

# AGAIN VACUUM TUBES

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**Abstract-** Transistor is the major invention in electronics field, vacuums tubes are used in older times. But vacuum tubes have lot of drawbacks when comparing with transistor like their large size high power consumption etc. So transistor will easily replace vacuum tubes because transistors are small size, low power consumption cheap etc. but transistor can't completely replace these vacuum tubes because transistor can't work In high frequency application and also transistor will almost hit its minimum size further reduction in size is not easy so need a better replacement. Nano size vacuum tubes are better option.

## I. INTRODUCTION

In electronics vacuum tubes are devices which are used to control the electric current. This devices are enclosed in a chamber with thermionic emission. Vacuum tubes contains mainly 3 terminals De Forest, inserted a third electrode which is known as grid. So the current flow in the vacuum tubes controlled by adjusting the grid potential with respect to the cathode. Unfortunately vacuum tubes are inefficient for on/off application. These triode are consumes lot of electrical power and gave enormous heat energy these are the major problems.

One of the major revolution in electronics is conversion from vacuum tubes to transistor. Transistors are solid state electronics switches which are suitable to replace vacuum tube. Because transistors are small size. Fast and less power consumption. So normally size of all electronic devices reduced and efficiency will be increased.

Silicon transistors are not completely perfect so many drawbacks one of the major is hit the limit on shrinking silicon transistor any further. So need to find another material. Silicon transistors can't operate much faster than a few giga hertz. These transistors are operated by the movement of electrons through solid state but comparing with the vacuum tubes electrons move more slowly in the solid. These transistors are not suitable for military or radiation experiments. Semiconductors are influenced by strong radiation strong radiations then the atomic structure of silicon will change and later electrons will not move properly. So when comparing with these drawbacks need a better replacement then only further size reduction will be possible. Make the vacuum tubes in nano size is the best option. Nanometer-scale vacuum tubes that is early testing, has reached speeds upto 460Ghz.

## II. VACUUM TUBE

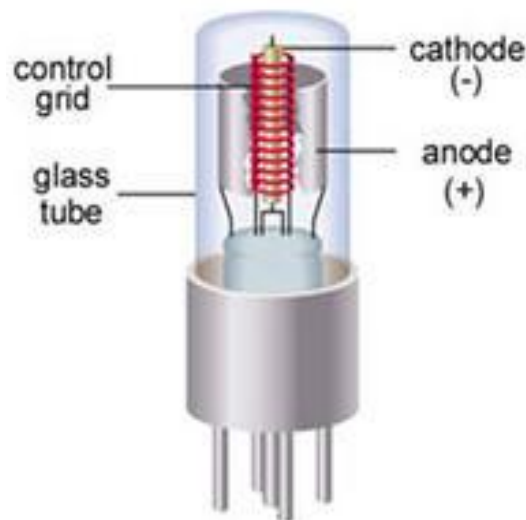


Figure1: vacuum tube (image from:<http://mobile.extremetech.com/#/latest/221582-the-vacuum-tube-strikes-back-nasas-tiny-460ghz-vacuum-transistor-that-could-one-day-replace-silicon-fets>)

here is the diagram of the old vacuum tubes. Consist of three terminals cathode, anode and a grid. These terminals are enclosed in a evacuated chamber as shown in the diagram. When voltage applied to the cathode then it start to emit electron, and it will accepted by positively charged anode. Electron flow is controlled by third terminal known as grid. Cathode is heated by a filament so this filament is also start to emit electrons. The rate of electron flow from cathode to anode is controlled by charge on the intervening grid.

The filament used to heat up the cathode will consume more power that's why vacuum tubes consume more energy. Vacuum tubes rely on a process called thermionic emission: heating the cathode cause it to shed electron in to the surrounding vacuum[2]

### III. VACUUM CHANNEL TRANSISTOR

These types are a combination of conventional transistor and vacuum tubes. Here between cathode and anode only vacuum here is using a field emission process in definition "emission of electron induced by an electrostatic field, field emission can takeplace from solid or liquid to vacuum.

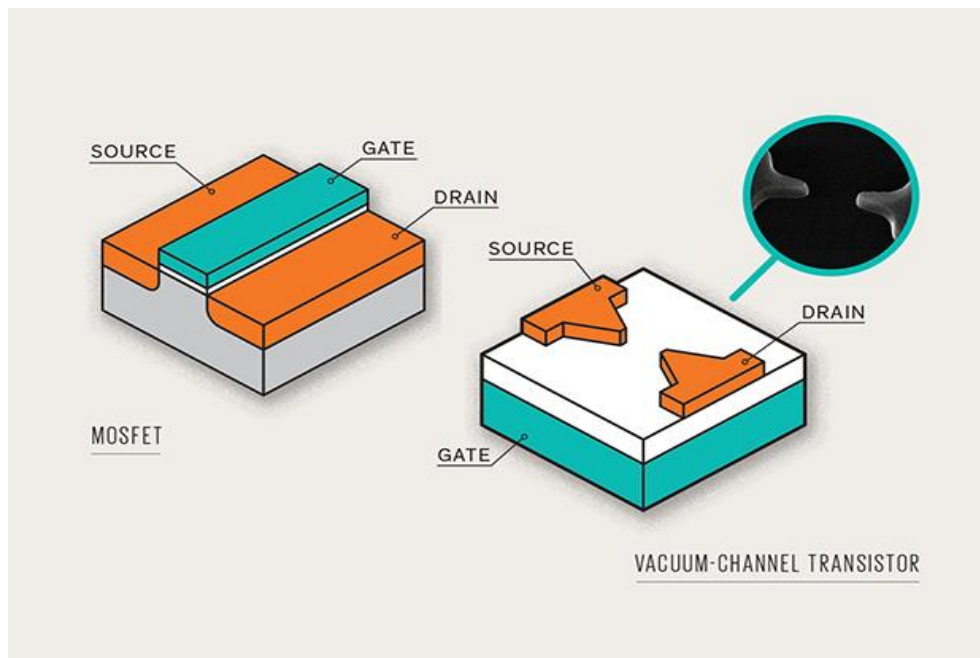


Figure2: mosfet Vs Vacuum channel transistor

(image from: [spectrum.ieee.org/semiconductors/devices/introducing-the-vacuum-transistor-a-device-made-of-nothing](http://spectrum.ieee.org/semiconductors/devices/introducing-the-vacuum-transistor-a-device-made-of-nothing))

Development of vacuum channel transistor are ongoing, research is still at an early stages. But the works show that this device is extraordinary. When comparing the work efficiency with the conventional transistor vacuum transistor could work 10 times faster than our conventional silicon based transistor. The calculation of researchers shows that it wok terahertz of frequency.

Major problem of vacuum tubes are heat dissipation and power consumption it will be solved here. Vacuum transistors are small enough so electrons will not required more energy to travel so filament is not used to heat the cathode. Electric field applied to the cathode will sufficient to emit electrons. Not required more electric field to emit electrons so it can work properly.

Another important advantage of small size is that the mean distantance that an electron travel is less, so normally collision probability is less. Gate electrodes are used to control the flow of current. It is made-up of insulating dielectric material, the dielectric insulator transfer the electric field where it's needed while preventing the flow of current into gate [2].

By analyzing both silicon transistor and vacuum transistor we can find one thing that the main difference between them is only one in vacuum transistor electron flow from the source to drain through vacuum instead of silicon.

#### IV. CONCLUSION

Nano vacuum tubes are better option to replace transistor for high frequency application. These Vacuum tubes can work in high frequency. They are manufactured in small size so they don't require high power so generally power consumption is less and also their heat dissipation is less. So nano vacuum tubes are better option to replace transistor especially in high frequency application

#### REFERENCES

- 1 <http://wattsupwiththat.com/2012/05/24/nanoscale-vacuum-transistors-way-cool-but-still-not-as-pretty-as-a-glowing-12au6/>
- 2 [spectrum.ieee.org/semiconductors/devices/introducing-the-vacuum-transistor-a-device-made-of-nothing](http://spectrum.ieee.org/semiconductors/devices/introducing-the-vacuum-transistor-a-device-made-of-nothing)
- 3 <http://news.sciencemag.org/physics/2012/05/return-vacuum-tube?ref=hp>
- 4 <http://mobile.extremetech.com/#/latest/221582-the-vacuum-tube-strikes-back-nasas-tiny-460ghz-vacuum-transistor-that-could-one-day-replace-silicon-fets>
- 5 <http://www.comsol.co.in/blogs/vacuum-tube-plus-mosfet-equals-vacuum-transistor/>
- 6 Valley, G. E., Jr., and H. Wallman: "Vacuum Tube Amplifiers", MIT Radiation Laboratory Series, vol. 18, chap. !!, McGraw-Hill Book Company, Newyork, 1948.
- 7 Jacob Millman., Christos C. Halkias. "Electronic Devices And Circuits", Tata McGraw-Hill publishing company limited, New Delhi
- 8 [www.tomshardware.com/reviews/upgrade-repair-pc,3000-2.html](http://www.tomshardware.com/reviews/upgrade-repair-pc,3000-2.html)