




Hybrid vacuum tube/solid-state audio power amplifier

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Having built a number of vacuum tube output transformer-less (OTL) amplifiers in recent years, it seemed as though it might be a good idea to try combining older with newer technology and using both to best advantage.

The modern MOSFET is easy to drive, so it appeared likely that a standard vacuum tube circuit could be configured to drive a P/N pair of MOSFETs. The Semelab MOSFETs used are specifically designed for audio applications (See [Semelab Lateral MOSFET Application Guide](#)). The use of MOSFETs for the output stage eliminates some of the problems associated with vacuum tube OTL output stages: inefficiency, high heat, the need for a phase inverter, and, sometimes, reliability problems. The output tube heaters alone draw a considerable amount of current.

The goal was to keep the circuit simple and the number of amplification stages to a minimum while having enough gain to be driven by most preamplifiers, solid-state or vacuum tube. This suggested using a pentode voltage amplifier stage feeding a cathode follower stage to drive the MOSFETs' rather high gate capacitance. With this configuration, the goal of limited amplifier stages and simplicity is satisfied. The amp can drive 40W into a 4Ω or 8Ω load. 

In order to apply feedback, it is necessary to invert the feedback signal. This is accomplished with an active feedback stage using a single wideband op-amp configured as an inverter. The op-amp also scales the feedback to the desired level: in the circuit shown, a reduction of 20:1. The op-amp is easily powered from the same source that is used to power the vacuum tube heaters.

resistors and a higher VA rating to accommodate the extra load. This would be another simplification of the circuit.

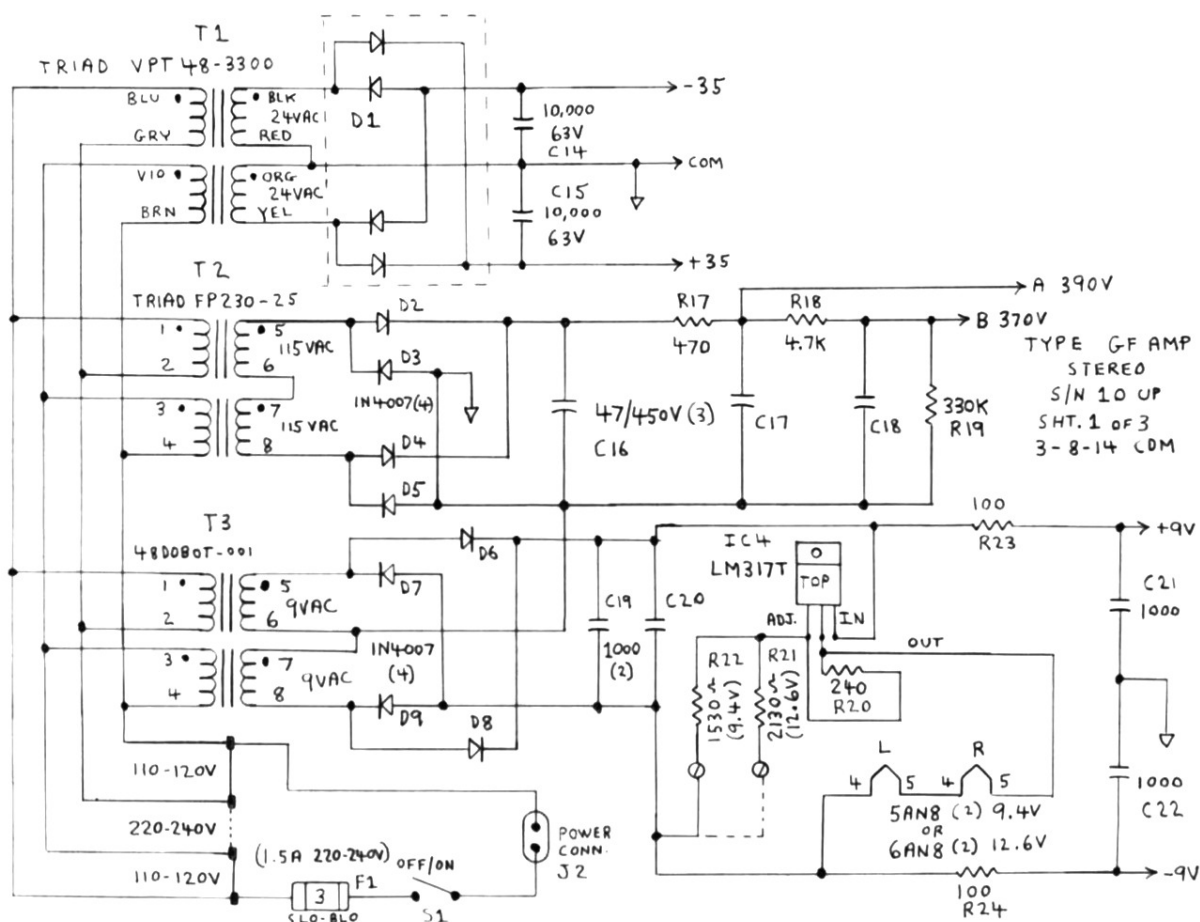


Figure 2 Power supply

An optional delay circuit (**Figure 3**) will eliminate any turn-on transient noises as the vacuum tubes warm up. This circuit holds points X and Y to common until the vacuum tubes warm up. The advantage of placing this mute circuit at the gates of the two MOSFETs rather than a contact in the output to the speaker is that it eliminates any possible contact resistance a relay would add in the speaker path. IC6 and IC7 may be small-signal relays if desired. If C2 & C3 are reduced to 0.1μF, this will further reduce any transients, at the expense of some low frequency roll-off below 20Hz.

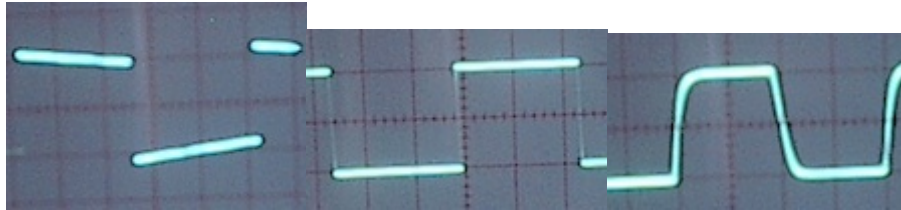


Figure 4 Square wave response at 10Hz, 1kHz, 50kHz

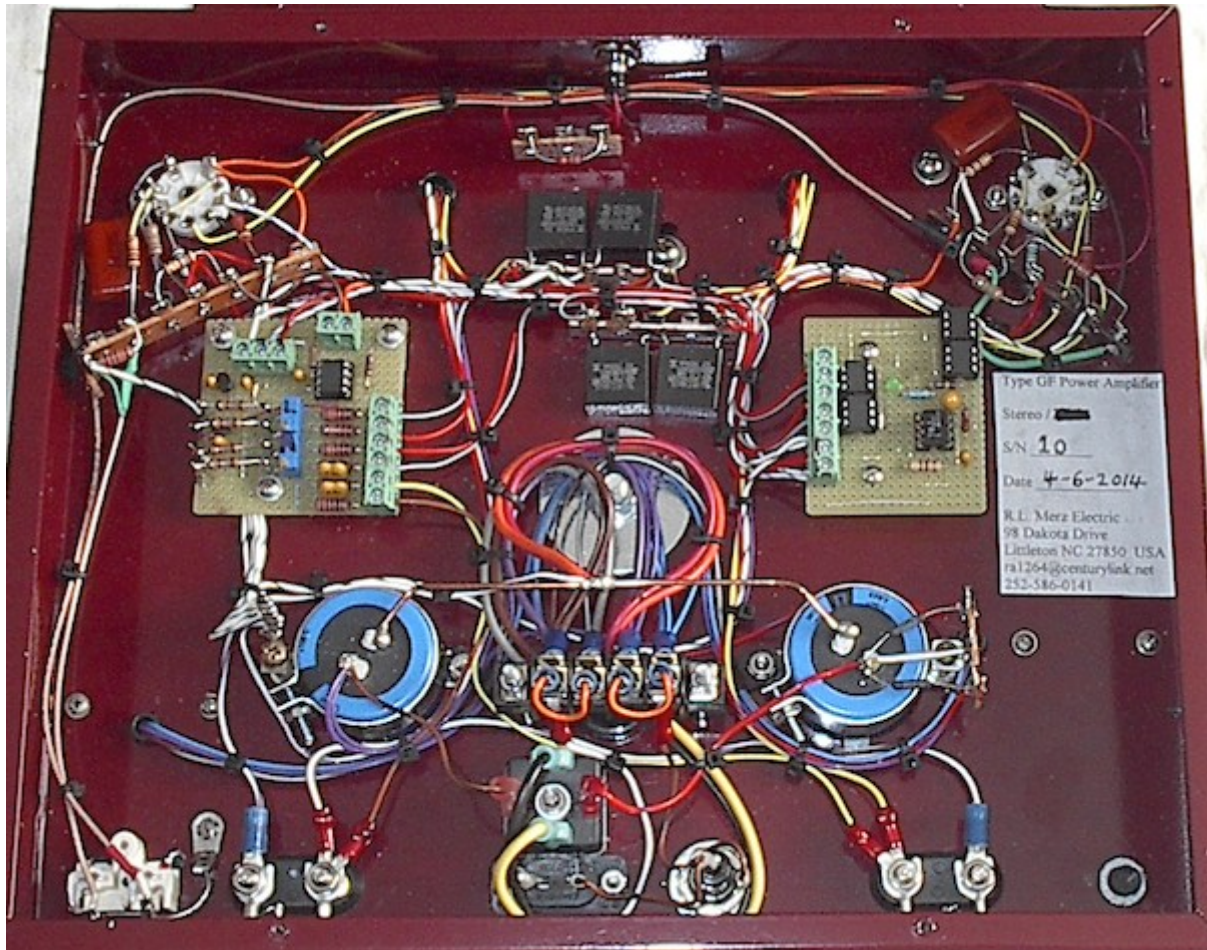


Figure 5 Construction details



Figure 6 Component mounting

Also see:

[Friday Fun: Test Those Tubes](#)