Vacuum Tube Amplifier

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Objective

* The objective of this project is to become familiar with vacuum tubes and vacuum tube amplifiers
* As seniors in electrical engineering and having had an experience with solid state transistors in the classroom and laboratory, we want to explore an alternative way of electrical signal amplification

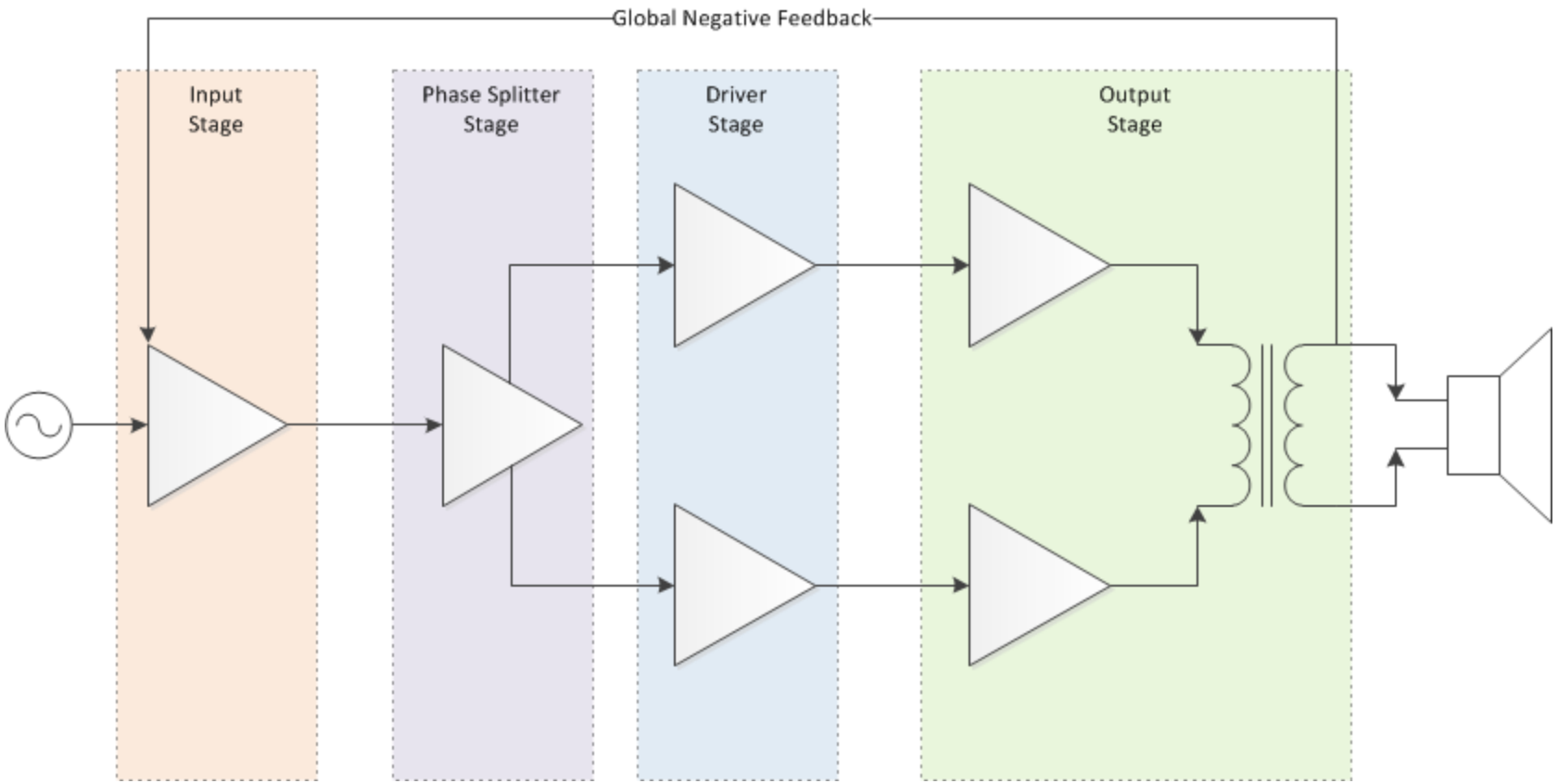
Why the vacuum tubes are still in use

* Very Linear even when driven in saturation region
* Can be used in high voltage circuits
* Able to withstand over-voltage and a lot of heat for minutes where transistors would blow out in milliseconds
* Subjectively has “warmer” sound based on numerous Audiophiles

Goal

* Design and build audio vacuum tube amplifier
* Design and build the power supply
* 25 Watts
* 4 stages
* Be able to drive an 8 ohm speaker

Block Diagram of the Amplifier



Design Approach

* Specify Output Power with a given input signal
* Choose Operation configuration and mode
* Determine whether phase splitter is needed
* Determine required voltage gain
* Design Power Supply

Design Approach

PUSH-PULL CLASS AB_1 AMPLIFIER, VALUES FOR TWO TUBES

Plate Voltage	360	360	450	Volts
Screen Voltage	270	270	400	Volts
Grid-Number 1 Voltage	−22.5	−22.5	−37	Volts
Peak AF Grid-to-Grid Voltage	45	45	70	Volts
Zero-Signal Plate Current	88	88	116	Milliamperes
Maximum-Signal Plate Current	132	140	210	Milliamperes
Zero-Signal Screen Current	5.0	5.0	5.6	Milliamperes
Maximum-Signal Screen Current	15	11	22	Milliamperes
Effective Load Resistance, Plate-to-Plate	6600	3800	5600	Ohms
Total Harmonic Distortion	2	2	1.8	Percent
Maximum-Signal Power Output	26.5	18	55	Watts

Input Stage

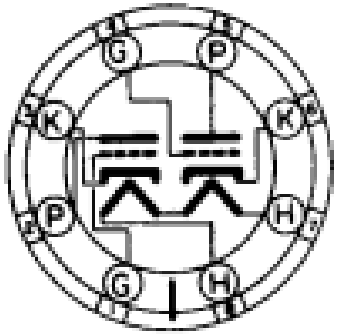
* High Input Impedance
* One half of a 6SN7 dual triode
* Common Cathode Configuration
* Provides some voltage gain

Phase Splitter

* Needed for Push-Pull Configuration
* Splits single signal into two signals
* Equal Magnitude, Opposite phase
* Concertina Type
* Equal Resistors at cathode and anode
* One half of 6SN7 tube

Driver Stage

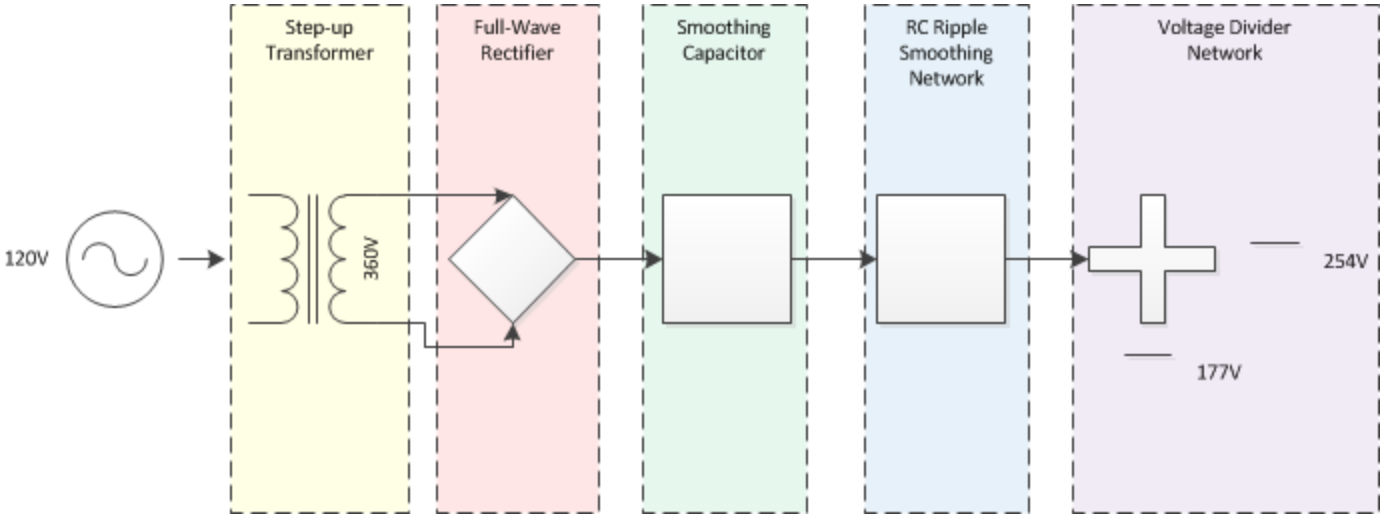
* Used to drive output stage
* Provides voltage gain
* One 6SN7 dual triode tube



Output Stage

* Push Pull Configuration
* Class AB1 Operation
* Two 6L6 Beam Power Tetrodes
* Output transformer
* Negative Feedback

Block Diagram of the Power Supply



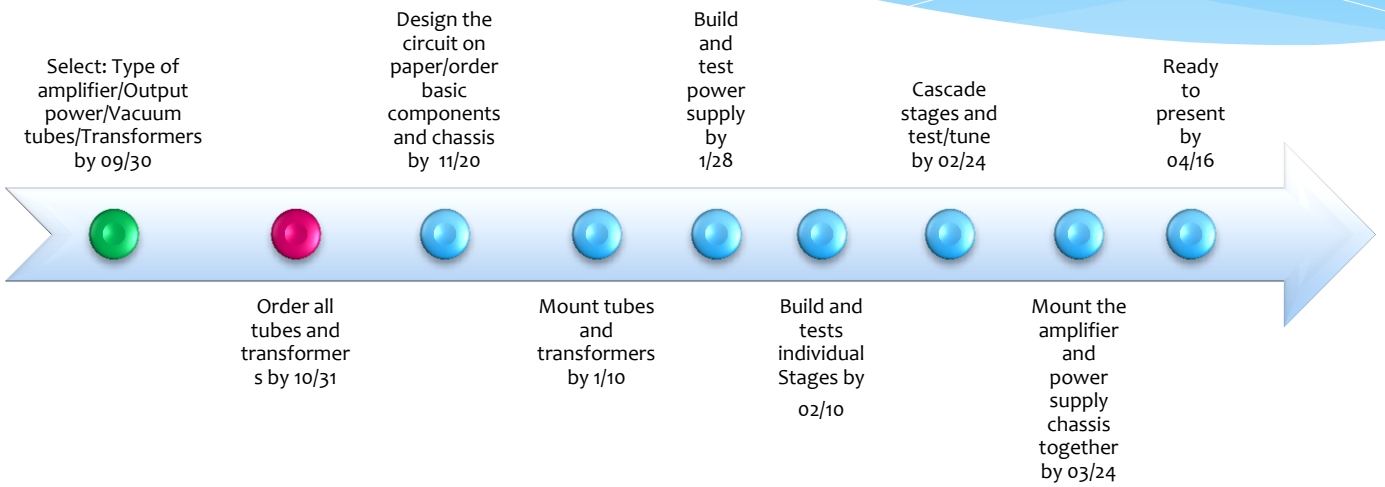
Power Supply

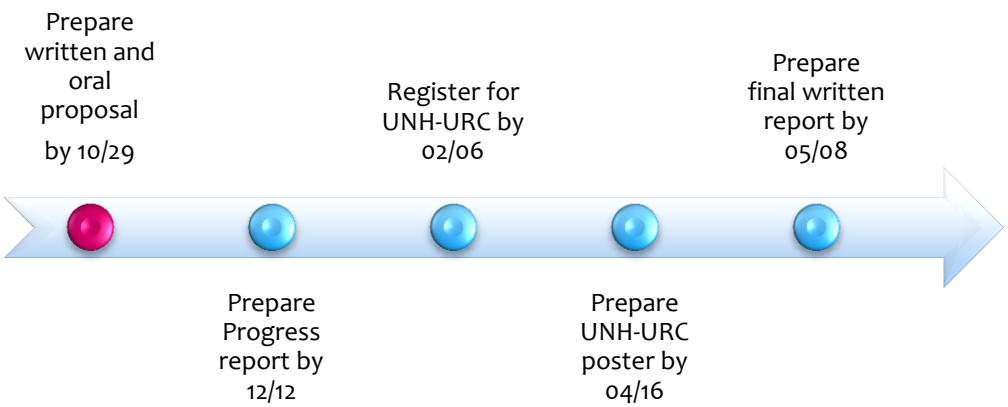
* Select a power transformer based on the tubes' voltage and current ratings
  * Step up to 360V peak
  * Current rating of at least 128mA
* Full-wave diode rectifier with ratings of at least 5A
* Smoothing Capacitor and RC smoothing network for ripple voltage elimination
* Voltage divider network to supply the needed voltage to differently rated tubes/components

Testing

* **Total Gain**
* **Power output**
* **Frequency Response**

Timeline


Select: Type of amplifier/Output power/Vacuum tubes/Transformers by 09/30
Order all tubes and transformers by 10/31
Design the circuit on paper/order basic components and chassis by 11/20
Mount tubes and transformers by 1/10
Build and test power supply by 1/28
Build and tests individual Stages by 02/10
Cascade stages and test/tune by 02/24
Mount the amplifier and power supply chassis together by 03/24
Ready to present by 04/16


Prepare written and oral proposal by 10/29
Prepare Progress report by 12/12
Register for UNH-URC by 02/06
Prepare UNH-URC poster by 04/16
Prepare final written report by 05/08

Budget

Component	Cost
Power Transformer	$71.15
Output Transformer	$62.26
6L6 Tubes (2)	$36.95
6SN7 Tubes (2)	$65.90
Tube Sockets (4)	$27.80
Chassis	$30.00
Basic Components (resistors, capacitors, etc)	Pending Design Work
TOTAL	$294.06 + Basic components

Project Allocation

Matt Andrews	Yuriy Kharin
Design on Paper	
Build/Test Power Supply	
Phase Splitter	Input Stage
Output Stage	Driver Stage
Chassis Mounting	
Presentation	