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Nikola Tesla - The Electrical Genius

by Peter Lamb

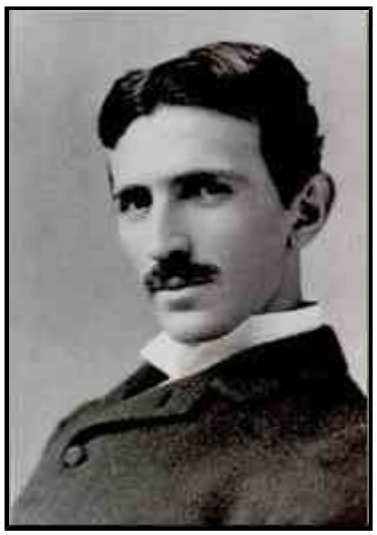
I have been intrigued with Nikola Tesla for many years, since he has appeared in so many documents I have read on electricity history and is credited with inventing many devices, especially the AC polyphase motor as far back as 1883. So I have often asked myself why he is so little known and, if Tesla's AC motor was available so far back in time, why was it not used until the 1930's? The DC motor was the industrial "work-horse" from the 1890's for four decades at least due to its variable speed facility for starting. I am told that his AC motor was a single speed motor and wasn't suitable for heavy industrial loads, until variable speed devices were invented..

Nikola Tesla was born in Croatia in 1856, second son of a local priest at Smiljam. The family were of Serbian origin and his father's church was Serbian Orthodox. They were moved to another parish shortly afterwards called Gospic about 70 miles from Zargreb. He went to a school at the nearest town, then known as Carlstadt, modern-day Karlovac, still a long way away. At 19 he went on to study engineering at Graz Politechnic in Austria and later at Prague University. At Graz he was taught by a Prof. Poesehl, who showed him a Gramme dynamo (DC). Tesla was surprised at the sparking of the commutator, thinking it to be very inefficient. Nobody at that time had been able to design an AC machine, which the Professor said was impossible and he determined to do so at an early age. His first job was working for a telephone company in Budapest, and within a short time was put in charge of their first telephone exchange. This he did for a few years, before moving to Paris to work for the Continental Edison Company. They had recently supplied a DC lighting system to a German Railway company at Strasbourg and it did not work very well. Tesla was promised a bonus, if he sorted it out and was despatched to Strasbourg. He was there a long time with plenty of spare time waiting for work to be done on his recommendation, so he hired a workshop and set to build his AC generator/motor, the World's first in 1883. Others had tried, but failed due to the rotor locking solid due to the reciprocating nature of AC currents. Tesla put two winding out of phase with each other to maintain the momentum. He was then a mere 27 years old.

Even though he was successful he was not paid his bonus, but it was suggested that he should go the America and work under Edison's direct supervision. He sailed for New York in 1884. At the time Edison was having problems with running DC generators in parallel, since his small generating stations were getting overloaded. Tesla was given the task, once again offering him a bonus if he was successful. Tesla

worked fanatically hard and designed a control system, which enabled the dynamos to run in parallel. Hard-nosed Edison refused to give him his promised sum and Tesla left Edison's employment in a huff after only a year. This is not surprising, since Edison was strong advocate of DC, whereas Tesla was fanatical about AC systems. Both men were equally inventive, but Edison honed his inventions by trial and error, whereas Tesla was a keen mathematician and worked everything out from scratch.

Continually he seemed so keen to show his worth without being able to make a satisfactory employment contracts to protect himself from being used. This characteristic haunted him throughout his life. He was a bit of loner and did not get on well with colleagues, regularly falling out with them and not finding a suitable compromise or even taking charge of the situation particularly from a commercial point of view. This was a distinct disadvantage in American business-life as he would find out.



Picture 1 : Tesla aged around 30

Nikola Tesla Museum, Belgrade Web Site

He next joined a group of businessmen in building arc lamps, when he designed a new arc lamp for them. He quickly found out that these new colleagues were totally disinterested in his AC system, so he moved on again without any adequate repayment. He was literally at rock bottom, when he took a job digging sewer trenches in New York. However during this time he was introduced to a businessman, Mr. A.K. Brown of the Western Union Telegraph Company, who was interested in his ideas and agreed to back him. Tesla developed a laboratory at South Fifth Avenue, New York, where he worked for six months to build a total AC system, including transformers and then applied for the necessary patents. He was granted 30 patents including his precious AC motor on 1st May 1888. Then Brown introduced him to George Westinghouse, who was a keen AC advocate, having built a single phase AC system of supply at Great Barrington two years earlier. Westinghouse was so keen on Tesla's polyphase system that he offered him million dollars for all his patents. The opportunity was too good to miss and Tesla accepted with the proviso of a royalty of one dollar per horsepower to be included in the contract. He only received half the money, since his business associates took the other half. Part of the deal was that Tesla should work as a consultant for one year for Westinghouse at his Pittsburgh factory, a task which he did fulfil, falling out with Westinghouse's assistant over the use of high or low frequency. At that time Tesla was keen on 60 cycles AC. Westinghouse tried to get him to stay, offering him a fantastic salary and even a laboratory thrown in, but Tesla threw

these offers to the wind. He was determined to go it alone.

It is interesting to note that in all the books referenced at the end, Tesla is credited with inventing the AC alternator/motor and the polyphase system in 1883, but at the same time in England, Sebastian de Ferranti was inventing an alternator with a zig-zag armature. By 1889 Ferranti was building his major Deptford power station with 3 phase alternators and cables designed by him (see Supplement dated December 2003).

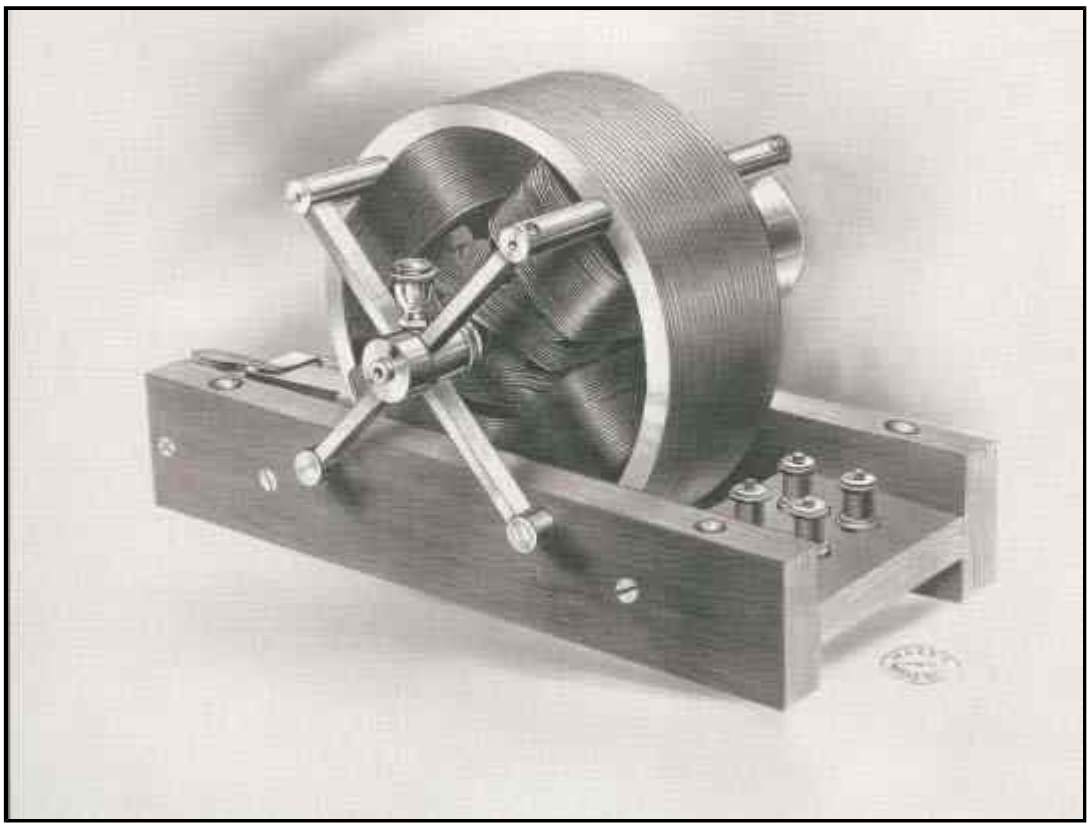
By the close of 1889, Tesla was back in his own laboratory in New York. He first built a vibrating platform trying to determine the natural resonance of the Earth. He found that the vibrating platform had medical benefits for constipation, i.e. mechanical laxative! His further research into resonance involved building AC machines with 384 magnetic poles and was thereby able to generate high frequency currents up to 10,000 cycles per second. He designed air-cored transformers involved a coil and capacitor producing high voltage and high frequency electricity, due to the resonance between the two. He patented this coil, later known as the "Tesla Coil", a radio tuning device six years before Marconi's radio patent was issued. Working with these high voltages, he discovered the best insulation by immersion in oil, decades before the system was universally used. Also at this time he discovered the workings of fluorescent gas filled tubes, since observers said that he had fluorescent tubes around his laboratory worked by "wireless power", i.e. from a high voltage cable loop around the laboratory. He even invented an X-ray lamp taking photos of the bones in his hand, but never claimed a patent for it. During this period he was hosting dinner parties and afterwards would take his guests back to his laboratory giving demonstrations of high voltage electricity, producing flaming discharges that leapt across the width of his laboratory, accompanied by the smell of sulphurous fumes. He wowed observers and reporters with seemingly death defying demonstrations, passing hundreds of thousand volts at high frequency with low currents through his body, lighting a carbon button lamp, which he held. Very high temperatures were created in the vacuous globe vaporizing the carbon into a gas!

Whilst Tesla was making new discoveries in his laboratory, the battle of the lamp patents was being played out in the courts. Westinghouse had been infringing Edison's lamp patents, which was draining Edison's company from making adequate returns. Westinghouse was also developing the Tesla patents and was keen to publicise the benefits of AC electricity. He installed a hydro-electric system at Colorado to give a supply to gold mine 2 ½ miles away transmitting electricity at 3,000 volts, which gave him excellent AC publicity. Edison on the other hand, tried to "rubbish" Westinghouse by setting up an AC electrocution system for capital punishment in New York, saying that AC was more dangerous than DC. Westinghouse lost the infringement court battle and his AC Tesla system endured bad publicity, which left him in serious financial difficulties. He sold his British factory at Trafford Park to a combine of Metropolitan Trains and Vickers Armstrong (Metropolitan Vickers). His bankers persuaded

him to approach Tesla in order to remove the royalty payments, which would have made Tesla a rich man. To save his friend and the only man, who had had faith in his AC system, Tesla tore up the contract, although some books state that he received a one-off payment of $216,000. He also attempted to help Westinghouse by giving public demonstrations on the safety of the AC system.

In 1891 Tesla set off for Europe for a lecture tour, in order to include a visit to his sick mother in Gospic, Croatia. His tour included a lecture to the Institute of Electrical Engineers in London and the International Society of Engineers in Paris. After his IEE lecture Sir James Dewar implored him to repeat his lecture to the Royal Institution, to which Tesla refused. Dewar was very persuasive getting Tesla to sit in Faraday's chair and offered him a sample of Faraday's whiskey, untouched for a quarter of a century. Tesla relented. In Paris he heard that his mother was failing and rushed to her bedside only just in time to see her before she died.

After his mother's death, he visited Belgrade, where he was received as a national hero. On his return, he found that his friend, Westinghouse, was embroiled in an ambitious scheme to light the World Columbian Fair in Chicago, which would take place in 1893; ambitious, because he had no lamp to use with the Tesla system. Westinghouse set about designing a lamp, so as not to infringe the Edison patent. It had a metal filament in a bottle, and the whole venture with Tesla's help was a huge success!



**Picture 2 : Tesla's AC Motor –
Tesla Memorial Society of
New York Web Site**

Westinghouse, buoyed up by this success and renewed fortune, decided to put forward a quotation for building a hydro-electric scheme for the Niagara River. This idea had been mooted as long ago as 1886 and a Commission had been appointed with Lord Kelvin, described as an eminent British engineer, as the Chairman and consultant. Westinghouse's company did not have enough money to build the scheme, although it had the Tesla AC patents, so he approached Edison's company, which was now called General Electric, an amalgamation of Edison General Electric and Thomson Houston, who had the capital with a well-known banker, J.P. Morgan behind them. But they did not have the necessary AC polyphase system, so that a deal was brokered for the two companies to set about designing a suitable scheme. They appointed George Forbes, a Scottish engineer in charge of the project. The hydro-electric station was commissioned on 20th April 1895 with three water driven alternators each of 5,000 HP. Although not getting any financial reward, Tesla was acclaimed for his inventiveness and feted at dinners given in his honour.

In 1895 he lost everything when his laboratory went up in smoke. Friends including Mr Adams, a banking associate of J.P. Morgan, helped him set up a new laboratory in Houston Street, New York with a grant of $40,000. It took him two years to rebuild the radio system from his head, which he then patented, but was unable to persuade anyone to invest in his ideas. He staged an impressive demonstration in Madison Square Gardens, where he had a large tank of water on which floated a boat. He directed its movement by remote radio control. He even managed to get the boat to submerge still controlling its underwater movement. He claimed he could design a remote controlled submarine torpedo boat, but the US Navy never took him up the idea. He was experimenting with very high voltages for the time, and had the vision of transmitting power through the air i.e. without wires. This tended to give him a bad name with other engineers and the technical press. They were uncertain of taking his wild predictions seriously. He was still experimenting with resonance in 1896, when he created a small earthquake. This shook buildings in a radius of a dozen square blocks, so that the rumbles reached the local police station, and a squad of policeman was despatched to his laboratory. They arrived there only to find that he had smashed the offending equipment with a sledgehammer. At this time Tesla published the complete description of the Tesla/Thomson coil in electrical journals (Elect. Review 1896), which was described as a high frequency, high voltage (10,000 – 15,000 volts) transformer with no iron core. By 1899 Tesla was running short of money again and a dangerous situation was developing with such high voltages wafting around a confined laboratory.

A friend of his offered him a piece of land at Colorado Springs, Middle America to build a bigger laboratory. He borrowed some money and set off for Colorado, leaving his New York laboratory in the hands of his capable and loyal assistant, George Scherff. Here he built a large wooden shed and two masts on high ground. He set about designing

equipment to measure lightning. His first tests were to create artificial lightning. He experimented with a low frequency wireless system (long wave), which could transmit around the globe, when Marconi could only transmit (short wave) a mere 62 miles. He extended this system to involving some power component up to 10 kilowatts. One of his last experiments at Colorado was to develop very high voltages at high frequencies for transmission at high altitudes, described as through the "rarefied strata", but in the process burnt out a generator belonging to the local electricity supply company. He had been using free electricity by agreement at off-peak times and he was told that from then on he would only get more electricity, when he had rewound the generator and then it would be from that one alone!

By 1900 he had run out of capital again and returned to New York with the intention of realising some money on his discoveries. He patented these ideas and commenced writing articles in many magazines. He claimed that would be able to transmit electricity through the air to customers providing "free electricity". Another idea was conducting electricity through the Earth. He proposed a "World System" of communications, involving 12 aspects, most of which have been realised, including a synchronous motor (AC) for accurate time-keeping. The main financier of General Electric, J.P. Morgan, heard of these outrageous statements and that he was broke again. Morgan in a surprisingly altruistic gesture agreed to make a "no strings attached" gift of $150,000 to get him off the ground with his World System. With what he perceived as the complete backing of Morgan, Tesla set out to build a large transmitting station at Wardencliff, Long Island, 60 miles from New York, but within a year had run out of money again. He approached Morgan for a second time, but JPM refused to dole out any more cash. It is believed that Morgan considered the new project may have undermined the thriving electricity industry, which he controlled. Tesla soldiered on, but by 1906 had got nowhere and abandoned the project.

Another kind friend lent him some money to develop a bladeless steam turbine. Within four years Tesla had produced two turbines, each developing 100 HP. He persuaded GE to let him test them in their New York power station. He installed them setting them up in opposition to each other and thus his demonstration was poor. He tried his ideas on a manufacturer in Milwaukee, but this was equally unsuccessful.

Even if Tesla failed to win over the business community with his ideas, he was eventually recognised at the age of 61 by the American Institute of Electrical Engineers with the award of the Edison Medal in 1917. After heaping great praise on his many achievements, it was customary for medal winners to give a brief thank you, but Tesla chose to bore everyone present, including supporters and friends, by running through his many ideas over one hour. This showed his inability to work with his contemporaries and a misunderstanding of people generally.

As Tesla neared his 80th birthday, he was recognised in Yugoslavia, where the Foundation of the Tesla Institute was opened in Belgrade,

supported by the Yugoslav Government, who also gave him a honorarium of $7,000 a year. Today there is a Museum in his honour in Belgrade, which is available on the internet. At his birthday (82nd) dinner put on in his honour in New York, he described his wireless system and, of all things – a death ray he had invented! He claimed his system was capable of communicating with the planets.

Not only was Tesla a hopeless businessman, but also he was pretty useless with money. John O'Neil summed up his problem, saying that he lacked the personality (and character) that made possible the securing of financial returns directly from his inventions. Throughout most of his life, he lived in hotels, the Alta Vista at Colorado Springs, the Waldorf Astoria in New York, until he was thrown out for not paying his bills. He moved on from hotel to hotel, often with other people picking up the bill behind his back, and died alone in a hotel room in 1943 aged 87. His name lives on the unit of magnetic flux density, which unfortunately is not in the public arena very often. Even with these hidden friends, he was a solitary person, having never got married or allowed anyone to get too close to him – he was married to science.

References :

"The Man Who Invented the Twentieth Century – Nikola Tesla – the Forgotten Genius of Electricity" by Robert Lomas - 1999

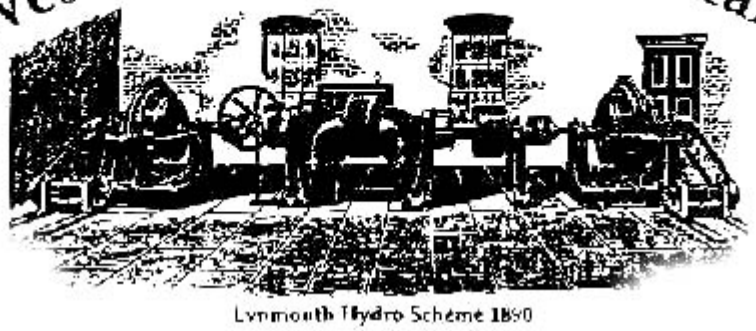
"Lightning in His Hand – the Life Story of Nikola Tesla" by Inez Wanetta & W. Draper - 1964

"Nikola Tesla – Electrical Genius" by Arthur J. Beckhard - 1961

"Prodigal Genius – the Life of Nikola Tesla – Inventor Extraordinary" by John O'Neil - 1944 (USA)
(Reprint in UK 1968) (J O'Neill knew him personally, and his book is the most interesting read).

Electrical Reviews from 1897 to 1900

South Western Electricity Historical Society



Lynmouth Hydro Scheme 1890

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South Western Electricity Historical Society website at
www.swehs.co.uk

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