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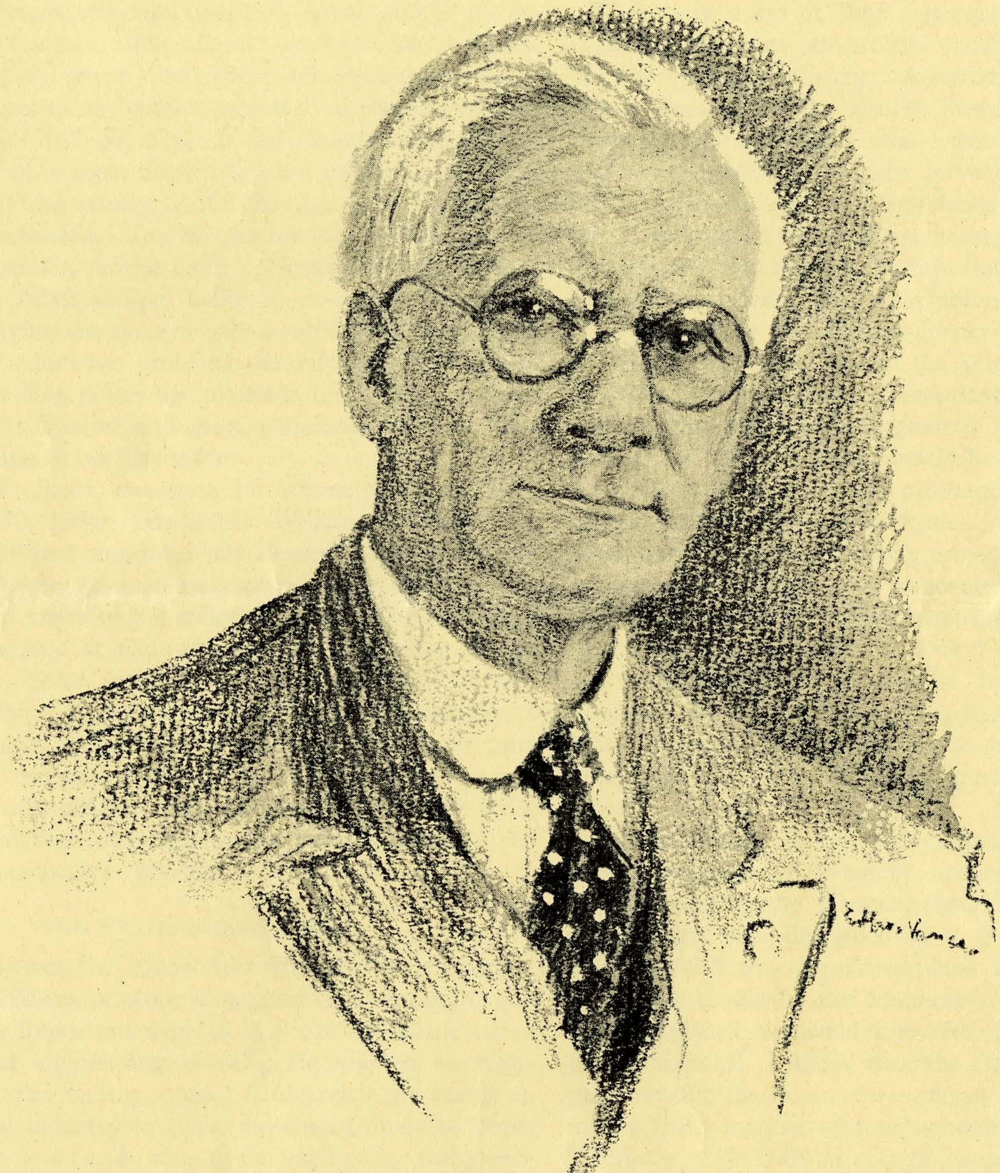
Charles Felton Scott



Engineer, Educator, Co-ordinator

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NOT OFTEN in any profession, or in any generation, does there appear a man who follows youthful pioneering achievement by half a century of truly significant work; one who, having distinguished himself as inventor and engineer, displays equal ability as organizer and teacher. The life and work of Charles Felton Scott stand to prove that the combination can exist. One of the group of "great engineers" of the 90s, he was for 22 years (1911–33) head of the electrical engineering department of a great university, and at the age of 75 is still contributing vitally to the development of engineering as a profession. In the pattern of his rich accomplishment certain motifs recur consistently: the ability to perceive relationships, belief in co-operation, and a gift for applying the same simple scientific methods to the solution of whatever problems he encounters. One of the few surviving power-age pioneers, he is today perhaps more widely honored and more genuinely beloved than any other man in his profession.

Charles F. Scott was born in Athens County, Ohio, September 19, 1864. His father, William H. Scott, was professor of Greek and later president of Ohio University at Athens, where the son took preparatory training and the first two years of his college course. Entering Ohio State University at Columbus at the beginning of his junior year, Scott graduated with a bachelor of arts degree in 1885. He had a year and a half of postgraduate work at Johns Hopkins University, at the same time teaching in the apprentice school of the Baltimore and Ohio Railroad, and was then employed for a time by a company that was installing an a-c lighting plant in the Baldwin Locomotive Works.

THE WESTINGHOUSE PERIOD

In 1888 began the connection with the Westinghouse Electric and Manufacturing Company that represents one of the three important aspects of Scott's versatile life—his technical engineering career. He started as night assistant in the testing room. University graduates in the electrical industry in those days were likely to begin by sweeping floors and oiling dynamos, but for the young engineer who could endure the unpromising apprenticeship there were opportunities in the rapidly developing industry that make the more dignified course of today's graduates seem dull in contrast. Within a short time Scott was working under Nicola Tesla on the development of the polyphase induction motor, which was patented in 1888. When Tesla left the company, Scott continued the work, doing much to make practical the motor for which its inventor had supplied the fundamental theory, and carrying on other important activity connected with the development of alternating current. He became assistant electrician in 1891, chief electrician in 1897, and in 1904 consulting engineer.

The early years of Scott's connection with the Westinghouse company covered a most dramatic period in the history of the industry. Alternating current, for which Westinghouse had the United States patent rights, was being developed; high-voltage power transmission was beginning; and the Niagara power project, a milestone in the progress of both, was being planned and built. Scott was one of the brilliant young engineers who were making electrical history at a rate that seems scarcely credible to the modern world that is built on their achievements.

In the history of "Niagara Power", Edward D. Adams wrote: "The reputations of the Westinghouse engineers, Stillwell, Shallenberger, Lamme, Scott, and others . . . impressed the Niagara management with the seriousness and skill of the efforts that would be made to produce the electrical machines desired, although absolutely novel in design and unique in magnitude."[1] As consulting electrical engineer on the Niagara project, Scott "acted in an advisory capacity in many important ways".[1] His great contribution was the "Scott connection," or "T connection", by which two-phase current from the generators was transformed to three-phase for transmission. He proposed its use at Niagara shortly after the Westinghouse company had secured the contract that marked an important milestone in the development of modern electric power.

The invention of the "T connection", Scott's best-known technical achievement, occurred two years before it was used in the Niagara installation. The circumstances have been described by L. B. Stillwell:

"In 1892 I was preparing plans and estimates as the basis for a tender by the company covering the transmission of several thousand kilowatts from Folsom, Calif., to Sacramento. I knew that the General Electric Company would figure on three-phase transmission, which meant three instead of four conductors and involved a difference of $12,000 in cost of copper for the transmission circuit. I called in Scott and showed him the situation. We discussed it briefly and he expressed the opinion that the problem could be solved. Then he withdrew to another office, and within a remarkably short time returned with his two-phase three-phase connection of transformers—a perfect solution. In the light of present-day knowledge this may not seem remarkable, but in 1892 few were competent to deal promptly with problems of this type, and the incident illustrates admirably Scott's ability in applying theory to practical problems."[5]

The portrait on the facing page is by Esther Vance, New Haven, Conn.

1. For all numbered references, see list at end of article.

The same sort of ability and the same direct approach and simple methods have characterized Scott throughout his life, whether he was solving technical problems, teaching students, or getting men and organizations to co-operate for objects of which the value was generally admitted but the achievement considered impossible. In every field of his activity, he has been able to see the essentials of a problem, recognize the simplest method of solving it, and co-ordinate the means available toward the solution.

Scott's first patent, a joint one for a lightning arrester, was taken out in 1892. It was followed by more than 50 others of which the majority related to power transmission and distribution, although the scope of his interests is attested by scattered patents on other aspects of the industry. Power transmission, however, was his particular concern for many years. He contributed in 1892 the first AIEE paper on high-voltage transmission, a description of the system he had designed and installed at Telluride, Colo., a pioneer installation unique for its time. It used 3,000 volts single phase and transmitted 100 horsepower for three miles. Scott was associated with other early transmission projects, and was chairman of the power transmission section of the International Electrical Congress, held in St. Louis, Mo., in 1904.

In his work with transformers, he was the first to apply water cooling. With R. D. Mershon, he was the first to measure the power loss caused by corona. He did important work in connection with early railway electrification, including studies of means for reducing inductive disturbance on communication circuits and the development of an effective "balanced plan" for supplying power to railroads.

Scott's technical achievements during his "Westinghouse period" would in themselves be enough to insure his fame. In addition, however, he was contributing effectively to the development of the professional aspects of engineering, especially through his leadership in the Institute. At the same time, his interest in engineering education was beginning to take shape. His career as an educator really began with the training of young men in the Westinghouse company, and the student training courses that are an important part of the company's program today are the logical outgrowth of his early work. In 1902 he founded the Westinghouse Electric Club, for the purpose of providing lectures, conferences, and advanced study for the young engineers in the company, and two years later established the *Electric Journal*, primarily to preserve for successive groups the lectures given at the Club's meetings. He was chairman of the publication committee until he left the company. The magazine's first editor, paying tribute 30 years later to his "guidance, experience, and inspiration",[7] also points out that although, "by training and position an engineer, in disposition Doctor Scott has always been an educator."

PROFESSOR OF ELECTRICAL ENGINEERING

The opportunity to devote himself primarily to education came in 1911, at the Sheffield Scientific School of Yale University. There, the electrical-engineering course, until then under the department of physics, was growing in importance. "The belief that the time had come to place it on a more distinctly engineering basis (without interfering with training in the fundamental sciences) led to the creation of the chair of electrical engineering to which Scott was called. He was chosen as a recognized authority, known especially through his study of alternating current in the transmission and utilization of power, and also because of his extensive connection with the training of apprentices at the Westinghouse company."[2]

When he went to Yale there was no laboratory for electrical engineering, but "Scott's presence, and the desire of the university to utilize fully all he could offer to graduates and undergraduates made it necessary to secure as speedily as possible needed facilities for expansion of experimental work in the electrical field."[2] The result was the Dunham Laboratory of Electrical Engineering, gift of A. C. Dunham, president of the Hartford Electric Light Company, which was ready for use in 1913. When the building that now houses the electrical-engineering department was designed, Scott counseled flexibility to meet possible future conditions. The developments of subsequent years have justified his foresight in a number of instances.

From 1911 until 1933, when he retired from active teaching and was made professor emeritus, Doctor Scott headed the department of electrical engineering at Yale. Of his work there one of his colleagues writes, "Professor Scott's outstanding contribution to education at Yale was in his simple approach to relatively complicated problems. He taught the student how to arrive at correct conclusions by the application of the simplest mathematics. Also deserving special mention was his correlation of mechanics, thermodynamics, and electrical engineering through illustrative problems, such as acceleration of street cars, use of flywheels in steel mills, and conduction of heat through various materials. He would direct the students' attention to the universal laws governing these different fields—usually to their considerable surprise. He deserves much credit for the simplicity and effectiveness of his method of approach."[8]

BUILDING A PROFESSION

In addition to his direct contributions to engineering education as teacher and administrator of the electrical-engineering course of a great university, Doctor Scott has made the training of engineering students a major object in the third of his spheres of activity—his service to the engineering profession. Here also, as in education and in engineering practice, his accomplishments constitute a career in themselves.

His ability, already emphasized, to reduce a problem to its essentials and suggest a simple and logical solution has been combined in his work for engineering as a profession with an active recognition of the interrelation of the work, education, and professional organization of engineers. His terms as president of the AIEE (1902–03) and of the Society for the Promotion of Engineering Education, nearly 20 years later, both marked conspicuous advances in the history of the societies, and his influence

can be detected in nearly every major move toward effective co-operation that the engineering societies have made in the past 40 years.

He became president of the AIEE in 1902, as a young man of 38, with the uncomfortable responsibility of following in office Charles P. Steinmetz. In his own words, "I acquiesced with some misgivings, as the alternatives seemed to be to continue if possible on the same level or to slump; but I had not counted on the aid and support others might give."[4] He gives his associates well-merited credit for their share in originating the program that made his presidency outstanding, but it was Scott as president who put into effect the plans outlined in his inaugural speech.

His program included: larger membership, more papers and discussions, local Sections, Student Branches, collection of data, support of the library, permanent quarters for the Institute, and co-operation with foreign engineering societies.[6]

During his presidency, membership increased more than 50 per cent. With the first systematic plan for local activities to be put into effect by any national engineering society, local Sections, of which a few were already in existence, began to sprout rapidly, accounting for much of the increase in membership.

The idea of inaugurating Student Branches in the colleges, to give students "an insight into the problems and practices of the profession, without waiting for a sudden plunge from theory to practice on graduation", arose, according to Doctor Scott's account, from a discussion of the rate at which the electrical industry was developing. It was then doubling every five years, and Scott was struck with the need for trained men that would arise if the curve continued to mount. "I had taken it for granted that the Institute was to promote the arts and sciences relating to the utilization of electricity through adding to knowledge. . . . Should not the Institute develop men was well as ideas?"[4] The idea appealed at once to the colleges and Student Branches began.

One way of realizing the objectives of more papers and discussions and collection of data was found in Scott's appointment, at the suggestion of R. D. Mershon, of the high-voltage transmission committee, the Institute's first technical committee.

PROPHET OF CO-OPERATION

The objectives of supporting a library and finding permanent quarters for the AIEE were soon to be merged in a broader program, when Scott began to consider co-operation on a large scale among the four national engineering societies. Toward the end of 1902 he made a speech on "The Engineer of the 20th Century",[4] in which he made certain predictions. These seem startlingly prophetic today—until a look at the record shows how great a part Scott himself has played in bringing about their fulfillment.

Inspired by the establishment of the John Fritz Medal as the first joint project of the engineering societies, he predicted a building for all the engineering societies, an "engineering congress . . . representing all the engineering professions and supported by the great union of national engineering societies", and a great national network of engineering organizations, connected in national and local groups.

The Institute's library dinner, early in 1903, gave him an opportunity to suggest the idea of a joint engineering-societies building to Andrew Carnegie, who had rejected an earlier request for funds for an AIEE building. Carnegie was interested, and when Scott and others presented definite plans, gave the funds for the building. As chairman of the building committee Scott had the difficult task of achieving in practice the co-operation in which he believed so heartily. His accomplishment is attested by the Engineering Societies Building, dedicated in 1907, and managed by United Engineering Trustees, Inc., in which the national societies of civil, mining and metallurgical, mechanical, and electrical engineers are jointly represented.

The organization necessary to operate the Engineering Societies Building was given a charter that enables it not only to administer the building but to handle funds for the advancement of engineering. When in 1914 Ambrose Swasey was considering the establishment of a fund for engineering research, Scott called his attention to the latter provision. Thus Engineering Foundation, co-operative research agency, was set up as a function of United Engineering Trustees, Inc.

The "engineering congress" predicted in 1902 has been approximated by the formation of American Engineering Council, a joint agency which provides engineering and allied interests with a voice in public affairs. It came about as a result of the need for engineering counsel when the United States entered the World War in 1917. The organization set up at that time was reorganized after the war, with Scott as an AIEE member of the committee selected to plan its future. He served on the Council's administrative board from 1921 to 1933.

The fulfillment of the third part of the 1902 prophecy may be seen in the variety of projects in which national engineering, scientific, and other societies work together today, and in the many state and local engineering organizations in which local Sections representing all branches of the profession are united. Considering his widespread influence, through the AIEE and other organizations, it is probable that Scott's reiterated urging of co-operation has had no small part in bringing about the climate of opinion in which it has thus flourished.

An obvious medium for Doctor Scott's interests and talents was the Society for the Promotion of Engineering Education, which sought him as president in 1921. He demurred at first, feeling himself too busy to undertake the work, but having accepted the position, galvanized into effective action a body which he described at the time as "ponderous and topheavy".[9] Again he urged local activity, repeating the pattern he had instigated in the AIEE and which had been followed in the formation of local Sections by all the engineering societies; and again he secured results. Recognizing that the function of the SPEE must be "to develop leaders who can train engineers", he drove home the idea at meetings of the society and in its publication, endeavoring to draw from the members ideas as to how it could best perform that function. At his instigation a development committee was appointed, on which he served, and which recommended the appointment of a board of investigation and co-ordination, to make a comprehensive study of engineering education in the United States and other countries.

Turning his attention to financing the proposed survey, Doctor Scott secured funds from the Carnegie Foundation and other sources, including the Engineering Foundation and engineering societies. Doctor William E. Wickenden, now president of the Case School of Applied Science, was director of the survey, and Doctor Scott chairman of its supervising board. Five years of fact-finding, seven seasons of summer-school sessions for engineering teachers, and two European trips by the director culminated in a comprehensive report, the first volume of which was published in 1930 and the second in 1933.[3] The findings of the survey provided a basis on which engineering education could be evaluated and its future intelligently planned. Doctor Scott's contributions are suggested indirectly in his report as chairman, published with the findings of the investigation, in which he says, "What engineering education must have is a guiding philosophy based on a clearer visualization of the place of engineering in modern life."[3]

One of the conclusions reached in connection with the survey was that the development of engineering education in the directions suggested by the survey findings could best be achieved by the co-operation of the schools under the guidance of a central body. The findings of another survey, a study of the economic status of the engineer made by The American Society of Mechanical Engineers during the early 1930s, pointed in the same direction. The result was the formation in 1932 of the Engineers' Council for Professional Development, on which the national societies of civil, chemical, electrical, mechanical, and mining and metallurgical engineers, the SPEE, and the National Council of State Boards of Engineering Examiners are represented, and of which United Engineering Trustees, Inc., is treasurer. Doctor Scott has been active in ECPD since its organization, served as its chairman 1935–38, and is now chairman of its committee on professional recognition, and a member of its executive committee. The organization is the embodiment of his belief that "the development of the young engineer is the joint responsibility of the schools, the professional societies, and the registration boards."[10]

Doctor Scott might seem to have taken his own full share of that "joint responsibility," through his work at Yale and in the societies; since 1935 however, he has been active also in engineering registration, as chairman of the Connecticut State Board of Examiners and a member of the National Council of State Boards of Engineering Examiners. He represents the latter body on ECPD, was vice-president 1937–38, and since 1938 has been its president.

Along with his many other duties and activities, Doctor Scott has had a record of continuous service in the AIEE that has been equaled by few other members, and by none now living. He joined the Institute in 1892, transferred to Member grade in 1893, and to Fellow in 1925. He has been a manager (1895–98), vice-president (1899–1901), president (1902–03); member at various times of many of the Institute's committees and Institute representative on many other organizations. At present he is a member of the committee on Student Branches and Institute representative on the Thomas Alva Edison Foundation. He was one of the founders and the first chairman (1921–22) of the Connecticut Section, and was also founder of the Yale Student Branch. In 1929 he was made an Honorary Member, and was awarded the Edison Medal, the highest Institute honor, for that year, with the citation "for his contributions to the science and art of polyphase transmission of electric energy." In 1930 he was awarded the Lamme Medal of the Society for the Promotion of Engineering Education, which is conferred "for accomplishment in technical teaching or actual advancement of the art of technical training."

The degree of master of arts was conferred on him by Yale University in 1911, and he has received four honorary doctor's degrees: doctor of science from the University of Pittsburgh in 1912 and from Ohio State University in 1937; doctor of engineering from Stevens Institute of Technology in 1912 and from the Polytechnic Institute of Brooklyn in 1935. In addition to the various society affiliations already discussed, he is a member of The American Society of Mechanical Engineers, the Engineers' Society of Western Pennsylvania, of which he was president in 1902, the Illuminating Engineering Society, American Philosophical Society, Sigma Xi, Tau Beta Pi, and an honorary member of the Connecticut Society of Civil Engineers.

"DIAMOND JUBILEE"

In recognition of Doctor Scott's lifetime of achievement, a number of special celebrations were arranged in honor of his 75th birthday, which was September 19, 1939. A testimonial dinner, sponsored by the AIEE Connecticut Section, and held in New Haven, Conn., on his birthday, was a gratifying example of the co-operation he has urged, as representatives of the American Chemical Society, American Institute of Architects, American Society of Civil Engineers, American Society of Metals, American Society of Mechanical Engineers, Connecticut Society of Civil Engineers, Kiwanis Club of New Haven, AIEE Yale Branch, and Yale University joined with the AIEE to do him honor.

During 1939 and 1940, many AIEE Student Branches have held "Scott diamond jubilee" programs in recognition of Doctor Scott's attainments and his special position as founder of Student Branches. Doctor Scott attended the first of these meetings, which was held by the Yale Branch March 17, 1939, and has attended a number of others since. At about 75 of these Branch meetings, motion pictures depicting Doctor Scott's career have been presented. In response to a request for a letter of greeting for occasions when he could not be present, Doctor Scott supplied the characteristic summary of his own career, which follows.

"My impression on seeing the film," he wrote, "was that it was a fairly true picture of the kind I have tried to make. It seemed to me that the career I was presenting was one in which many instances had a common background. I realized a situation. I saw in it a problem, a need, and after a little simple straightforward thinking, I realized that maybe something could be done about it. And I set about in a simple way to do a few little simple things, starting along a new path. The principal element in success lay in the fact that I kept at it. At least, I kept at those things which did materialize. There are many others, bygone possibilities which I have not mentioned, and many of which I have forgotten; but in the long run it is not what a man has not done, but what he has done, that really counts. Half the things that he seems to have done are due to the efforts of others who have aided in bringing about results."

REFERENCES

1. NIAGARA POWER, **Edward Dean Adams.** The Niagara Falls Power Company, Niagara Falls, N. Y., 1927.

2. HISTORY OF THE SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY, **Russell H. Chittenden.** Yale University Press, New Haven, Conn., 1928.

3. REPORT OF THE INVESTIGATION OF ENGINEERING EDUCATION, 1923–29. Society for the Promotion of Engineering Education, office of the secretary, Pittsburgh, Pa., volume 1, 1930; volume 2, 1934.

4. THE INSTITUTE'S FIRST HALF-CENTURY, **Charles F. Scott.** ELECTRICAL ENGINEERING, volume 53, May 1934.

5. "Edison Medal Presented to Charles F. Scott", JOURNAL OF THE AIEE, volume 49, March 1934, pages 233–4.

6. PROPOSED DEVELOPMENTS OF THE INSTITUTE, **Charles F. Scott.** AIEE TRANSACTIONS, volume 20, July–December 1902.

7. *The Electric Journal*, volume 31, February 1934, page 47.

8. Unpublished letter, H. M. Turner, Yale University, October 18, 1939

9. *Engineering Education*, volume 12, 1921–22, page 46.

Other sources consulted include articles and addresses by Doctor Scott and others in ELECTRICAL ENGINEERING (especially the 50th Anniversary Issue, May 1934); AIEE TRANSACTIONS, volumes 20–22 (1902–03); *Electric Journal*, volumes 1 (1904) and 31 (1934); *Engineering Education*, volumes 12 and 13 (1921–23); and unpublished addresses and letters.

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