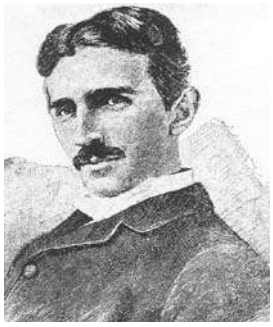
Nicola Tesla

1856 - 1943

The Eccentric Genius of Electricity


You may have grown up as I did, believing that Guglielmo Marconi invented radio. Well, he didn't. Radio's true inventor was a Serbian American by the name of Nicola Tesla.

Indeed, Tesla invented a lot more besides, like AC power systems, the polyphase AC motor, the hydro-electric generator, fluorescent light and many more useful and useless things. It is amazing how many of this almost forgotten man's inventions we still use on a daily basis, but then Tesla was one of the most truly eccentric characters in the history of electrical science and technology.

Early days

Nikola Tesla was born in 1856 in the village of Smiljane, the fourth child of the local Orthodox priest. Showing an early interest in learning he went on to a prestigeous grammar school in Carlstadt. Here he soon showed himself a brilliant mathematician who could do complicated mental arithmetic at blinding speed. Spurred on by a gifted physics teacher he also developed an overwhelming interest in electricity and its applications. Shown an early demonstration model of a DC electric motor with a brightly arcing commutator he reckoned that a motor without a commutator would be so much better. The idea of a better motor, running on AC, became a persistent itch with him, which he had to keep scratching until he found his brilliant solution some years later.

From Carlstadt Tesla went on to study engineering at Graz Polytechnic and Prague University. Here, as in Carlstadt, his fellow students got to know him as a loner without any real friends - male or female, totally absorbed in his studies.

The first job

His father's death brought Tesla's studies to a halt. He had to find himself a job, which he found with a telephone company in Budapest. His obsession with the AC motor didn't leave him alone, however. He felt there had to be a way to overcome the fact that single phase AC wouldn't create a rotating field suitable to power his motor. Eventually he found the answer.

Tesla's solution was revolutionary. He envisaged not one, but multiple AC voltages shifted in phase. As one phase went down, another would rise, thus creating a rotating field for his polyphase motor. Over the next few months he developed a complete multiphase power system complete with generators, motors and transformers, all in his head and on paper. Tesla's work methods were as revolutionary as his results in that he was the first electrical engineer to solve his problems theoretically, rather than by trial and error.

Meanwhile, in America . . . .

Thomas Alva Edison had gravitated into electricity from quite a different angle. Starting out as a telegraph operator he was quick to realise the potential of Faraday's DC generators. Soon the Edison company was making a lot of mony making generators and incandescent lamps and installing complete electric lighting systems. Edison himself was a thoroughly practical

experimenter. Shunning all theory - Ohm's law included - he totally relied on trial and error to achieve the results he wanted. Whilst this approach worked well initially, it lead to problems as Edison attempted to build bigger systems and tried to bridge longer distances. The problem of voltage drop was rearing its inevitable head.

Tesla meets Edison
Tesla changed jobs and joined the Continental Edison Company in Paris. Here he made several improvements to the company's DC motors and invented an automatic dynamo regulator. He was half-promised a bonus for this work but this never eventuated.

In 1883 the company suffered a disastrous setback with a complete power system and lighting installation supplied for the Strassbourg railway station. The design was seriously flawed. A short-circuit blew the wall off the power station as it was officially opened by Kaiser Wilhelm. Tesla was called in and was promised a $25 000 bonus if he quickly fixed the problems. However, this was never put in writing before Tesla undertook the work and was conveniently forgotten once the job had been completed.

In his spare time, meanwhile, Tesla had built his first small scale AC motor and generator and was looking for financial support. The Con. Ed. people were unimpressed, however. If your company has so many millions of dollars invested in DC technology you don't take kindly to a 27 year old engineer telling you your stuff is obsolete and you should change to AC.

Tesla's manager, however, recognised Tesla as a brilliant troubleshooter who could bring welcome relief to the growing problems at Edison's head office. He persuaded Tesla to migrate to the U.S. and gave him a glowing letter of introduction to Edison.

The two men met, and Edison immediately put Tesla to work, promising him $50 000 for improving the designs of his DC power generations. Tesla set to work with a vengeance and produced dozens of designs for improved generators, regulators and synchonisers. When he went then to Edison's office to collect his hard-earned bonus Edison's response was: “Tesla, you don't understand our American humour”. Tesla was so incensed that he resigned on the spot and took a temporary job digging sewer trenches at $2.- a day.

The Tesla Electric Company
In 1887 Tesla finally managed to set up little company in New York with the help of a Mr. Brown of the Western Union Telegraph Co. and a friend. At last Tesla could get to work on his polyphase AC system. Within 6 months he had made up several working prototypes of motors, generators and transformers, all working well over thin wires. Tesla applied to the Patent Office for a single patent to cover his whole system but, at the Patent Office's insistence, this was broken down into 30 simpler and more detailed patents.

Brown, meanwhile, had concluded that these patents somehow had to be turned into moneymaking products and that Tesla was not the man to do this. However, Brown happened to know a business entrepreneur called George Westinghouse who, he thought, might just be the man. In 1888 Brown invited Westinghouse to a lecture which Tesla was to give before the American Institute of Electrical Engineers and Westinghouse came away impressed.

Westinghouse
Westinghouse already had some interest in AC. In 1883 he had bought the U.S. rights to an English transformer patent. He also employed a young engineer called William Stanley who understood transformers. If he could get Tesla and Stanley to work together he would be home and hosed.

Westinghouse promptly met Tesla in his laboratory to see the new equipment demonstrated. He then persuaded Tesla to sell him the patents for one million dollars plus a royalty of a dollar per horsepower - about half the price he had been prepared to pay. Still, Tesla was happy with the

money.

Now Westinghouse had to turn the prototypes into saleable products -and quickly too, because he was embroiled in an expensive patent litigation with Edison about incandescent lamps. Tesla was offered a job as consultant to work with Stanley in Westinghouse's Pittsburg factory, but this never worked out. Tesla just couldn't work with anybody else and was relieved when he could retreat to his New York laboratory to work on new things.

Edison and Westinghouse, meanwhile, went on to wage a monumental “battle of the giants” in and out of courts - DC versus AC systems. We know which system won. When the Pittsburg World Fair opened in 1893 Westinghouse's Tesla AC system powered 96 000 lights.

Resonance
Back in his New York laboratory Tesla sold his outstanding royalties for $26,000 and then got busy spending his money on new experiments. He was totally absorbed by two subjects: resonance, and the wireless energy transmission. He was the first to understand that all wave motion, mechanical, electrical or heat, were basically the same and if he could understand one he could understand the other. This led him to a series of experiments on mechanical and electrical resonance.

His mechanical experiments had some bizarre side-effects. To observe the effects of resonance on mechanical bodies he built a vibrating platfom with variable oscillating frequency. When he connected this to one of the iron pillars that carried the laboratory roof he almost brought down the building when he struck resonance. He then decided to stand on the platform himself and tried to bring his body to resonance. This turned out to have an acute and potentially embarrassing laxative effect.

His electrical experiments during the 1893 - 1895 period centred on combinations of coils and and capacitors, and he gained a deep insight in electrical resonance. This led him to the invention of the invention of the “Tesla Coil”, which uses resonance to produce high voltage R.F. electricity at discrete frequencies, and an L-C tuning device for frequency-selective radio reception, both of which he patented.

He found that the RF high voltage from his Tesla coils radiated quite well, as he demonstrated by running a wire loop around his laboratory wall. He placed gas tube lamps (somewhat similar to today's fluorescent tubes) around the lab and these would light up when the loop was energised. He also demonstrated that he could operate lights selectively at a distance by connecting them to a resonating LC circuit for reception.

In 1893 Tesla gave a lecture to the National Electric Light Association in St. Louis. Here he described the essentials of the wireless system we still use today : antenna, ground, resonating circuits in transmitter and receiver tuned to the same frequency, and a electronic signal detector. Tesla had invented true radio three years before Marconi made his first experiments.

Down but not out
Tesla spent the last remains of his money on building a series of radio transmitters and receivers. In 1895 he was ready for a demonstration, which would involve communication with a ship he would hire to sail the Hudson river. Then calamity overtook him: his laboratory was completely gutted by fire the night before the final tests. Equipments, records, tools, all were lost. Typically Tesla had not bothered with insurance, and as his money was gone, Tesla was ruined.

Surprisingly he managed to get a $40,000 grant from a banker and soon Tesla was busy resurrecting his radio system from memory. In 1897 he had perfected a multi-channel wireless system, his patents were secure and he was ready to show the world his new marvel.

Typically, Tesla completely bungled the demonstration. Instead of higlighting the system's huge

telecommunication potential he put on a circus-like show centred on a 5 foot model boat floating in a water tank in Madison Square Gardens. Tesla made the little boat go, stop, turn left and right, turn its lights on and off, and even submerge, but the public was not impressed. Neither was the Navy, to whom he touted the model as a prototype for an unmanned submarine. Press reports spoke of “mind control”, which didn't help Tesla's scientific reputation. Tesla abandoned the project and turned to other ideas.

Marconi

To appreciate just how far ahead Tesla was with his frequency-selective system, let us look at the principle behind Marconi's early “non-resonant” transmitters. Theoretically you could still rig up such a transmitter today from a few scrap parts. To to so in practice, though, would be potentially lethal apart from being quite illegal: you would be likely to blank out out communication in your neighbourhood.

All you would need is a 12V car battery, an automotive ignition coil, an old style electromechanical interruptor - say from an old bell or buzzer , an antenna of indeterminate length and an earth connection. Connect the high-voltage side of the ignition coil to antenna and earth, connect the coil primary to the battery in series with the interruptor, that's all. Close the primary circuit and the transmitter will produce damped waveform oscillations, generating a nasty RF noise over a wide frequency band. There is no tuning, no resonant circuits. To receive this noise all you need is an (equally unselective) receiving antenna, earth, and a signal diode rectifier with, at its output, sensitive headphones in parallel to a small capacitor.

In the early days this brute force method actually worked fairly well over short distances, mainly thanks to the fact that hardly anybody used radio waves and the RF spectrum was immeasurably quieter than it is today. Amazingly, last-ditch emergency transmitters built along this principle could still be found in some lifeboats up to WW II.

Tesla later went on to experiment with very low frequencies. He actually managed to make his signals circle the world whilst Marconi was still struggling to cover 100km.

Marconi, however, was way ahead of Tesla in realising the huge potential of wireless telegraphy. He had a head for business and could work with others in commercialising his systems. Whilst Tesla kept experimenting with whatever grabbed his attention at the time, Marconi systems went on to conquer the world.

Fred Backer VK2JFB
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