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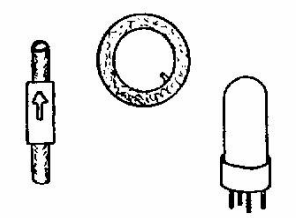
Introduction

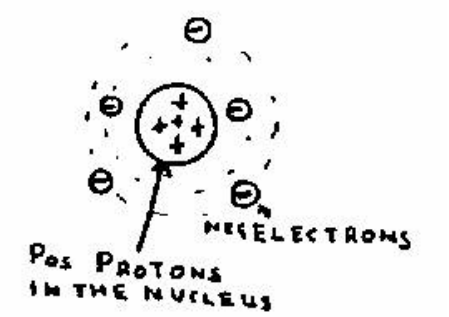
No It's not a misprint. The title of this lesson is "valves". This topic was dropped from the syllabus several years ago when it was considered that valves were outmoded. However, to bring the UK Amateur Radio licenses in line with those of other countries it has been necessary to reintroduce thermionic valves into the RAE syllabus.

A 'one way street'



Mention a valve and you are likely to think a 'non return' item of plumbing or the little thin$_9$ on your car tyre to connect the air 1 Inc to. There is an important similarity with the Radio Thermionic Valve... they all allow flow in one direction only, be it water, air or in our case - electrons.

Back to basic electronics



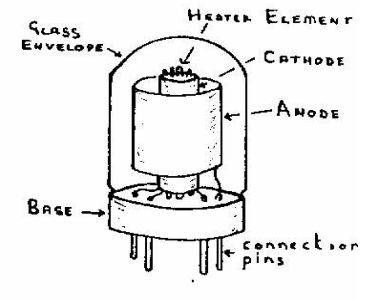
An atom comprises: a central Nucleus and a number of orbiting negatively charged Electrons.
The Nucleus is made up of positively charged Protons arid perhaps some uncharged Neutrons.
Normally, the number of protons is equal to the number of electrons.

Thus the atom is electrically neutral.

The electrons are travelling so fast as they orbit the nucleus, even at room temperature, that some of them fly off at a tangent. This loss of a (negative) electron means that the atom becomes positive instead of neutral. However, the electron does not get far as it is soon attracted back to the atom.

Remember the old rule: Like repel and Unlike attract.

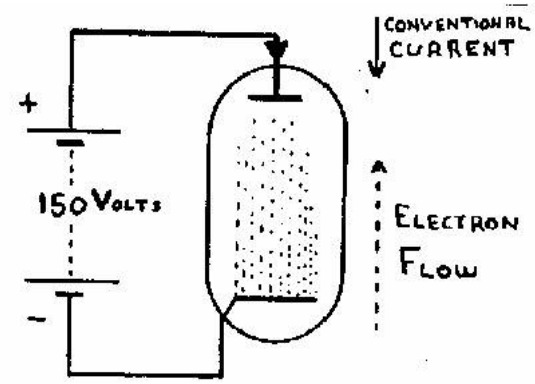
Thermionic Diode Valve



By heating the metal (called the cathode) the electrons become very agitated and many of the electrons escape from its surface.
A diode is constructed with one tube inside another. These are both fitted in a glass bulb that has had all the air removed. The inner tube (cathode) has a heater wire threaded through it and is connected to the negative supply. The outer tube is the anode and is connected to a high positive voltage, say, 150 Volts.

Thermionic Diode Valve

In order to provide a copious supply of electrons$_5$ The cathode is coated with Barium Oxide arid made very hot. It is heated by a heater wire (element or filament) passing through its centre. The heater supply is usually 6.3 Volts AC. The liberated negative electrons are attracted to the Anode because It is at a positive potential.



Thus, with the *.High Tension battery* connected as shown there will be a strong stream of electrons flowing, across the vacuum, from Cathode to Anode. If, however, the battery were turned round, the then negative Anode would repel the negative electrons and the flow would cease.

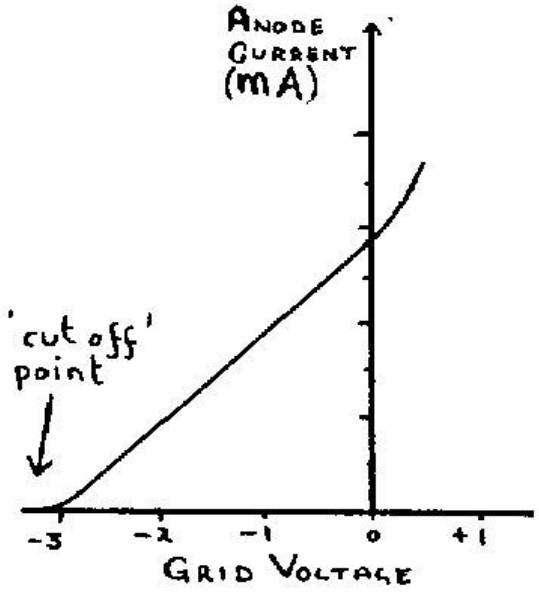
Remember the relationship: *Conventional Current and Electron Flow*

Contrary to electron flow, conventional current is said to flow from Positive to Negative. Thus, in this thermionic valve, the current will flow from Anode to Cathode but not from Cathode to Anode. This valve with its TWO electrODES is called a Diode. [Di means Two)

A diode can't amplify, but…….

In order to amplify, there has to be a means of <u>controlling</u> the flow of electrons from the cathode to the anode.

This is achieved by adding a wire mesh (grid) between the cathode and the anode. The mesh is wide spaced so it does not '.physically" impede the electron stream, it is more technical than that'.



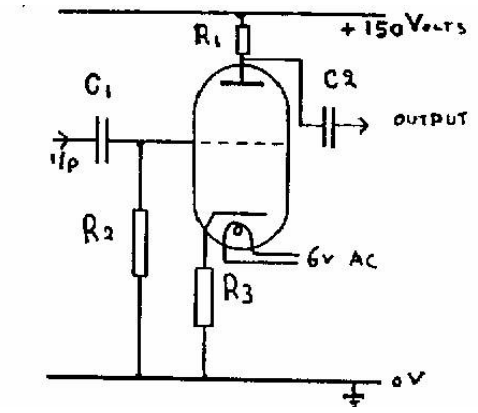
If the grid is not connected to anything, it won't have any effect. However, a small negative voltage on the grid will make a difference. The negative grid will repel some of the negative electrons and therefore cut down their flow from Cathode to Anode. The actual effect on the flow depends on the size of the negative voltage (grid bias) as can be seer, in the graph on the left. It shows the relationship between the negative grid bias and the Anode current.

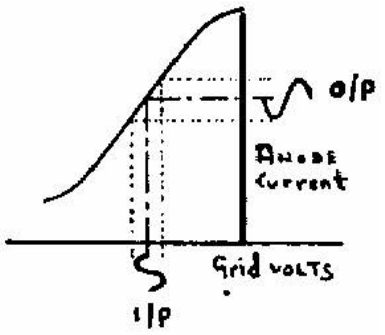
As the grid is kept negative, thus repelling the arrival of electrons,
no current will flow in the grid ...

Increasing the negative grid bias reduces the Anode current. As there is no grid current the Anode current will be the same as the Cathode current.
The valve, having three electrodes, is now known as a <u>Triode Valve</u>

Hold on a moment!

The syllabus calls for the use of a valve as a Power Amplifier. IE used as the final stage in a radio transmitter. Before this can be described, the introduction to valve theory is continued with an audio Class 'A' amplifier.





This Shows a valve biased to operate in the middle of the straight section of the anode current/grid voltage graph.

This grid bias voltage is developed across R3 and connected to the grid by a high resistance (R2).The audio is superimposed on the bias via C1.

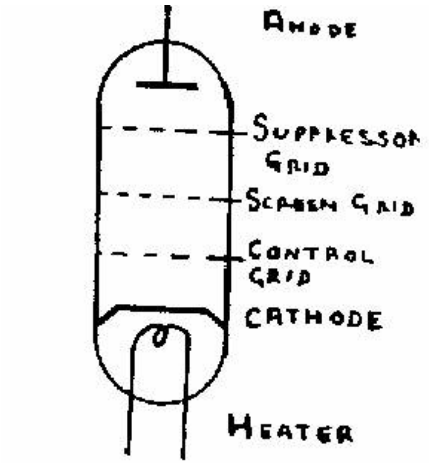
The DC anode current has an 'amplified' AC (audio) superimposed on it. This varying current develops both DC and AC voltage across RI. The AC is picked off by C2 and will be an amplified version of the input signal. You may see a similarity between this circuit and a common emitter transistor amplifier'.

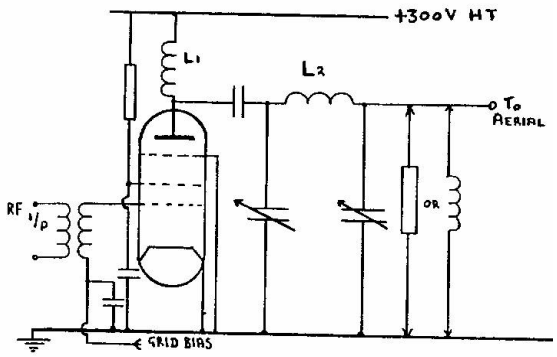
The Valve as a Power Amplifier

The type of valve often used is a pentode.

This is a valve with 5 electrodes:
Anode,
Cathode,
Control Grid,
Screen Grid and Suppressor Grid.

The suppressor grid is connected to earth and the screen grid to the +HT, making the pentode more efficient than the triode as a Radio Frequency Power Amplifier.





The "+300V" is connected to the anode via inductance L1 which will pass the anode current but block the Radio Frequency.

The RF energy will, instead, pass via capacitor C1 to the 'pi' network and the aerial.

In the Interest of safety, the quality of C1 is very important. If it were ever to fail by going 'short circuit' the 300V HT would be connected to the aerial wire! A high value resistor R1 keeps the right hand side of the capacitor at a low, safe voltage. For further protection a high frequency choke (Inductor L2) could be connected in place of this resistor. If C1 did fail the current would flow to earth via L2 and L3. The inductance of L3 must be high enough not to pass the radio frequency that it is intended to transmit!

Valves used as Radio Frequency Power Amplifiers:-

Advantages:
A valve will withstand a certain amount of 'mistreatment' during tuning.
A valve is more easily matched to the aerial circuit.
A poor SWR will tolerated by a valve.

Disadvantages:
Requires a high voltage power supply.
Precautions necessary to avoid electric shock.
Valves wear out and require replacement which is likely to be expensive.
Less convenient for 'mobile' operation.

Many commercial Amateur Radio transceivers are solid state (IE uses transistors) except for the RF Power Amplifier which is a valve or a pair of valves. The transceivers that do have transistor Power Amplifiers have to include special circuits to detect poor aerial matching. These are designed to reduce the RF drive to a value that will avoid the output transistors from "self destructing" …… hopefully

QUESTIONS:

I. What controls the Anode Current in a valve?
(A) Grid (B) Cathode (C) Anode (D) Vacuum

2. Which electrode in a valve is internally heated?
(A) Grid (B) Cathode (C) Anode (Dl Screen grid

3. A valve is used as an RF Power Amplifier because it is
(A) everlasting (B) cheap (C) robust (D) hot

4. A high voltage power supply Is not needed for
(A) triodes (B) transistors (C) pentodes (D) valves

5. Which class of emission is frequency modulated speech
(A) F3E (B) E3F (C) F3A ID) A3F

