



history | f.a. (tony) furfari

Charles F. Scott: A Pioneer in Electrical Power Engineering

James C. Brittain, Guest Author

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.

—FAF



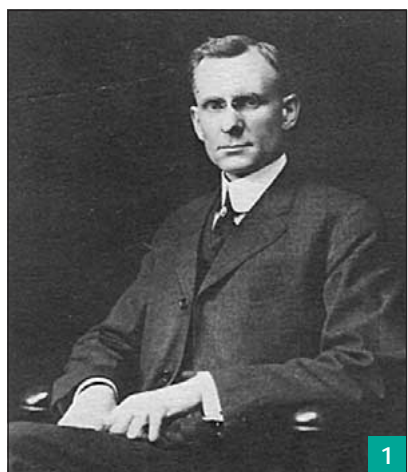
One hundred years ago (1902-1903), Charles F. Scott (Fig. 1) was President of the American Institute of Electrical Engineers (AIEE). Already well known to the power engineering community for his invention of the Scott trans-

former 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.

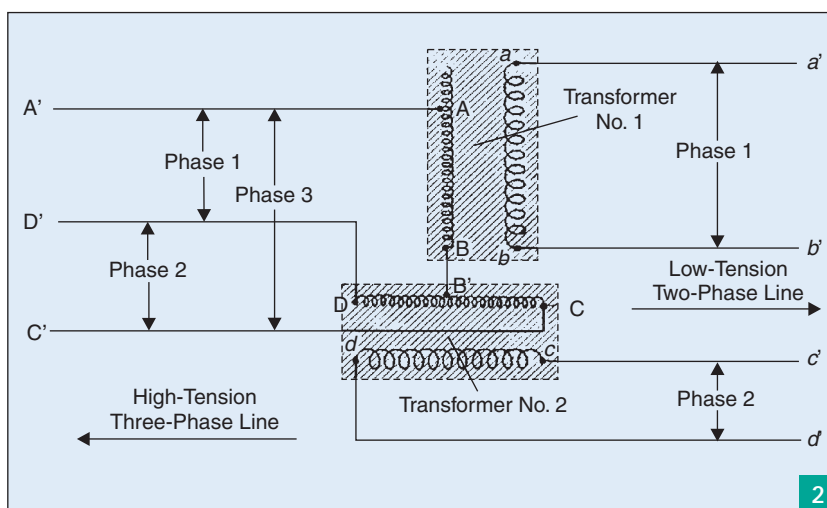
Scott was born in 1864 in Athens, Ohio, USA, where his father was a member of the faculty at Ohio University. Scott spent two years as an undergraduate at Ohio University before transferring to Ohio State University, from which he graduated in 1885. He then did graduate work in mathematics and physics at The Johns Hopkins University before joining the engi-

neering 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).

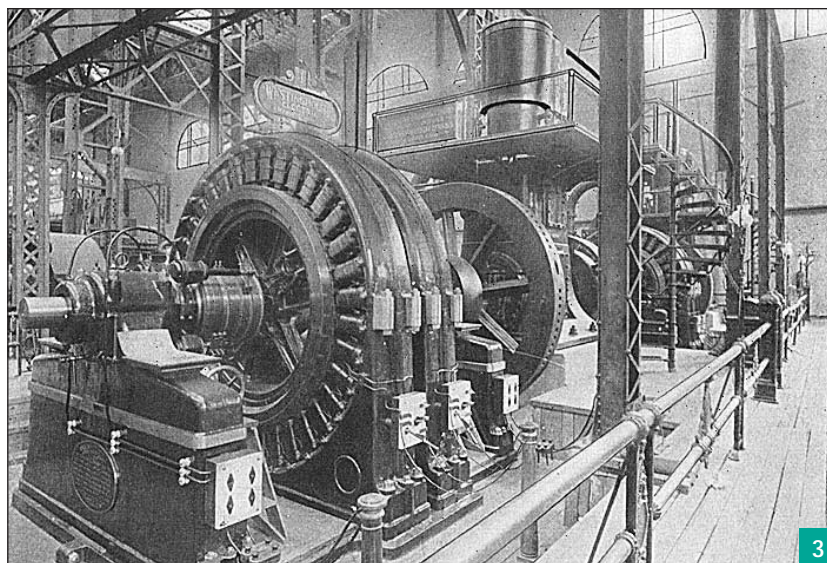


Schematic of the Scott two-phase to three-phase transformation (from V. Karapetoff, *Experimental Electrical Engineering*, vol. II. New York: Wiley, 1912).

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:



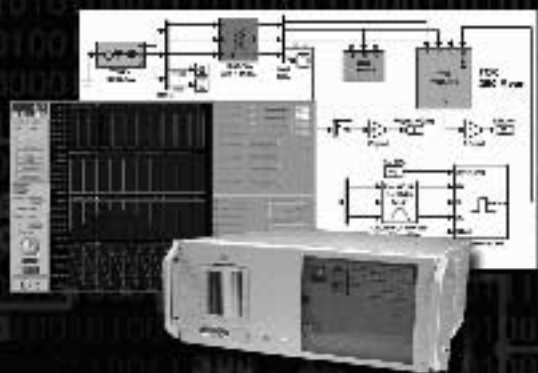
Part of the Westinghouse exhibit at the World's Columbian Exhibition in Chicago in 1893. Two single-phase generators are shown mechanically coupled to give two-phase current (from B.G. Lamme, *An Autobiography*. New York: Putnam, 1926).

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 a combination of the two systems might 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

Run Power System Blockset & Simulink™ Models in



Distributed Real-time Power
for Model-based Design

www.opal-rt.com/ees

All trademarks and trade names are property of their legal holders.

High-fidelity Simulation

RT-LAB™ provides simulation of transient phenomena up to 3 kHz. Hard real-time support achieves time steps of 40 microseconds or lower, and 1 microsecond precision for gate firing output and time stamped inputs.

Affordable & Compact

Runs on standard PC hardware. Price scales with number of nodes. Sleek compact chassis houses up to 3 processors and all I/O. Double chassis supports up to 7 processors.

Maximum Performance

Hardware technology allows for distributed parallel processing with shared memory. RT-LAB runs on QNX™, and supports Windows NT™ SMP for faster-than-real-time simulation.

Applications

RT-LAB is ideal for a variety of applications including control system prototyping and Hardware-in-the-Loop testing of wind turbines, electrical drives, hybrid electric vehicles, small power generation & distribution systems, and other self-contained energy systems.

The Choice of Industry Leaders

RT-LAB Engineering Simulators are used in mission-critical applications by leading companies including GE, Pratt & Whitney, Emerson, GEC Powertrain, NASA, Canadian Space Agency, United Technologies, MIT, and many others.



Opal-RT Technologies Inc.

1791 Richardson, Suite 2003
Montreal, Quebec, Canada H3K 1G4
Tel: (514) 377-9333 Fax: (514) 377-9333
E-mail: info@opal-rt.com

Product Info - www.ieee.org/magazines/DirectAccess



history

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*

**FLENDER
LOHER**

MOTORS & INVERTERS
Specializing In IEC (Metric) & Custom Built
Output powers from 1 to 10,000 hp

QUALITY PRODUCTS, QUALITY SERVICE

- A full line of IEC standard motors including:
 - Flameproof (EEx d) motors
 - Increased Safety (EEx e) motors
 - Non Sparking (EEx n) motors
- Large vertical motors for high thrust applications
- Wound rotor (slip ring) motors
- Water cooled motors
- Submersible motors
- Slow speed motors, with forced ventilation if necessary
- Enclosures from IP 23 to IP 68



770-977-8650

Fax: 770-234-4171

RFQ Online at
www.loher.thomasregister.com

www.loher.com

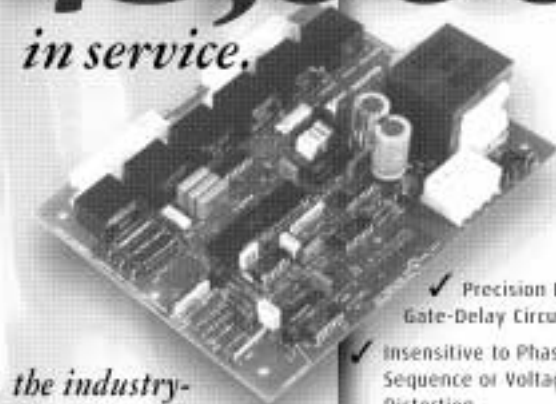
Loher Drive Systems

1240 Johnson Ferry Place, Ste F-10 • Marietta, GA 30068 • Fax: 770-234-4171

Email: sales@loher.com

Product Info - www.ieee.org/magazines/DirectAccess

45,000
in service.



*the industry-
standard Enerpro
30 SCR Firing Board*

- ✓ Precision LSI Gate-Delay Circuit
- ✓ Insensitive to Phase Sequence or Voltage Distortion
- ✓ 50/60Hz Select Plug
- ✓ Phase Loss Inhibit
- ✓ Connectorized
- ✓ Fused Power Transformer

Options:

• auxiliary board for 4-quadrant converters, parallel SCRs and sequence reversing controllers

• regulator board for battery charging and electro-chemical power supplies

variable frequency and 12-pulse firing boards also available!

ENERPRO

ENERPRO, Inc.
5780 Thornwood Drive
Goleta, CA 93117

(800) 576-2114

fax: (800) 486-0798

e-mail: info@enerpro-inc.com

www.enerpro-inc.com

Product Info - www.ieee.org/magazines/DirectAccess