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John Haller

TESLA, NIKOLA (*b.* Smiljan, Croatia [now Yugoslavia], 10 July 1856; *d.* New York, N.Y., 7 January 1943), *physics, electrical engineering.*

Tesla was born of Serbian parents in a mountain village that was then part of Austria-Hungary. His father, Milutin Tesla, was a clergyman of the Serbian Orthodox church, while his mother, Djuka Mandić, although illiterate, was a skillful inventor of home and farm implements. Tesla himself was intended for the clergy, but early developed a taste for mathematics and science. When he was seven, the family moved to Gospić, where he finished grammar school and graduated from the Real-Gymnasium. He then attended the Higher Real-Gymnasium in Karlovac and, upon graduation, persuaded his father to let him enter the Joanneum, the polytechnical college of Graz, Austria.

It was while he was a student in Graz that Tesla's attention was first drawn to problems of the induction motor. His observation that a Gramme dynamo that was being run as a motor in a classroom demonstration sparked badly between its commutator and brushes led him to suggest that a motor without a commutator might be devised—an idea that his professor ridiculed. Nothing daunted, Tesla continued to develop the idea. In 1879 he left Graz to enroll at the University of Prague, but left without taking a degree when his father died. He then held a number of jobs; in 1881 he went to Budapest to work for the new telephone company there. During his year there he thought of the principle of the rotating magnetic field, upon which all polyphase induction motors are based. The discovery, by his own account, was instantaneous, complete, and intuitive. Walking in a park with a friend, Antony Szigety, Tesla was moved to recite a passage from Goethe's *Faust* (of which he had the whole by heart) when " . . . the idea came like a lightning flash. In an instant I saw it all, and drew with a stick on the sand the diagrams which were illustrated in my fundamental patents of May, 1888, and which Szigety understood perfectly." It was, however, some time before he was able to exploit his invention commercially.

In 1882 Tesla went to Paris as an engineer with the Continental Edison Company. The following year he was sent to Strasbourg to repair an electric plant, and while there built a crude prototype of his motor. He thus experienced "the supreme satisfaction of seeing for the first time rotation effected by alternating currents without commutator." In 1884 he went to the United States to promote his new alternating-current motor. He arrived in New York with a working knowledge of a dozen languages, a book of poetry, four cents, and an introduction to Thomas Edison. Although Edison was totally committed to direct current, he gave Tesla a job, and for a year Tesla supported himself redesigning direct-current dynamos for the Edison Machine Works. By 1885 he had left Edison and had gone into business developing and promoting an industrial arc lamp. He was forced out of the company when production began, however, and for a time lived precariously, doing odd jobs and day labor. Within two years he was back on his feet, and had formed his own laboratory for the development of his alternating-current motor.

By 1888 Tesla had obtained patents on a whole polyphase system of alternating-current dynamos, transformers, and motors; the rights to these were bought in that year by George Westinghouse, and the "battle of the currents" was begun. Although Edison continued to espouse direct current, Tesla's system triumphed to make possible the first large-scale harnessing of Niagara Falls and to provide the basis for the whole modern electric-

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power industry. In 1889 Tesla became an American citizen.

During the next few years Tesla worked in his New York laboratories on a wide variety of projects. He was very successful, particularly in his invention of the Tesla coil, an air-core transformer, and in his further research on high-frequency currents. In 1891 he lectured on his high-frequency devices to the American Institute of Electrical Engineers, and this lecture, coupled with a spectacular demonstration of these apparatuses, made him famous. He repeated his performance in Europe, to great acclaim, and enjoyed international celebrity.

In 1893 the Chicago World Columbian Exposition was lighted by means of Tesla's system and work was begun on the installation of power machinery at Niagara Falls. In a lecture-demonstration given in St. Louis in the same year—two years before Marconi's first experiments—Tesla also predicted wireless communication; the apparatus that he employed contained all the elements of spark and continuous wave that were incorporated into radio transmitters before the advent of the vacuum tube. Engrossed as he was with the transmission of substantial amounts of power, however, he almost perversely rejected the notion of transmission by Hertzian waves, which he considered to be wasteful of energy. He thus proposed wireless communication by actual conduction of electricity through natural media, and, working in Colorado Springs, Colorado, in 1899–1900, proved the earth to be a conductor. In a further series of experiments, Tesla produced artificial lightning in flashes of millions of volts that were up to 135 feet long—a feat that has never been equaled. It was at his Colorado laboratory, too, that Tesla, who had become increasingly withdrawn and eccentric ever since the death of his mother in 1892, announced that he had received signals from foreign planets, a statement that was greeted with some skepticism.

Tesla's vision always embraced the widest applications of his discoveries. Of his wireless system, he wrote in 1900: "I have no doubt that it will prove very efficient in enlightening the masses, particularly in still uncivilized countries and less accessible regions, and that it will add materially to general safety, comfort and convenience, and maintenance of peaceful relations." With the financial backing of J. P. Morgan, he began work on a worldwide communications system, and a 200-foot transmission tower was constructed at Shoreham, on Long Island. By 1905, however, Morgan had withdrawn his support, and the project came to an end. The tower was destroyed by dynamite, under mysterious circumstances, in 1914.

Although he continued to enjoy a measure of fame, Tesla made little money from his inventions, and became increasingly poor during the last decades of his life. His name continued to flourish before the public, however, since he was a reliable source for scientific prophecy, and exploited as such in the popular press. While he gave demonstrations of some of his earlier marvels—his exhibition of a radio-guided teleautomatic boat filled Madison Square Garden in 1898—he became oracular in his later years and, for example, offered no proof of the potent "death-ray" that he announced in 1934, on his seventy-eighth birthday. Nonetheless, Tesla continued to invent devices of commercial and scientific worth, from which, since he seldom bothered to seek a patent, he received little profit.

Tesla was a complete recluse in his last years, living in a series of New York hotel rooms with only pigeons for company. At his death his papers and notes were seized by the Alien Property office; they are now housed in the Nikola Tesla Museum in Belgrade, Yugoslavia, a country in which he is revered as a national hero.

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