Seeking Redress for Nikola Tesla

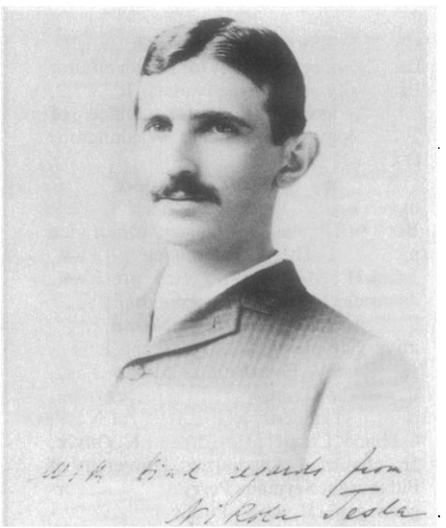
His admirers say that Americans have ignored the most important rival of Edison and Marconi

Who invented wireless communication? Was it Marchese Guglielmo Marconi, the Italian radio builder? No, it was not, according to revisionists who think the world has neglected a brilliant contemporary of Marconi's: it was Nikola Tesla.

Few people in America know about Tesla, an electrical engineer and inventor of the late 19th and early 20th centuries. He was born in 1856 in Croatia, now part of Yugoslavia, and spent most of his adult life in New York City. He was doubtless a genius and decidedly an eccentric. Tesla arrived penniless on the docks in New York in 1884 and died just as poor in his room at the New Yorker hotel in 1943. Yet during the intervening years he created machines and sketched out ideas that later proved critical for the distribution of electricity, radio communication, and even—some claim—for modern electronic weaponry.*

For a time, Tesla was adopted by the highest of high society. J. Pierpont Morgan befriended him and gave him money to conduct electrical experiments on Long Island. But Tesla died in relative obscurity, and memory of him seems to have followed him to the grave.

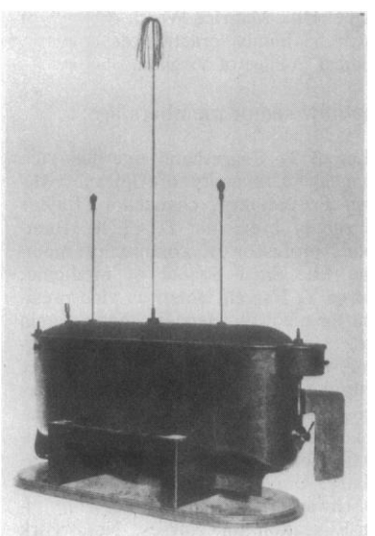
Now, in the 125th year after Tesla's birth, some admirers are trying to refurbish his reputation. The Tesla Memorial Society and the Yugoslav embassy scheduled the showing of a film on Tesla at the National Academy of Sciences on 20 October. The Smithsonian Institution has put together an exhibit. Other events to gain wider recognition of Tesla's work are planned for next year. A former chairman of the House public works committee, John Blatnik, has been influential in getting some of these projects started. He has persuaded friends in Congress, and through them, the Postal Commission, that it would be a good idea to issue a Tesla commemorative stamp in 1983. Blatnik is a Yugoslav-American like many members of the Tesla Society. He thinks Tesla deserves more credit for his contributions to American industry than he has received. Blatnik also confides that he would like to rescue Tesla from his more fanciful admirers, some of whom believe their hero literally came to earth like superman from outer space. However, most Tesla buffs concentrate on Tesla's well-documented achievements, such as his experiments in high-frequency energy transmission.



Smithsonian Institution

Nikola Tesla at 29

A year after coming to New York.



Smithsonian Institution

A seagoing teleautomaton

Built in 1897, Tesla's model boat received commands from a transmitter on shore.

Every schoolchild knows that Marconi invented the radio. The Tesla fans believe otherwise, for they have researched the case of the *Marconi Wireless Company of America* v. *the United States*, argued before the Supreme Court during the fall term of 1942. This was the first patent fight to fill an entire volume of court records, a foretaste of the kind of priority litigation that would later swamp the courts. Marconi's company claimed that the U.S. government had infringed on patents in producing radios during World War I. Justice Department attorneys argued the other side, saying that the patents were not binding since the concepts had been included in earlier applications.

The decision came on 21 June 1943. Marconi's patent for "a structure and arrangement of four high-frequency circuits with means of independently adjusting each so that all four may be brought into electrical resonance with one another" was held to be "invalid because anticipated." The court ruled that three inventors, including Tesla, had covered the basic principles of Marconi's system in patents filed several years before Marconi filed his.

There is a more controversial priority dispute than this, however. Who should be called the father of the modern electrical power system? Should it be Thomas Edison, who patented the light bulb and lends his name to some of the largest and oldest utility companies in America? No, Tesla's admirers say. It was Tesla who invented the first alternating current generator and sold it to a power company at Niagara Falls, to be installed at the world's first hydroelectric plant. The decision to adopt alternating current made it possible to transmit electricity over long distances and power both lights and motors from the same lines. Although others may have grasped the principle of alternating current generators and motors at about the same time, Tesla was clearly the leader in patenting and developing the concept, admirers say.

Ironically, one of the most formidable obstacles Tesla encountered was Edison himself. Edison, then famous and powerful, insisted that a system based on alternating current would be dangerous and

*An excellent account of Tesla's life and scientific achievements appeared in *Science*, 16 May 1958, p. 1147.

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New IOM Members

The Institute of Medicine–National Academy of Sciences has elected 50 new members, making the total active membership 371 when their terms begin on 1 January. Nine persons were elected directly to senior membership, a category established in 1977, to recognize individuals 66 years old and older. The new members are:

Mary Ellen Avery, professor of pediatrics, Harvard Medical School; **Albert L. Babb**, chairman of nuclear engineering, University of Washington; **Baruj Benacerraf**, president, Sidney Farber Cancer Institute, Harvard Medical School; **Floyd E. Bloom**, director, Arthur V. Davis Center for Behavioral Neurobiology, The Salk Institute; **Baruch S. Blumberg**, associate director for clinical research, The Institute for Cancer Research; **Edward N. Brandt, Jr.**, assistant secretary for health, U.S. Department of Health and Human Services; **Robert H. Brook**, senior staff health services researcher, The Rand Corp.; **Eric J. Cassell**, practitioner of internal medicine, New York City; **John D. Chase**, acting dean of medicine, University of Washington, Seattle; **Shirley S. Chater**, vice chancellor, academic affairs, University of California, San Francisco; **H. D. Collins**, practitioner of internal medicine, Caribou, Maine; **Pedro Cuatrecasas**, vice president of research, The Wellcome Research Laboratories, Research Triangle Park.

Worth B. Daniels, Jr., practitioner of internal medicine, Baltimore, Maryland; **Roman W. DeSanctis**, director of clinical cardiology, Massachusetts General Hospital; **Donnell D. Etzwiler**, pediatrician, St. Louis Park Medical Center, Minneapolis; **Alfred P. Fishman**, director, cardiovascular-pulmonary division, Hospital of the University of Pennsylvania; **Margaret J. Giannini**, director, Rehabilitative Engineering Research & Development Service, Veterans Administration; **Joseph Goldstein**, professor of law, Yale Law School; **David S. Greer**, dean of medicine, Brown University; **Barbara C. Hansen**, assistant professor of physiology, University of Michigan; **Clark C. Havighurst**, professor of law, Duke University; **Ruby P. Hearn**, assistant vice president, The Robert Wood Johnson Foundation; **Joseph L. Henry**, associate dean of oral diagnosis and radiology, Harvard School of Dental Medicine.

S. Richardson Hill, Jr., president, University of Alabama, Birmingham; **W. N. Hubbard, Jr.**, president, The Upjohn Co.; **Richard Janeway**, dean, Bowman Gray School of Medicine, Wake Forest University; **W. K. Joklik**, chairman of microbiology and immunology, Duke University Medical Center; **Mary E. Jones**, professor of biochemistry and nutrition, University of North Carolina, Chapel Hill; **Samuel L. Katz**, chairman of pediatrics, Duke University Medical Center; **Charles R. Kleeman**, professor of nephrology and medicine, University of California, Los Angeles; **Norman Kretchmer**, nutritional sciences, University of California, Berkeley; **Thomas W. Langfitt**, vice president for health affairs, University of Pennsylvania; **Joyce C. Lasnof**, assistant director, Office of Technology Assessment, Washington, D.C.

Barbara J. McNeil, professor of radiology, Brigham and Women's Hospital, Boston; **Thomas W. Moloney**, senior vice president, The Commonwealth Fund; **John H. Moxley, III**, vice president, American Medical International, Inc., Beverly Hills; **Bernard W. Nelson**, executive vice president, The Henry J. Kaiser Family Foundation, Menlo Park; **Daniel A. Okun**, professor of environmental engineering, University of North Carolina, Chapel Hill; **Thomas K. Oliver, Jr.**, chairman of pediatrics, University of Pittsburgh; **Seymour Perry**, assistant surgeon general, U.S. Public Health Service; **Frank A. Riddick, Jr.**, medical director, Ochsner Clinic, New Orleans; **Judith Rodin**, professor of psychology and psychiatry, Yale University; **Saul A. Rosenberg**, professor of medicine and radiology, Stanford University; **Mary M. Runge**, community pharmacist, Moraga, California; **James H. Sammons**, executive vice president, American Medical Association.

Frank A. Sloan, professor of economics, Institute for Public Policy Studies, Vanderbilt University; **Reuel A. Stallones**, dean of public health, University of Texas, Houston; **Paul D. Stolley**, professor of medicine, University of Pennsylvania; **Raymond P. White, Jr.**, dean of dentistry, University of North Carolina, Chapel Hill; **Maurice Wood**, director of research, family practice department, Medical College of Virginia.

The new senior members are:

Lowell T. Coggeshall, emeritus vice president, University of Chicago; **Michael E. DeBakey**, chancellor, Baylor College of Medicine; **E. Cuyler Hammond**, professor of community medicine, Mt. Sinai School of Medicine; **George T. Harrell**, emeritus vice president for medical sciences, Pennsylvania State University; **Alexander D. Langmuir**, visiting professor of epidemiology (retired), Harvard Medical School; **Bernice L. Neugarten**, professor of education and sociology, Northwestern University; **John Romano**, professor of psychiatry, University of Rochester; **Doris R. Schwartz**, faculty, School of Continuing Education for Nurses, New York Hospital–Cornell Medical Center; **George A. Silver**, professor of public health, School of Medicine, Yale University.

ought to be avoided at all costs. It would be far safer, Edison argued, to rely on direct current, just as he did in the small power plant he owned and operated in Manhattan. Edison went so far as to suggest that experimenting with alternating current should be made illegal in order to protect public health and safety. Nevertheless, Tesla's system was installed at Niagara Falls in 1896, and interest in Edison's direct current system faded rapidly.

Frank Jenkins, a vice president of Duke Power in Charlotte, North Carolina, looked into Tesla's career in writing a paper for a symposium in 1975. He found, he says now, that "Tesla has had far more impact on the United States and the world than Edison. What we have in terms of power generation, transmission, distribution, the basic elements that make up our use and applications of electric energy—the vast majority stems directly out of Tesla's contributions." Jenkins says it is unfortunate that Tesla has not been given more attention, and he thinks that Tesla's battle with Edison may have done long-term damage to his reputation.

Understandably, Tesla's admirers claim things for him that many historians of science will not grant. There is no question, however, that his work on alternating current systems was a major contribution to industry and the greatest practical achievement of his career. Tesla himself showed little interest in developing these inventions for commercial application; that he left to his partner, Edward Westinghouse. (Westinghouse, nearly bankrupt, eventually found it necessary to make a deal with his chief competitor, General Electric, swapping Tesla's patents for others held by GE.)

Tesla went off to conduct experiments with high-frequency resonances in coils. He also developed a specialty he called "teleautomatics," inventing machines that could be given commands by a remote transmitter. In 1897, the year Marconi took out a U.S. patent for the wireless, Tesla built a model boat that could be steered and made to fire explosives by remote control. He also developed a radio-guided torpedo.

Tesla's most spectacular experiments were carried out in 1899 at Colorado Springs, Colorado. There he built an enormous coil that he used to generate up to 10 or 12 million volts of current, creating sparks that were said to leap a gap of 135 feet. The effects were dazzling, but the machine never lived up to its promise. This "generator," like the one on Long Island financed by J. P. Morgan, was intended to electrify the

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entire earth, so that anyone on the planet could tap into a general power supply just by building a receiver. The concept, needless to say, had flaws. But the research provided valuable data on high-frequency phenomena and on techniques for simulating the effects of lightning.

Tesla's thinking and personal manners had always been distinctively different, and as he grew older, he gradually drifted out of society's mainstream. By the 1930's he had become an oddity. As a young man, Tesla had acquired an inordinate fear of bacteria and of human contact. He frequently wore gloves and, when dining, would wipe each implement with a fresh napkin. He never married. In later years he lived a solitary and hermetic life, ruminating on projects that he could not afford to pursue. According to Smithsonian archivist Elliot Sivowitch, one indication of Tesla's intellectual isolation is that he never acknowledged the work of the greatest contemporary in his field: James Clerk Maxwell.

While Tesla clearly had extraordinary powers of analysis and invention, he was not, after the turn of the century, counted in the handful of leading theoreticians and practitioners of electrical science. Chroniclers may have neglected him in the past, but today Tesla has a dedicated band of admirers eager to see that he is justly acclaimed for his discoveries.

—ELIOT MARSHALL

EPA May Be Redefining Toxic Substances

Agency officials' meetings with industry could be the reason, critics say

Shortly before Anne M. Gorsuch took office last spring as head of the Environmental Protection Agency (EPA), scientists there recommended that the agency give priority attention to two widely used chemicals because they are carcinogenic in animals. Top officials went so far as to draft notices to appear in the *Federal Register* to announce EPA's intention to consider regulating formaldehyde and di-(2-ethylhexyl) phthalate (DEHP).

Although the notices awaited only the administrator's approval, Gorsuch requested that more information on the chemicals be gathered. During the summer, EPA deputy administrator John Hernandez held several meetings which were attended for the most part by industry representatives and agency scientists. No consumer or environmental groups were invited to participate. Last month, an agency official recommended in an internal memorandum that formaldehyde should not be considered a significant risk. Apparently no recommendation has been made on DEHP.

Hernandez says that Gorsuch has not made a final decision on what to do about either substance. But many scientists fear that her indecision, particularly about formaldehyde, indicates a reluctance to regulate toxic substances in general. They are also disturbed at the lack of public disclosure about her decision-making process and the lopsided representation of industry at the summer meetings. Their apprehension is compounded by the belief that Gorsuch is systematically dismantling the agency.

The consequences of the agency meetings with industry have been far-reaching. Roy Albert, EPA's chief health adviser and the head of its Carcinogen Assessment Group resigned in September because he was not invited to the meetings, but last week he accepted an invitation by the agency to return to his post. The apparent secrecy of the sessions and the uncertainty about what information industry presented during the sessions has drawn congressional attention. Toby Moffett (D–Conn.), chairman of the environment, energy, and natural resources subcommittee of the Committee on Government Operations, questions the propriety of the meetings and has planned a hearing on 21 October to investigate the matter. An aide to Moffett's subcommittee, referring to the meetings, said, "That's not playing pool."

Albert, a professor at New York University (NYU) Medical Center's Environmental Health Institute, is troubled by the fact that EPA's decision on formaldehyde appears to be related to the summer meetings with industry. But whether that really is the case is not known. No minutes or transcripts were made of the discussions. Albert said, "There is nothing to sink your teeth into to say that this is the logic and information that [EPA] officials have used. There's no target to shoot at."

In 1978, about 1.1 million metric tons of formaldehyde and 185,000 metric tons of DEHP were produced. Formaldehyde is most commonly used in particle board, plywood, and urea-formaldehyde foam insulation. It also puts the press in permanent press fabrics. DEHP is widely used in plastic products, including building and flooring materials. Both chemicals are carcinogenic in rats.

Formaldehyde and DEHP would be the first chemicals to be classified as an immediate concern under a section of law that may ultimately result in regulation setting. According to the Toxic Substances Control Act, the EPA administrator must act if a chemical "presents or will present a significant risk of serious or widespread harm to human beings from cancer, gene mutations, or birth defects. . . ." Many scientists believe that EPA could not have a clearer candidate than formaldehyde. An EPA official who declined to be quoted by name said, "I find it hard to imagine that we could find a substance to qualify if formaldehyde doesn't."

Don Clay, the EPA official who recommended that formaldehyde is not a significant risk, says, "I think it's a problem but it's not a crisis type of thing. I am setting a high threshold [of evidence needed to regulate a substance]. I'm not bashful about it."

Two studies have demonstrated that formaldehyde is carcinogenic in rats, one sponsored by industry and the other led by Albert at NYU. The only dispute about the studies comes from the Formaldehyde Institute, a trade organization (*Science*, 7 August, p. 630). Arthur Upton, the head of the Environmental Health Institute and former director of the National Cancer Institute (NCI), wrote to several regulatory agency administrators, "If the carcinogenicity of formaldehyde is ignored, it would mean that no agent could be regarded as carcinogenic in the absence of positive evidence in humans."

The Formaldehyde Institute believes that without positive epidemiological ev-

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