Vacuum Tube Guitar Amplifier
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Goal
- To create a more portable and affordable vacuum tube amplifier.
  - Eliminate the power transformer (approximately 10 lbs and $120) and minimizing the number of components
- Maintain characteristic tube sound quality while taking advantage of modern design methods
- Research quantitatively musicians’ preference for tubes

Motivations – Why Tubes?
- Vacuum tubes produce a signal that is musically different from transistors. Transistor amplifiers output a tone with a strong third harmonic. The third harmonic is often a dissonant and unwanted sound. Alternatively, vacuum tube amplifiers output a strong second harmonic. The second harmonic is much more harmonious, resulting in a more musical output.

Research Challenges
- Eliminating power transformer and other components to reduce cost while maintaining high sound quality
- Isolating chassis for user safety
- Sourcing and modeling special hardware components in OrCAD software
- Researching properties of tubes that engineers and players prefer; taking advantage of these properties in our design

Acknowledgement
We would like to thank Professor Caggiano for his guidance and wealth of experience in vacuum tube amplifier design.

Methodology
1. Research properties of tubes and common tube amplifier topologies to investigate what we prefer for our design (minimum number of components and low implementation cost). Also research methods for eliminating power transformer.
2. Simulate preliminary designs in OrCAD Cadence simulation software
3. Gather hardware components and characterize transformers for emulation in modeling software
4. Optimize simulated circuit using new transformers, construct and test amplifier

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Results
- Driver stage uses 12AU7 tubes in a cascade amplifier for high voltage gain and a differential pair for phase splitting, noise cancellation, and additional gain.
- In the output section we used 6L6 tubes for high current gain to drive the speaker.
- Our design uses only 4 tubes, reducing cost.
- A charge pump circuit is used to increase the wall voltage from 120 V to 340 V.
- We used inexpensive isolation transformers to ensure the user’s safety.
- Our amplifier is extremely low cost and has a flat response over a guitar’s frequency range.

References