Charles F. Scott: A Pioneer in Electrical Power Engineering

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In this issue, we again feature a paper by Jim Brittain that appeared in the IEEE book Scanning the Past*. This article was initially published in the* Proceedings of the IEEE*, vol. 86, January 1998. James Brittain is an IEEE Fellow with the citation, "for development of the field of electrical history." He was chairman of the IEEE History Committee, 1978/1979, and 1988/1989.*

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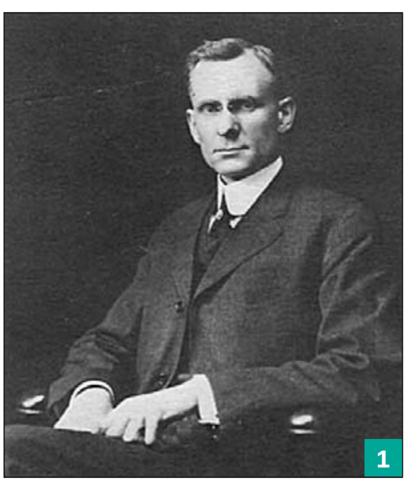
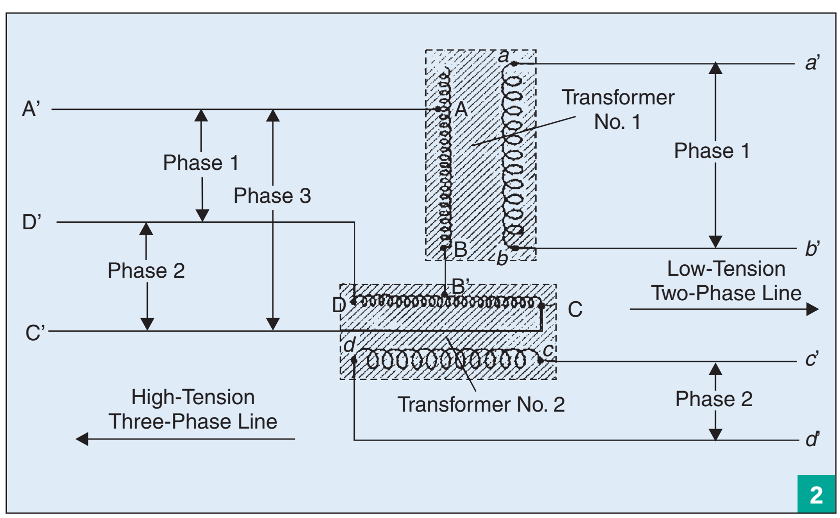
One hundred years ago (1902-1903), Charles F. Scott (Fig. 1) was President of the American Institute of Electrical Engineers (AIEE). Already well known to the power engineering community for his invention of the Scott transformer connection (Fig. 2) and his investigation of high voltage transmission, he undertook a number of significant initiatives during his tenure as AIEE president. These were intended to enhance the status of electrical engineers and to increase the outreach of the AIEE. His career pattern was somewhat unusual in that he devoted the second half of his professional career to electrical engineering education.

Scott was born in 1864 in Athens, Ohio, USA, where his father was a member of the faculty at Ohio University. Scott spent two years as an undergraduate at Ohio University before transferring to Ohio State University, from which he graduated in 1885. He then did graduate work in mathematics and physics at The Johns Hopkins University before joining the engineering staff of the Westinghouse Electric and Manufacturing Company (Fig. 3) in Pittsburgh, Pennsylvania, USA, in 1888. One of his first assignments was to assist the legendary inventor Nikola Tesla in developmental work on the ac motor.

Scott also participated in the design of a pioneering ac power installation near Telluride, Colorado, USA, which began operation in 1891. This project was designed to transmit power from a hydroelectric plant to a mining facility more than two miles away. Scott and his colleagues, including R.D. Mershon, used the Telluride transmission line for field experiments on losses due to corona discharge at high voltage. In a technical paper based on these investigations, Scott wrote that:



Charles F. Scott (from J.D. Ryder and D.G. Fink, *Engineers and Electrons.* New York: IEEE Press, 1994).

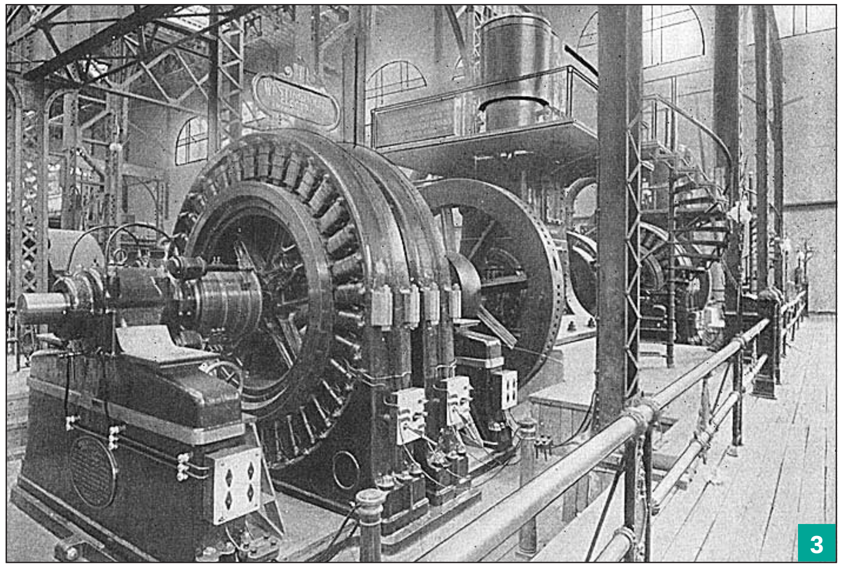


Schematic of the Scott two-phase to three-phase transformation (from V. Karapetoff, *Experimental Electrical Engineering*, vol. II. New York: Wiley, 1912).

The wires began to give a hissing or crackling sound and in the dark began to appear luminous at little below 20,000 V. As the voltage was increased, the sound became more and more intense, the wires vibrated and became more luminous until at the higher voltage they were surrounded by a coating of blue light many times the diameter of the wire.

He concluded that 40,000 or 50,000 V would be the highest transmission-line voltage that could be used without excessive losses, unless the corona problem could be overcome. Scott's analysis stimulated H.J. Ryan of Cornell University to carry out further research in the early 20th century that showed how to minimize corona losses by increasing the diameter and spacing of transmission-line conductors. This, in turn, enabled the use of much higher transmission voltages than Scott had recommended.

Scott reported on his new method of phase transformation, which became known as the "Scott Connection," in a paper presented at a meeting of the National Electric Light Association in March 1894. He stated that:



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Part of the Westinghouse exhibit at the World's Columbian Exhibition in Chicago in 1893. Two single-phase generators are shown mechanically coupled to give two-phase current (from B.G. Lamme, *An Autobiography.* New York: Putnam, 1926).

In considering the marked advantage of the two-phase system for distribution and of the three-phase system for transmission, it occurred to me that that a combination of the two systems night secure the advantages of both, and I have worked out a simple and effective method of accomplishing this result.

His technique utilized two transformers connected so that two-phase power applied to the primary windings transformed to three-phase power from the secondary windings. Among the first applications of the Scott connection was the conversion of the output of two-phase generators at a large hydroelectric plant at Niagara Falls, New York, USA, to three-phase power feeding a transmission line to Buffalo, New York, USA, in 1896.

Rapid growth in the membership of the AIEE during the 1890s and the changing environment of engineering practice produced stresses that Scott addressed during his tenure as AIEE President. He used statistical data that reflected changing patterns of employment and education to justify institutional innovations, including student branches and technical committees. He wrote to immediate past president C.P. Steinmetz that technical committees would encourage continued growth of the AIEE by helping members to keep in "touch with the latest engineering practice in new lines." Scott advocated engineering unity and called for greater cooperation among the various engineering societies. To facilitate interaction and cooperation, he proposed a single location as a home for American engineering societies and managed to persuade the philanthropist A. Carnegie to donate funds needed to construct a 13-story engineering societies building in New York City.

In 1911, Scott resigned from Westinghouse to become a professor and head of the Electrical Engineering Program of the Sheffield Scientific School at Yale University. During World War I, he and some Yale colleagues engaged in research related to antisubmarine warfare. In 1929, Scott received the prestigious Edison Medal of the AIEE as recognition of his early contribution to the field of polyphase power transmission. The same year, he was elected an Honorary Member of the AIEE. He retired from Yale in 1933 and died in 1944 at age 80. **IAS**