
When you get to about 60 volts you don't want to see more than a few hundred milliamps. If the current meter reaches anywhere above half an amp, roll the *Variac* back to zero, shut everything down, discharge the caps, and look for the error, short or bad component. Correct the problem and repeat until this test passes.

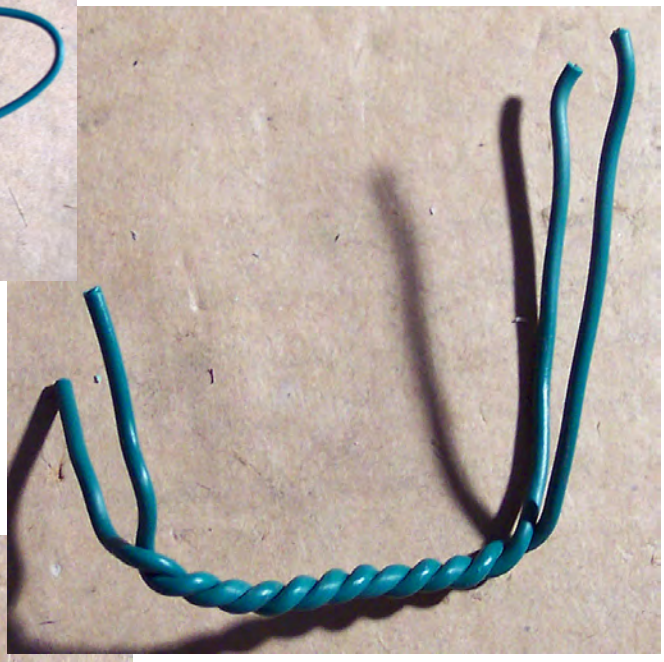


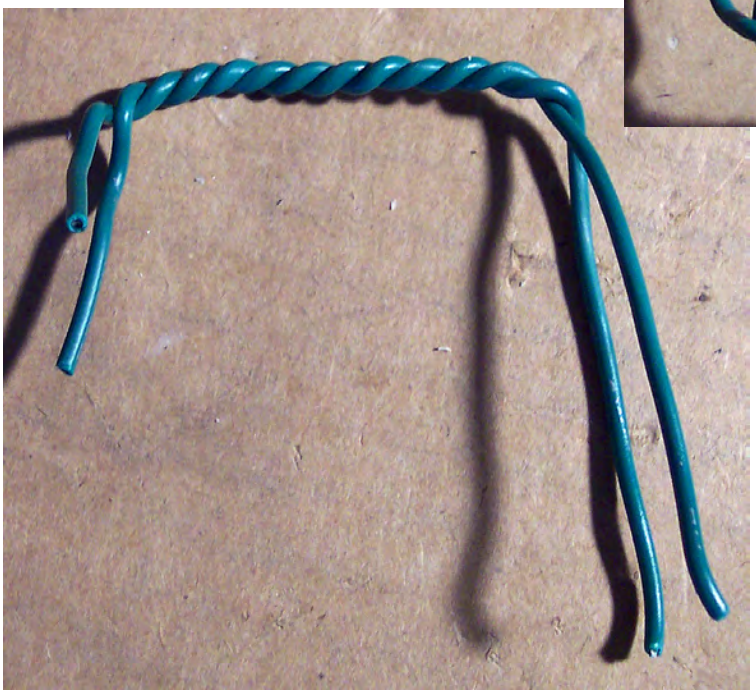
STEP D: Once you can reach 120 volts drawing less than half an amp, you are in good shape.

NOTE: If you don't have a current meter on your *Variac*, remove the fuse from the amp, and with an amp meter across the empty fuse holder socket, turn on the amp and perform the test above.

Tips 'n Tricks for
Making the Filament Supply Leads



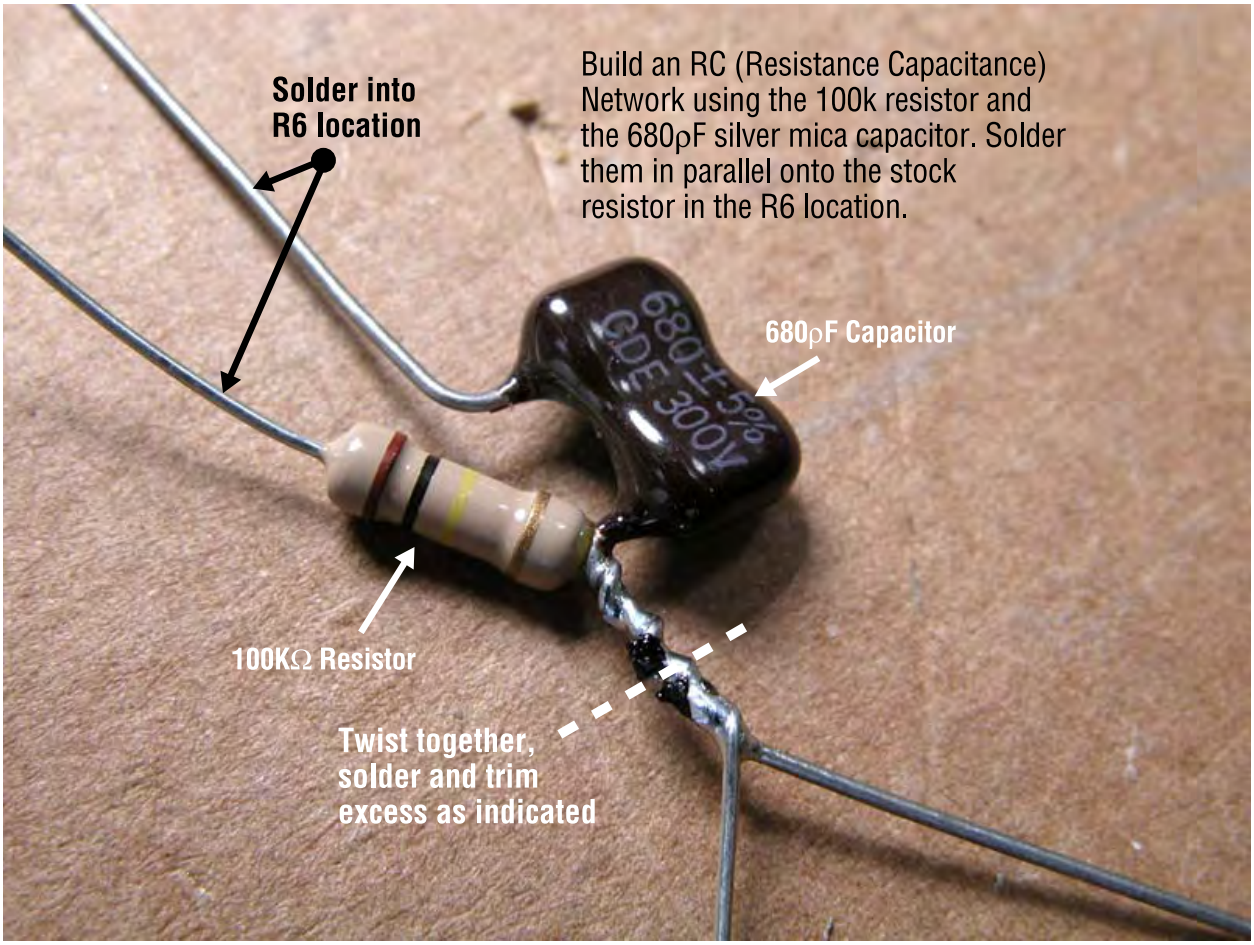




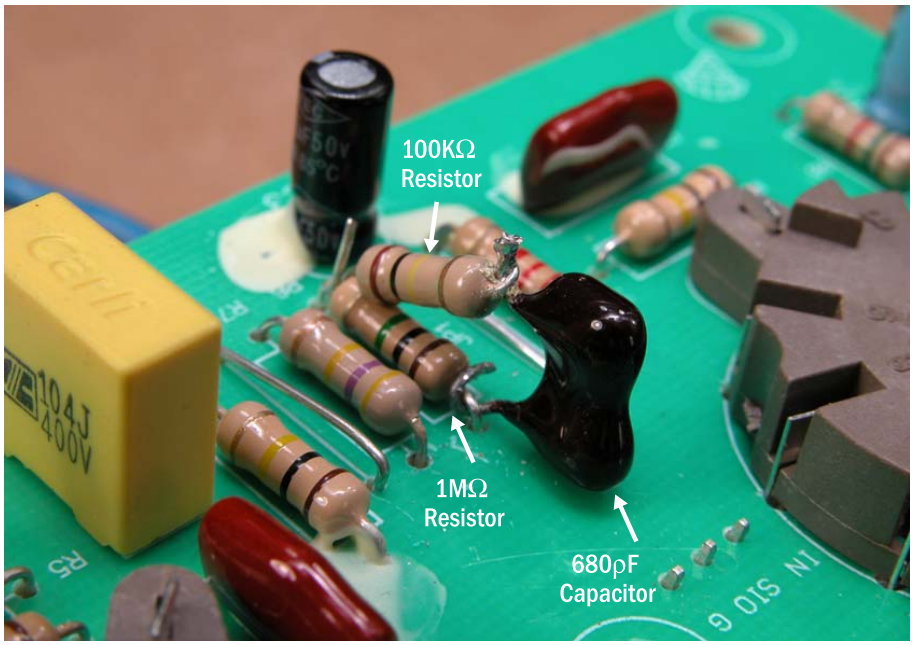
Consistent, even twisting is important. Ideally you want about 10 twists per inch. And bring the twist of the leads as close as possible to the terminals they'll be soldered to.

The ***Valve Jr.'s*** original circuit ran the filaments to DC, we're converting it back to AC. Running the filaments to DC is a common enough technique intended to reduce excessive noise problems. Unfortunately this method also "cooks" the tubes and cuts their working life up to about a third. Because you're now using quality transformers, combined with Alan's reworking of the circuit, this "solution" is no longer necessary. The above illustrations show how to create new filament supply leads which you'll be using to make the conversion. The leads are then soldered into the locations indicated on the schematics.

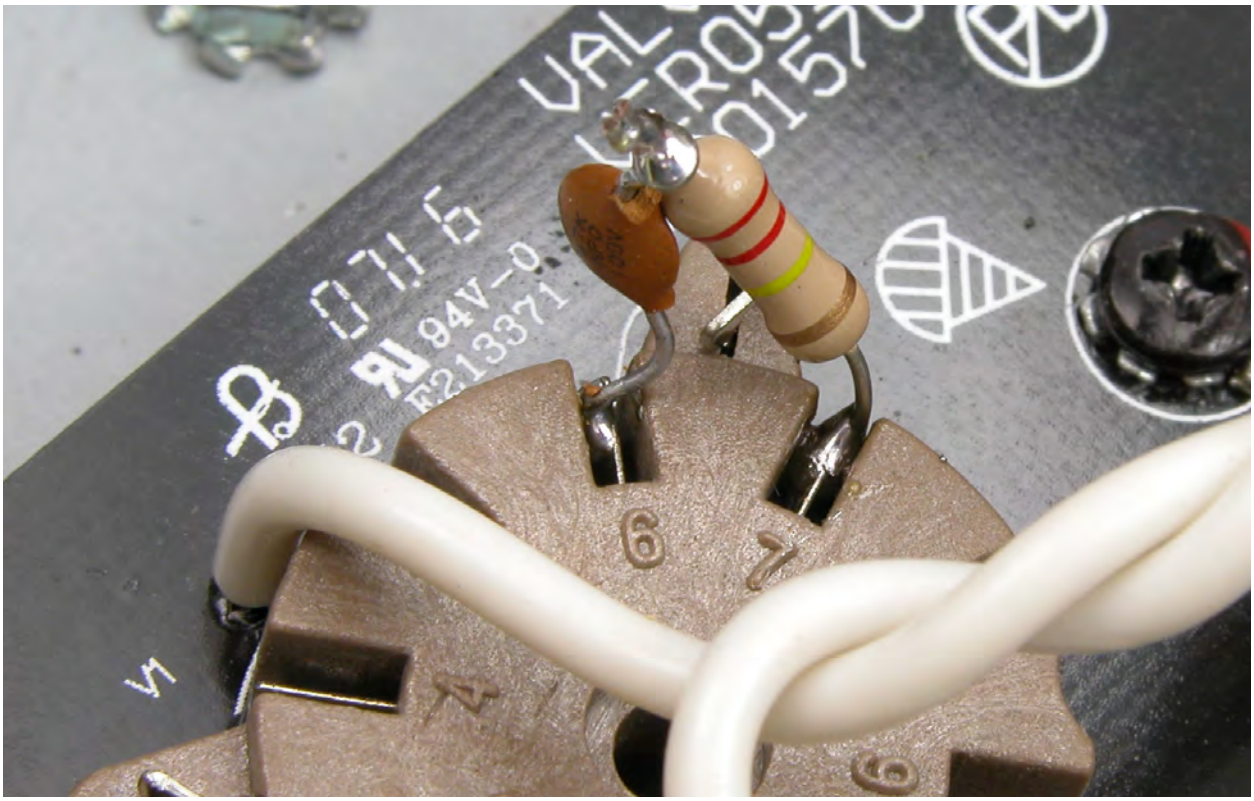
Tips 'n Tricks for
Making the "RC Network"



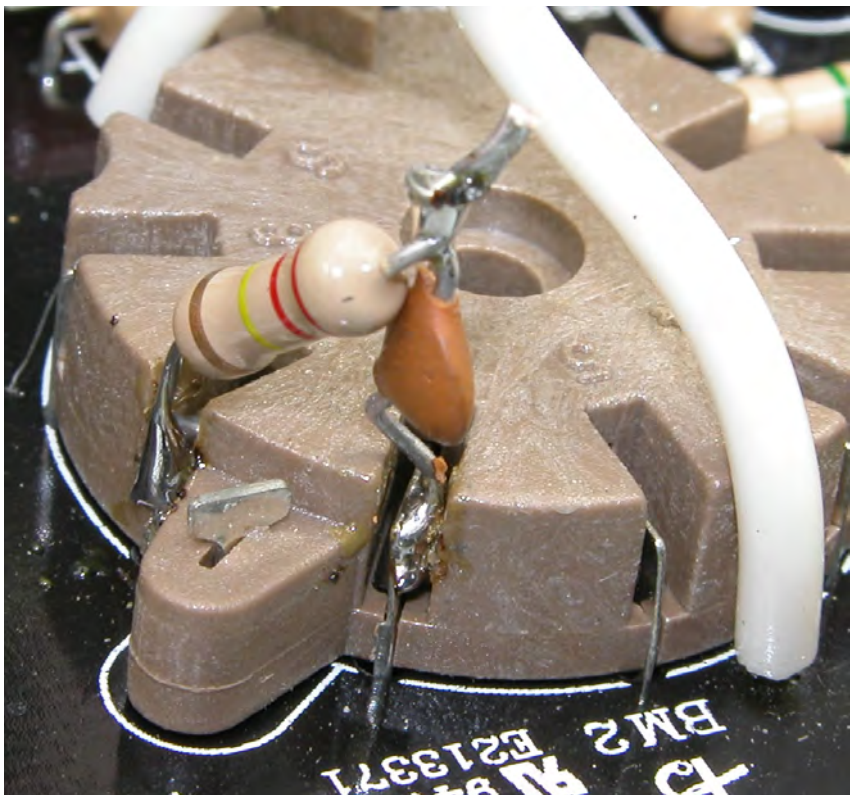
These photos detail the making and installation of the "RC Network." Refer to the schematic for specific connection information.



Tips 'n Tricks for
Alan's "Anti-Squeal" Circuit Option



Join the provided 47ρF ceramic disk capacitor to the 220KΩ resistor and jump them across pins 6 and 7 of the V1 socket (12AX7) as shown.



Due to quality issues with some of the Chinese materials being used some (but not all) Version 3 ***Valve Jr.*** amps will emit a "squeal." If you're one of the unlucky ones, install this anti-squeal option. Refer to the schematics for specific connection information.

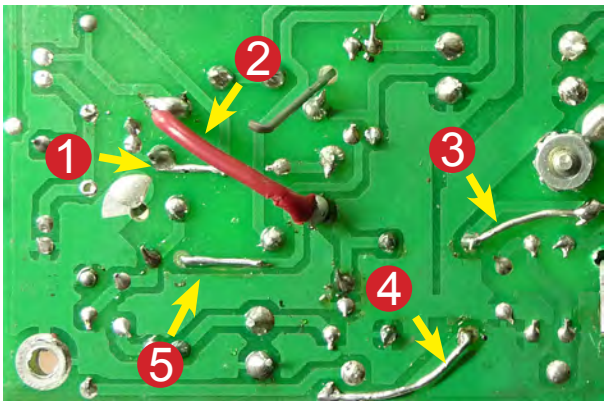
Tips 'n Tricks for
Working on PCBs

A PCB (printed circuit board) begins life as a solid sheet of thin copper foil across a backing material made of epoxy resin. Then, using a photographic process, a circuit is imprinted onto the foil and all unnecessary copper is etched away. What's left are copper foil "traces" that take the place of wires. To prevent shorts, PCBs are laminated with a colored insulating material that functions just like the shielding around insulated wire. Although PCBs may be many layers thick, the PCB used in the this amp is single-layered, which makes it easier to work on or modify.

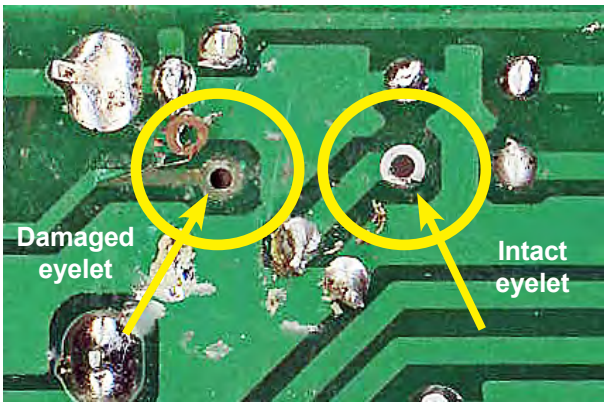
PCBs cost substantially less to produce than their predecessors, i.e. *point-to-point* circuit boards. And are used by amp manufacturers to maintain affordable prices for consumers.

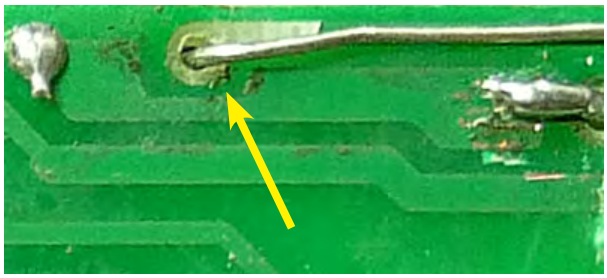
On a PCB components are often attached to the top of the board and then soldered from the back via pass-through conductive "eyelets" where they follow the traces that make up the circuit.

Asian-made PCBs are typically not as resilient as those made in the west. Therefore they're likely to require patching and repair work as you make the ***Upgrade***. This is normal, and easy to do – as long as you know a few tricks.



Various examples: 1. Jumper. 2. Jumper. 3. Trace repair (jumper soldered from terminal to terminal on same trace). 4. Trace repair (ditto). 5. Damaged eyelet repair (lead is soldered to a revealed trace).





Repair to a damaged eyelet: The lead from component bypasses the damaged eyelet and is soldered to either a revealed trace or another terminal on the same trace (as in this example).

Revealing a Trace: Sometimes we need to "reveal" traces so that the PCB can be modified or repaired. An easy way to do this is to take a sharp knife or *Exacto* and carefully scrape away the lamination to "reveal" the copper foil under it. Use high-grade (99%) Isopropyl alcohol and a Q-tip to clean these new contacts before soldering to them.

How to Repair Damaged Eyelets: The PCB's conductive eyelets are easily damaged and

Continued on next page ➔

often just fall off in the process of making repairs and modifications. If this happens the easiest workaround is to reveal about 1/8” of trace material (near the eyelet hole on the same circuit) and solder the component’s lead connection directly to that.

Or, if there’s a nearby soldered connection on the same trace, you can use the component’s lead to jumper directly to the terminal.

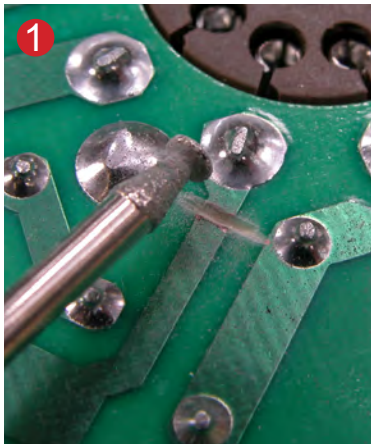
If an eyelet is damaged or missing or the trace material around it is very thin, then you may consider soldering a reinforcement jumper across it.

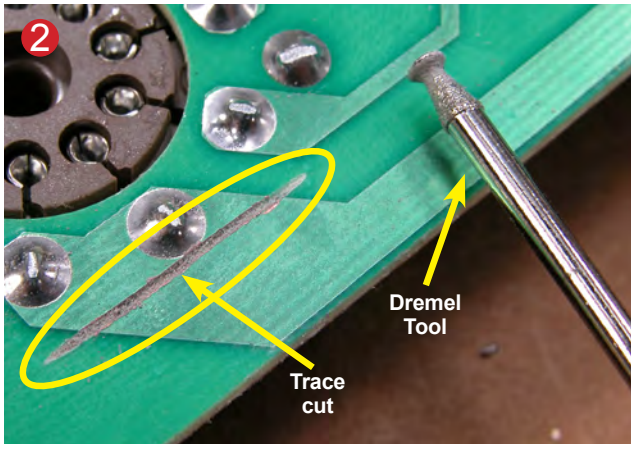
How to Cut a Trace: A “trace” is the conductive strip (foil) on a printed circuit board. It has a very thin laminate or lacquer layer over it. Cutting a trace is like clipping a wire. Use a box knife, *Exacto* knife or a *Dremel Tool* with a cutting or grinding edge attachment to make the cuts.

Various examples: This photo shows a cut trace, and a component lead jumpered and soldered to a revealed trace. It’s best to not drill a hole directly into a trace. Instead make the hole off to the side of the trace and then, as in this example, solder the component’s leg to the trace.

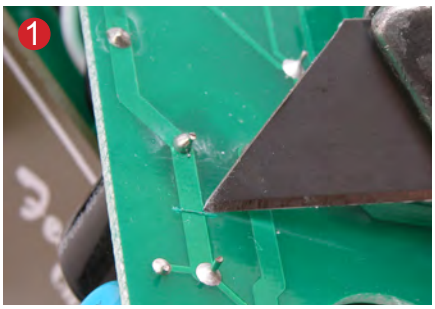
A *trace cut* severes the embedded metal laminent on a PCB. The purpose of a *trace cut* is to modify or re-route the electrical flow of the circuit.

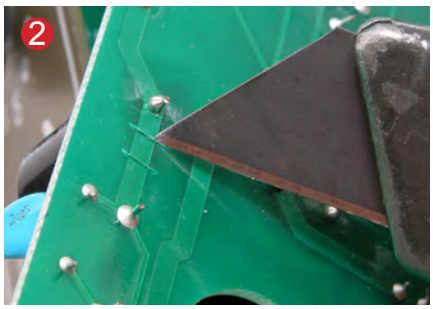
Here’s two different ways to cut a trace:

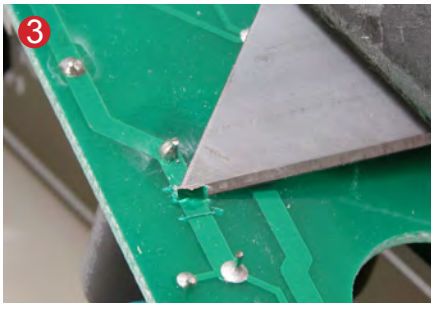




OR







Tips 'n Tricks for
Reducing RF & Other Noise in the Circuit

A little finessing is needed to reduce RF and other noise. A correctly set up ***Mercury Upgraded Valve Jr.*** should be almost stone-quiet. If you already have a quiet amp, your done! If not, read on.
Here's a few noise-reducing recommendations:

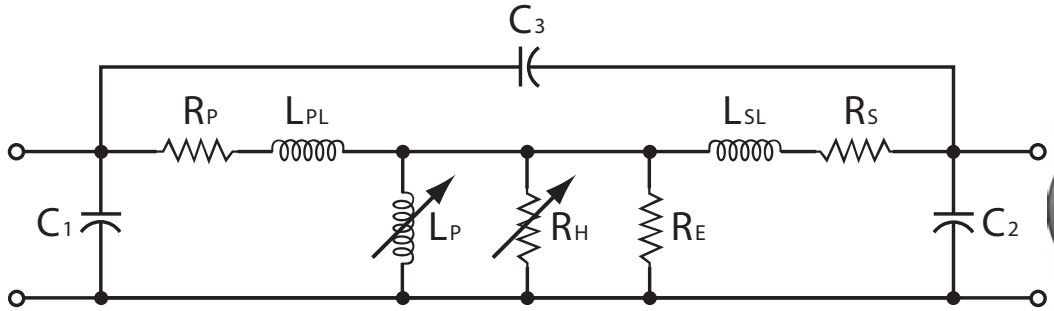
1. With the amp powered-up, turn its volume control off and unlplug the guitar.
2. Listen. Do you hear an unusual amount of extra noise?
3. The key to reducing noise is the layout of the wiring. Looking at the supplied photos of a finished amp, you'll notice patterns as to how the filament leads and other leads are twisted together. How some are not twisted. Their lengths. The use of wire ties, and the positions of others.
4. The filmament wires should be as evenly twisted as possible—about 10 twists per inch. Symetry is important.
5. Try to follow our examples as closely as possible.
6. The ***output transformer's*** primary YELLOW lead is another source of noise. Keep it under and away from as many components and other leads as possible, but close to the chassis.
7. Make sure that the twin RED B+ leads from the PT are NOT TWISTED together.

Tips 'n Tricks for
Drilling the Tube Socket for the 6v6 Mod

To create the proper-sized hole for the 6V6 tube socket, you'll need varibit or stepped drill bits similar to these.

The Output Transformer Circuit

Mercury's circuit equivalent of an Output Transformer



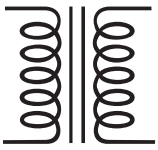
C_1	Primary Self Capacitance	L_P	Primary Inductance
C_2	Secondary Self Capacitance	R_P	Primary Resistance
C_3	Interwinding Capacitance	R_S	Secondary Resistance
L_{PL}	Primary Leakage Inductance	R_E	Core Eddy Current Losses
L_{SL}	Secondary Leakage Inductance	R_H	Core Hysteresis Losses

"Blessed are the Tone Makers"

The above circuit reveals the properties of an audio *output transformer*. The transformer is a *reactive* component—its values change depending upon the information feeding it. Transformers for tube-based electric guitar amps are designed to *intentionally provoke* the tubes into distortion—the polar-opposite of demands of *hi-fi*. The best guitar tone comes from harnessing and *manipulating* the inherent flaws of the imperfect transformer. This is where art meets science in our pursuit of great guitar tone.

—Sergio Hamernik

Consider the above *vs.* this typical dummied-down transformer symbol



DANGER! READ ME!

DISCHARGE THOSE FILTER CAPS!!!!!

The following is a collection of notes on discharging Filter Capacitors

Compiled by the staff at ***Mercury Magnetics***

DISCHARGING CAPACITORS – The filter capacitors in an amp will retain a charge for quite some time after the amp is shut off and unplugged. It is a good idea to make sure your amp is safe to work on. One way is to take a wire with an INSULATED alligator clip on each end, clip one end to a good ground point, and the other to one of the plate leads for the first stage preamp tube. Another method would be to put a 100K, 5W or more resistor in line of these two clips by attaching one end to ground (first), then the other to the filter caps themselves. NEVER SHORT THEM OUT DIRECTLY!

BE THE ONE-ARMED TECHNICIAN – There will come a time when you have to work on a chassis that is running. When doing so, if possible clip one of your meter's test leads to ground, and use only one hand to probe the circuit, keeping the other in your pocket, *etc.* That way if you DO take a shock, your heart is not in line of the path of least resistance – in one arm and out the other. When you ABSOLUTELY must use two hands, be EXTREMELY CAREFUL, and use common sense, but PLEASE try to avoid these situations!

* * *

"Filter" caps can store ***fatal*** amounts of electrical current. The caps are connected near the rectifier and are part of the power supply, and aid in converting AC to DC. In fact, they are a standard component in any power supply.

If you're completely lost, and don't understand this, DON'T MODIFY YOUR AMP. You haven't enough knowledge to work on high voltage/current circuits safely.

Several ways to discharge caps:

FIRST, UNPLUG THE AMP! (But that doesn't make it safe!)

THEN, take a screwdriver or a jumper and short the capacitors leads.

– OR jumper the power amp tube plate pin to ground for a minute or so (Class A, single power tube only)
– OR jumper the positive (+) lead of each large cap to ground for several seconds. A jumper with a built-in resistor (10K or so) will help prevent sparks here.

Some or all of these methods may result in a spark. Obviously, your flesh can act as a jumper also.

It's NEVER a good idea to touch amp circuitry when it's switched on. And don't work on amps in bare feet, or on a damp basement floor.

* * *

Letting the capacitors discharge slowly is preferable to having them do it all at once through your body while you're poking around inside the amp. Having the supplies you need on hand makes the job go faster.

You'll want screwdrivers, contact cleaner (you can use *Gunk* brand choke and carburetor cleaner or *WD-40*), a toothbrush and – unless you own an air compressor – an aerosol can of compressed air – soldering supplies and a volt/ohm meter (learn how to use them!).

Start by unplugging the amp from the wall, the speakers from the amp, and removing the amp chassis from the case. For Fender amps, removing the chassis involves unscrewing the upper back case panel, then unscrewing the chassis from the top of the case. Put the screws, nuts, and lock washers where they won't get lost.

With the chassis out of the case, you can locate the filter capacitors you'll want to avoid touching as you perform the tune-up. These will be cardboard cylinders (usually orange or tan or vintage Fenders) with "+" printed near one terminal. It's also a good idea to steer clear of wiring connected to the power transformer because it's a discharge path for the filter capacitors.

If you haven't given the capacitors a couple of days to discharge – or if you just want to be cautious – you can use a short length of insulated wire with alligator clips on the ends to discharge them. First, make certain that the amp is unplugged. Attach one alligator clip to a capacitor's positive (+) lead, then touch the other clip to the amp chassis several times. Repeat the procedure for each capacitor marked with a voltage (VDC) rating higher than 25. The time spent on this precaution can spare you from a numbing electric shock that you'll remember long after the amp is back together.

How to Discharge a Power Capacitor in Tube Amp

by Kevin Krause
eHow contributing writer

To be able to properly test and troubleshoot your tube amplifier with a multimeter it is important to discharge the capacitors located in the amp's power section to avoid false readings. Capacitors act as short-term batteries, storing a charge that can be called on by other components. This charge will remain in the capacitor even after the amp has been powered off, and can produce misleading voltage readings along circuit paths. Because of the high level of the stored power in the capacitor, safe discharging is a must.

Things you'll need:

1. High wattage resistor
2. Alligator clip
3. Copper wire
4. PVC tube or dowel rod
5. Soldering iron
6. Solder
7. Multimeter

Instructions

Level of difficulty: Moderate

Step 1: Strip about 1/4 inch of insulation off each end of a 2-foot length of insulated copper wire, and solder one end of the wire to one of the leads of a high wattage resistor. The resistance required can be determined by adding 5 to 50 ohms per volt of the capacitor's rating. For instance, a 100V capacitor would require a resistor rated anywhere from 500 to 5k ohms.

Step 2: Attach the other end of the wire to an alligator clip.

Step 3: Solder the free lead of the resistor to a short piece of bare copper wire.

Step 4: Tape the resistor and bare copper wire to one end of a length of non-conductive material, such as PVC tubing or a dowel rod. Make sure enough of the copper wire is exposed to act as a contact point.

Step 5: Attach the alligator clip to one of the capacitor's leads. Be sure the amplifier is completely powered off before doing so.

Step 6: Touch the bare wire end of the PVC tube or dowel rod to the other lead of the capacitor. It is very important to not touch any of the exposed leads or wires at this time. Hold the bare wire on the lead for at least several seconds to fully discharge the capacitor.

Step 7: Test the capacitor with a multimeter to be sure all voltage has been safely removed.

Discharging Capacitors in a Guitar Tube Amp

Take pride in how safe you can be.
You can't play guitar or build amps if you're dead.

You may have heard various horror stories about things inside amps that can store a charge that can kill you. Well, it's true! However, those dangerous voltages can be easily drained in just a few minutes, so take your time and don't rush.

It is absolutely vital that we drain the filter capacitors in the DC power supply before working on any guitar amplifier. These often hold a charge of several hundred volts, which is potentially deadly. Capacitors can hold their charge for a long time, even with the power off and the amp unplugged. It's very important that we learn to properly "drain" this residual voltage so that we may safely work on the inside of our amplifiers.

What You'll Need:

Filter Capacitor Discharge Tool

1. **Safety glasses.** Always use safety glasses. If you wire a capacitor in backwards there is a very good chance that it will explode in your face.

2. **Digital multi-meter.** Capable of reading 500 volts DC.
3. **Capacitor discharge tool.** A jumper wire consisting of alligator clips on the ends, with a resistor in series in the middle of the jumper.
4. **Needle nose pliers.** With very good insulation on the handles for holding the alligator clips of the capacitor discharge tool.

Always make sure your tools are in good condition. If there's any question, replace them. Cracked insulation is one of the first things to check, and check often.

Turn the power switch OFF, and place the standby switch in the ON position. This isn't the same as having your amp "on standby."

Always unplug the amp from the wall. Unplugging from the wall will not drain the filter capacitors completely, but again this is for our own safety. Unplugging is the equivalent to "locking out" before working on a downed machine.

Because filter caps are almost always of the electrolytic type, they're "polarized" and therefore have a positive and negative end. We can identify the positive or negative ends by looking for the "polarity indicator" printed on the cap's side.

Our first objective is to check for residual voltage with a multi-meter. In some cases most of the voltage may have already been drained. Many amplifiers will incorporate "bleeder" resistors, which will drain the capacitor charge automatically in a few minutes after the amp is turned off. Don't depend on this resistor to do the job. Never assume the caps have been drained to a safe level without checking with a reliable multi-meter.

Here's a couple of ways to measure the residual voltage contained in the filter capacitors. Note that these are also equally valid for draining the caps:

1. **Across the capacitor**.
2. **From the positive side of the cap to the chassis**. This is essentially the same as draining "across" the caps since the negative side is at the same electrical potential as the chassis.
3. **From the chassis to a tube pin**. This can be done at pin 3 of any power tube, or pins 1 or 6 of any preamp tube. By shorting the chassis to the correct pin the caps will be forced to drain through the plate load of that tube. This prevents sparking from high current.

IMPORTANT NOTE, HOW NOT TO DO IT: In old electronics books they tell you to use a screw driver with an insulated handle to short out the caps. "Shorting" with a screwdriver will almost instantly drain the caps to zero volts, causing sparks from high current. This is not acceptable. If there are several hundred volts stored in the caps, be prepared for a nice sized spark. It will most likely leave a black mark on the chassis, and in extreme cases, partially weld the screwdriver to the chassis.

Now we're ready to start testing and discharging

Set your multi-meter to read DC voltage. Adjust the meter's range so that it's above 500 volts. Clip the black lead of your multi-meter to the chassis. Using only one hand, with the other hand far from the chassis (preferably in your pocket or behind your back), measure the DC voltage across one of the filter capacitors. You can adjust the meter's range down if you can't get a clear reading. Any DC voltage readings less than 5 volts are harmless, so the amp can be safely worked on, but do a double check of all the caps just to make sure. If not we must drain off the residual voltage with a resistor until it is safe.

Use a resistor value somewhere between 10K and 100K, with a power rating of 5W or so (a high power rating is not really necessary for heat dissipation reasons, but mainly because the higher power resistors are physically more robust and won't tend to break). The larger the resistor value, the longer it will take to discharge. If your capacitors do not have a dangerously high voltage, say around 30 volts, feel free to use a smaller 1K 1 Watt resistor.

Now take your capacitor discharge tool and clip one side to the chassis. Always clip to the chassis ground first before connecting to the circuit. If you clip to the circuit first you will have a hot wire hanging out of your amp, which is very dangerous. Once you have one side clipped to the chassis, take your needle nose pliers with good insulation on the handles and hold the alligator clip that will go to the circuit with the needle nose pliers.

Clip this to pin 1 or 6 of the first preamp tube. This seems to be the safest way of discharging the capacitors. If you're working on the first preamp tube socket, then clip your discharge tool to pin 1 or 6 of the second preamp tube. Wait a few minutes (about 5 minutes, if the amp has bleeder resistors this time will be shorter) then, while the discharge tool is still in place recheck all the capacitors with your multi-meter and keep that other hand behind you. Keep checking until the voltage has reached a safe level. Note: This procedure must be done every time you turn the amp on then off.

Remember to remove the discharge tool before powering on the amp. Make it a bright color like

yellow and maybe put a piece of shiny tape on it to make it more visible. You can even put a fuse in series with the resistor on the discharge tool in case you forget to remove it.

Filter capacitors are wired in parallel, so draining one should drain them all, but never assume. Always recheck for residual voltage in every filter capacitor until there's absolutely no doubt in your mind that all are drained.

Less than 5 volts is safe, but I prefer to drain mine to 1 volt for peace of mind. Don't be surprised if you find the capacitors slowly recharging themselves. This phenomenon is known as dielectric absorption and is quite normal in electrolytic capacitors. The filter caps shouldn't recharge to a lethal level, but leave the discharge tool in place while working on the amp.

A few final notes:

1. Never work on an amp if you're tired, fatigued, frustrated or intoxicated.
2. Never work while distracted.
3. Never work on an amp around small children. There are just too many dangers involved to take that chance.
4. Try to have a plan in case something does go wrong. You might consider asking someone in your household to take a CPR class.
5. Take your time and don't rush.
6. Use common sense.

http://tubenewbie.com/discharge_capacitors.html