Kenotrons and Rectification

Kenotrons are thermionic vacuum rectifying hot-cathode valves of the diode type, used until the Seventies in the high tension circuits of x-ray tubes. The first Kenotron was introduced by Saul Dushman in 1914 (the K3 of General Electric, put on the market years later).

Early kenotrons were of a remarkably large size in order to ascertain adequate cooling in the free ambient air. Later makes were fitted, like x-ray tubes, with some sort of metal heat radiator fixed to the anode end of the tube. But finally, like x-ray tubes, kenotrons became smaller in their external size and were oil-immersed in the high-tension transformer tank of the x-ray unit.

(Hyperlink to G16)

In the late sixties and during the seventies solid state semiconductor rectifiers replaced kenotrons in high tension generators. Most present day x-ray units are equipped with electronically controlled high frequency high tension generators.

Prior to the invention of the kenotron in 1914, rectifier valves were of the cold-cathode (filament-less) type. Four of them are presented in this collection.

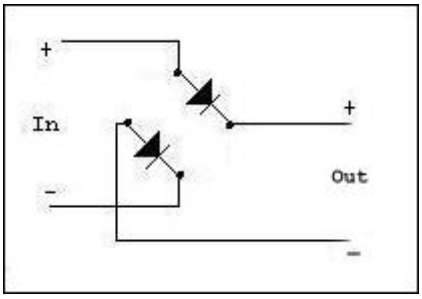
How do they work

Thermionic diodes, which by definition, have only two electrodes, are called "valves" because when inserted in an electric circuit, like a water valve, they let the current flow in one direction only, from the positive electrode to the negative one. This negative electrode is a heated filament emitting electrons, and the positive electrode is the "plate" which is usually of a much larger size, attracting the electrons. So, the current flows through the valve, between the electrodes, in the direction opposite to that of the electrons.

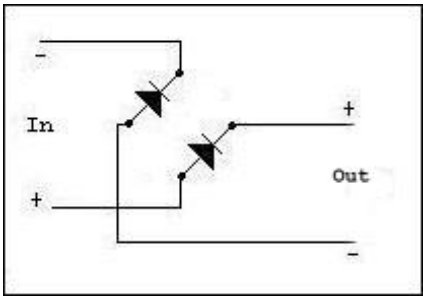
If an alternating current is used in the electric circuit, only the positive half of the cycle flows through valve, and that's what is called "half wave rectification". Thus only one half of the electric energy is being used.

In early cold cathode valves, rectification was obtained by creating a very important asymmetry of size of the electrodes. When a positive half cycle applies to the larger electrode, it "snatches" electrons from the small one, and the current flows in the opposite direction to that of the electrons, from the large electrode to the small one, also resulting in a half wave rectification.

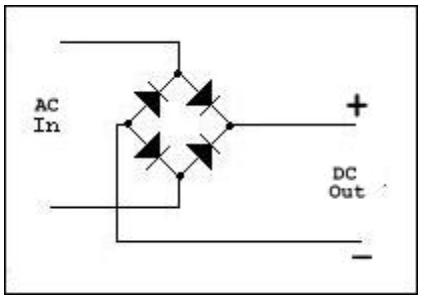
In order to use the full energy of an alternating electric current, four valves are used in what is called a "bridge" circuit which schematically functions as follows :



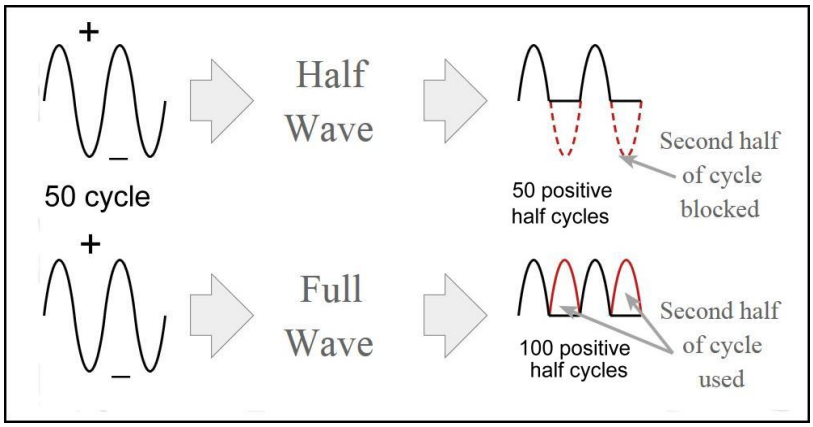
Rectification of the first half wave.



Rectification of the second half wave.



Full wave rectification.



Final result