Elihu Thomson: man of many facets

This foremost inventor and industrialist also directed a corporate engineering and research department and was president of MIT

When he was still a high-school student, Elihu Thomson wrote, "There is scarcely a day passing, on which some new use for electricity is not discovered. It seems destined to become at some future time the means of obtaining light, heat, and mechanical force." In making this remark, Thomson could well have been anticipating his own future, for few men discovered more new uses for electricity than he. Along with Thomas A. Edison, George Westinghouse, and Charles Brush, Thomson helped create the first electric light and power systems. By the time of his death in 1937, he had come to be considered by the engineering profession as "indisputably the dean of American electrical engineers."

A prolific inventor, Thomson acquired 696 patents in a career that spanned five decades. His inventions included a repulsion-induction motor, electric welding, and improved transformers, all of which were central to the rapid development of alternating-current distribution systems. More than just an inventor, though, Thomson was also a respected scientist, director of engineering and research at the General Electric Co., and president of the Massachusetts Institute of Technology. Involved in the growth of modern corporations, educational institutions, and professional engineering groups, Thomson's career reveals how a capable engineer and inventor participated in the United States' industrial development in the late nineteenth and early twentieth centuries.

A promising student

Thomson was born in Manchester, England, in 1853, but at an early age immigrated with his family to Philadelphia, Pa. Eager to learn, young Elihu passed rapidly through Philadelphia's public elementary schools and its Central High School [see "Science at Central High School," p. 74]. Unlike other early American high schools, which emphasized the liberal arts, Central High concentrated on the sciences; consequently, Elihu took courses in physics, chemistry, mathematics, and astronomy. Encouraged by his teachers, he set up his own chemical laboratory at home and organized a junior scientific society. Such studies and activities rapidly convinced Thomson to pursue a career in science and technology. Upon graduation from Central with honors in 1870, he spent the next few years establishing himself as a chemist in Philadelphia.

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Elihu Thomson was just 23 years old when he stopped teaching at Central High School in Philadelphia to become a professional inventor. He is pictured here five years later when he was perfecting his arc-lighting system.

From chemistry to electricity

Thomson worked briefly in a commercial chemistry laboratory, then returned to Central High to teach chemistry. Intensely curious about science and the mechanical arts, he devoted much of his free time to conducting chemistry experiments and writing brief papers for local scientific journals. He also built a pipe organ, a telescope, and a camera. Like other scientific devotees of the time, this young high-school teacher was especially interested in the discoveries being made in electricity, and he constructed electrostatic machines and self-exciting dynamos.

In 1877 Thomson participated in comparative tests of electric-lighting machinery at the Franklin Institute in Philadelphia, and these greatly enhanced his knowledge of electrical technology. During the tests he examined several arc-lighting systems that created a powerful light by passing an electric arc between two carbon electrodes. To supplement his knowledge of U.S. systems, Thomson visited Europe in the summer of 1878 and studied the alternating-current arc-lighting systems of Paul Jablochkoff and Dieudonné François Lontin.

A flawed beginning

Based on what he saw in the tests and on his trip, Thomson decided that he too could construct a practical set of arc lights. Collaborating with Edwin J. Houston, another teacher at Central High, Thomson designed and built an alternating-current system in the fall of 1878. In demonstrating their system at the Franklin Institute, Thomson and Houston employed a crude transformer to make each arc lamp independent and to transmit power to an electric motor. Their machinery, although novel, did not perform very well and failed to impress local businessmen.

Several investors, however, did ask Thomson and Houston to design a more practical direct-current system that could compete with the successful arc-

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lighting equipment of Charles Brush. Anxious to obtain the capital needed to support their inventive work, they designed a dc generator and arc lights in the spring of 1879. By incorporating a three-coil armature in their dynamo, the two teachers were able to construct a commercial lighting system that avoided the Brush patents. The generator's first commercial test was in D.B. Fuller's Aerated Biscuit Bakery in Philadelphia, where it powered nine lights on a series circuit.

A career as inventor launched

The test was a success and soon attracted additional financial backers. In 1880 Thomson resigned from Central High to become a professional inventor. During the next three years he worked for the American Electric Co. of New Britian, Conn. Soon disappointed by the company's failure to market his inventions, Thomson next secured funding from several shoe manufacturers in Lynn, Mass., and moved there in 1883. This new group of investors was led by Charles A. Coffin, an entrepreneur who provided the Thomson-Houston Electric Co. with financial and marketing strategies that led to rapid growth. With Coffin's support, Thomson was able to give his undivided attention to inventing.

Through the 1880s Thomson perfected his arc-lighting system by introducing an automatic current regulator. He also designed an incandescent lighting system to compete with Edison's and promoted the introduction of alternating current by inventing safety devices for transformers, an induction-repulsion motor, and a recording wattmeter. His invention of electric resistance welding in 1886 contributed to the increased use of electricity in industrial processes and was soon employed in many mass-production factories.

In developing and introducing these many inventions, Thomson frequently had to negotiate with Coffin and other managers, since they had different perceptions of the market for new electric equipment. Nonetheless, Thomson and Coffin were able to reconcile the laboratory with the front office, thereby permitting the Thomson-Houston Co. to be competitive in the electrical industry.

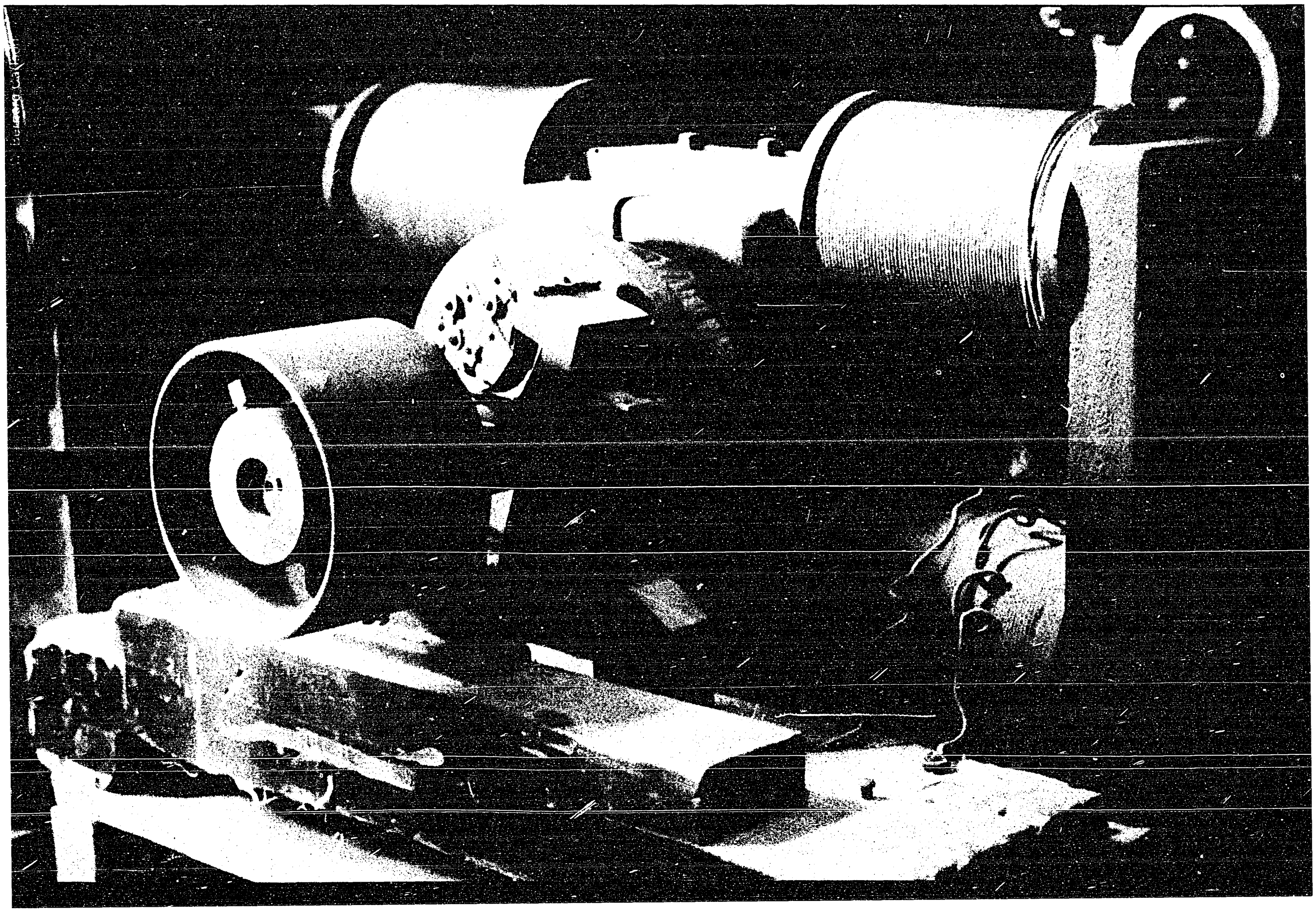
In 1892 Thomson-Houston merged with its major rival, the Edison General Electric Co., to form the General Electric Co., one of the largest corporations of its time. Coffin became its president and Thomson stayed on as the new company's chief technical advisor.

Pioneering research

Thomson's research and inventions helped to establish a tradition of basic research and product innovation at General Electric. With Thomson's guidance, the company hired other inventors and scientists, including Charles Van Depoele, Charles Steinmetz, and Willis R. Whitney. In 1900 Thomson joined with Steinmetz and other company executives to create the General Electric Research Laboratory, thus formally institutionalizing the research process. The GE laboratory, the first of its kind in the world, served as a model for industrial research in other high-technology fields.

As the industrial research laboratory and teams of engineers took over the development of electric equipment for

Thomson's first attempt to power several arc lights was by means of a dynamo that used alternating current and a rudimentary transformer. This machine, co-invented with Edwin J. Houston while the two were teachers at Central High in 1878, is now in storage at the National Museum of American History in Washington, D.C.



Science at Central High School

Established in 1836, Central High School in Philadelphia was one of the earliest public high schools in the United States. Known as the "People's College," Central High in the nineteenth century was attended by intelligent boys from the lower-middle and working classes. By providing a broad education with some business skills, the school helped these youngsters become clerks, storekeepers, or skilled craftsmen and it prepared a few for the university or for medical school

For Elihu Thomson and his classmates, Central High was very much an avenue of upward mobility, and they consequently took their education very seriously. Along with Thomson, who became a successful inventor, his class included Robert E. Pattison, twice governor of Pennsylvania; Dewey Bates, a successful painter in England; and others who became prominent businessmen and lawyers in Philadelphia. Associating with such young men at Central High undoubtedly reinforced Thomson's aspirations.

During the years Thomson attended Central High School, the curriculum was designed to help ambitious boys become men capable of handling the practical problems of life. This goal led to an emphasis on scientific and vocational courses. While the students studied elementary Latin and German, they spent much more time taking courses in physics, calculus, chemistry, astronomy, and physiology. To develop practical skills for the business world, they studied composition, bookkeeping, political economy, and drawing. There were no electives in the curriculum and every student had to pass every course. Taught by a faculty of 15 professors, the classes at Central High were probably the most rigorous and broad education then available in Philadelphia.

Bored by languages, Thomson was enthusiastic about his science courses. In physiology, natural philosophy, and mathematics, he took careful and extensive notes, often with detailed sketches and marginal glosses. His lecture notes reveal that he learned his science in an orderly way, with general principles followed by examples, facts, and experiments. His science classes were a balance of theory and practice; a chemistry examination dating from just before Thomson's time at Central had questions on the theories relating to electricity and heat, on the preparation of ethyl and acetal alcohol, and on the history of the steam engine.

The courses were also exhaustive. In anatomy, for instance, Thomson studied the entire human body, including bone structure; arrangement of muscles; digestive, nervous, and circulatory systems; and even sexual reproduction. The school possessed a well-equipped astronomical observatory, but Thomson was disappointed that the students were not permitted to use the telescopes as much as he would have liked. Given the range and thoroughness with which science was taught at Central High, Thomson in all likelihood received one of the best post-Civil War science educations offered in the United States. —*W.B.C.*

GE, Thomson devoted more of his time to science. From developing high-frequency ac apparatus, he moved easily to the study of liquid air, X-rays, and quartz optics. In 1896, he made GE a pioneer in the manufacture of X-ray tubes and power sources, and he showed considerable foresight in investigating the physiological effects of prolonged exposure to X-rays.

In the area of quartz optics, he worked with George Ellery Hale in developing large-diameter mirrors for astronomical telescopes. Under Thomson's direction, GE attempted in 1928 to cast the first blank for the 200-inch Mount Palomar telescope, but the casting proved useless since Thomson was unable to prevent bubbles from forming when the molten quartz was not uniformly cooled. Because of his steady stream of research reports and improved scientific instruments, Thomson came to be considered one of the leading American physical scientists of his day. Impressed by his scientific contributions, one journalist remarked in *Electrical World* in 1904 that "Had Professor Thomson devoted his life to pure science, he would in this department have conquered a place second to none of the present generation."

Thomson also participated in professional activities. Early in his career, as a member of the Franklin Institute—the most active technological organization of the nineteenth century—he gave lectures, served on committees, and participated in dynamo tests. In 1884 he signed the "call" for the first meeting of the American Institute of Electrical Engineers, and in 1889 he was elected its fifth president.

In 1908 Thomson succeeded Lord Kelvin as the head of the International Electrotechnical Commission, where he presided over the introduction of new standards for electrical measurement. During World War I Thomson was appointed to the national Research Council, where he assisted in the first attempt to coordinate scientific research on a national level. Also concerned with engineering education, Thomson was for many years an influential member of the governing corporation of the Massachusetts Institute of Technology in Cam-

After fusing the Thomson-Houston Co. with the Edison General Electric Co. to form the General Electric Co. in 1892, Thomson and Charles Steinmetz, shown above on a street corner in Lynn, Mass., in the mid-1890s, helped establish in 1900 the General Electric Research Laboratory, the first of its kind in the world.

bridge, and he was MIT's acting president from 1920 to 1923.

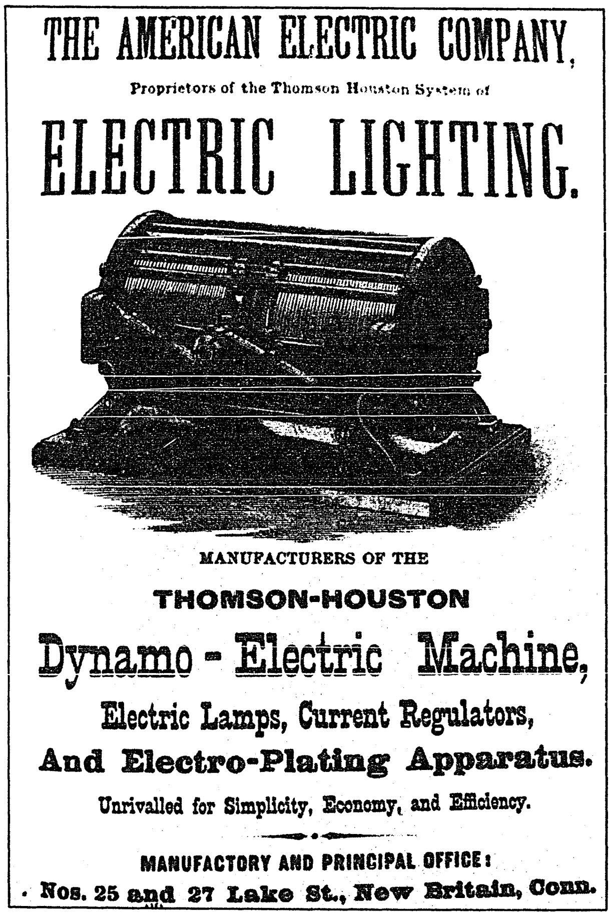
A recipient of many awards

Thomson's contemporaries recognized and rewarded his scientific and technological genius. His peers named him, even before Edison, a member of the National Academy of Sciences (he was one of a handful of inventors in the academy). Both the American Philosophical Society and the American Academy of Arts and Sciences enrolled him as one of their distinguished members.

The joint American engineering societies gave Thomson their highest honor, the John Fritz Medal. Internationally renowned as well, Thomson received the Lord Kelvin Medal from British engineering societies, was named by the French an *Officier et Chevalier de la Légion d'Honneur,* and received the Grashof Medal from the *Verein Deutscher Ingenieure,* the German engineering society. When leading scientists and inventors were discussed in the popular scientific magazines of the 1910s and 1920s, Thomson was frequently acclaimed as one of the creators of the new electrical age.

Although he did research and filed patents through the 1920s, he retired from active participation in General Electric. Settling into a spacious home in Swampscott, Mass., Thomson pursued his many hobbies, including astronomy, color photography, painting, and music. Married twice (his first wife died in 1916), he had three sons and lived to enjoy grandchildren.

He died in 1937 after several years of declining health; his loss was greatly mourned by professional engineers who remembered him as being "second to none among the small group of his contemporaries upon whose inventive genius the electrical industry was founded."



In the New Britain, Conn., city directory, Thomson advertised his spherical armature machine used in arc-lighting systems for his first company in 1880. The dynamos were built from the experience Thomson obtained doing the lighting for D.B. Fuller's Aerated Biscuit Bakery in Philadelphia.

To probe further

Elihu Thomson is the subject of only one full-length biography, by David O. Woodbury, titled *Beloved Scientist: Elihu Thomson—A Guiding Spirit of the Electrical Age,* New York, Whittlesey House, 1944. A convenient biographical source is Karl T. Compton, "Biographical Memoir of Elihu Thomson, 1853–1937," National Academy of Sciences' of Biographical Memoirs, Vol. 21, no. 4, 1939.

For general information on the electrical industry during Thomson's active years as an inventor, see *Networks of Power: Electrification of Western Society, 1880–1930,* by Thomas P. Hughes, Baltimore and London, Johns Hopkins University Press, 1983, and *The Electrical Manufacturers, 1875–1900,* by Harold Passer, Cambridge, Mass., Harvard University Press, 1953.

Thomson left for historians a rich legacy of manuscripts and artifacts. His personal and business papers, which numbered over 50 000 items, are at the Library of the American Philosophical Society in Philadelphia. Many of his early machines are in storage at the Franklin Institute Science Museum in Philadelphia and at the National Museum of American History in Washington, D.C. Thomson's bakery dynamo, however, is on display at the National Museum. Additional Thomson memorabilia may be seen at the Boston Museum of Science, the Lynn Historical Society, and the Massachusetts Institute of Technology Museum in Cambridge.

About the author

W. Bernard Carlson teaches in the Science, Technology, and Society Program at Michigan Technological University in Houghton. Before this, he taught at the University of Pennsylvania and the Virginia Polytechnic Institute. He was also an assistant editor in the Thomas A. Edison Papers Project at Rutgers University, N.J. Specializing in the history of American technology, he received a master's degree in 1981 from the University of Pennsylvania's department of history and sociology of science and expects to earn a Ph.D. in 1984. His research on Elihu Thomson has been supported by an IEEE Fellowship in Electrical History and a Predoctoral Fellowship from the Smithsonian Institution. ◆