VACUUM TUBE

CONTENTS

- INTRODUCTION
- DIFFERENT TYPES
- DIFFERENT PARTS
- WORKING
- USES
- DISADVANTAGES
- CONCLUSION
- REFERENCES

ELECTRONIC DEVICES

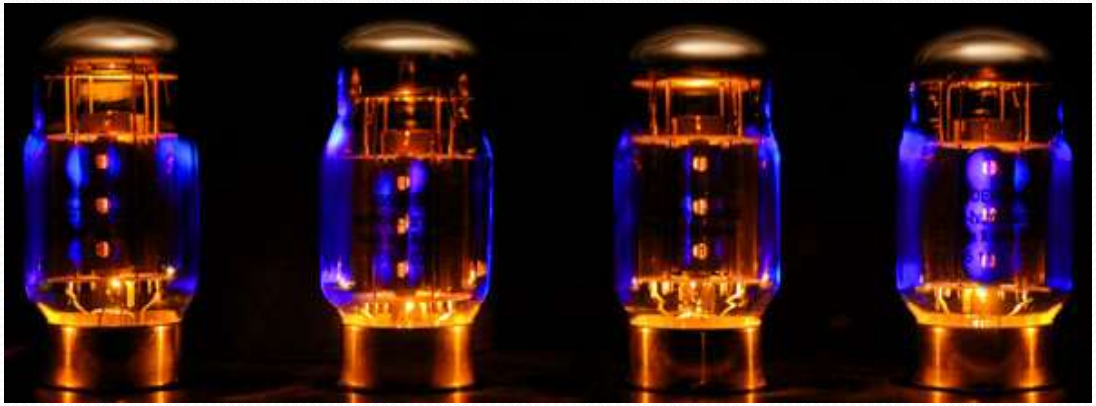
- Any device whose action is based on the controlled flow of electrons through it.

- Two types-

  A. **Vacuum tube/ Electronic tubes/Thermionic valves**

  B. Solid state electronic devices.

VACUUM TUBES



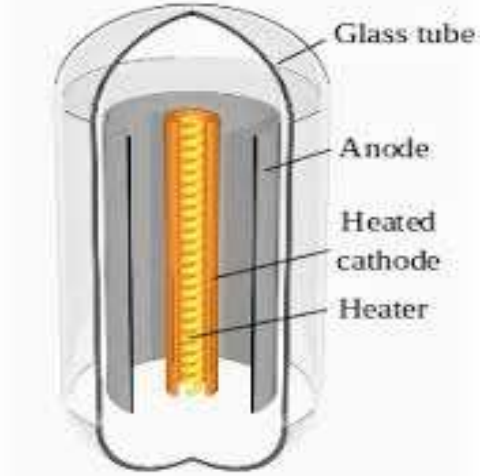
•It is a device that controls electric current between electrodes in an evacuated container.

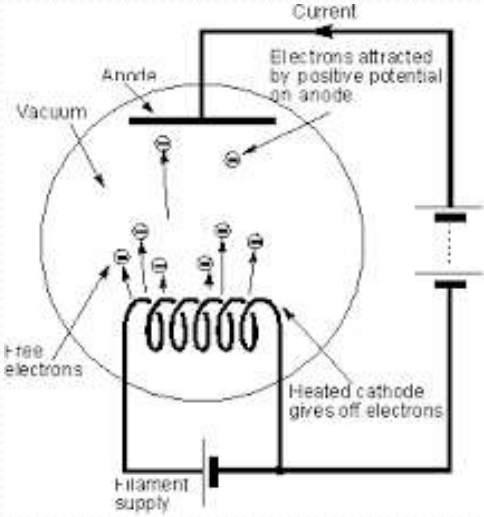
•Mostly rely on thermionic emission of electrons from a hot filament or a cathode heated by the filament. This type is called a thermionic tube or thermionic valve

•The simplest vacuum tube, the **DIODE** contains only

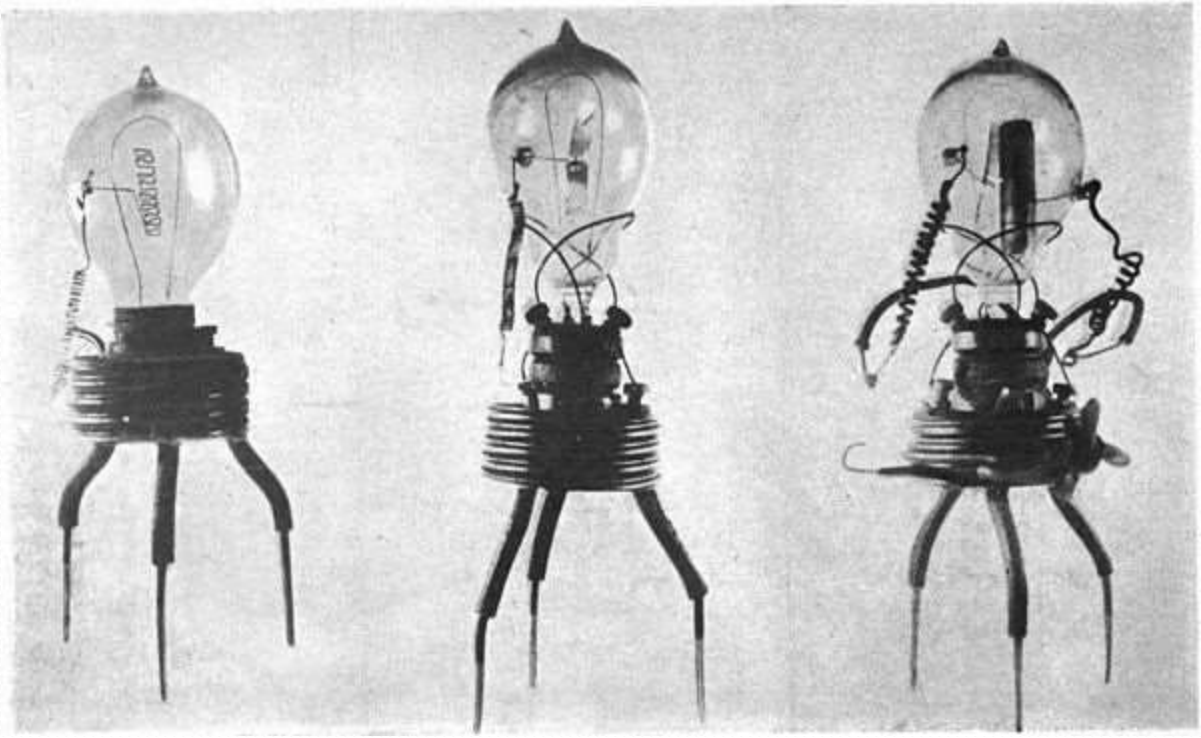
1. A heater or heated electron-emitting cathode (the filament itself acts as the cathode in some diodes).
2. A plate (anode).

•Current can only flow in one direction through the device between the two electrodes.





Fleming's first diodes invented in 1904

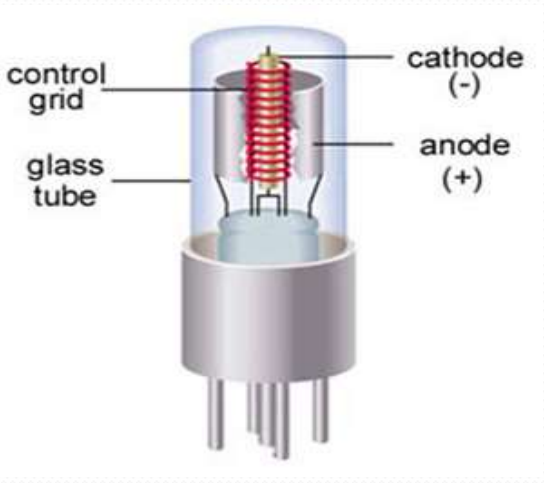


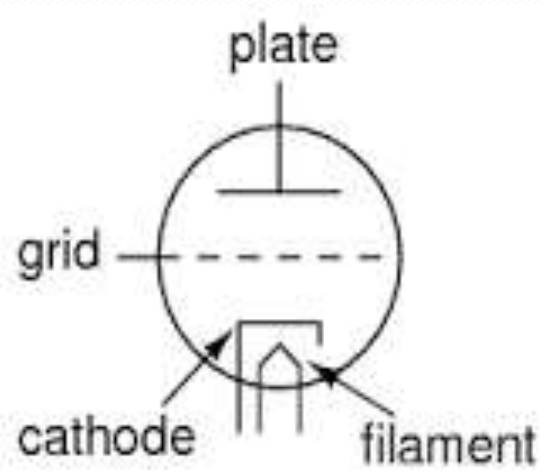
TRIODES

• Adding one or more control grids within the tube allows the current between the cathode and anode to be controlled by the voltage on the grid or grids.

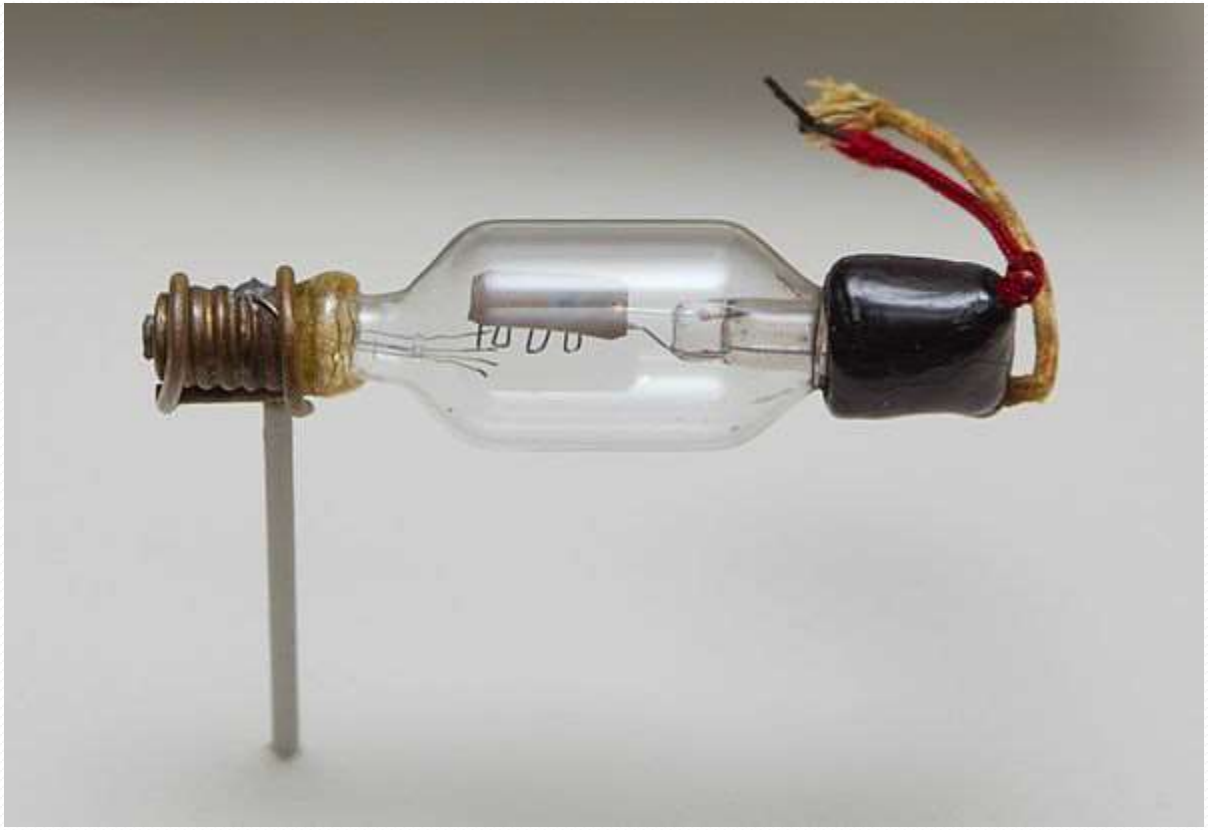
•A few volts' difference at the grid would make a large change in the plate current and could lead to a much larger voltage change at the plate; the result was voltage and power amplification.

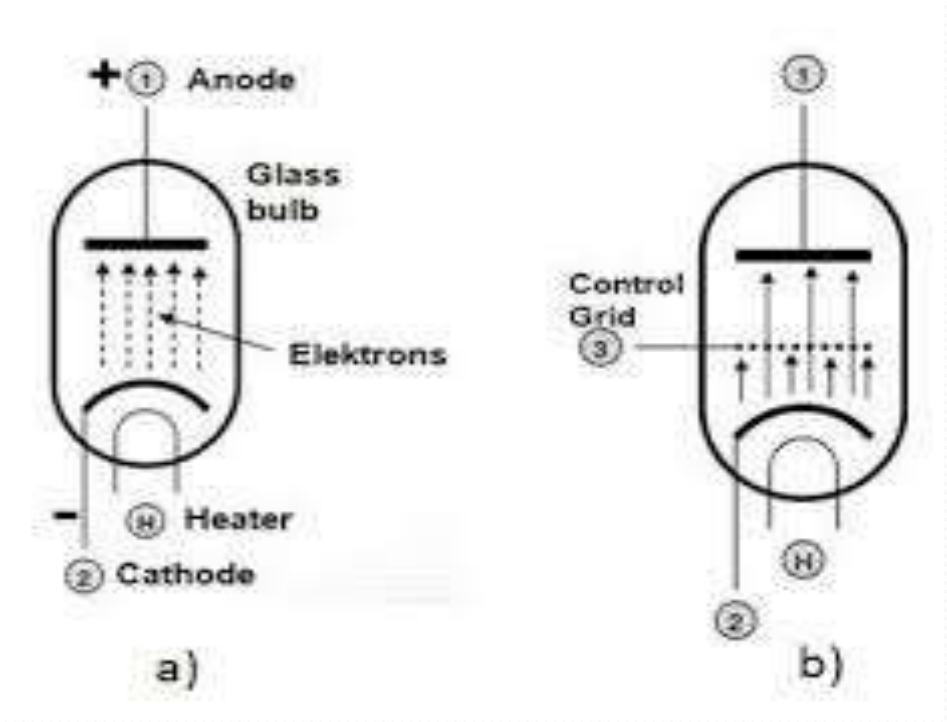
•Tubes with grids can be used for many purposes, including amplification, rectification, switching, oscillation.





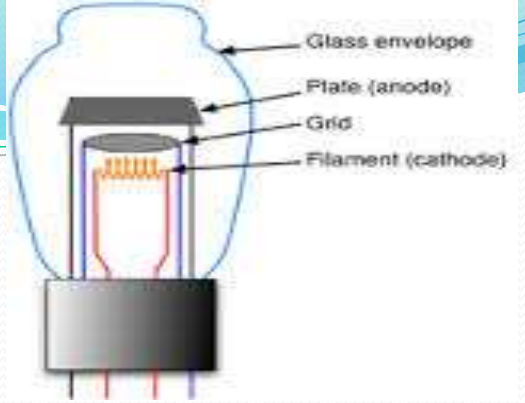
The first triode invented in 1906 by Lee De Forest




+
1
Anode
Glass
bulb
Elektrons
-
H
Heater
2
Cathode
a)
1
Control
Grid
3
H
2
b)

Triodes as they evolved over 40 years of tube manufacture, from
1918 to a 1960s era miniature tube.

1. CATHODE



1) The thoriated filament:

- It is just a tungsten filament like in a light bulb, except that a tiny amount of the rare metal THORIUM was added to it.
- When the filament is heated white-hot (about 2400 degrees Celsius), the thorium moves to the outer surface of it and emits electrons.
- The filament with thorium is a much better maker of electrons than the plain tungsten filament by itself.
- Nearly all big power tubes used in radio transmitters use thoriated filaments
- The thoriated filament can last a very long time, and is very resistant to high voltages.

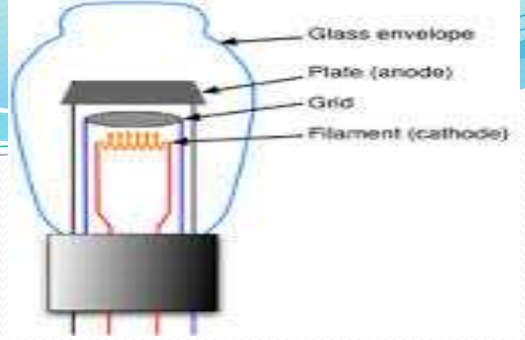
2. Oxide-coated cathode or filament.

- This can be either just a filament coated with a mixture of barium and strontium oxides and other substances
- The cathode (and oxide coating) is heated orange-hot, not as hot as the thoriated filament--about 1000 degrees Celsius.
- Better at making electrons than the thoriated filament.
- It can be damaged by very high voltages and bombardment by stray oxygen ions in the tube

Lifetime of cathodes

- The lifetime of a tube is determined by the lifetime of its cathode emission.

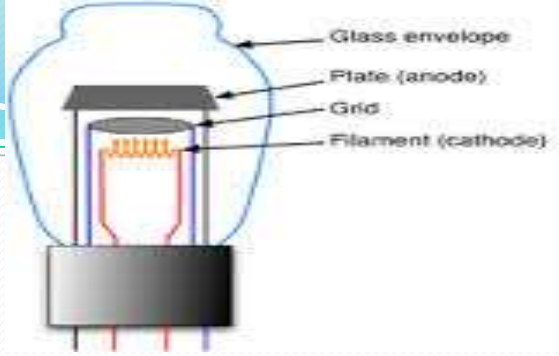
- Emission is dependent on the cathode temperature, the degree of vacuum in the tube, and purity of the materials in the cathode.



2. ANODE (PLATE)

- It is the electrode where the output signal appears on.
- Because the plate has to accept the electron flow, it can get hot, especially in power tubes. So it is specially designed to cool itself off, either by radiating heat through the glass envelope .
- Some tubes use a plate made of graphite, because it tolerates high temperature.

3. CONTROL GRID



- A piece of plated wire, wound around two soft-metal posts.
- In small tubes the plating is usually gold and copper.
- Grids in big power tubes have to tolerate a lot of heat, so they are often made of tungsten or molybdenum and graphite wire welded into a basket form.
- Mostly negative potential is applied to it.

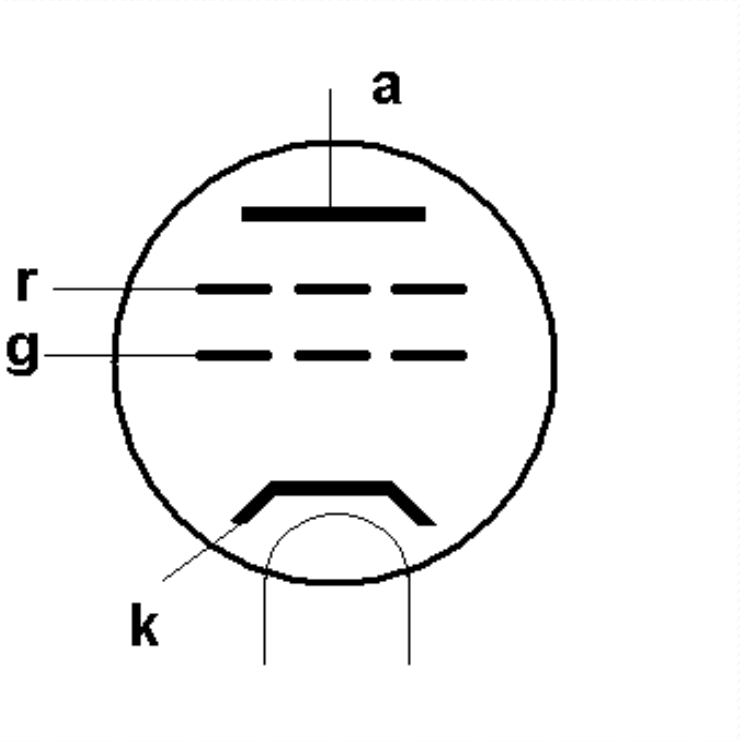
4. HEATER INSIDE CATHODE

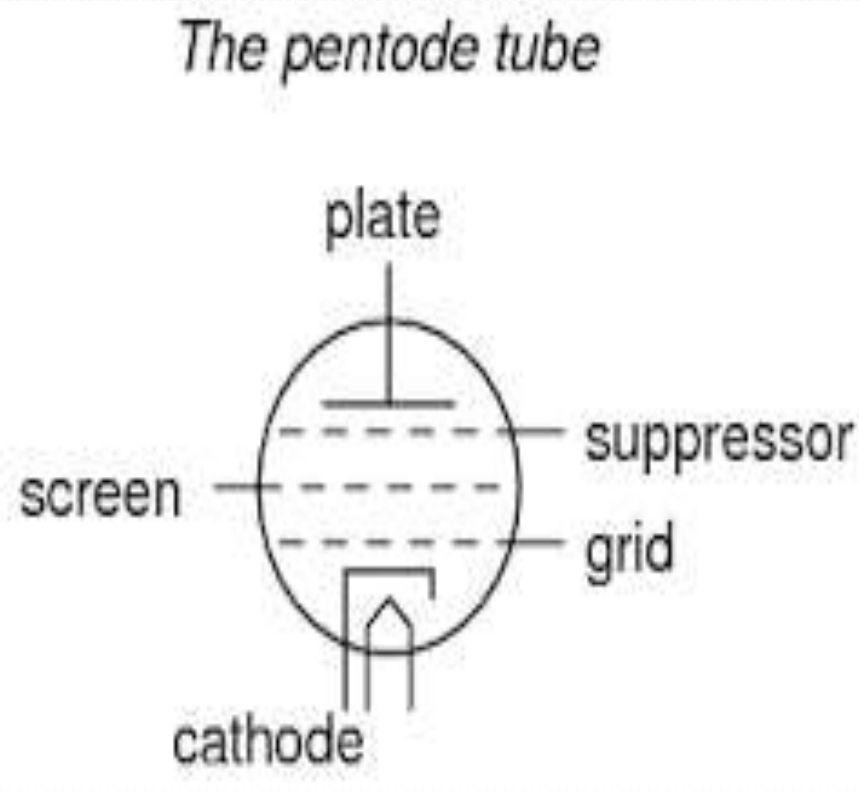
- An oxide-coated cathode can't heat itself, and it has to be hot to emit electrons. So, a wire filament heater is inserted within the cathode.
- Coated with an electrical insulation that won't burn up at high temperatures (powdered aluminum oxide).
- If the coating rubs off or cracks, the heater can touch the cathode causing damage.

5. GETTER

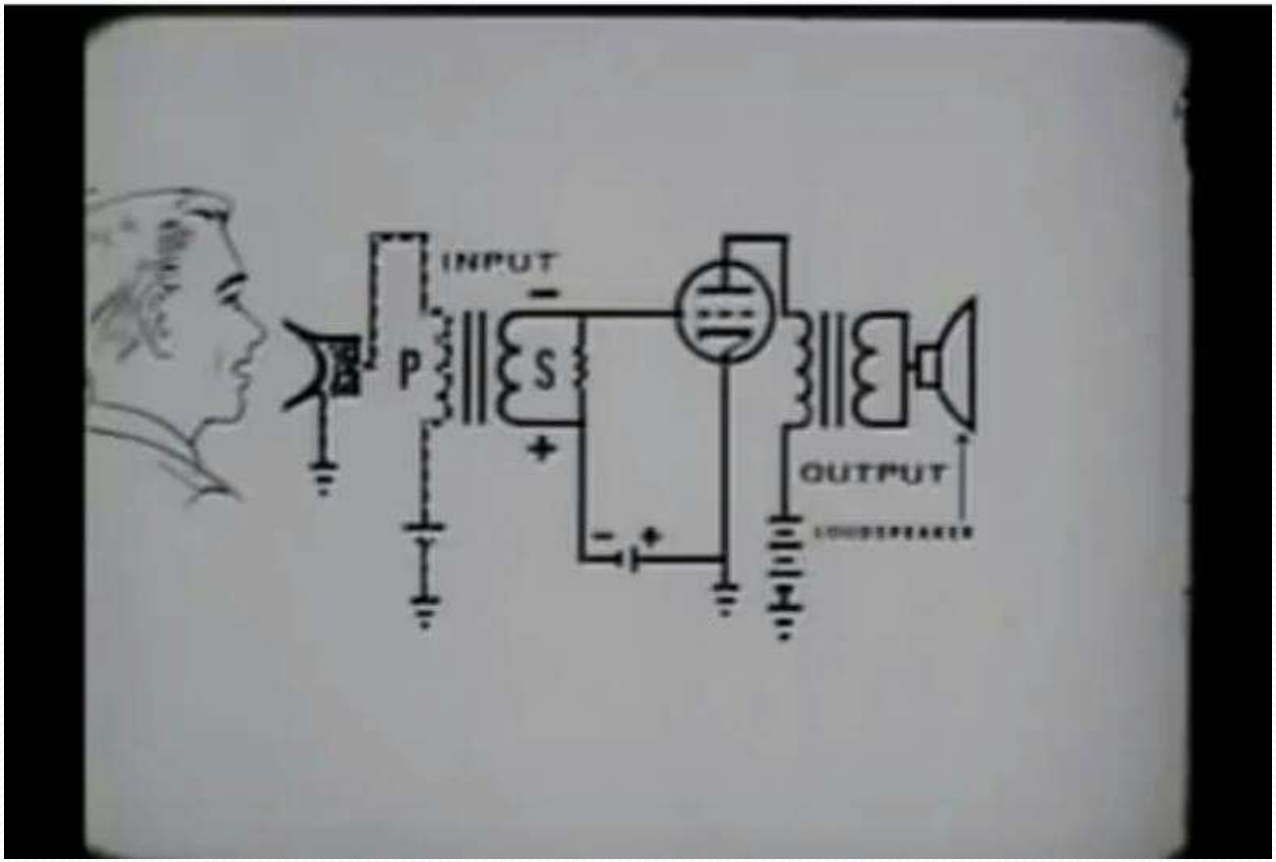
- A good, hard vacuum is needed to make the tube work properly.
- Sometimes, very small leaks can appear in a tube or the tube may not have been fully "degassed" on the vacuum pump at the factory, so there may be some stray air inside. The "getter" is designed to remove some stray gas.
- The getter in most glass tubes is a small cup or holder, containing a bit of a metal that reacts with oxygen strongly and absorbs it.
- In most modern glass tubes, the getter metal is barium, which oxidizes very easily when it is pure.

TETRODE and PENTODE





AMPLIFIER ACTION OF VACUUM TUBE



WORKING OF VACUUM TUBE AMPLIFIER

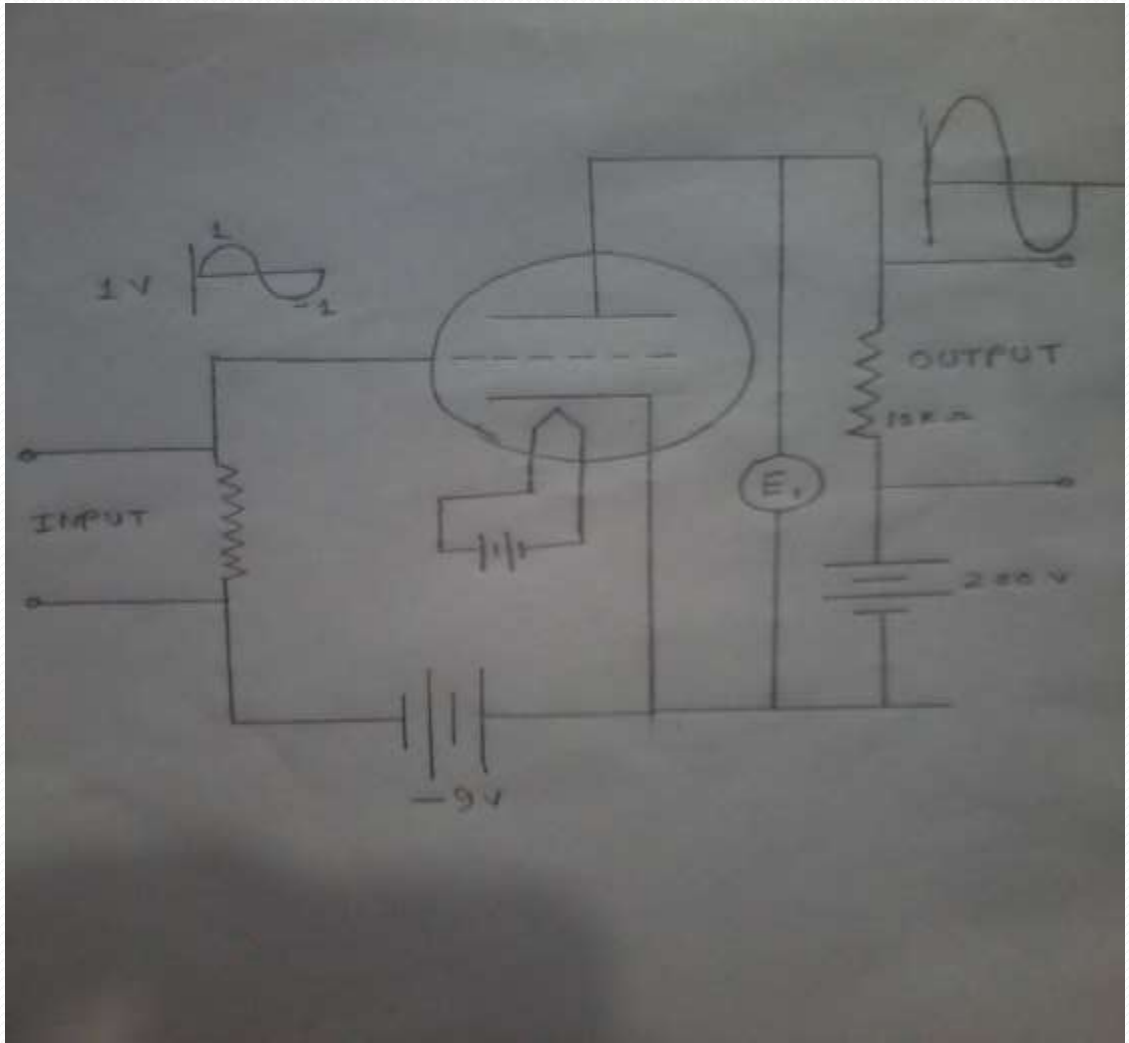


PLATE CHARACTERISTIC CURVE

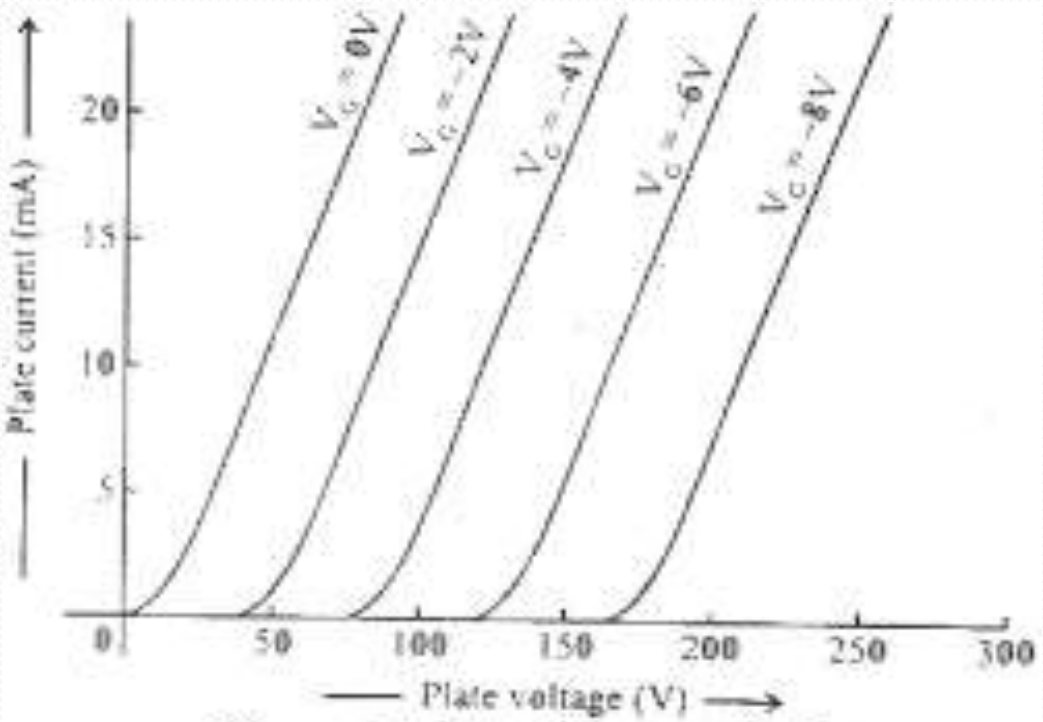


Figure (c): Plate Characteristics

USES OF VACUUM TUBES

- As rectifier and amplifier.
- A typical glass audio tube.

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- Component of early digital computers.
- Cathode ray tube, the specialized kind of vacuum tube that is in most desktop display monitors.
- However, tubes are still used in some high-power amplifiers, especially at microwave radio frequencies and in some hi-fi audio systems.

DISADVANTAGES OF VACUUM TUBES

- Tubes operate at higher voltages than transistors. A typical transistorized amplifier needs 6 to 12 volts to function; an equivalent tube type amplifier needs 200 to 400 volts.

- The major disadvantages of tubes include the fact that they require bulky power supplies, and the high voltages can present an electric shock hazard.

- Large size, limited life and low reliability.

Vacuum tubes are making a comeback among audiophiles who insist that tubes deliver better audio quality than transistors. These old-fashioned components are more electrically rugged than their solid-state counterparts; a tube can often withstand temporary overload conditions and power-line transients that would instantly destroy a transistor.