NIKOLA TESLA

MASTER OF IMAGINATION

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Nikola Tesla was born on July 9/10 (midnight), 1856 in Smiljam, Croatia, to a Serbian family. His father was an orthodox priest. His mother was unschooled but quite intelligent. Nikola was a dreamer who loved poetry. He was self-disciplined and compulsive. His principle contribution to the field of electromagnetic engineering is the discovery of the rotating magnetic field and the development of the polyphase electrical system [1 p. 161]. Historians credit Tesla with being a genius because he not only made unique discoveries in electromagnetic engineering but developed these discoveries into working systems in an area of science that had almost no existing body of knowledge other than what he himself had uncovered. Pioneering experiments were also conducted in fluorescent lighting, vacuum tube, radio, robotics, and X-ray technologies [3 pp. 9-13].

EARLY EXPERIENCES

Circumstances in Nikola's early life resulted in his imagination being exercised to the extreme. In his mind, Nikola would see flashes of light and vivid images. These images were not of imagined subjects, but were familiar scenes. The effect was so intense that it affected his ability to see. Interestingly, his brother exhibited similar difficulties. To gain relief, Nikola would take control of his hallucinations by conjuring up his own images—creating his own imaginary world. He would take imaginary journeys to strange places. These experiences were intense and made as strong an impression on young Nikola as his real life experiences. He played this game constantly from early childhood until the age of 17 when he began channeling his thoughts toward invention [2 p. 11-12].

As an inventor, he was able to eliminate a lot of models, drawings, and experiments by using the imagination he had developed in childhood to work through the development and trials of a new idea. He would conduct his first experiments in his imaginary world, noting problems and making adjustments, thus completing much of the preliminary work before conducting physical experiments [2 p. 12].

The first commercially generated power was direct current. Although alternating current could be more efficiently transmitted, it was not used because no satisfactory alternating current motor had been developed. Tesla pondered this problem for many years. Finally, while walking through a park in Budapest, the idea came to him in a flash. He conceived of a rotating magnetic field, created by multiple phases of AC power. This concept would eventually permit him to develop the first successful AC motor [2 p. 22, 23].

In 1882, Tesla worked at a telegraph office. He invented a telephone amplifier, which he didn't bother to patent. In the fall of 1882, he went to Paris to work for an Edison subsidiary. He worked as a troubleshooter at power plants in France and Germany. He wanted to sell Mr. Edison on his AC power ideas, but was told that Edison was solidly in favor of DC current over AC. On his own time, he built his first AC motor [2 p. 24, 25].

In 1884, Tesla immigrated to America, bringing a letter of recommendation addressed to Thomas Edison. He happened to catch Edison at a time when the inventor desperately needed help maintaining his many DC electrical systems. Edison sent Tesla immediately to repair dynamos aboard the SS Oregon. Tesla worked through the night to complete the repairs [2 p. 30-31].

Tesla informed Edison that he could make major improvements in Edison's DC dynamos. Edison said if he did, there would be $50,000 in it for him. Tesla worked long hours for almost a year to complete the redesign. He visited Edison and asked about his $50,000. Edison replied, "Tesla, you don't understand our American humor." Tesla resigned [2 p. 33-34]. America was entering an economic depression and Nikola Tesla found himself working on a New York street gang from 1886 to 1887 [2 p. 36].

THE ALTERNATING CURRENT SYSTEM

Finally, Tesla's foreman took him to meet A. K. Brown, manager of Western Union Telegraph Co. With Brown's help, Tesla Electric Co. was formed in April 1887. Tesla patented single-phase, two-phase, and three-phase AC systems, and two AC motors. In the first four years of

operation, he was granted 40 patents. The patents were processed quickly since there was nothing like them at the patent office. Both scientific and business interests took note of the patent office activity and Tesla was soon receiving invitations to lecture. He turned out to be a natural speaker [2 p. 36-39].

George Westinghouse had more than 30 AC power systems in operation at the time (under a different patent) and was interested in Tesla's motor. Westinghouse paid Tesla a visit at his lab. Tesla went to work for Westinghouse and moved to Pittsburgh. Tesla's motors ran at 60 Hz AC and could not be adapted to the 133 Hz Westinghouse system. Westinghouse was forced to switch to 60 Hz and this has become the standard electrical power frequency in the U.S. After several months in Pittsburgh, Tesla returned to New York [2 p.40]. He became a U.S. citizen on July 30, 1891, a status which he valued above all scientific honors. In September 1891 he went to Paris to lecture at the International Exposition and also visited his family in Croatia [2 p. 41].

Edison was outraged when he learned of Tesla's alliance with Westinghouse. He issued propaganda about the dangers of AC current. Edison conducted weekly demonstrations in which dogs and cats were electrocuted. Through a third party, he bought rights to Tesla's AC patents and worked a deal with New York prison authorities to carry out the first execution by electrocution on 8/6/1890. The convict failed to die after the first shock and the ordeal had to be repeated. It was reported as "an awful spectacle, far worse than hanging [2 p, 41-45]."

George Westinghouse became worn down financially by Edison's anti-alternating current initiatives. A major obstacle to the ability of Westinghouse to get new funding was his contract with Tesla to pay him $2.50 for each horsepower manufactured. George Westinghouse appealed to Tesla to relinquish his claim to the patents. Tesla, interested in seeing his inventions put to use, agreed and settled for a cash sum [2 p. 48-49].

Tesla proved to be quite a showman on the lecture circuit. He had glass tubes that glowed without electrical connections. This was the forerunner of the florescent bulb, another invention he didn't bother to patent. He wore insulated shoes and allowed high-voltage, high-frequency electric current to flow across his body. His purpose in doing this was, in part, to counter

Edison's propaganda about the danger of AC current. At high frequencies and voltages, electricity would run across the surface of the skin without penetrating. He demonstrated a motor run on one wire, with the return path through air. He spoke of the possibility of transmitting power long distances through the upper atmosphere. One dazzling display was his "carbon-button lamp," a partially evacuated glass globe with a piece of carborundum in one end connected to a single wire terminal. When high-frequency current was applied, "The central 'button' of material electrostatically propelled the surrounding gas molecules toward the glass globe. They were then repelled back toward the button, striking it and heating it to incandescence [2 p. 54]." The bulb was 20 times as efficient as the Edison bulb. Since a technical language had not yet evolved to describe these phenomena, Tesla described them poetically. For example, a static discharge he called a *brush* or a *luminous stream* [2 p. 54-55].

George Westinghouse won the contract for electrifying the Chicago World's Fair of 1893—the first electrical fair. He invited Tesla to speak. 25 million Americans visited the fair, which was one-third of the population at the time. Tesla had blown tubes to spell "Welcome Electricians," as well as the names of many famous scientists. He dazzled audiences with numerous demonstrations of high frequency, high-voltage current.

TESLA'S GIFTS TO ENGINEERING

Tesla's discovery of the rotating magnetic field and his inventions of the transformer and induction motor were valuable advancements that are still the means for the production, transmission and use of electrical power today. Less tangible but important contributions were his inspiring lectures and the ideas he left unpatented. In his dazzling demonstrations, he not only amazed his audiences but also sparked the interest of many contemporary and future inventors. It has taken decades for scientists to reproduce some of the experiments he demonstrated publicly. How Tesla was able to electrically produce a ball of flame and hold it in his hands remains a mystery. He energized a wave of invention during the late 19^{th} and early 20^{th} centuries and continues to inspire engineers today.

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