

The Vacuum Tube – An Introduction

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Many hams think that vacuum tubes are strictly a thing of the past. The truth is there are a lot of tubes still filling important roles daily in the amateur radio world. This brief article is intended to provide a very basic introduction to tube technology and act as a springboard to obtain further knowledge. Read, enjoy, ask questions!!

What is a vacuum tube?

1. A glass envelope or bulb containing the elements of the tube. The envelope is evacuated.
2. A Cathode and a Plate (Anode) are required – diode tube. The cathode may also be the heater element directly or it may be isolated from the heater.
3. A control grid may be added to control the flow of electrons between Cathode and Anode.
4. Additional grids may be added:
 - a. Screen grid – A tube with two grids is called a tetrode. The screen grid shields the control grid from the plate, greatly reducing the dependency of plate current flow on plate voltage. Consequently, the tetrode has a much higher output resistance and behaves more nearly as a current source than the triode. The tetrode is capable of greater voltage amplification than the triode because of its higher output resistance.
 - b. Suppressor grid - The suppressor grid is normally connected to the cathode. Its effect is to reduce the secondary emission of electrons from the plate, allowing the tube to operate over larger excursions of plate voltage. The pentode is thus capable of large output voltages with minimal distortion. Because of this fact, the pentode is a more efficient power amplifier than the triode.

How does the vacuum tube work?

1. A heated element (Cathode) emits electrons.
2. A plate element (Anode) has a positive potential in relation to the Cathode and attracts those electrons to itself. This is Diode mode. Current flows only one direction – Cathode to Anode, hence, the diode configuration is often used as a rectifier to convert AC to DC.
3. The Control Grid acts as a regulator or controller for the current flowing Cathode to Anode. The more negative a voltage placed on the grid with respect to the Cathode, the less current will flow Cathode to Anode. A very small control voltage can control (modulate) the current flowing between Cathode and Anode. We call this amplification.
4. Additional grids make the tube more efficient and stable.

What are the pros of vacuum tube technology?

1. Amplification, Rectification
2. Quiet operation – low quiescent noise
3. Simple to work with

What are the cons of vacuum tube technology?

1. Power consumption
 - a. Filament power
 - b. Plate voltage
2. High voltage
 - a. Dangerous
 - b. Harder to generate
 - c. Shielding
3. Heat – and more heat
 - a. Filament heat
 - b. Plate dissipation
 - c. Transformers
 - d. Bleeder resistors
 - e. Power divider networks

Who cares today?

1. Amateur operators – lots of power amplifiers use tube technology.
2. Amateur operators – lots of great, used gear exists at very attractive prices. There are receivers, transmitters, amplifiers, and transceivers in this category. There are a lot of hybrid systems available.
3. Amateur operators – lots of us just like the feel of real knobs for settings and tuning.
4. Amateur operators – heat your shack with orange glow!!!

Now – a little fun information...

The “Magic Eye” tube

This tube was often used as a tuning indicator, level indicator, or null detector.

It was invented by Allen DuMont in 1937 as the Cathode Ray Indicator and later trade-marked by RCA as the “Magic Eye”. It is actually a form of CRT (Cathode Ray Tube or better, picture tube). This tube is also known as a tuning eye, cat’s eye, and “idiot lamp”.



How does it work?

1. A fluorescent-coated target is attached to the anode.
2. A small cathode light shield (“button”) is placed above the target.
3. A ray-control electrode is placed in close proximity to the target and controls the amount of illumination produced by the fluorescent coating. It is negative with respect to the plate or target. As its negative voltage increases, the shadow of the electrode is widened.

What were some of its uses?

1. Inexpensive replacement for a mechanical meter – used in test equipment
2. Tuning indicator – used in many brands of receivers
3. Level setting indicator – used in many older Sony tape recorders
4. Null meter – used with control knobs that were adjusted to produce a null or neutral point. The knob positions were then read in place of a meter.