(100th anniversary of the triode - introduction presented by Peter van Willenswaard during the 2006 European Triode Festival)

Birth of the Triode

I'll be speaking to you about the birth of the electronic valve (and I prefer to use the English nomen VALVE in this story and not the later American term TUBE for three reasons: 1. Englishman Fleming created (or should I say recognized) the first ELECTRONIC component in history, 2. most valves were round bulbs at the time and not tubelike cylinders, 3. in the triode the current could be shut down or opened up by means of the grid, just like water in a mechanical valve).

The birth of the valve was by no means planned. No one was looking for an amplifying device, nothing remotely like that: the first two steps on the road to the concept of the electronic valve were set even before the discovery of the electron in 1897 by Thompson. You can't speak of electronics if you don't know that electrons exist.

Before going into detail, it pays to take a look at the second half of the 19th century and the beginning of the 20th. This was a weird time because of the profound technological revolution taking place, on a scale never seen previously in history. On the contrary, you might be forgiven to think that between the demise of the Roman Empire in the 5th Century or so and the end of the Middle Ages lie 10 Centuries during which hardly any technological progress was made. One exception that springs to mind is the advance in clockwork artistry in the Late Middle Ages, but on the other hand many advances made by the Romans had been lost by that time, like central heating, how to make concrete for building four-story houses, etc.

Then, finally, comes a time in which some individuals start to do clever things: the discovery that the earth rotates around the sun, the making of lenses, the basics of Western physics and mathematics, culminating in the very practical invention of the steam engine in the early 19th century. Which after some refinements led to trains and railways halfway through the century, and that proved so successful that by 1890 clocks across the country and across Europe had to be synchronized because without that time tables for trains would be meaningless. Imagine: until that moment each and every city had had its own time..... What I mean to say is this: for 10 centuries time had nearly stood still, then for two more centuries there was something stirring here and there, but relative to that the 19th century was a explosion.

Speaking through wires (telephone), a stereo demo in 1870 at the World Exhibition in 1870 in Paris, dynamos and the production of electrical energy, electric light, Marconi sent radio telegraph signals across the English Channel using spark transmitters, and in a few years Einstein would disclose his Theory of Relativity. By the end of the 19th century many started to believe that anything was possible.

As an example, let's take Nicolai Tesla. Tesla was mainly concerned with electromagnetic energy stored in coils. The Tesla coil is famous, it is amazingly powerful even by today's standards. People are still building them, see the Internet. Tesla was an advocate of AC electrical power and wisely so (Edison wouldn't have it and stuck to DC all his life), and he built the world's first AC power plant. But Tesla also believed he could surround the earth with an electromagnetic resonant wave and directly feed all the homes in the country from that. He never succeeded, he claims his experiments were sabotaged. He did very dangerous experiments with artificial lightning. He claimed energy could be captured for free by lifting a plate high up in the air to collect solar electrical energy and store that in a capacitor: free energy for all! Tesla even built a tower on the US East-Coast during WW1 and claimed he could destroy Enemy Armies thousands of miles away using beamed electromagnetic energy. The authorities tore down the mythical tower before it became operational because neighbours were too scared of it. Tesla had become so excited by all the new developments and possibilities of his time that his imagination went wild. Type Tesla in Google, plus maybe Tower, read for an hour or so and you'll see what I mean.

In a time like that Thomas Alva Edison melts a carbon filament wire into a glass bulb, applies a vacuum pump and creates an electric light which lasts longer than the instantaneous flash of a filament wire in free air. But after a while the glass darkens on the inside. And Edison also notes that when finally a filament burns the break always occurs at the negative side of the wire. Possibly in an attempt to find a way of preventing the blackening of the glass, he makes a bulb with an extra metal plate inside connected to a lead-out wire. He has already developed a moving coil meter for measuring currents, and connects such a meter to the lead-out wire, possibly to see if he can catch an unknown current and divert it from the glass. Connecting the other side of the meter to the negative gives nothing, but he does find a current when connecting the meter to the positive. Although the discovery of a current through a vacuum looks like hot news to us, Edison stops there, in 1884, maybe because the extra plate doesn't prevent the blackening of the glass. He does file a patent, but not for the bulb with the plate but for the moving coil meter - but the first electronic device ever appears in the drawing of the patent as the object being measured.

One or two of these lamps travel across the Atlantic and end up on the workbench of one John Ambrose Fleming. Fleming is intrigued, and his experiments confirm the findings of Edison. But as we are still 2 years away from the discovery of the electron, Fleming can get no further, and finally stores the lamps away in a cupboard in 1896.
Five years later Marconi wants to improve upon his first stunt, and now cross the Atlantic with his wireless telegraph signals. The detection of the weak signal at the reception side was a problem though. Marconi used a coherer, a device in which iron powder moved by magnetic fields. It was then that Fleming thought back of the Edison plate-lamps, they were subsequently applied as diodes, and successfully. We're talking 1904 now.

Why did Lee de Forest add a third electrode to the diode? Well, he hadn't seen the light, so to speak, he didn't intend to do something revolutionary, he just wanted to be different. De Forest was building telegraphy detectors and he couldn't use the two-element device Fleming had brought to Marconi

(and also because a US competitor of De Forests was using something similar). So he added a third electrode to escape infringements of patents. That explains why this third electrode (a plate, by the way, not a grid) ended up in the wrong place: on the other side of the filament, instead of between filament and anode. He speaks of a 'gaseous medium' and 'ions around the filament' (both of which are the last things you would want in a radio valve!), and inserts electro magnets in his circuit expecting to modulate the location of his third electrode. Conclusion: he had no clue what he fallen into his hands. See the December 1906 Audion patent (No. 841,387) he filed.
In June 1907 followed a second patent, this time actually for a sort of grid between filament and plate. Unclear is why he did so; presumably this appeared to work better in his detector circuits. He never used his Audion as an amplification device until about 1912, but even then he himself hardly believed in it because he sold the patents for all purposes other than wireless to Western Electric for not too much money. Western Electric needed amplification devices for their long distance telephone lines, and although De Forest's Audion was a very weak performer in that area, one Edward Armstrong at WE in 1914 realized the potential value. It took him another two years to make it into a useable product. If Western Electric hadn't been there and then, we would not have been together here now at this Triode Festival.

The whole of this development paved the way for something sublime as radio, It had been a discouragingly slow process though: 1884, 1896, 1901, 1906, 1907, 1912, 1914. And it eventually also paved the way for audio and hifi. But maybe more importantly, this rather sorry story marks the beginning of ELECTRONICS.
It is not easy to make a clear distinction on when something electrical becomes electronic. For instance, it is not strictly necessary to have an active device in a circuit to characterize that circuit as electronic: everyone will agree that a simple radio receiver consisting of just a coil, a capacitor, a diode and headphones, all passive components, is electronics. But how about a transformer followed by a diode bridge and an electrolytic capacitor? When it feeds valves and (god forbid) transistors, it would be electronics, right? But when it feeds a DC motor, it can't be more than electricity, or what? I'll leave it to you to try and define what is electronics and what is not. But we'll agree on one thing here: if it happily glows in the dark, it is electronics!

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