Building the “Tone Frenzy” Amp

A Torres Engineering amp design kit

Our good friend Jeff D. is a regular at Torres Engineering and has the great “Tone Frenzy” web page (http://www.tonefrenzy.com) dedicated to getting “the tone.”

We are always looking at and testing real interesting/unusual guitars and effects Jeff brings in to the shop.

Jeff also has a couple of Torres Engineering Prototype amps including the world famous “mini-Dual Marshall” and the “Tone Frenzy Champ Amp” described here.

The latest project was a relatively ill Fender Champ amp. Since it was in rough condition we decided to get some good stuff going in it and Jeff wanted to develop the ultimate single ended rock amp at a non-bankruptcy price.

First we added a real tube reverb circuit, complete with extra tubes, transformer and 3 spring reverb tank.

Next it was an extra gain stage for some full-on overdrive and sustain.

After all that sounded perfect, Jeff wanted to step the power up from the single ended 6V6 to a 6L6 - cool!

One of these mods can be done to the amp fairly easily, but when you get to adding multiple tubes for a reverb, increasing the filament string current requirements, needing more power trans current, and then mis-matching the output transformer, the project gets more complex.

To make it a dependable amp, and get the last ounce of performance from the amp, all the design factors have to be accounted for.

The Champs ended up with an auxiliary filament transformer to take the load off of the original champ power transformer filament winding.

The complete amp project uses a power transformer with enough current capacity for all the tubes, filaments and rectifier tube.

Also hefty 1 x 6L6 output transformers of the correct primary impedance, and capable of driving an 8 ohm 10" speaker in stead of the now-overpowered 8" champ speaker.

Of course all this doesn’t fit!! Adding two 12AX7 tubes to the chassis and such, plus transformers (filament, reverb, and new output about 3 times as large), and fitting it all back into the champ cabinet is a real 3 dimensional design project, we won’t go into all that, but will build a new amp from scratch taking all design considerations into mind, and making still more improvements.

Check out the block diagram. I’ll go through each of the stages in the process of building a complete single ended 8 to 10 watt amp with reverb and killer “Tone Frenzy tone.”

Input of the amp is to the extra gain stage. It has its own volume, and outputs to a switch jack that allows you to bypass it and plug into the “normal” fender style preamp.

The preamp is modified a bit to get a fuller, warmer tone, and better frequency response when used with a better power supply and high quality (higher than the original Fender) output transformer.

A complete reverb circuit is next - reverb circuit are actually in parallel with the main amp circuit, and are actually a little amplifier driving the reverb springs.

A new driver circuit using both sides of a tube in parallel is used to get more current drive to the power tube.

A single stage of a 12AX7 as found in the champ is somewhat underpowered and incapable of really driving a 6L6 with enough “voltage swing” to make the tube come to life.

The 6L6 is wired in pentode for the most output power. It would also be possible to use a high end audiophile ultra-linear single ended air gap transformer for lots and lots of clean power from the amp. I certainly will try that on the completed model.

A whole new power supply is designed for this amp. Single ended amps do not have the benefit of hum cancelling that push-pull amps have. Some degree of hum exists in the very simple champ power supply circuit. This is completely eliminated for a professional quality low noise amp.

One of the difficulties with single-ended amps, those using only one power tube, is the loss of the "humbucking effect" from two power tubes in push pull. This push-pull humbucking effect reduces the hum in the amp (called "ripple") quite a bit, making it easier to design the DC power supply for the amplifier.

Without the noise reduction of push-pull, many (almost all) vintage single ended amps have noticeable residual hum in their power supplies and in the audio signal.

After all, these were designed as cheap amps. Low cost for practice or beginners, not at all for the uses we put them to today - recording, high gain, higher expectations in performance etc.

It is fairly easy to reduce the ripple of the power supply, but it was not considered in the design of the vintage amps.

The Tone Frenzy amp is designed to be a professional level amp with very low noise and no apparent ripple sneaking into the audio signal from the power supply.

Adding an extra stage of filter capacitance, separated from the rectifier by a low value resistor reduces the power supply ripple by a factor of over 100 -(see "Inside Tube Amps" by Dan Torres for full details on the math and ripple reduction).

So take a look at the drawing for the added filter cap and resistor.

This power supply also feature a "turn on" cap at the output of the rectifier tube. A .1 mfd 600V metal film cap (we have them custom made just for this purpose.) This cap keeps the rectifier tube from seeing an open circuit when turned on with the standby switch open.

Since voltages are fairly low for a single ended amplifier, filter caps in series, as found on other higher voltage push pull amps, are not necessary.

The first 47 mfd filter cap (rated for 450 volts) has a 100k resistor in parallel with it. This resistor is a "capacitor bleed" resistor. It will bleed off the stored cap voltages when the amp is turned off.

At 100k it adds a bit of regulation to the power supply - helps it remain more stable. 50k would add more regulation but would have to be a 5 or 10 watt resistor and would also bleed off some of the B+ voltage.

The second 47 mfd cap (450V) is the first node of the power supply - called B+1. From there the power supply is pretty standard single ended vintage amp.

The second resistor, a 1k 1 watt could be replaced by a choke for a smoother sounding

amp with higher voltages appearing down the power supply. The final version of the amp will, most likely, include a choke.

When building the amp new, the old fashioned Fender one piece "can caps" won't be used - a separate power supply board is used to accommodate the individual capacitors.

This amp has a modern preamp with a full tone circuit, single ended 6L6 tube instead of a 6V6 for more power, plus an extra overdrive stage, and a full tube/transformer driven reverb - a very cool and versatile amp.

Pint to point eyelet circuit boards are available Torres Engineering, as well as a kit for the entire "Tone Frenzy Amp."

Ok, take a look at the preamp circuit.

This isn't a super complex circuit, but it has a few "twists" of interest, and the high gain and high performance will require top quality assembly and materials.

Take a look at the schematic for the details of the preamp circuit.

Input is pretty normal with a grid load resistor and into the first stage - half of a 12AX7 tube.

This is the overdrive stage. Plugging into its jack provides an extra stage of gain to "push" the rest of the preamp into pleasing tube distortion with lots of sustain.

The "trick" here is the local feedback[1] shown as a .1 mfd. capacitor and 10 meg resistor going from the input of the tube stage to the output. Instead of blasting hard-to-control overdrive typical of 1970's designs, this local feedback circuit lowers the gain to provide more of a "tube screamer" subtle "push" effect with lots of compression, low noise and clarity. (Feedback reduces noise.)

The 500k pot at the output of the first stage controls the amount of added gain from the extra circuit.

This feeds into another input jack (#2) with a switch. The switch disconnects the overdrive stage when you plug into jack #2 for a clean tone - easy, not a new idea. This type of circuit is found on many amps back to the 1970's, boogie, Marshall etc.

Following Jack #2 is a fairly standard Fender amp tone circuit comprising two more stages of a 12AX7 tube. There are changes in the tone control circuit (called the "tone stack" by some) and in the tube gain stages to adapt the frequency response for the single ended 6L6 tube and to modify the overall tone so the "Tone Frenzy amp" sounds like it is a 30 year old classic Fender.

A modified reverb circuit is inserted right after the tone control recover stage. This reverb circuit is modified to have the reverb effect cover a wider frequency range and the input dwell to the reverb driver tube (specified as a 12AT7) is slightly reduced for better application in a high gain amplifier.

Reverb return comes back to the circuit using the Reverb pot as the following stage's grid load resistor.

Overall, a circuit that will work beautifully if attention to detail and layout are done correctly.

This is the final section of the amp, the driver and power tube.

This is a fairly easy part of the project, the final schematic is included with all the power supply connections and entire amp shown.

[1] *Not to be confused with the squeal feedback of a microphone. This is signal feedback designed to lower the gain of the input by sending some of the output back to the input out of phase to reduce gain*

The “driver” is a 12AT7 tube, wired with both stages in parallel for more current capacity and a stronger drive to the 6L6 power tube.

(Class A tubes require considerably more drive than the standard Class AB amps. A 6L6 in class A requires much more drive than a 6V6 to really get the tube working right.)

The cathode bias resistor for the 12AT7 may need to be adjusted a bit to get 2.5 ma current draw for the tube. A one ohm (1 ohm) resistor is installed in the cathode circuit of the 12AT7. The current converted to milliVOLTS can be read across this resistor with your VOM meter. If the current draw is too high, use a larger resistor (1k for example.) If the current draw is too low, use a lower value resistor (680 ohm for example.)

12AT7 tubes vary considerably in response so this adjustment may be necessary.

The 8 pin 6L6 tube is next, with drive at the control grid from the 12AT7 plate to a 250k master volume which acts as the plate load resistor for the 6V6 (can not be left out. If you do not wish to have a master volume. Replace the pot with a 220K 1W resistor.

This is a cathode biased output. Contrary to popular (internet) knowledge, cathode bias amps can and do need to have the bias adjusted.

The process is fairly simple. Again, a one ohm resistor in installed in the cathode circuit.

The current draw of the tube (milliamperes - ma) can be read at this resistor. The resistor automatically converts the current into a voltage figure.

The plate voltage using the specified transformer, is about 330 volts with the 5V4 rectifier tube specified.

Place your VOM meter red lead at the tube side of the 1 ohm resistor, and the black lead at the cathode resistor side of the same 1 ohm resistor. You must have clips on the meter leads to be sure you don’t get a shock.

Notice: this kind of work requires the amp to be on. You must be experienced and trained in working with high voltages and current, and knowledgeable of the dangers and concerns in doing this kind of work. If you do not have the correct experience and verified training, do not work on any kind of electronic device when it is turned on.

The current draw of the tube can be read on your VOM meter in millivolts. The single ended Class A 6L6 should draw between 40 and 53 ma (mv) adjust the cathode bias resistor (5 watt minimum, 10 watt suggested) to get as close as possible to this current reading.

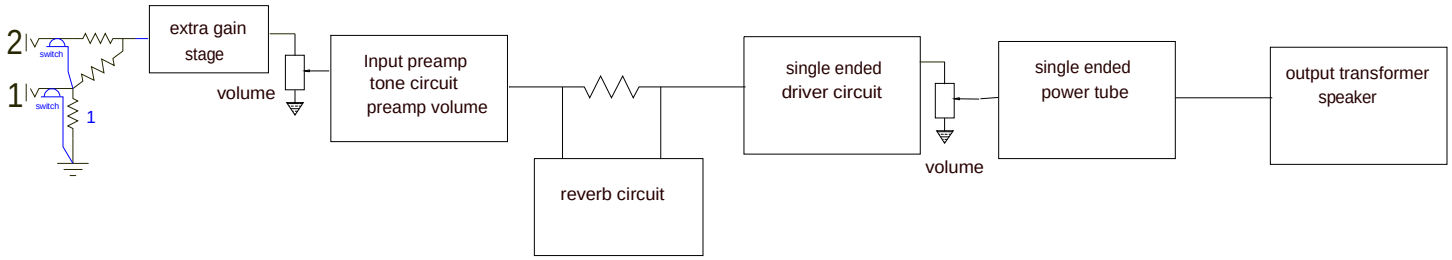
You can adjust the required current if you have slightly higher or lower plate voltages by consulting the bias charts found in “Inside Tube Amps” by Dan Torres

The new 6L6 sounds very, very good at 50 ma in this amp design.

The output transformer is rated for about 15 watts to be sure it has sufficient headroom. Primary impedance is best at 4.1k to 4.2k for a 4 or 8 ohm load. The transformer specified on the schematic has both output impedances available.

Revised Wednesday, September 15, 2004

The Tone Frenzy Amp Block Diagram



amp circuit only (power supply not included)

DANGER CAUTION 300 - 400 VOLTS	Drawing By Dan Torres	DANGER HIGH VOLTAGE
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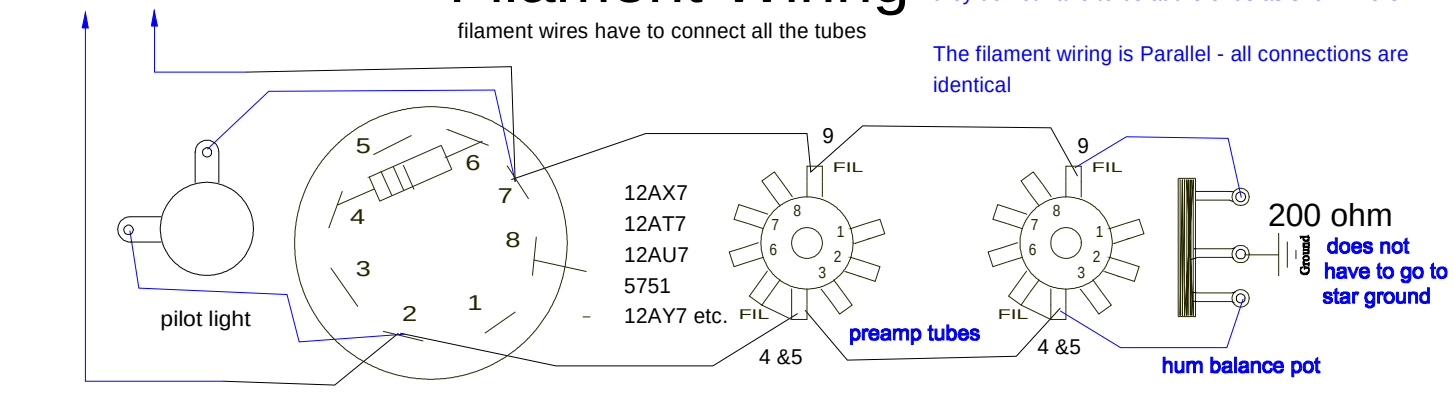
Filament Wiring

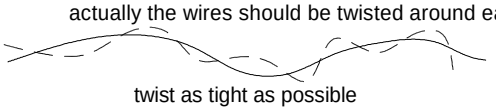
filament wires have to connect all the tubes

the pilot light and hum balance can be connected anywhere along the filament string (to any tube) they do not have to be at the ends as shown here.

The filament wiring is Parallel - all connections are identical



actually the wires should be twisted around each other



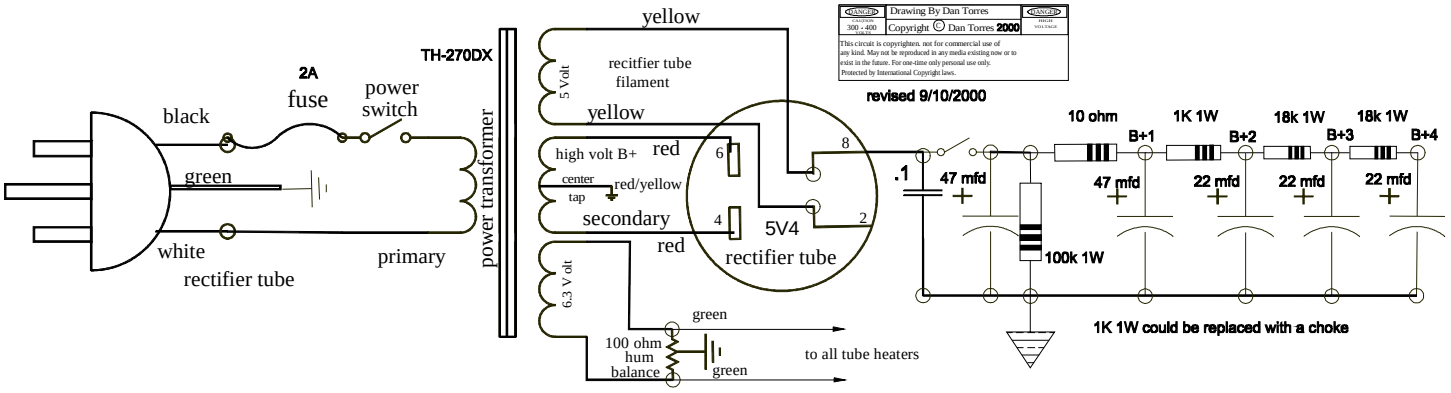
twist as tight as possible

route filament wires away from any other signal wires in the amp

Power tube connections (6L6, 6V6, EL34, 6CA7, 6550, KT66, KT88) are pins 2 and 7

Preamp tube filaments are pin 9 and pins 4 and 5 - pins 4 & 5 are connected together

Tone Frenzy Power Supply



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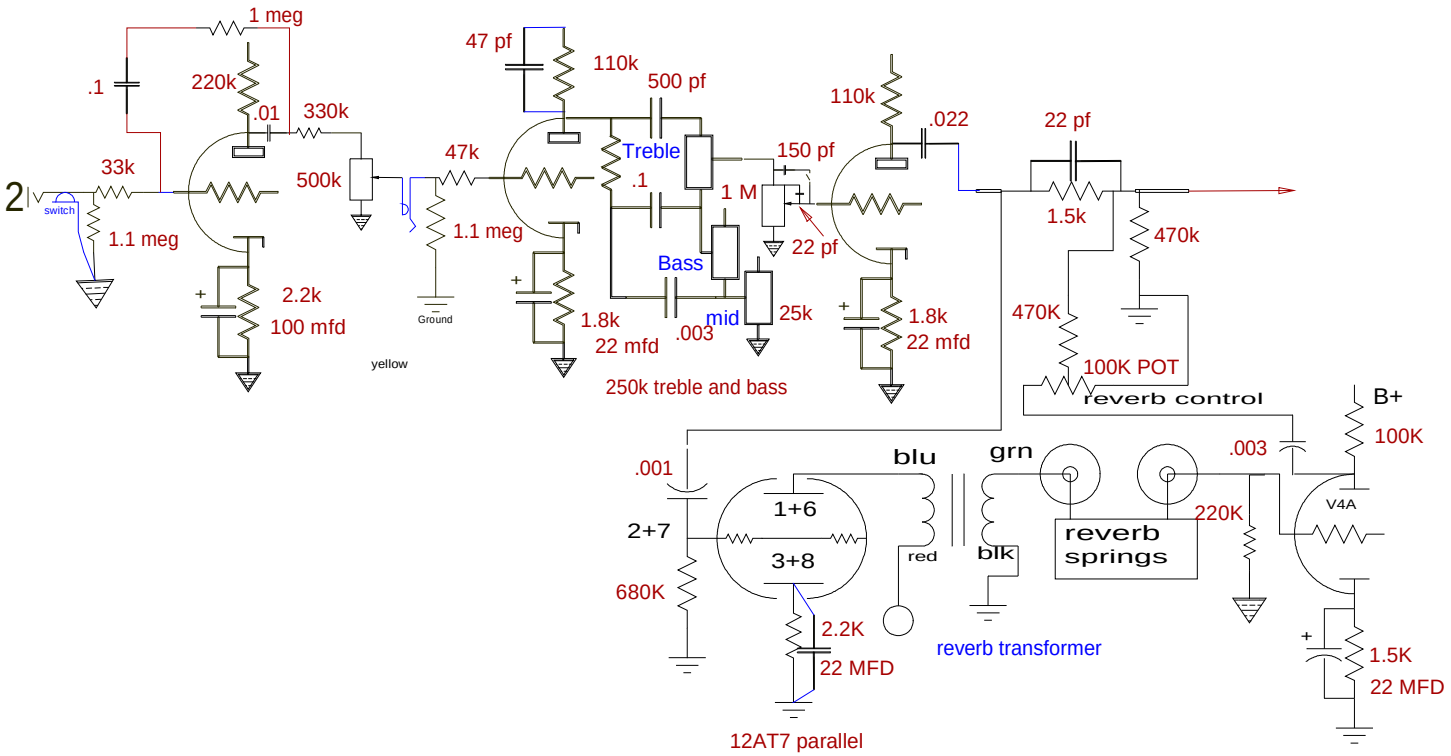

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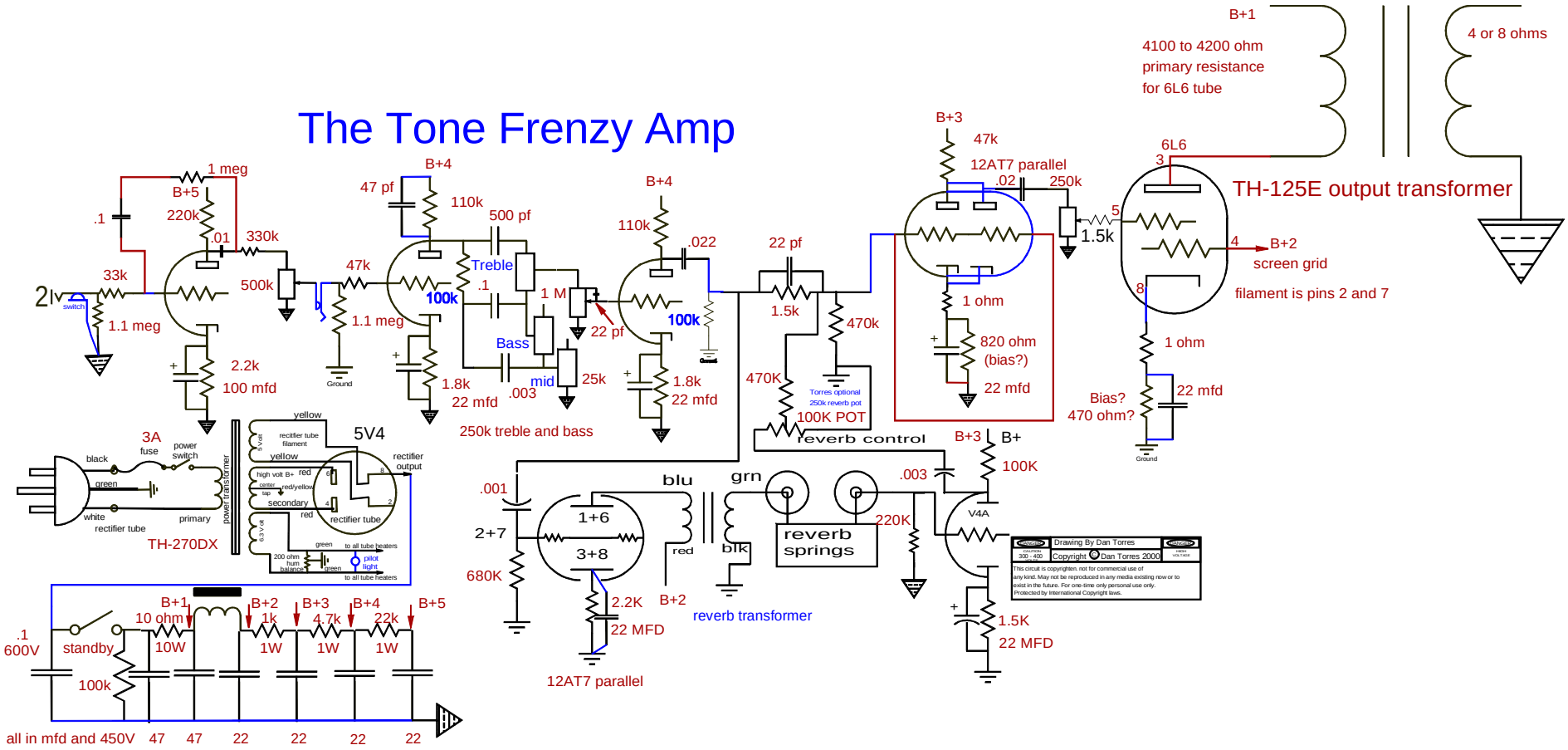

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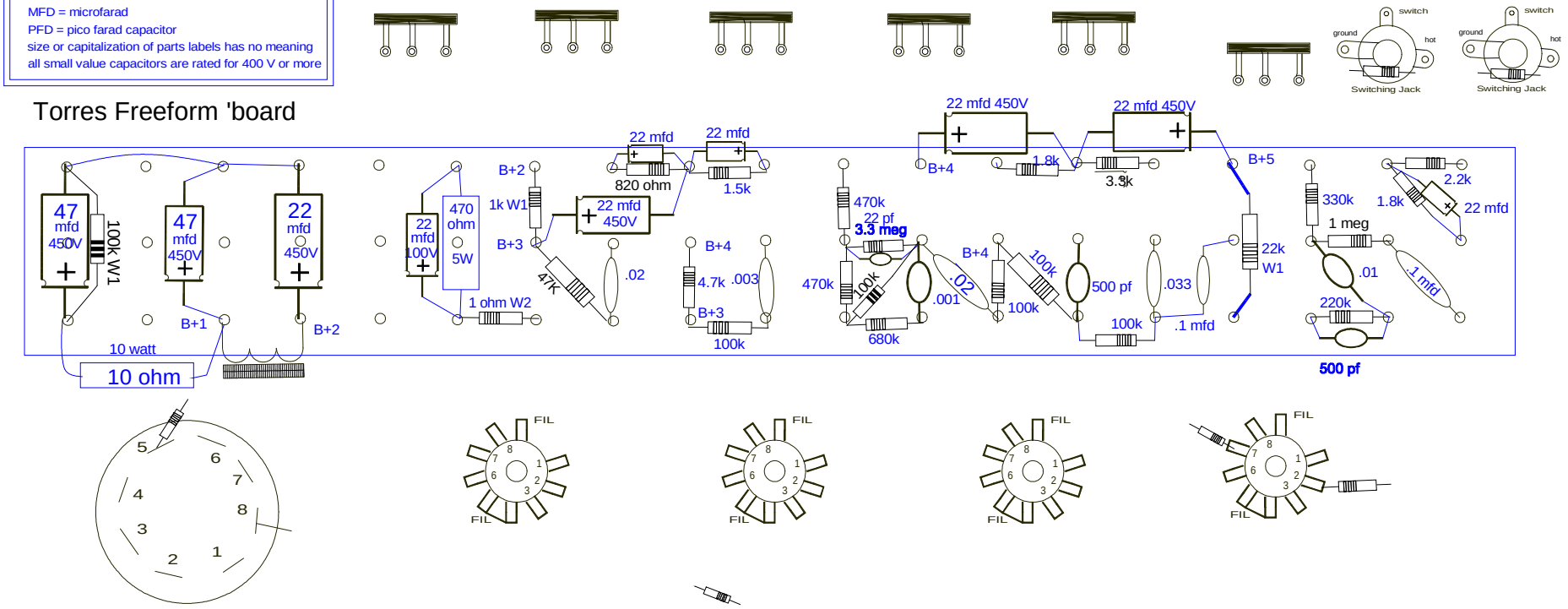
Tone Frenzy Amp Layout

front of the amp (where the controls go)

Parts ID legend
M = meg (as in 1 M)
K = 1000 ohms as in 100k
W1 = 1 watt
W2 = 2 watt
W5 = 5 watt
No ID on resistors = 1/2 watt
MFD = microfarad
PFD = pico farad capacitor
size or capitalization of parts labels has no meaning
all small value capacitors are rated for 400 V or more



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Black Ground wires

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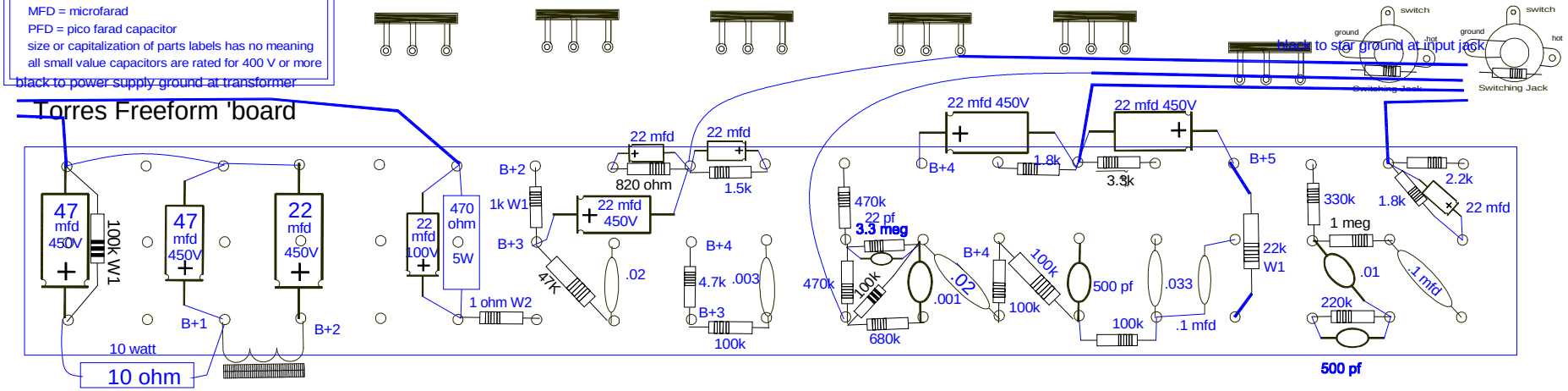
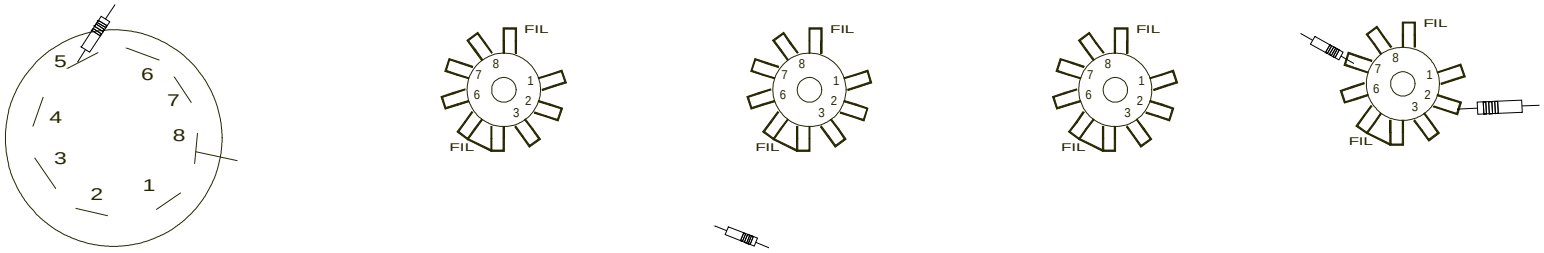
black to power supply ground at transformer

black to star ground at input jack

Torres Freeform 'board





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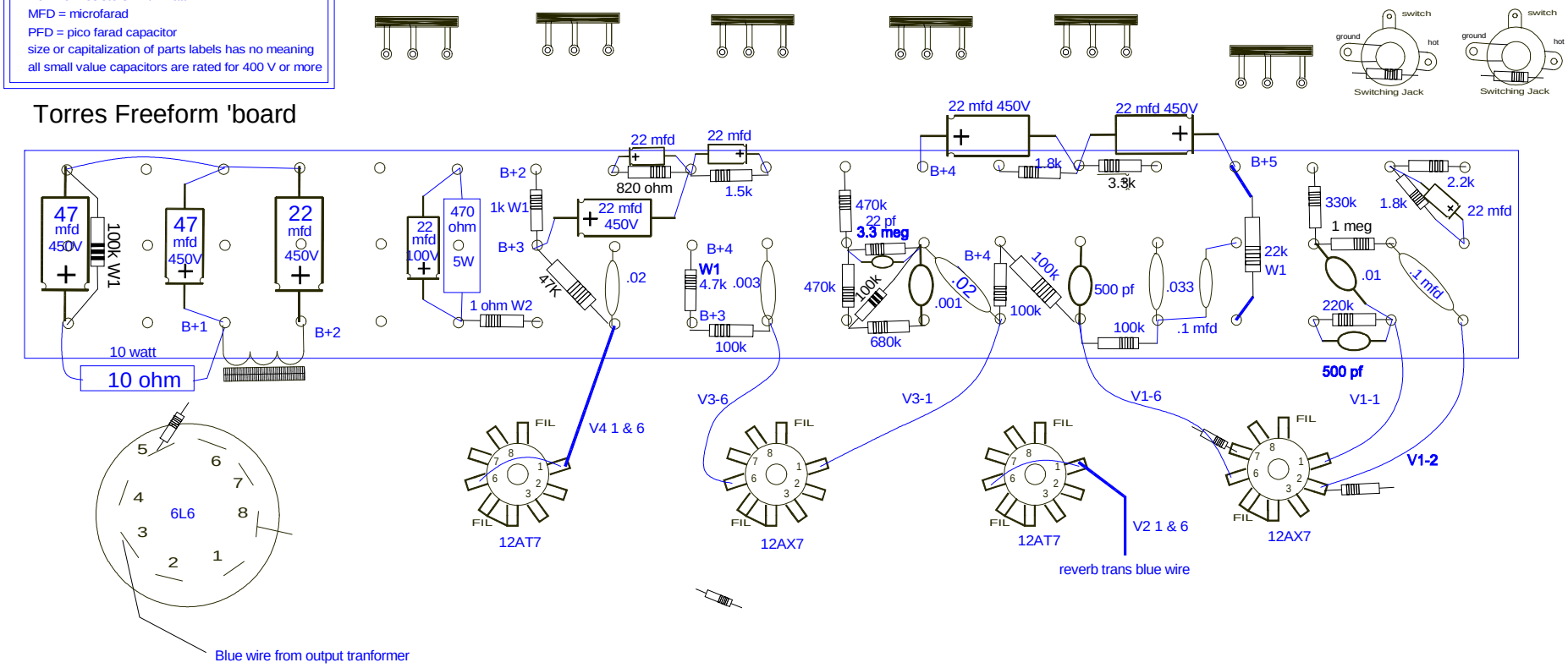

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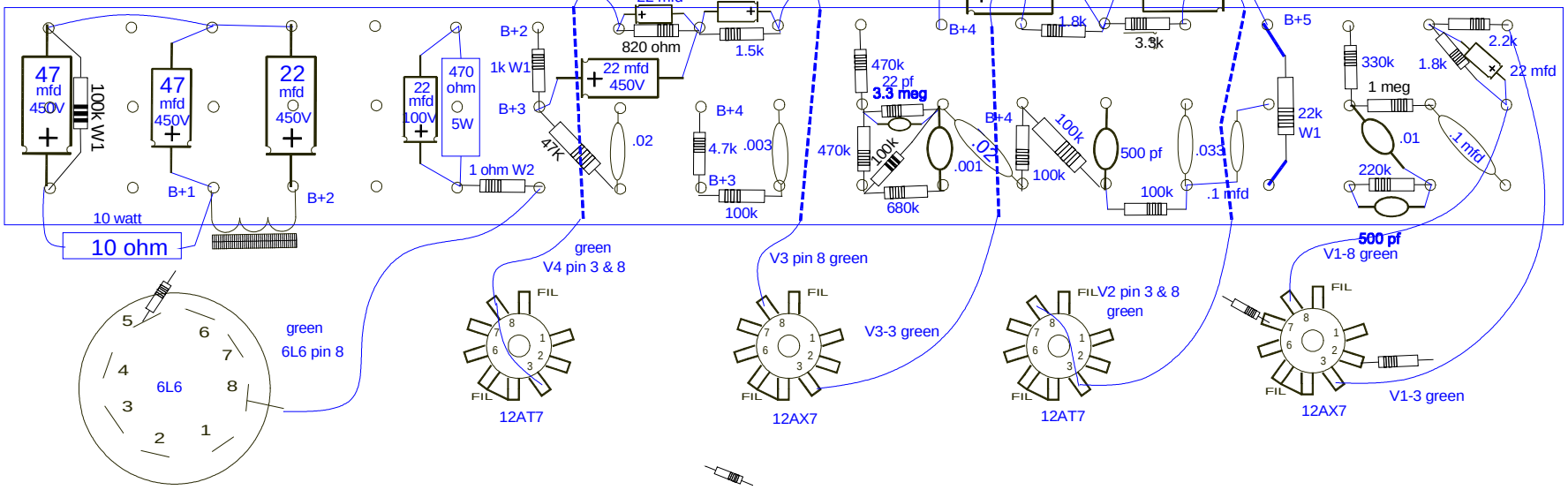
Torres Freeform 'board



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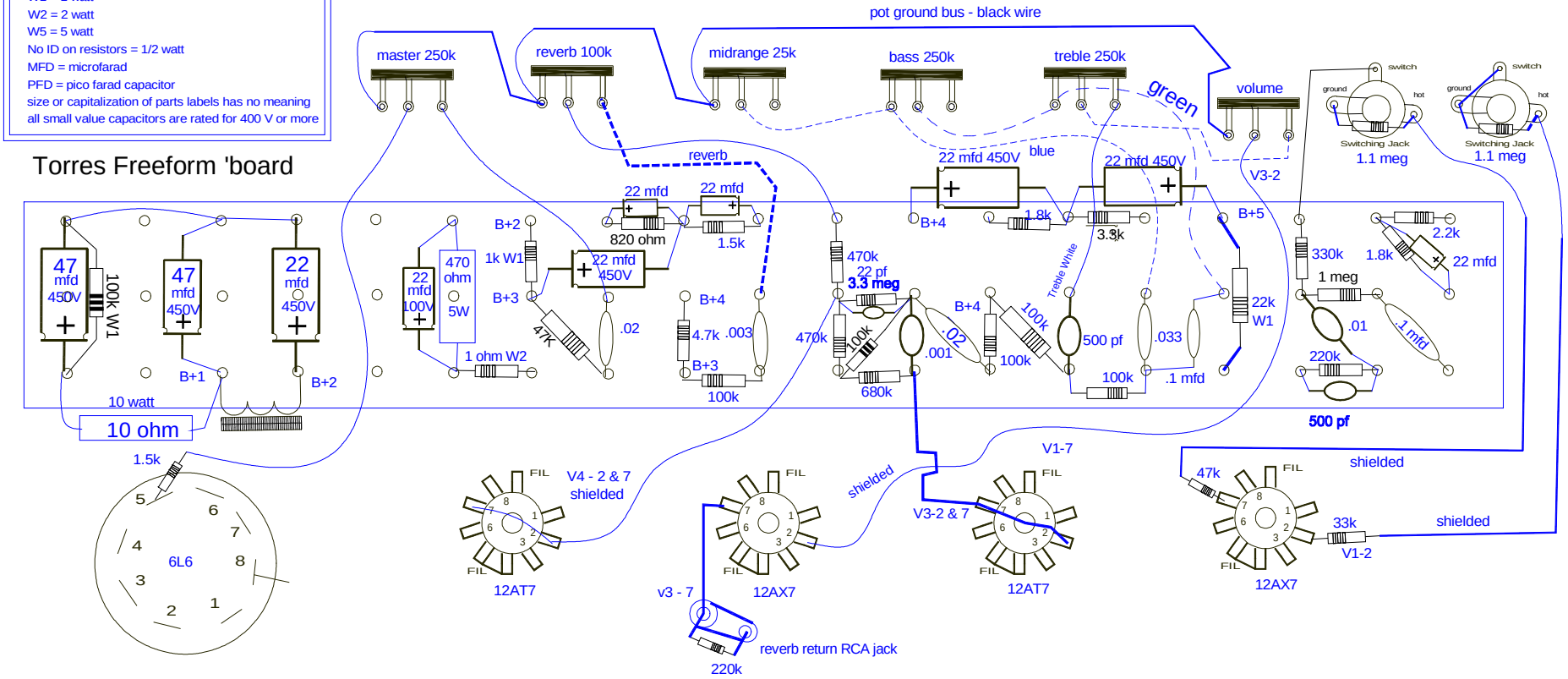

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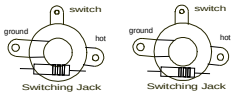
power supply connections



to power supply ground

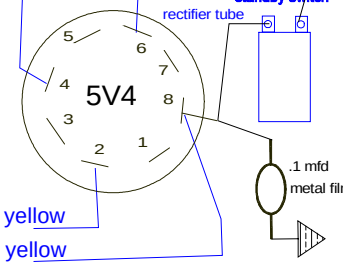
hi voltage secondary
from power transformer

red/yellow
center tap

red
red

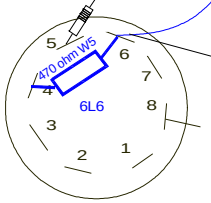
10 watt
10 ohm

standby switch
rectifier tube

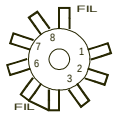


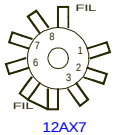
.1 mfd
metal film

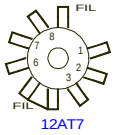
yellow
yellow
5V filament from power transformer

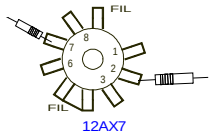


brown wire from output transformer
red wire is NOT USED at all









green from reverb trans
reverb send

black (ground) from reverb trans

red wire from reverb transformer