THE JOHN FRITZ MEDAL

THE
JOHN FRITZ
MEDAL

THE JOHN FRITZ MEDAL

ESTABLISHED BY THE PROFESSIONAL ASSOCIATES AND FRIENDS OF JOHN FRITZ OF BETHLEHEM, PA. V.S.A. AVGVST 21ST 1902, HIS EIGHTIETH BIRTHDAY, TO PERPETVATE THE MEMORY OF HIS ACHIEVEMENTS IN INDVSTRIAL PROGRESS

THIS CERTIFIES THAT THE MEDAL FOR THE YEAR
1905
HAS BEEN AWARDED TO
Lord Kelvin
FOR
"Cable Telegraphy
and other General Scientific Achievements"

THE JOHN FRITZ MEDAL BOARD OF AWARD

James Douglas CHAIRMAN
Chas Warren Hunt SECRETARY

MEMBERS OF THE BOARD BY WHICH THIS AWARD WAS MADE

AMERICAN SOCIETY OF CIVIL ENGINEERS
Robert Moore
Alfred Noble
Chas. Warren Hunt
Charles Hermany

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
John E. Sweet
Robert W. Hunt
Samuel T. Wellman
James M. Dodge

AMERICAN INSTITVTE OF MINING ENGINEERS
E. G. Spilsbury
James Douglas
Chas. Kirchhoff
E. E. Olcott

AMERICAN INSTITVTE OF ELECTRICAL ENGINEERS
Carl Hering
Chas. P. Steinmetz
Chas. F. Scott
B. J. Arnold

FACSIMILE OF THE FIRST DIPLOMA ISSUED

THE JOHN FRITZ
MEDAL

DESIGNED, ENGRAVED AND PRINTED BY BARTLETT ORR PRESS, NEW YORK

TABLE OF CONTENTS

THE JOHN FRITZ MEDAL

THE John Fritz Medal is a gold medal presented for achievement in applied science, as a memorial to the great engineer whose name it bears. In 1892, just after Mr. Fritz's seventieth birthday, a number of his friends, representing membership in all the engineering societies, united to tender him a dinner in celebration of his birthday. The dinner was held in the Opera House of Bethlehem, Pennsylvania, Mr. Fritz's home city, and the affection and devotion of all who were assembled centered in a mock trial after the banquet. The victim was accused of having made the city of Bethlehem a place where grass no longer grew between the stones in the streets and a place where the meadow by the river had no longer an opportunity to feed the common or bucolic pig because of the enormous production of pigs of another sort which was a feature of that area. He had, it was alleged, made hollow forgings so that the content of phosphorus might escape through the hollow of the mandril through which they were forged, and there were other high misdemeanors of success with which he was charged.

In 1902, when his eightieth birthday was approaching, the idea of a similar celebration and social event was canvassed, but in view of the merely temporary and effervescent character of such a celebration, there was born a larger concept of a fund, to be subscribed by the same persons who would attend such a dinner, the income to be used in creating each year a John Fritz Medal for scientific and industrial achievement in any field of pure or applied science. The idea was received with acclaim and the fund necessary was raised in a very short time. The names of subscribers to the fund are on record in an album which the executors of Mr. Fritz have turned over to the American Society of Mechanical Engineers for safekeeping. A committee was appointed consisting of representatives from the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers. This committee secured an appropriate design of a medal by Mr. Victor D. Brenner and the first impression from the artist's design was cast and given to Mr. Fritz himself at an important dinner held in the Waldorf Hotel, New York, which strained the capacity of the great ballroom to its limit. After the die of the medal had been completed, the committee which had been appointed by the several societies was continued as the John Fritz Medal Fund Corporation. Four members from each of the engineering societies named are appointed by the governing board of such society to serve for four years.

TRUST FUNDS

THE trust funds supporting the medal are held and administered by a board of sixteen directors, consisting of four from each of the four national engineering societies, which are in the order of their foundation: American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, and American Institute of Electrical Engineers. The term of service of each director is four years; the term of one director from each society expires annually and a new appointment or a re-appointment becomes necessary. The table on pages 16, 17 and 18 gives the names and years of those who have served from the establishment of the medal, in 1903, to the present. The Board of Directors is incorporated. The same persons, however, under a separate organization and with separate minutes serve as a Board of Award. Both boards meet on the evening of the third Friday in January.

RULES OF AWARD

1. The John Fritz Medal was established by the professional associates and friends of John Fritz, of Bethlehem, Pennsylvania, U. S. A., on August 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress.

2. The medal shall be awarded for notable scientific or industrial achievement. There shall be no restriction on account of nationality or sex.

3. The medal shall be of gold and shall be accompanied by an engraved certificate, which shall recite the origin of the medal, and the specific achievement for which the award is made. Such certificate shall be signed by the Chairman and Secretary of the Board of Award.

4. The medal may be awarded annually, but not oftener.

5. No award of the medal shall be made to any one whose eligibility to the distinction has not been under consideration by the Board of Award for at least one year.

6. Awards shall be made by a board of sixteen, appointed or chosen in equal numbers from the membership of the four national societies: American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, and American Institute of Electrical Engineers. The governing bodies of each of those societies shall be requested to appoint from its membership one representative who shall hold office for one year, one for two years, one for three years, and one for four years; and each succeeding year to appoint one member to serve for four years.

7. In case of failure of any of the national societies to make the original appointments as requested, the selection of representatives from its membership shall be made by those appointed from the other societies, and should any future vacancy occur by reason of the failure of any of the said societies to act, or otherwise, such vacancy shall be filled by the Board of Award, from the membership of the Society so failing.

8. Should one or more of the four national societies go out of existence, its representation on the Board shall cease and terminate, and future awards shall be made by the representatives of the remaining societies.

9. The vote of the Board of Award shall be by letter-ballot, which shall be canvassed not less than thirty days subsequent to its issue, and the affirmative vote of at least three-fourths of the Board of Award shall be necessary for an award.

DIRECTORS

AMERICAN SOCIETY OF CIVIL ENGINEERS

Onward Bates, 1910–1913. President, 1911
G. H. Benzenberg, 1908–1911
J. James R. Croes, 1903
Fayette S. Curtis, 1920 to date
Arthur P. Davis, 1921 to date
M. T. Endicott, 1912–1915
Charles Hermany, 1904–1907
Clemens Herschel, 1917–1920. President, 1919
Charles Warren Hunt, 1903–1918. Secretary, 1903–1912. President, 1915
Charles Macdonald, 1909–1912
Charles D. Marx, 1916–1919
Robert Moore, 1903–1904
Alfred Noble, 1903–1905. President, 1903. Medallist, 1910
John A. Ockerson, 1913–1916
George H. Pegram, 1918–1921. Treasurer, 1920–1921
C. C. Schneider, 1905–1908. President, 1907
Frederic P. Stearns, 1906–1909
George F. Swain, 1914–1918
Arthur N. Talbot, 1919 to date
George S. Webster, 1922

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

Christopher R. Corning, 1916 to date
James Douglas, 1903–1911. President, 1904. Medallist, 1915
Herbert Hoover, 1920 to date
James F. Kemp, 1912–1915. President, 1912. Secretary, 1914–1915
Charles Kirchhoff, 1903–1914. Treasurer, 1903–1909. Secretary, 1913
Robert V. Norris, 1912–1913
Eben E. Olcott, 1903–1911
Charles F. Rand, 1915 to date. Secretary, 1916 to date
Albert Sauveur, 1913–1916. President, 1916
E. Gybbon Spilsbury, 1903–1912, 1914–1919. President, 1908
Benjamin B. Thayer, 1917 to date. President, 1920. Treasurer, 1922

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

John A. Brashear, 1911–1919
James M. Dodge, 1904–1907
John R. Freeman, 1913–1920. President, 1913
W. F. M. Goss, 1912, 1919. Treasurer, 1919
C. Wallace Hunt, 1909–1911
Robert W. Hunt, 1903–1905. Medallist, 1912
Frederick R. Hutton, 1908–1918. Treasurer, 1910–1918
Gaetano Lanza, 1903
W. M. McFarland, 1921 to dat
Fred J. Miller, 1920 to date
Henry B. Sargent, 1920 to date
Ambrose Swasey, 1907–1910, 1914 to date. President, 1917, 1921
John E. Sweet, 1903–1908. President, 1905. Medallist, 1914
Henry R. Towne, 1906–1913. President, 1909
S. T. Wellman, 1903–1906

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Comfort A. Adams, 1919 to date. President, 1922
Bion J. Arnold, 1904–1907
A. W. Berresford, 1921 to date
H. W. Buck, 1917–1920
John J. Carty, 1916–1919. President, 1918
Gano Dunn, 1912–1915. President, 1914
Lewis A. Ferguson, 1909–1912
Carl Hering, 1903–1904
Dugald C. Jackson, 1911–1914
Arthur E. Kennelly, 1903
John W. Lieb, Jr., 1905–1908
Paul M. Lincoln, 1915–1919
C. O. Mailloux, 1914–1917
William McClellan, 1922
Ralph D. Mershon, 1913–1916
E. Wilbur Rice, Jr., 1918–1922
Charles F. Scott, 1903–1906. President, 1906
Samuel Sheldon, 1907–1910. President, 1910
Charles P. Steinmetz, 1903–1905
L. B. Stillwell, 1910–1913
Henry G. Stott, 1908–1911
Calvert Townley, 1920 to date
Schuyler S. Wheeler, 1906–1909

Directors and Board of Award	Years to Serve	1903	1904	1905	1906	1907
President		Alfred Noble	James Douglas	John E. Sweet	Charles F. Scott	Charles C. Schneider
Secretary		Charles Warren Hunt	Charles Warren Hunt	Charles Warren Hunt	Charles Warren Hunt	Charles Warren Hunt
Treasurer		Charles Kirchhoff	Charles Kirchhoff	Charles Kirchhoff	Charles Kirchhoff	Charles Kirchhoff
American Society of Civil Engineers	1	J. James R. Croes	Robert Moore	Alfred Noble	Charles Warren Hunt	Charles Hermany
	2	Robert Moore	Alfred Noble	Charles Warren Hunt	Charles Hermany	Charles C. Schneider
	3	Alfred Noble	Charles Warren Hunt	Charles Hermany	Charles C. Schneider	Frederic P. Stearns
	4	Charles Warren Hunt	Charles Hermany	Charles C. Schneider	Frederic P. Stearns	Charles Warren Hunt
American Institute of Mining Engineers	1	E. E. Olcott	E. Gybbon Spilsbury	James Douglas	Charles Kirchhoff	E. E. Olcott
	2	E. Gybbon Spilsbury	James Douglas	Charles Kirchhoff	E. E. Olcott	E. Gybbon Spilsbury
	3	James Douglas	Charles Kirchhoff	E. E. Olcott	E. Gybbon Spilsbury	James Douglas
	4	Charles Kirchhoff	E. E. Olcott	E. Gybbon Spilsbury	James Douglas	Charles Kirchhoff
American Society of Mechanical Engineers	1	Gaetano Lanza	John E. Sweet	Robert W. Hunt	S. T. Wellman	James M. Dodge
	2	John E. Sweet	Robert W. Hunt	S. T. Wellman	James M. Dodge	John E. Sweet
	3	Robert W. Hunt	S. T. Wellman	James M. Dodge	John E. Sweet	Henry R. Towne
	4	S. T. Wellman	James M. Dodge	John E. Sweet	Henry R. Towne	Ambrose Swasey
American Institute of Electrical Engineers	1	Arthur E. Kennelly	Carl Hering	Charles P. Steinmetz	Charles F. Scott	Bion J. Arnold
	2	Carl Hering	Charles P. Steinmetz	Charles F. Scott	Bion J. Arnold	John W. Lieb, Jr.
	3	Charles P. Steinmetz	Charles F. Scott	Bion J. Arnold	John W. Lieb, Jr.	S. S. Wheeler
	4	Charles F. Scott	Bion J. Arnold	John W. Leib, Jr.	S. S. Wheeler	Samuel Sheldon

Directors and Board of Award	Years to Serve	1908	1909	1910	1911	1912
President		E. Gybbon Spilsbury	Henry R. Towne	Samuel Shelden	Onward Bates	J. F. Kemp
Secretary		Charles Warren Hunt	Charles Warren Hunt	Charles Warren Hunt	Charles Warren Hunt	Charles Warren Hunt
Treasurer		Charles Kirchhoff	Charles Kirchhoff	F. R. Hutton	F. R. Hutton	F. R. Hutton
American	1	Charles C. Schneider	Frederic P. Stearns	Charles Warren Hunt	G. H. Benzenberg	Charles Macdonald
Society	2	Frederic P. Stearns	Charles Warren Hunt	G. H. Benzenberg	Charles Macdonald	Onward Bates
of Civil	3	Charles Warren Hunt	G. H. Benzenberg	Charles Macdonald	Onward Bates	Charles Warren Hunt
Engineers	4	G. H. Benzenberg	Charles Macdonald	Onward Bates	Charles Warren Hunt	M. T. Endicott
American	1	E. Gybbon Spilsbury	James Douglas	Charles Kirchhoff	E. E. Olcott	E. Gybbon Spilsbury
Institute	2	James Douglas	Charles Kirchhoff	E. E. Olcott	E. Gybbon Spilsbury	R. V. Norris
of Mining	3	Charles Kirchhoff	E. E. Olcott	E. Gybbon Spilsbury	James Douglas	Charles Kirchhoff
Engineers	4	E. E. Olcott	E. Gybbon Spilsbury	James Douglas	Charles Kirchhoff	J. F. Kemp
American	1	John E. Sweet	Henry R. Towne	Ambrose Swasey	F. R. Hutton	W. F. M. Goss
Society	2	Henry R. Towne	Ambrose Swasey	F. R. Hutton	C. Wallace Hunt	Henry R. Towne
of Mechanical	3	Ambrose Swasey	F. R. Hutton	C. Wallace Hunt	Henry R. Towne	John A. Brashear
Engineers	4	F. R. Hutton	C. Wallace Hunt	Henry R. Towne	John A. Brashear	F. R. Hutton
American	1	John W. Lieb, Jr.	S. S. Wheeler	Samuel Sheldon	Henry G. Stott	Lewis A. Ferguson
Institute	2	S. S. Wheeler	Samuel Sheldon	Henry G. Stott	Lewis A. Ferguson	L. B. Stillwell
of Electrical	3	Samuel Sheldon	Henry G. Stott	Lewis A. Ferguson	L. B. Stillwell	Dugald C. Jackson
Engineers	4	Henry G. Stott	Lewis A. Ferguson	L. B. Stillwell	Dugald C. Jackson	Gano Dunn

Directors and Board of Award	Years to Serve	1913	1914	1915	1916	1917
President		John R. Freeman	Gano Dunn	Charles Warren Hunt	Albert Sauveur	Ambrose Swasey
Secretary		Charles Kirchhoff	J. F. Kemp	J. F. Kemp	Charles F. Rand	Charles F. Rand
Treasurer		F. R. Hutton	F. R. Hutton	F. R. Hutton	F. R. Hutton	F. R. Hutton
American Society of Civil Engineers	1	Onward Bates	Charles Warren Hunt	M. T. Endicott	John A. Ockerson	George F. Swain
	2	Charles Warren Hunt	M. T. Endicott	John A. Ockerson	George F. Swain	Charles Warren Hunt
	3	M. T. Endicott	John A. Ockerson	George F. Swain	Charles Warren Hunt	Charles D. Marx
	4	John A. Ockerson	George F. Swain	Charles Warren Hunt	Charles D. Marx	Clemens Herschel
American Institute of Mining Engineers	1	R. V. Norris	Charles Kirchhoff	J. F. Kemp	Albert Sauveur	E. Gybbon Spilsbury
	2	Charles Kirchhoff	J. F. Kemp	Albert Sauveur	E. Gybbon Spilsbury	Charles F. Rand
	3	J. F. Kemp	Albert Sauveur	E. Gybbon Spilsbury	Charles F. Rand	Christopher R. Corning
	4	Albert Sauveur	E. Gybbon Spilsbury	Charles F. Rand	Christopher R. Corning	B. B. Thayer
American Society of Mechanical Engineers	1	Henry R. Towne	John A. Brashear	F. R. Hutton	John R. Freeman	Ambrose Swasey
	2	John A. Brashear	F. R. Hutton	John R. Freeman	Ambrose Swasey	John A. Brashear
	3	F. R. Hutton	John R. Freeman	Ambrose Swasey	John A. Brashear	F. R. Hutton
	4	John R. Freeman	Ambrose Swasey	John A. Brashear	F. R. Hutton	John R. Freeman
American Institute of Electrical Engineers	1	L. B. Stillwell	Dugald C. Jackson	Gano Dunn	Ralph D. Mershon	C. O. Mailloux
	2	Dugald C. Jackson	Gano Dunn	Ralph D. Mershon	C. O. Mailloux	Paul M. Lincoln
	3	Gano Dunn	Ralph D. Mershon	C. O. Mailloux	Paul M. Lincoln	John J. Carty
	4	Ralph D. Mershon	C. O. Mailloux	Paul M. Lincoln	John J. Carty	Harold W. Buck

Directors and Board of Award	Years to Serve	1918	1919	1920	1921	1922
President		John J. Carty	Clemens Herschel	B. B. Thayer	Ambrose Swasey	C. A. Adams
Secretary		Charles F. Rand	Charles F. Rand	Charles F. Rand	Charles F. Rand	Charles F. Rand
Treasurer		F. R. Hutton	W. F. M. Goss	George H. Pegram	George H. Pegram	B. B. Thayer
Ass't Secretary		. . . .	. . . .	Alfred D. Flinn	Alfred D. Flinn	Alfred D. Flinn
American Society of Civil Engineers	1	Charles Warren Hunt	Charles D. Marx	Clemens Herschel	George H. Pegram	A. N. Talbot
	2	Charles D. Marx	Clemens Herschel	George H. Pegram	A. N. Talbot	F. S. Curtis
	3	Clemens Herschel	George H. Pegram	A. N. Talbot	F. S. Curtis	A. P. Davis
	4	George H. Pegram	A. N. Talbot	F. S. Curtis	A. P. Davis	George S. Webster
American Institute of Mining and Metallurgical Engineers	1	Charles F. Rand	Christopher R. Corning	B. B. Thayer	Herbert Hoover	Charles F. Rand
	2	Christopher R. Corning	B. B. Thayer	Herbert Hoover	Charles F. Rand	Christopher R. Corning
	3	B. B. Thayer	E. Gybbon Spilsbury	Charles F. Rand	Christopher R. Corning	B. B. Thayer
	4	E. Gybbon Spilsbury	Charles F. Rand	Christopher R. Corning	B. B. Thayer	Herbert Hoover
American Society of Mechanical Engineers	1	John A. Brashear	W. F. M. Goss	John R. Freeman	Ambrose Swasey	Fred J. Miller
	2	F. R. Hutton	John R. Freeman	Ambrose Swasey	Fred J. Miller	Henry B. Sargent
	3	John R. Freeman	Ambrose Swasey	Fred J. Miller	Henry B. Sargent	W. M. McFarland
	4	Ambrose Swasey	John A. Brashear	Henry B. Sargent	W. M. McFarland	Ambrose Swasey
American Institute of Electrical Engineers	1	Paul M. Lincoln	John J. Carty	Harold W. Buck	E. W. Rice, Jr.	C. A. Adams
	2	John J. Carty	Harold W. Buck	E. W. Rice, Jr.	C. A. Adams	Calvert Townley
	3	Harold W. Buck	E. W. Rice, Jr.	C. A. Adams	Calvert Townley	A. W. Berresford
	4	E. W. Rice, Jr.	C. A. Adams	Calvert Townley	A. W. Berresford	Wm. McClellan

THE JOHN FRITZ MEDAL HAS BEEN CONFERRED *on the* FOLLOWING DISTINGUISHED ENGINEERS

1902—JOHN FRITZ
For scientific and industrial achievement

1905—LORD KELVIN
For work in cable telegraphy and other general scientific achievements

---

1906—GEORGE WESTINGHOUSE
For the invention and development of the air-brake

1907—ALEXANDER GRAHAM BELL
For the invention and introduction of the telephone

1908—THOMAS ALVA EDISON
For the invention of the duplex and quadruplex telegraph; the phonograph; the development of a commercially practical incandescent lamp; the development of a complex system of electric lighting, including dynamos, regulating devices, underground system, protective devices and meters

---

1909—CHARLES TALBOT PORTER
For his work in advancing the knowledge of steam engineering and improvements in engine construction

---

1910—ALFRED NOBLE
For notable achievements as a civil engineer

1911—SIR WILLIAM HENRY WHITE
For notable achievements in naval architecture

1912—ROBERT WOOLSTON HUNT
For his contributions to the early development of the Bessemer process

1914—JOHN EDSON SWEET
For his achievements in machine design; and for his pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine

---

1915—JAMES DOUGLAS
For notable achievements in mining, metallurgy, education and industrial welfare

---

1916—ELIHU THOMSON
For achievements in electrical invention, in electrical engineering and industrial development, and in scientific research

---

1917—HENRY MARION HOWE
For his investigations in metallurgy, especially in the metallography of iron and steel

---

1918—J. WALDO SMITH
For achievement as engineer in providing the City of New York with a supply of water

---

1919—GENERAL GEORGE W. GOETHALS
For achievement as builder of the Panama Canal

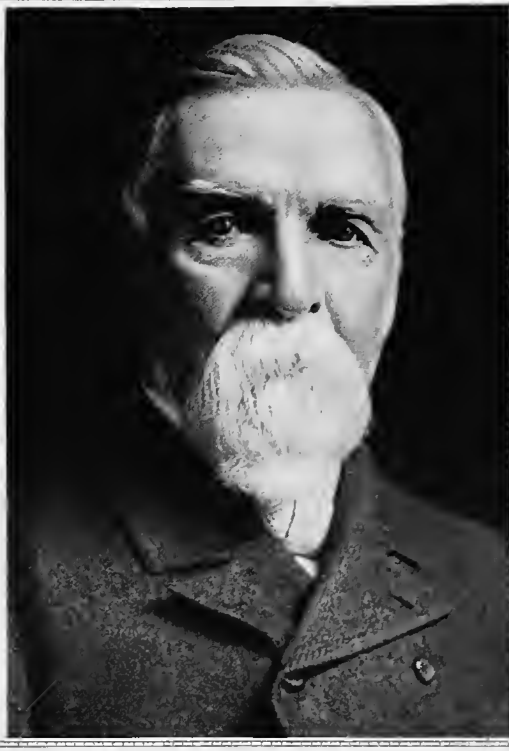
1920—ORVILLE WRIGHT
For achievement in the development of the airplane

1921—SIR ROBERT A. HADFIELD
For the invention of manganese steel

1922—CHARLES PROSPER EUGÈNE SCHNEIDER
For achievement in metallurgy of iron and steel, for development of modern ordnance, and for notable patriotic contribution to the winning of the Great War

BIOGRAPHICAL NOTICES
OF THE
JOHN FRITZ
MEDALLISTS

JOHN FRITZ



John Fritz

JOHN FRITZ

JOHN FRITZ was born August 21, 1822, in Londonderry, Chester County, Pa. His grandfather, Johannes Fritzius, of Hesse Cassel, settled in Pennsylvania in 1802. His father, George Fritz, married the daughter of a Scotch-Irish immigrant. They had seven children—four girls and three boys, of whom John was the first. His father, a millwright and mechanic, repeatedly followed the call of the trade which he loved better than farming; and the three sons, inheriting his talent and his predilection, after dutifully following the plough in their youth, abandoned it for the pursuit of mechanical engineering, in which, educating themselves without the aid of technical instruction, they all achieved high position.

Like other American boys, John Fritz had the benefit of some schooling; but his epigrammatic summary: "Five days in the week, for three months in the year, is too short a time for the study of Bennett's Arithmetic," tells the whole story. The school of those days could only show the door, and give the key to those who would enter. Perhaps, after all, our modern systems accomplish little more!

In 1838, at the age of sixteen, he became an apprentice in the trades of blacksmith and machinist—the latter comprising repairs of agricultural and manufacturing machinery, including the simple blast furnaces of that day.

In 1844, he obtained employment in a rolling-mill, then in process of erection, at Norristown, Pa. After it started, he was put in charge of all the machinery, and he seized the opportunity to master thoroughly the thing nearest to him, outside of his immediate task. This happened to be the puddling furnace. After working through a long day at his job as superintendent and repairer of machinery, he spent the evening in the exhausting work of a common puddler, studying the apparatus and the process, while he rabbled or drew the glowing charge. Months of such toil and thought made him at last not only a master puddler but also an expert, qualified to improve the old construction and practice. Before long he was the Superintendent of the whole works, with the hearty support, not only of the proprietors, who knew his value, but also of the workmen, whose comrade and friend he had been—as, to the end of his life, he continued to be.

In 1849, he accepted a position in connection with a new rail mill and blast furnace, at Safe Harbor, Pa. The salary was smaller ($650 a year, instead of $1000!); but he wanted to learn all about blast-furnace practice and the manufacture of rails.

His next engagement was in 1852, to superintend the rebuilding and improvement of the Kunzie blast furnace, on the Schuylkill, about twelve miles from Philadelphia. This involved the new method of manufacturing pig iron with anthracite, instead of charcoal or coke, as fuel—a scheme which had just been proved practicable by David Thomas and William Firmstone in the Lehigh valley. After the furnace had been put in blast and was running successfully, his desire to learn all about operation, as well as construction, led him to pursue his old habit of prowling about at odd times, day and night; and in this way he discovered one of the most important principles of modern blast-furnace practice, namely, that of the "closed front," replacing the old fore-hearth and those frequent interruptions of the blast for cleaning out the crucible, known as "working" the furnace. This revolutionary change of practice was afterwards embodied and made more effective in the water-cooled cinder notch, patented by Lürmann, and now universally employed.

In 1854, he became general superintendent of the Cambria Iron Works, Johnstown, Pa. This may be regarded as the turning point of his career. His preparation for it had occupied sixteen years, during which he had mastered every part of the manufacture of iron into commercial forms—the blast furnace, the foundry, the puddling furnace, the heating furnace and the rolling-mill—while he had also learned the higher art of commanding the enthusiastic loyalty of workmen, and the highest art of all, perhaps—that of securing the confidence of employers.

All these patiently acquired qualifications were immediately demanded and tested in his new position, and the lack of any one of them would have been fatal to his success. Impending bankruptcy, requiring financial reorganization with fresh capital, and a disastrous fire, necessitating physical reconstruction, were surmounted by his courage and genius, aided by the faith of other men in him.

Against much opposition, he introduced the three-high rolls into the Cambria Company's mill, laying thereby the foundation not only of unexampled prosperity for that establishment, but also of an improvement which was rapidly adopted throughout this country and the world, and has been justly called the last great step of progress in iron manufacture preceding the Bessemer process.

He introduced also many other improvements which he had conceived in previous years, when as yet there was no opportunity to realize them—improvements in puddling furnaces, gearing, boilers, etc. One of his most characteristic and radical measures was the abandonment, in connection with the roll trains, of light coupling boxes and spindles, and a special "breaking box," holding the rolls in place—all of which were intended to break under special strain, so as to save the rolls from fracture. The continual breaking of these weak parts was to him a source of greater delay and loss than was likely to occur in their absence. He said he "would rather have a grand smash up once in a while than be thus annoyed all the time!" And this remained his guiding principle as a mechanical engineer throughout his life. The structures and machines designed by him have been occasionally criticized, from the standpoint of theory, as unnecessarily costly at the outset, but, so far as we know, none of them ever failed in service. His trusses are still standing; his engines are still running; and perhaps his abundant "margins of safety" have proved to be worth more than they cost.

After six years of continuous hard work with the Cambria Iron Company, Mr. Fritz accepted, in July, 1860, the position of general superintendent and chief engineer of the Bethlehem Iron Company.

The works of this company, designed and erected by Mr. Fritz, were so far completed by September, 1863, as to begin the rolling of rails made from the product of its own blast and puddling furnaces. It is impossible, as well as unnecessary, to narrate here the history of his connection with this enterprise. A few features of it, however, deserve mention, by reason of their relation to the general progress of iron metallurgy.

The first of these was the introduction of high-pressure blast in the iron blast furnace. The iron-masters of the Lehigh valley were startled indeed when they learned that Fritz was blowing air at 12 pounds per square inch into his furnaces, and was prepared even to blow at 16 pounds in an emergency. This was the beginning of the new blast-furnace practice, in which rapid running, immense product and high blast, while creating fresh problems of blast-furnace management, have superseded many of the old ones. Fritz's horizontal blowing engines were much criticized at the time; but they have run continuously, day and night, for more than thirty years, blowing at from 10 to 12 pounds pressure, and frequently more. He was so well satisfied with the result of his innovations in blast-furnace practice, that he designed a larger furnace, with an engine that would supply a 20- to 30-pound blast. But, to his great regret, the directors of the company were too conservative to authorize this experiment.

During the Civil War, the Government needed a rolling-mill somewhere in the South, in which rails torn from the track, twisted and deformed by Confederate raiders, could be re-rolled for renewed use. Mr. Fritz was selected as one who could procure the necessary machinery and secure the erection of the mill with the least possible delay. He immediately prepared the plans and obtained the necessary machinery for the mill, which was built at Chattanooga, Tenn., and run successfully by his brother William until the end of the war.

During nearly thirty years of work with Bethlehem Iron Company, Mr. Fritz, supported by the faith and courage which he inspired in other men, made that enterprise one of the most famous in the world. The introduction of open-hearth furnaces and of the Thomas basic process; the progressive improvements of strength, simplicity, and automatic handling in the rolling-mills; the adoption of the Whitworth forging-press; the manufacture of armor-plate; the erection of a 125-ton steam hammer; and innumerable other improvements in the manufacture of iron and steel, owe their present perfection in large degree to his inventive genius, practical resourcefulness, and patient study. The stamp of his mind may be found on almost every detail of construction and operation throughout a wide range of processes and products.

In 1892, at the age of seventy, he retired from this responsible and arduous work; but for nearly twenty years longer he lived to enjoy, as few men have been permitted to do, the fame and the friendships which he had amply earned. Indeed, he had received world-wide recognition before his retirement, and that event elicited numerous public expressions of the pre-existing fact. The American Institute of Mining Engineers, of which he had been a loyal member since 1872, elected him its President in 1894; the American Society of Mechanical Engineers, which he joined in 1882, made him an Honorary Member in 1892, and President in 1895; the American Society of Civil Engineers, of which he became a member in 1893, conferred Honorary Membership upon him in 1899; the Iron and Steel Institute of Great Britain made him an Honorary Member in 1893, and a perpetual Honorary Vice-President in 1909; and the recently organized American Iron and Steel Institute elected him an Honorary Member in 1910. Meanwhile, he had received the Bronze Medal of the U. S. Centennial Exposition in 1876; in 1893 the Bessemer Gold Medal of the Iron and Steel Institute; in 1902 the John Fritz Medal (the fund for which was established by subscription, to honor his eightieth birthday, by awarding a gold medal annually "for notable scientific or industrial achievement"—the first medal being bestowed with enthusiastic unanimity upon John Fritz himself); in 1904 the Bronze Medal of the Louisiana Purchase Exposition, in connection with which he served as Honorary Expert on Iron and Steel; and in 1910, the Elliott Cresson Gold Medal of the Franklin Institute of Philadelphia, "for distinguished leading and directive work in the advancement of the iron and steel industries." And he received *honoris causa* the following academic degrees: Master of Arts, from Columbia University, in 1895; Doctor of Science, from the University of Pennsylvania, in 1906; Doctor of Engineering, from the Stevens Institute of Technology, in 1907; and Doctor of Science, from Temple University, in 1910.

But these official distinctions could not tell fully the story of love and praise which pressed for the utterance which it found on two memorable occasions—celebrations of his seventieth and eightieth birthday anniversaries, in which hundreds of his friends and professional colleagues participated. The first took place at Bethlehem in 1892, and the second at New York in 1902.

Lehigh University, located in the Lehigh Valley of Pennsylvania, was founded in 1866 by a Pennsylvanian—Asa Packer—who knew and appreciated the great qualities of John Fritz, and who named him as one of the original Board of Trustees. He was remarkably broad in his conceptions of education. Only a few years before his death, in commenting to a friend on the antagonism manifested by another distinguished iron-master to all forms of classical training, Mr. Fritz said: "I think a well-educated man ought to know something of Greek and Latin. If I had a son I would see that he had some knowledge of those languages in addition to his more practical studies."

In 1900, he gave to the University a fully equipped, up-to-date engineering laboratory. What is more, he acted as his own architect; designed the building (substantially on the lines of the large shop he had built at the Bethlehem Steel Works); selected, purchased and installed the superb testing equipment; and renewed his youth in the task, which was a great pleasure to him. At his death, it was found that (after making generous provision for his near relatives, and for bequests to the Free Library of the Bethlehems, to St. Luke's Hospital at South Bethlehem, to Temple College at Philadelphia, to the Methodist Hospital at Philadelphia, to the American University at Washington, and to other charitable purposes) he had bequeathed his residuary estate, estimated to amount to about $150,000, to Lehigh University, as an endowment fund for the maintenance and operation of this laboratory.

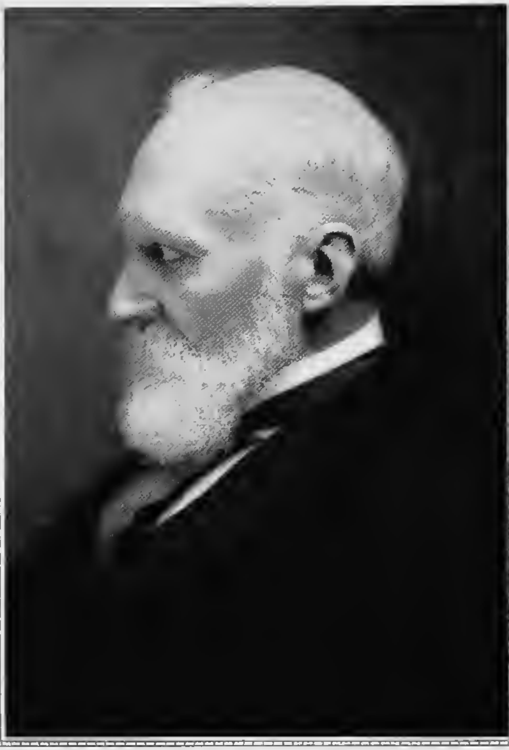
Mr. Fritz retained much of his vigor and activity up to the autumn of 1911. He took frequent trips alone to Philadelphia and New York, and attended many gatherings of his old engineering friends and associates. In 1911, he wrote his *Autobiography*—an instructive and inspiring human document.

And then came the beginning of the end. This literary work finished, the laboratory built, his affairs in good order, our dear old friend began to fail. But his life was prolonged by surgeons, physicians and nurses, aided by his own patient docility, strong will, rugged constitution and genial humor, until February 13, 1913, when he died quietly, without apparent pain, passing away in sleep.

His funeral, held at Bethlehem on February 17, was attended by a large concourse of his friends; and he lies at rest in the beautiful Nisky Hill cemetery of his home town, beside his only daughter, who died in childhood, and his beloved wife.

So lived and died a great man—strong, wise, brave, invincible; a good man — simple, generous, tender and true; a loving husband; a loyal friend; a public-spirited citizen; a real philanthropist, giving "himself with his gift!" To us who miss and mourn him now, the man shines even more illustrious than the famous engineer.

LORD KELVIN



Lord Kelvin

LORD KELVIN

WILLIAM THOMSON was born in Belfast, Ireland, June 25, 1824. His father, James Thomson, professor of mathematics in an institute in Belfast, removed in 1832 to his alma mater at Glasgow, and William received his education in part from his father, and in part from the College of Glasgow. In 1845 he was graduated from St. Peter's College, Cambridge, where he won notable honors, being first Smith's prizeman of his year, as well as second wrangler. While at Cambridge, Thomson was devoted to athletics, and rowed in the winning boat in a race with Oxford.

At the age of twenty-two, after several months spent in the laboratory of Regnault, at Paris, Thomson became professor of natural history in the University of Glasgow, to which he always remained loyal. In 1896, half a century after his appointment, he received a wonderful tribute of admiration and affection, in which the university and civil authorities of Glasgow, leading scientific societies of America and Europe, and distinguished individuals, including the Prince and Princess of Wales, united by personal presence, formal addresses, letters, telegrams, and cable messages. He was elected Chancellor of the University in 1904.

One of Professor Thomson's first great achievements was in overcoming the retardation affecting electrical signals sent through a submarine cable, which threatened to blur them beyond recognition. Faraday had previously furnished a partial solution; but Thomson invented the instrument which made it possible to transmit signals with reasonably satisfactory clearness and speed, and was retained as consulting engineer, both for the Atlantic cable of 1858 and for that of 1866. He was also electrical engineer for the French Atlantic cable in 1869, the Brazilian and River Plata cable in 1873, the West Indian cables in 1875, and the Mackay-Bennett cable in 1879.

Moreover, Professor Thomson invented a method of testing the conductivity of a submarine wire while being laid, so that any defect might be promptly discovered and remedied. He also invented instruments for receiving messages. A mirror was so mounted on a tiny magnet that the feeble electric impulses traversing a cable caused it to sway, and a beam of light was deflected to the right and left, on a blank white surface in a dark room. The magnet being suspended by a silk fibre, its movements were virtually unimpeded by friction.

This apparatus was supplemented by one which would leave a permanent trace on a strip of paper. This was called "the siphon recorder," and was employed to receive some of the greetings sent to its inventor in 1896. He was knighted in 1866, as one who had done more than any other scientific man to develop submarine telegraphy. Subsequently he devised a sending-key for use with a cable, and perfected apparatus for taking deep-sea soundings, thus greatly facilitating the exploration of cable routes.

Two of Sir William Thomson's valuable inventions are his improvements in the construction of the compass, and his provision for overcoming the influence of a ship's magnetism on that instrument. The compass card was lightened, and a large number of fine needles were substituted for the coarse ones formerly attached to it. To attain the other object, small globes of iron, the sizes and distance of which had been carefully computed, were placed near the compass on opposite sides.

For measuring charges of static electricity, Sir William originated the quadrant electrometer, and made useful additions to other types of apparatus. One of the most important of his non-electrical inventions is a machine for predicting the level of the tides in any part of world. His wide experience, deep insight, and sound judgment made him an authority on electrical science.

As early as 1848, Professor Thomson published an article on an absolute thermometric scale, and in 1854 he modified his proposition. Two long articles from his pen in the "Encyclopaedia Britannica" have been republished under the title, "On Heat and Electricity." His work in connection with Professor Tait, "A Treatise on Natural Philosophy," contains material of the highest value.

While consistently conservative, Lord Kelvin took a deep and lively interest in the investigations regarding radium and radio-activity. He would not assent to the theory that one element could be evolved from another, or to the theory lately advanced, that the heat of the sun or the earth is due to radium, rather than to gravitation.

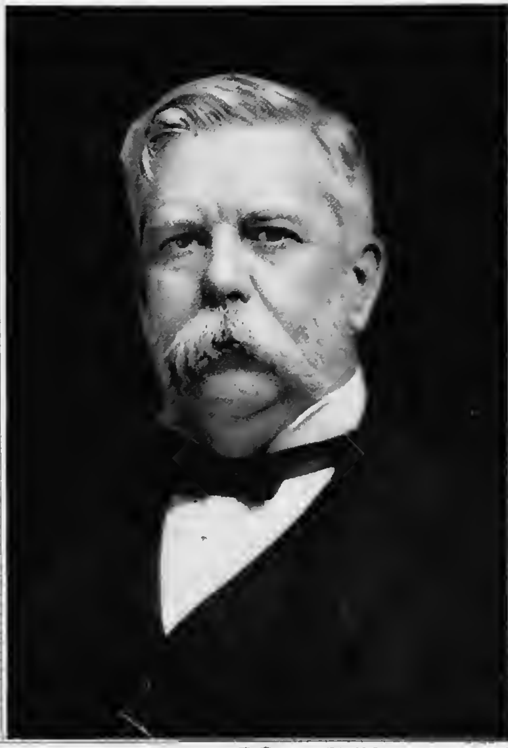
Lord Kelvin's development of the relation which exists between heat and mechanical power enabled him to reconcile the diverse doctrines advocated by Joule and Carnot, and he co-operated with Joule in experiments which aided in dispelling the uncertainty relating to thermal effects in fluids. The results were communicated to the Royal Society in 1862.

Lord Kelvin's other published writings are: "Electrostatics and Magnetism" (1 vol.); "Mathematical and Physical Papers" (3 vols.); "Popular Lectures and Addresses" (3 vols.); and "Baltimore Lectures," delivered at Johns Hopkins University, in 1884. He visited Montreal in 1884, and Toronto in 1897 to attend meetings of the British Association for the Advancement of Science, these meetings being ordinarily held on the other side of the Atlantic. That he was made a peer by Queen Victoria at the opening of the year 1892, was a delight to his scientific friends, who felt not only that the honor was deserved, but also that it was a public though tardy recognition of the value of science. The title, Lord Kelvin, was suggested by the name of a stream, the Kelvin, that empties into the Clyde at Glasgow. The buildings of the University of Glasgow border on this stream.

He received degrees from the leading universities of Great Britain and America. In 1893 he was elected an Honorary Member of the American Institute of Electrical Engineers. He was a foreign Associate of the Academy of Sciences of Paris, and an Honorary Member of other French scientific organizations. He was a Grand Officer of the Legion of Honor in France; a Knight of the Grand Cross of the Royal Victorian Order; a Knight of the Order of Merit of France, and a Commander of the Order of Leopold of Belgium. He was also a member of the Order of the First Class of the Sacred Treasure of Japan, and of the Order of Merit established by Edward VII in 1902. He had been President of the Royal Society of Edinburgh, the British Association for the Advancement of Science, and three times President of the Institution of Electrical Engineers. As President of the Royal Society of London he attained an honor that has been regarded since Newton's day as the highest to which a British scientist could aspire.

In death, as in life, Great Britain gratefully bestowed upon Lord Kelvin her highest honors; for he rests with Newton, Herschel, Darwin, and other illustrious dead, in the nave of Westminster Abbey.

GEORGE WESTINGHOUSE



George Westinghouse

GEORGE WESTINGHOUSE

GEORGE WESTINGHOUSE was born at Central Bridge, N. Y., October 6, 1846. He died in New York City, March 12, 1914. A few years after his birth, his father, who was a manufacturer of agricultural machinery, moved to Schenectady, where the boy attended the public schools and, outside of school hours and during vacations, studied mechanics and learned to handle machinery in his father's shop.

When the Civil War came on, the patriotic ardor which filled the youth of the country drew young Westinghouse into the volunteer army. Although he was under the age for enlistment, his size and strength were such that he was admitted to the service, first joining the cavalry. In December, 1864, he became an assistant engineer in the navy, serving in that capacity until August, 1865.

After the war, he returned to Schenectady and entered Union College; but this was a classical institution, and the bent of young Westinghouse was in the direction of mathematics and engineering. Acting upon the advice of the President of the college, who felt that such latent ability should be given an unrestricted opportunity for growth, he left before graduation and started seriously upon his career in engineering.

Putting the President's advice into practice, he took out his first patent. He had seen a crew of railroad men tediously working to replace a derailed car on the tracks and thought their primitive methods were wasting time. He invented a simple device for the operation and undertook to sell it to the railroads.

On one of his journeys "frog selling," as he has called it, he was close to a collision of trains. The brakemen, tugging at their hand-brake wheels, did their best, but the best of handbrakes were primitive affairs, and in emergencies almost useless. He conceived the idea of instantly braking an entire train with some form of power-apparatus controlled by the locomotive engineer. In a year or so, after much experiment, he was satisfied that he had made a practical design, but he was without capital to manufacture the equipment of even a single train and to get the invention tried. He went to Pittsburgh, where he obtained encouragement enough to begin in a small way. He patented the air brake in 1867.

The first train to which this brake was applied ran west from Pittsburgh on what is now a portion of the Pennsylvania Railroad. During the trial trip a collision with a loaded team stuck on a grade crossing was prevented. This practical illustration of the utility of the invention led to the adoption of the brake. Mr. Westinghouse, retaining the control of his invention, undertook to manufacture it, and organized the Westinghouse Air Brake Company, establishing at Pittsburgh the business which subsequently became the nucleus of the many industries associated with his name. He later applied compressed air to switching and signaling, and utilized electricity in this connection. From this grew the Union Switch and Signal Company.

His introduction of electricity into switch and signal work led him far into electrical experiment, and he devoted his energies to a cause in which few then believed, the adoption of the alternating current for lighting and power. In this he had to meet and overcome almost fanatical opposition, which in many States sought legislation against the use of the alternating current as dangerous to the public welfare. In 1885, he acquired the patents of Gaulard & Gibbs, and having undertaken a comprehensive study of the distribution and utilization of electrical currents in a large way, he personally devised apparatus and methods for the work, and gathered around him a group of men who were to become experts in the new electrical art. He also organized the electrical company which bears his name and undertook the development and manufacture of the induction motor which made practicable the utilization of the alternating current for power.

The Westinghouse Machine Company was established by Mr. Westinghouse in the eighties for the manufacture of high-speed steam engines, and at this plant has come in succession the construction of large steam engines, gas engines and steam turbines.

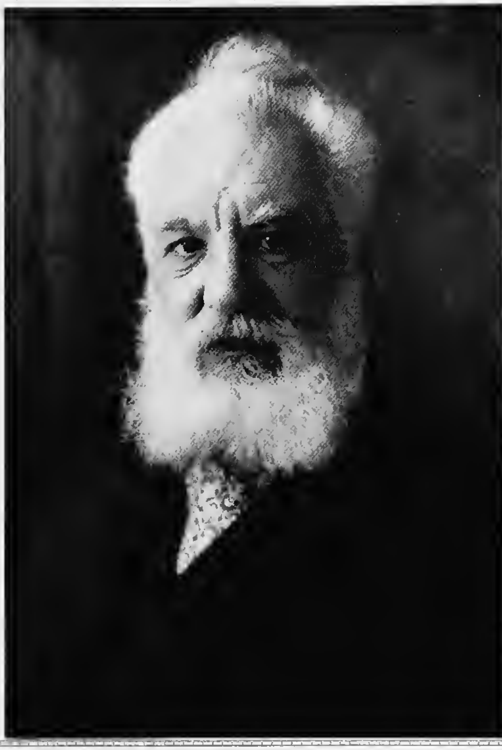
Following the discovery of natural gas in the Pittsburgh region, Mr. Westinghouse devised a system for controlling the flow and for conveying the gas over long distances through pipe lines, thus supplying fuel to the homes and factories of Pittsburgh. He took up the study of the gas engine, and for ten years conducted a series of exhaustive experiments in this line, at the end of that time putting into commercial use a gas engine of large power for electric generating.

Mr. Westinghouse introduced the Parsons steam turbine into this country, adding to it improvements and developments of his own, and others carried out under his supervision. The reduction gearing for driving the propeller shaft of a ship by means of a steam turbine was developed at the Machine Company's works, with the co-operation of the late Admiral Melville and John H. Macalpine. Very recently, also, the Westinghouse air spring for motor vehicles was brought out.

It is impracticable to enumerate here the inventions which Mr. Westinghouse personally made or those which his staff made under his supervision. As a result of this work and enterprise, there grew up thirty corporations of which he was President at one time, employing 50,000 men, with works at Wilmerding, East Pittsburgh, Swissvale and Trafford City, Pa.; at Hamilton, Canada; London and Manchester, England; Havre, France; Vardo, Italy; and at Vienna and St. Petersburg.

Mr. Westinghouse made many visits to Europe in connection with his inventions and industries. There, as in his own country, he won the friendship of the foremost men of his time and the high esteem of the engineering profession. He has been decorated by the French Republic and by the sovereigns of Italy and Belgium; and he was the second recipient of the John Fritz Medal "for the invention and development of the air brake," Lord Kelvin, his friend of many years, having been the first. The *Königliche Technische Hochschule*, of Berlin, bestowed upon him the degree of Doctor of Engineering; and his own college, Union, gave him the degree of Ph.D. The Edison Gold Medal was presented to him in 1912, for his "meritorious achievement in connection with the development of the alternating system for light and power." In 1913, the Grashof medal of the *Verein Deutscher Ingenieure*, the highest honor in the gift of the engineering profession of Germany, was awarded to Mr. Westinghouse on the occasion of the official visit to Germany of the American Society of Mechanical Engineers, and accompanying the medal was a certificate which read: "To George Westinghouse, who opened up new fields by his invention of the automatic railway brake, successfully fought for the introduction of the alternating current in the United States, and did useful work in the designing of high-speed machinery." Besides being a Past-President and Honorary Member of The American Society of Mechanical Engineers, Mr. Westinghouse was one of the two Honorary Members of the American Association for the Advancement of Science and an Honorary Member of the National Electric Light Association.

ALEXANDER GRAHAM BELL



Alexander Graham Bell

ALEXANDER GRAHAM BELL

ALEXANDER GRAHAM BELL has had the rarest of human experiences. He has lived to see the dreams of his youth come true. When he talked into a replica of the first telephone transmitter at the celebration of the completion of the New York-San Francisco telephone line, there were 9,000,000 telephones in the Bell system, serving 100,000,000 persons. Forty years ago, Bell talked of sending the human voice over electric wires, and men gaped at him in pity.

The inventor of the telephone was born in Edinburgh, Scotland, March 3, 1847. He was the son of Alexander Melville Bell, the dean of British elocutionists and inventor of the system of "visible speech." The boy was educated at Edinburgh and London, and acquired a smattering of music, electricity and telegraphy. At the age of sixteen he taught elocution in British schools, and by the time he was of age he had met several noted scientists who encouraged him in his studies of sound.

In 1870, he went to Canada, and the next year came to Boston as professor of vocal physiology in Boston University. His system of teaching deaf mutes won immediate recognition, and his success encouraged him to open a school of his own. He went to live at the home of five-year-old Georgie Sanders, one of his pupils, in Salem, and in the Sanders cellar, after school hours, he started a series of inventions that were to culminate in the telephone. For three years, he worked with tuning-forks, magnets and batteries, and in 1874 he had evolved the idea for what he called his "harmonic telegraph." This was a device for sending a number of Morse messages over a single wire at the same time by utilizing the law of sympathetic vibration. Bell used a telegraph transmitter and receiver, an electromagnet and a flattened piece of steel clock spring.

One day in the winter of 1874, Bell took his harmonic telegraph to the electrical workshop of Charles Williams, of 109 Court Street, Boston, where Thomas A. Watson was employed. Watson made six instruments at Bell's instructions and thereafter devoted most of his time to working out in brass and iron the ideas that came pouring out of Bell's active brain. The two young men labored day and night at their experiments in the Williams workshop and out at Salem. All the while there was a dream that haunted Bell. It was that, somehow, some day he could get an electric wire to carry the human voice. On

June 2, 1875, after months of countless experiments on the harmonic telegraph, something happened that convinced Bell that at last he was on the right track. One of the transmitter springs of his telegraph instrument stuck, and the magnetized steel generated a current that sent a faint noise over the electric wire to Bell's receiver. This was all the proof Bell needed to persuade him that the principles were right. Thereafter it was a question of working out details.

On March 10, 1876, in a boarding-house at 5 Exeter Place, Boston, where the two were experimenting, Bell, in his room on the top floor, put his mouth to the telephone and said:

"Mr. Watson, come here, I want you." Watson came rushing into the room shouting: "I heard you; I could hear what you said!"

Bell decided that he had made sufficient progress to justify him in exhibiting his invention at the Philadelphia Centennial. He was shoved into a corner and overlooked by the public until Dom Pedro, Emperor of Brazil, who knew Bell as a master of acoustics, happened along. Bell explained the telephone and persuaded the Emperor to listen at a receiver while he talked. Dom Pedro dropped the instrument, exclaiming: "My God, it speaks!" and the amazement of the distinguished visitor attracted attention to its cause. Bell and his invention were soon the main features of the Centennial. Bell returned to Boston to persuade an incredulous public that he had a practical means of instantaneous communication. It was no easy task. With a few loyal friends behind him he did heroic missionary work, lecturing up and down New England, everywhere prophesying that some day men would talk as readily from Boston to New York as from one room to another. The press reflected the universal scepticism; funds ran low. Those were dark days for the young inventor. But finally, in August, 1877, when Bell's patent was sixteen months old, there were 778 telephones in use, and the pioneers decided that the time had come to organize the business. "The Bell Telephone Association" was created with no capital and a membership of four men — Bell, Watson, Gardener G. Hubbard (Bell's father-in-law) and Thomas Sanders (father of Bell's pupil and sole financial backer of the telephone).

Bell was an inventor, not a business man, and after 1877 he had little active connection with the organization of the telephone industry. He married in that year, and went abroad to help introduce the telephone in England. But before he sailed, he suggested to Watson that as soon as the telephone became a matter of routine business, the two should begin experimenting on flying machines. Watson turned to building battleships, but Bell, always a long way ahead of his time, took up the problems of flight with his characteristic energy.

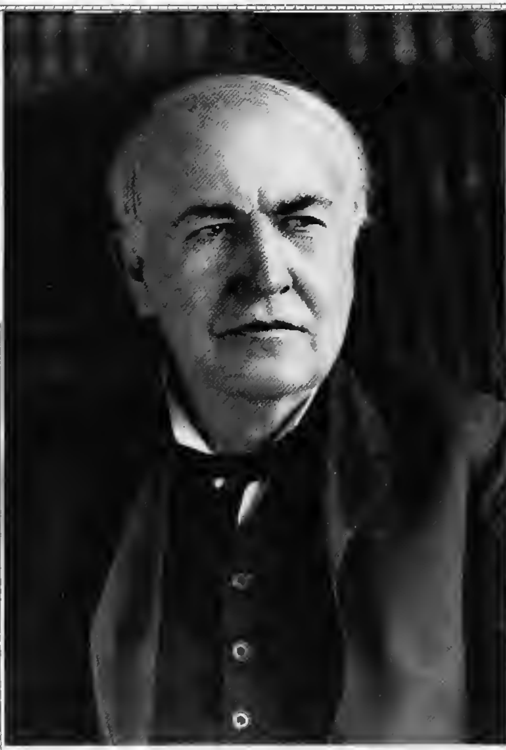
In February, 1913, *The Scientific American* printed an account of patent No. 1,050,601, just issued. Dr. Bell received this for a vertical balancing rudder for aeroplanes, thirty-seven years after receiving patent No. 174,465 for the telephone. About two years later, he announced an attempt to be made by one of his assistants to cross the Atlantic in an aeroplane in seventy-two hours. To invent what has been called one of the seven modern wonders would satisfy most men, but it did not satisfy Alexander Graham Bell.

While Theodore N. Vail and his associates were busy making Bell's membrane transmitter a universal household servant, Professor Bell was inventing a telephone probe for the painless detection of bullets in the human body and receiving for it the degree of M. D. from the University of Heidelberg. In 1883, Dr. Bell's name once more appeared before the public, associated this time with the names of C. A. Bell and Sumner Taintor in the invention of the graphophone. A little later he returned to his first love—the study of acoustics—and organized a movement for the teaching of speech to the deaf along the lines of visible speech.

It has always been Dr. Bell's practice to keep complete records of his scientific researches, and the volumes into which these records are bound now number several hundred. They tell the story of an intellectual life of almost unprecedented activity. A recent visitor to Dr. Bell's home at Washington was permitted to examine records made from 1908 to 1913. There were thirteen volumes, each as thick as a law book and each containing 500 pages. The index to one of these volumes covered such subjects as experiments on aircraft, the scientific breeding of sheep, the utilization of waste heat, a new metric system, experiments in preserving food, notes on eugenics and the biological history of a cat.

Dr. Bell has received many honors. The honorary degree of M. D., awarded by the University of Heidelberg in 1886, on the 500th anniversary of its foundation, has been mentioned already. The French Government gave him in 1880 the Volta Prix, and he has received gold medals as follows: The London Society of Fine Arts (1902); the Royal Albert, the Elliott Cresson and the Hughes medal of the Royal Society of Arts (1913). He is an Officer of the French Legion of Honor. He founded and endowed with $250,000 the American Society to Promote Teaching of Speech to the Deaf, of which he has been President, as also of the National Geographical Society. He is a member of the National Academy of Sciences and the American Philosophical Society, and Fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, etc.

THOMAS ALVA EDISON



Thomas Alva Edison

THOMAS A. EDISON

THOMAS ALVA EDISON was born February 11, 1847, at Milan, Ohio. His father was descended from a Dutch miller on the Zuyder Zee, who came to America and settled in New Jersey about 1735. His mother, who was of Scotch descent, had been a school-teacher, and educated him largely at home. At ten or twelve years of age, he became greatly interested in chemistry, and having procured some books on the subject, obtained permission to establish a laboratory in the cellar, where he continued for two years his studies and experiments. In order to earn money for apparatus and reagents, he then became a railroad newsboy, selling papers, magazines, candy, etc., on the Grand Trunk Railway. Part of a baggage-car was allowed him for his stock of goods, and into this space he moved his home laboratory. He also bought a printing-press and type, and published on the train a weekly journal, called "The Weekly Herald," of which he was proprietor, publisher, editor, compositor, pressman and distributor.

A laboratory accident, which set fire to the baggage-car, put a summary end to this business; and at about fifteen years of age, the boy became a telegraph-operator, learning this trade through the favor of a station-master on the road, the life of whose child he had saved. For more than five years he worked in telegraph offices in different parts of the United States, continually experimenting and devising improvements in apparatus, and at last determined to seek his fortune in New York City, where he arrived, one morning in 1869, without money or acquaintances. Later in the day, he found a telegraph-operator who lent him a dollar. He applied for work in the Western Union office, and while awaiting an answer, spent his time in the operating-room of the Gold Indicator Company. About the third day, there was an accident to the machinery, which he repaired so skillfully that he was made superintendent of the office, at $300 a month.

This was the beginning of Edison's real inventive and commercial career. He made inventions for which he received $40,000; and with this money he opened a factory in Newark, N. J., and became a manufacturer of stock-tickers and other electrical apparatus, employing more than 150 men. He also perfected several other important electrical inventions, such as the automatic-telegraph, by which more than 5000 words per minute were sent between distant cities. It was during this period that he invented the duplex and quadruplex telegraphs and the electromotograph. The quadruplex made it for the first time commercially practicable to send four messages at once, two in each direction, over one wire. For the electromotograph, which was made to order for the Western Union Telegraph Company, he received $100,000.

After Bell's telephone had been introduced, Edison devised for it an improved transmitter, which has been in universal use ever since. This invention also was sold to the Western Union for $100,000.

In 1876, he removed from Newark to Menlo Park, N. J., making invention his life-profession. Here for nearly two years he continued to bring forth improvements in telegraph and telephone apparatus, etc. In the autumn of 1877, he startled the world with his phonograph. This kept him very busy until the autumn of 1878, when he took up the electric light problem, and worked with unremitting ardor and fierce energy until, in October, 1879, he perfected the first incandescent lamp with its fragile carbon filament *in vacuo*. He proceeded to complete an entire system of electric lighting, including a new type of dynamo, with an efficiency previously unknown. His successful development of the electric railway in 1880-82 was largely based on his efficient dynamo, the principles of which have remained a permanent feature of the art.

This was one of the most intensely active periods of Edison's life. Between 1880 and 1887, he obtained more than 400 U. S. patents. In 1887, he removed to the new laboratory he had built at Orange, and soon after took up the further improvement of the phonograph, which had lain practically dormant for ten years. Within three years he had applied for 82 patents on the phonograph and its parts.

In 1891 he brought out an invention of profound and world-wide influence—his basic patent, covering apparatus for the making of motion-pictures.

The next nine years of his life were devoted chiefly to the magnetic concentration of low grade iron-ores, concerning which he made many important inventions, and secured 50 patents. But the competition of the rich and cheap iron-ores of Lake Superior rendered this enterprise unprofitable; and he reluctantly abandoned it, after spending upon it more than $2,000,000.

Returning to his laboratory, he worked hard for several years, with a band of chosen assistants, to design a new type of storage-battery, which should employ neither lead nor sulphuric acid. The ultimate outcome was the now well-known Edison storage-battery with nickel and iron elements, and an alkaline solution for electrolyte—the whole enclosed in nickeled steel containers.

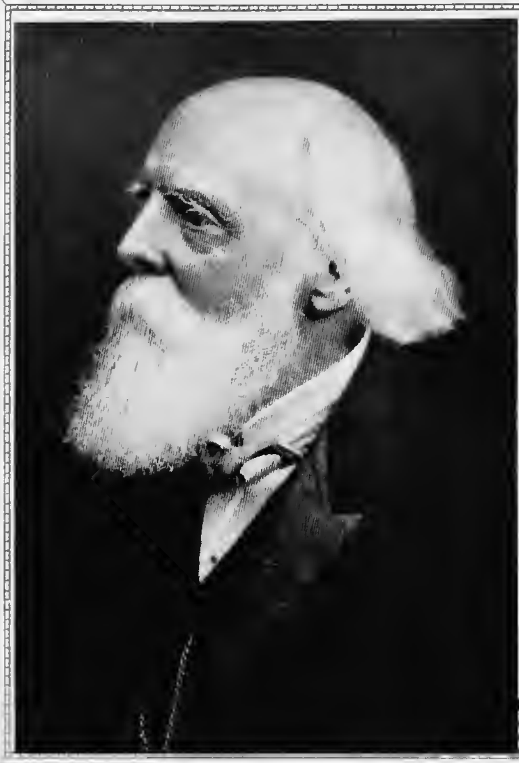
He turned his attention next to the cement industry, which he enriched with many improvements. In 1913, his new diamond disk phonograph was put on the market. The work of perfecting this invention, which has been continued ever since, has required much patience and persistence because of the microscopic character of many disturbing elements.

Since 1869, Mr. Edison has filed more than 1400 applications for patents, and more than 1500 other inventions are embraced in caveats. He has secured also 1239 foreign patents.

The outbreak of the present war in Europe shut off his supply of various chemicals, and forced him to install plants for their manufacture. He has also erected plants to help the textile, fur, rubber and other industries, and since the beginning of 1915, he has manufactured, for these industries or for himself, carbolic acid, myrbane oil, aniline oil, aniline salt, acetanilid, acetate of soda, paraphenylenediamine, para-amido-phenol, benzidine. He has also planned, installed and put in operation two plants for producing benzol, toluol, solvent naphtha, naphthalene, etc.

In 1915, Mr. Edison's eminence was recognized by his appointment as Chairman of the Board of Experts organized by the United States Government in connection with the improvement of the Navy.

CHARLES TALBOT PORTER



CHARLES TALBOT PORTER

CHARLES TALBOT PORTER

CHARLES TALBOT PORTER, a charter member of the American Society of Mechanical Engineers and recipient of the John Fritz Medal for his "work in advancing the knowledge of steam engineering and for improvements in engine construction," died in New York, August 28, 1910. Mr. Porter was born at Auburn, N. Y., January 18, 1826, and was descended from a notable line of New England ancestors including, on his father's side, the Rev. Jonathan Edwards, and on his mother's side, Governor John Winthrop of Massachusetts and Governors Saltonstall and Winthrop of Connecticut. He was graduated from Hamilton College in 1845 and at the fiftieth reunion of the class presented the Half-century Annalist's Letter, a feature of the annual meetings of the Hamilton alumni. After graduation he read law in his father's office in Auburn, and was admitted to the bar in 1847.

After practising his profession for six or seven years, first at Rochester and afterwards in New York City, Mr. Porter became interested in mechanics in connection with a stone-dressing machine invented by one of his clients, which failed to operate satisfactorily. Believing that the fundamental principles of the machine were correct, Mr. Porter went to work to improve it, picking up by the way a knowledge of drafting and designing, and thus incidentally developing his latent mechanical ability. The stone-dressing machine was driven by a steam engine which he desired to run at high speed; but the governor was of the usual simple fly-ball type which could not be speeded up, and consequently the regulation of the engine was faulty. To remedy this defect, Mr. Porter was led to design and perfect the well-known central counterpoise type of governor which has since carried his name.

Subsequently came the development of the high-speed Allen steam engine, later known as the Porter-Allen engine, which was essentially the life-work of Mr. Porter. The first engine was built in this country and shown at the London Exhibition of 1862, equipped with the Porter governor, and operating non-condensing. In 1867 at the French Exposition five engines were installed, the only high-speed engines exhibited.

The exhibit at London and subsequent attempts to sell engines of this type in England showed the demand to be entirely for condensing engines. This brought about the development by Mr. Porter of a jet condenser to be direct-connected to his engines, with an air pump adapted to the high speed at which the engines ran. The building of these engines was begun in England in 1864.

In his work in steam engineering Mr. Porter became associated or intimately acquainted with many of the early distinguished engineers, notably with John F. Allen and Charles B. Richards. Mr. Allen had originated a link and valve motion for steam engines, well adapted for use with the Porter counterpoise governor, and it was the combination by Mr. Porter of this mechanism with his governor, together with Mr. Porter's advanced ideas upon high rotative speeds and methods of engine construction, that resulted in the Porter-Allen engine.

The study of steam economy showed the need of a steam engine indicator adapted to high speeds. This led to the design by Mr. Richards of the first indicator to meet these requirements. The patents were acquired by Mr. Porter and an instrument was shown in connection with the engine at the London Exhibition. It was shortly afterwards manufactured by Elliott Brothers of London.

In the early manufacture of his engines, many practical difficulties had to be met, owing to the crudeness of machine shop methods. Numerous devices and systems of manufacture were introduced by Mr. Porter to attain the accuracy, without which successful high-speed machinery would be impossible.

In 1868, Mr. Porter returned from England, formed a partnership with Mr. Allen and began the manufacture of engines in a small shop in Harlem, N. Y. During the three years of business depression, beginning with 1873, the manufacture of the engines was discontinued, but later was renewed at the Hewes & Phillips Iron Works, at Newark, N. J., under Mr. Porter's own name. They have since been manufactured by the Southwark Foundry and Machine Company at Philadelphia.

In 1880, Mr. Porter installed a high-speed steam engine in the Edison laboratory at Menlo Park, N. J., which marked the beginning of direct-connected generators. Following this, the first of a series of engines for so-called steam dynamos, each independently driven by a direct-coupled engine, was constructed for the Edison Station at Pearl Street, New York.

While these events are important in the history of the high-speed engine for electric generating, the introduction of Mr. Porter's engines into rolling-mill work was of even greater moment. The early processes were deliberate because men were habituated to slow movements. The first power came from the slow-turning water-wheel, later from the slow-speed steam engine. Faster movements were obtained through gears and belts; and then came the direct-connected, easily controlled high-speed engine.

At the first annual meeting of the American Society of Mechanical Engineers in 1880, Mr. Porter read a brief paper upon "The Strength of Machine Tools," and he subsequently presented numerous others. At the beginning of the manufacture of the Richards indicator, he prepared for the makers, Elliott Brothers of London, a brief treatise on the "Steam Engine Indicator," and in 1874 this was revised and very much enlarged by him and brought out simultaneously in London and New York. This contained the tables of the properties of saturated steam, based upon the experiments of M. Regnault, which so long remained a standard. Not long before his death he published his "Engineering Reminiscences," which are an interesting and valuable account of many incidents in the development of steam engineering. Mr. Porter was a member of the Board of Judges at the Centennial Exposition of 1876.

ALFRED NOBLE

Alfred Noble

ALFRED NOBLE

ALFRED NOBLE was born August 7, 1844, at Livonia, Wayne County, Mich. That State had then been only seven years a member of the Union, but had already laid the foundation of a splendid material and intellectual progress. Colossal enterprises in lumbering, mining, railroading, manufacturing and inland navigation were mated with an excellent public school system, reinforced by numerous high schools and colleges and crowned by a great university. In such an environment the young farmer's son naturally dreamed of a university course and a professional career. But the fulfillment of the dream was postponed by reason of the war for the Union. In August, 1862, at the age of eighteen, Alfred Noble enlisted as a private in the 24th Michigan, and served with his regiment in the Army of the Potomac until he was mustered out, at the end of the war, with the rank of Sergeant. He then resumed the purpose of his youth. By working for more than a year as a clerk in the U. S. War Department, and studying hard when off duty, he secured the means and the necessary preparation to enter Michigan University as a sophomore in 1867. In 1870 he was graduated as a civil engineer, having paid his way by outside work as recorder on the U. S. Lake Survey, and as clerk, and afterwards assistant engineer, in river and harbor work on the east shore of Lake Michigan. After his graduation, he continued his connection with the work of the U. S. Army Corps of Engineers on Lakes Michigan and Huron, and in 1870 was placed in local charge of the improvement of the Sault Ste. Marie. This position he retained for twelve years, during which period the great masonry lock at the Sault—at that time by far the largest canal lock in the world—was built. In 1882, after its completion, Mr. Noble resigned his position to become resident engineer for Mr. G. Bouscaron in the construction of the truss bridge over the Red River at Shreveport, La.

Early in 1884, he was appointed general assistant engineer of the Northern Pacific Railroad, in charge of bridge construction on its line. During the three following years he superintended the building of highly important bridges, including the truss bridge, with draw, over the Snake River, near its junction with the Columbia; the bridge over Clark's Fork of the Columbia, the bridge over St. Louis Bay on Lake Superior, and the foundation and superstructure of the Marent Gulch viaduct, near Missoula, Montana.

In August, 1886, Mr. Noble removed to New York to become, and to remain until July, 1887, resident engineer for the erection of the Washington steel arch bridge over the Harlem River. He then took charge for Messrs. Morison & Corthell of the building of the Cairo bridge over the Ohio. This brought him into association with the late George S. Morison, whom he served as chief assistant engineer in the erection (1888-1892) of the great cantilever bridge over the Mississippi at Memphis, and other bridges at Bellefontaine and Leavenworth, over the Missouri, and at Alton, over the Mississippi. Mr. Morison's high opinion of his colleague and assistant is matter of record.

In April, 1895, Mr. Noble was appointed by President Cleveland a member of the first Nicaraguan Canal Commission. In this capacity he visited Central America, and spent about three months in examining the lines of the proposed Panama and Nicaraguan Canals.

After reporting, jointly with his colleagues, at the end of October, 1895, he engaged himself in private practice as consulting engineer, until he was appointed in 1897, by the Secretary of War, to serve with Colonel Charles W. Raymond, Corps of Engineers, U. S. Army, and George T. Wisner, of Detroit, as a board of engineers to survey and prepare estimates for deep waterways from the Great Lakes to the sea-board. This board spent half a million dollars in its investigations; fixed twenty-one feet as the most economical depth, proved the most practicable route to be *via* Lake Ontario and the Oswego and Mohawk Rivers, examined by borings, etc., every part of that route, and determined the nature and cost of the work (in every particular except the price to be paid for private property taken) so accurately that a contractor might safely have based his bid for any section upon its report.

In 1899, Mr. Noble was appointed by President McKinley a member of the Isthmian Canal Commission, and when this subject subsequently came before Congress, a private letter from him, clearly and tersely stating the argument in favor of a lock canal, was read in the House of Representatives, and is said to have influenced decisively the action of both Houses.

Among other engineering enterprises with which Mr. Noble was connected at this period, may be named the great sea wall, built to protect the city of Galveston, Texas, against a recurrence of the disastrous flood of 1900, and the bridge across the Mississippi at Thebes, Illinois, which was erected by him in partnership with Mr. Ralph Modjeski. Moreover, he was employed as consulting engineer in connection with the difficult problems presented by the foundations and structures of some of the lofty office buildings of New York City.

Almost the latest of Mr. Noble's labors was, perhaps, the most important. He was appointed in 1902 a member of the board of engineers which directed the operations of the Pennsylvania Railroad Company (through auxiliary corporations in New York and New

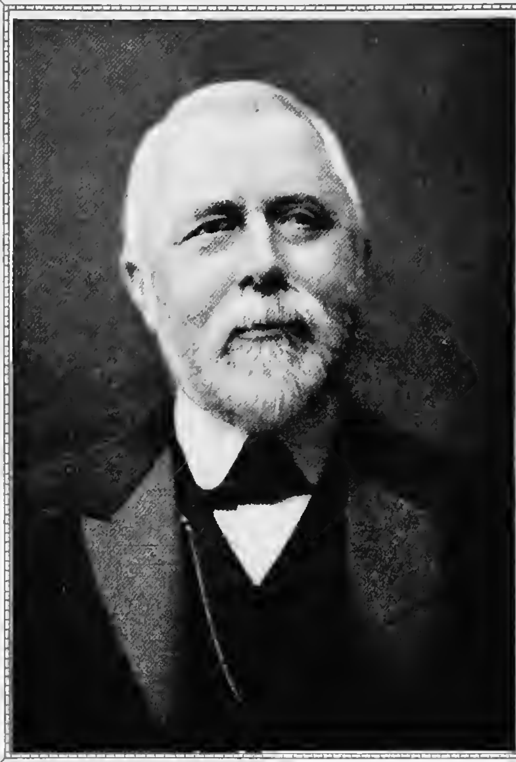
Jersey) in tunneling under the North and East Rivers and the borough of Manhattan, building the great Pennsylvania terminal in New York, and yards and shops in New Jersey and Long Island, etc. Besides serving on the board, Mr. Noble was, as chief engineer of the East River division of the Pennsylvania, New York and Long Island Railroad, directly in charge of the construction of the tunnels from the terminal in Seventh Avenue under Manhattan and the East River, to the portals on Long Island, the approaches from the east and the immense terminal yard at Long Island City. This part of the great undertaking is reported to have cost more than $30,000,000.

In 1895, the University of Michigan conferred upon Mr. Noble the honorary degree of Doctor of Laws, and the University of Wisconsin did the same in 1904. In 1898, he became President of the Western Society of Engineers, and, in 1903, President of the American Society of Civil Engineers. He was also a member of the Institution of Civil Engineers of Great Britain.

In 1910, the John Fritz Gold Medal was awarded to him "for notable achievements as a civil engineer."

He died April 19, 1914.

SIR WILLIAM HENRY WHITE



Sir William Henry White

SIR WILLIAM HENRY WHITE

WILLIAM HENRY WHITE was born February 2, 1845, at Devonport, England. In March, 1859, at the age of fourteen, he was apprenticed at the Royal Naval Dockyard. He also attended the Dockyard School maintained by the Admiralty, where he showed his ability by winning an Admiralty Scholarship in 1863.

In 1864, the Admiralty established at South Kensington, the Royal School of Naval Architecture which was afterwards merged into the Royal Naval College at Greenwich. Sir William was one of the first students received at this newly founded college, taking first place at his entrance examinations in 1864, which standing he maintained during his three years of attendance. He was graduated in 1867, with the highest honors, as a Fellow (first class).

In 1870, he was made Professor of Naval Architecture at this school, a position which he held until 1881. This work was in addition to his duties at the Admiralty. Among his pupils during this period were men who afterward became chief constructors and naval architects in the various navies of the world.

Immediately after his graduation from the Royal School of Naval Architecture, Sir William entered the Admiralty as Private Secretary to Sir Edward Reed, Chief Constructor, and was much engaged in the solution of scientific problems in naval architecture, etc.

In 1870, on the resignation of Sir Edward Reed and the appointment of a commission to continue his work, Sir William was made Professional Secretary to the Commission. In this position, and with the aid of his life-long friend, the late Mr. William John, he carried out numerous experiments on the stability of ships for the Commission appointed to investigate the capsizing of the ironclad *Captain*, in the Bay of Biscay. The results were embodied in a paper before the Institution of Naval Architects, which greatly advanced the science of ship design.

In 1875, Sir William was promoted to the rank of Assistant Constructor, and, in 1881, to that of Chief Constructor. As such he effected the organization of all the trained architects in the Admiralty into one corps—the Royal Corps of Naval Constructors—which has proved of great service to the British Navy. In 1883, he was engaged by Sir William Armstrong to organize and direct the warship-building department of the great shipyard at Elswick, England. In this position he designed naval vessels for Austria, Italy, Japan, China and Spain and had charge of the construction of several for the British Navy.

In 1885, returning to the Admiralty, Sir William was appointed Director of Naval Construction and Assistant Controller of the Navy. This position he held until February, 1902, when he resigned on account of ill-health.

Sir William commenced his work as Director of Naval Construction at the Admiralty at the beginning of a period of expansion in British naval affairs. On the passage of the Naval Defence Act of 1889, providing for the construction of 70 ships at a cost of £22,000,000 sterling, he had a chance to carry out his idea of homogeneity in a fleet, namely, ships bearing a distinct relation to each other and to the fleet as a whole. The Spencer programme of 1894 and the Goschen programme of 1896, the latter comprising the construction of the first dreadnought of the British Navy, were also carried out under his supervision. The development of the torpedo boat and the torpedo-boat destroyer was due to his skill, and he designed also the river gun-boats built for the Nile Expedition under Lord Kitchener. When he retired in 1902, he had had responsible charge of the design and construction of 245 vessels, valued at about £100,000,000 sterling. All this vast work was done under constantly changing conditions of material, type, size, speed, armament, etc., and to him may be attributed the introduction of several innovations in British warships, notably that of water-tube boilers and the use of oil fuel for firing boilers.

He was made C. B. in 1891 and K. C. B. in 1895, and on his retirement from the Admiralty in 1902, Parliament voted him a special grant for "exceptional services to the Navy."

He subsequently began practice as a Consulting Naval Architect, and was engaged on many important works. He was a member of the Cunard Commission which decided the type of machinery for the *Lusitania* and the *Mauretania*; a Director of the firm of Swan, Hunter & Wigham Richardson, Limited, the builders of the *Mauretania*, during her construction; a Director of the Parsons Marine Turbine Company; and a Director of the Grand Trunk Railway Company after that company became the owner of steamships. He designed steamers with geared turbines for service between India and Ceylon, and was a member of the Government Commission to investigate the question of load lines of merchant ships.

On February 27, 1913, Sir William suffered a paralytic stroke at his offices in Westminster, and died the same day at Westminster Hospital, to which he had been removed.

Sir William was a frequent contributor to technical and engineering journals and to the publications of technical and scientific societies. He was also the author of several books: his "Manual of Naval Architecture" and "Treatise on Shipbuilding" have become classics, the former having been translated into German, Italian, Russian and Spanish. His most notable contributions were made to the *Transactions* of the Institution of Naval Architects, the best known being the papers on the stability of ships (already referred to), the rolling of sailing ships, and the effect of bilge keels on rolling, and his description of the design of the battleship *Royal Sovereign.*

He was Chairman of the Committee on Education and Training of Engineers, appointed by the Institution of Civil Engineers in 1903, and also a member of the Governing Body of the Imperial College of Science and Technology.

Sir William was a Fellow of the Royal Society; Honorary Vice-President of the Institution of Naval Architects; Past-President of the Institutions of Civil Engineers, Mechanical Engineers, Marine Engineers, Junior Engineers and the Institute of Metals; President-Elect of the British Association for the Advancement of Science, having been President of the Mechanical Science Section. He was also an Honorary Member of many other British and foreign technical societies, including the American Society of Mechanical Engineers, the American Society of Civil Engineers and the Society of Naval Architects and Marine Engineers.

In 1911, he received the John Fritz Medal "for notable achievement in naval architecture." He had also received honorary degrees from many colleges and universities, among which were: LL. D. from Glasgow; D. Sc. from Cambridge, Durham and Columbia (New York City) Universities; and D. Eng. from Sheffield. He also belonged to the Athenaeum and British Empire Clubs.

ROBERT W. HUNT

Robert W. Hunt

ROBERT W. HUNT

ROBERT WOOLSTON HUNT was born December 9, 1838, in Fallsington, Bucks County, Pennsylvania. His father, Dr. Robert A. Hunt, died in March, 1855, at Covington, Kentucky. In 1857, he moved with his mother to Pottsville, Pennsylvania, where, in the iron rolling-mill of John Burnish & Co., he spent several years acquiring a practical knowledge of puddling, heating, rolling and other details of the iron rail business. In 1859, he took a course of analytical inorganic chemistry in the laboratory of Booth, Garrett & Reese in Philadelphia. In 1860, he was employed as chemist by Wood, Morrell & Co., then lessees of the Cambria Iron Works at Johnstown, Pa., and established at these works the first analytical laboratory maintained in America by an iron and steel company, as a part of its organization.

In the spring of 1861, as night-foreman of the Elmira rolling-mill, Elmira, N. Y., he assisted in the organization of the working force and the starting of that industry. In the fall of that year, he entered the United States army military service and was stationed at Harrisburg, Pa., where a year later he was put in command, with the rank of Captain, of Camp Curtin at Harrisburg, rendezvous for Pennsylvania volunteers. In 1863, with the same rank, he served as mustering officer for the State of Pennsylvania, and in 1864, he, together with his friend, Oberlin N. Ramsey, assisted in recruiting Lambert's Independent Mounted Company of Pennsylvania Volunteers.

After the war, he returned to the employ of the Cambria Iron Company, and on May 1, 1865, was sent to Wyandotte, Mich., where the Kelly Pneumatic Process Company, in which the Cambria was interested, had erected a plant. This company controlled the William Kelly American patents and Mushet's American patent for recarburization, and was an opponent of Winslow, Griswold & Holley, who had purchased Bessemer's American patents, and under Alexander L. Holley's direction had built an experimental plant at Troy, N. Y.

The rival enterprises were wisely consolidated in 1866. In his "History of the Bessemer Manufacture in the United States" (*Trans.* A. I. M. E., Vol. 5.), Mr. Hunt has narrated in detail the interesting and complicated events of the period of their conflict. It appears that the Kelly plant produced in 1864 from pig iron remelted in a reverberatory, the first pneumatic steel made in America, and that the use of a cupola for remelting was introduced by Mr. Hunt in 1865. In 1866, he returned to Johnstown, Pa., where he had charge of the hammering and rolling of steel. He superintended the rolling of the first steel rails produced on a commercial order in America, a lot rolled by Cambria for the Pennsylvania Railroad from ingots made by the Pennsylvania Steel Company. The behavior of these ingots led to the successful introduction of blooming by rolling instead of hammering.

The Cambria Company finished in 1871 a Bessemer plant, presenting many new features in construction and practice. One of the latter was the running of the cupola continuously, like a blast-furnace, a revolutionary improvement, which played an important part in the great increase of product. Another was a new system of bottom-casting. In these and other improvements, Mr. Hunt was associated with his intimate friend, A. L. Holley, Consulting Engineer, and George Fritz, Chief Engineer, of the Cambria Company.

Mr. Hunt left the Cambria Company in 1873, to become Superintendent of the Bessemer plant at Troy, N. Y., later known as the Albany and Rensselaer Steel and Iron Company, and in 1886 as the Troy Iron and Steel Company. Through all these changes, Mr. Hunt remained the General Superintendent, the works being enlarged and remodeled, and producing in rolling-mills of various sizes a great variety of steel and iron articles, "from a steel rail to a shingle nail." Under Mr. Hunt's supervision, the Troy Iron and Steel Company erected three 16 x 80 feet blast-furnaces on Breaker Island, opposite its Bessemer plant, and conveyed the molten metal on a ferry-boat across the Hudson river to the converters.

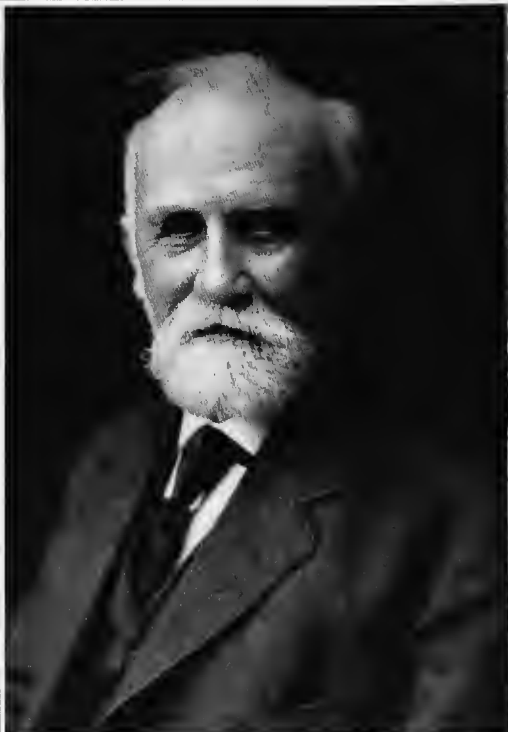
Mr. Hunt made at Troy many grades of Bessemer steel not previously produced in America, notably soft steel for drop forgings. He was also a pioneer in the production of steel for gun-barrels, carriage-axles, drills and springs. Several processes for the manufacture of special steels were patented by him and Dr. August Wendell, chemist of the works, and the driven tables on both sides of the rolls, afterwards used by nearly all the rail-mills of the country, were first developed by him and Max M. Suppes, his master mechanic, at Troy. Another notable improvement patented by Mr. Hunt was the rolling of wire-rod blooms into billets, which were then rolled to 120-150 feet length, and cut into 30 feet pieces.

In 1883, Mr. Hunt was elected President of the American Institute of Mining Engineers, and in 1891 President of the American Society of Mechanical Engineers. In 1906, he was again elected President of the American Institute of Mining Engineers; in 1893, President of the Western Society of Engineers; in 1912, President of the American Society for Testing Materials; and in 1914, American Vice-President of the International Association for Testing Materials. At different times he has served in other positions on the Boards of all five Societies. He is also a member of the American Society of Civil Engineers, the Institution of Civil Engineers, and the Institution of Mechanical Engineers.

Mr. Hunt was Secretary of the Committee on Standard Rail Sections appointed by the American Society of Civil Engineers, the final report of which was made in 1893, and of the Special Committee on Rail Sections, appointed in 1892, which reported finally in 1910. The sections recommended by this committee were generally adopted by the railways of America.

In 1888, Mr. Hunt resigned his position at Troy, and established in Chicago the firm of Robert W. Hunt & Company, which now has offices and laboratories in the principal cities of the United States, and in London, England, Canada, and Mexico City. In 1912, the John Fritz Medal was awarded to Mr. Hunt "for his contributions to the early development of the Bessemer Process." He has been for many years a Trustee of the Rensselaer Polytechnic Institute, which conferred upon him (June 4, 1916) the honorary degree of Doctor of Engineering. He has been a frequent contributor to the proceedings of technical societies, and has often lectured before educational and scientific bodies. While residing in Troy, he was elected for four successive terms Commander of John A. Griswold Post, No. 338, Grand Army of the Republic.

JOHN EDSON SWEET



JOHN EDSON SWEET

JOHN EDSON SWEET

JOHN EDSON SWEET was born at Pompey, near Syracuse, N. Y., October 21, 1832. His father, Horace, was a farmer, and his mother was a member of the well-known Avery family, distinguished for mechanics and inventors. He was educated at district schools, and in 1850 was apprenticed to John Pinkerton in the carpentry and joinery trade. At the end of his apprenticeship, he obtained a position in the architect's office of Elijah T. Hayden, of Syracuse, in the belief that to become a successful carpenter one must first learn the principles of drafting. After that, and until 1861, he was engaged in carpentry and the making of construction drawings for buildings. In that time and place there was small opportunity for the display of architectural talent. Nevertheless one of his first pieces of work was a design for a barn which won the first prize in a competition established by the farm paper, the *Rural New Yorker*. It was in 1850 probably one of the best of its type of buildings ever worked out. It was prophetic of the architect's work in succeeding years that the prize design was unique and individualistic and adapted to the requirements of the "great majority" of users.

When the Civil War broke out, young Sweet was supervising the erection of a hotel at Selma, Ala., which he had designed and which was planned to be one of the best in the South. Being a Yankee, he decided to leave that region. Incidentally, this change of location marked a change in his activities, which were thereafter almost entirely in the direction of mechanical construction, engineering, and teaching. After a year as draughtsman and pattern maker in machine and railroad shops, he spent two years as inventor and draughtsman at the London Works, Birmingham, England, returning in 1864 to be engaged until 1867 as designer of machinery at the Onondaga Steel Works, Syracuse, N. Y. Then came another year abroad, and then three years again at Syracuse (1868–1871) as Superintendent of the Syracuse Mower and Reaper Works. From 1871 to 1873, he was Superintendent of Bridge Building.

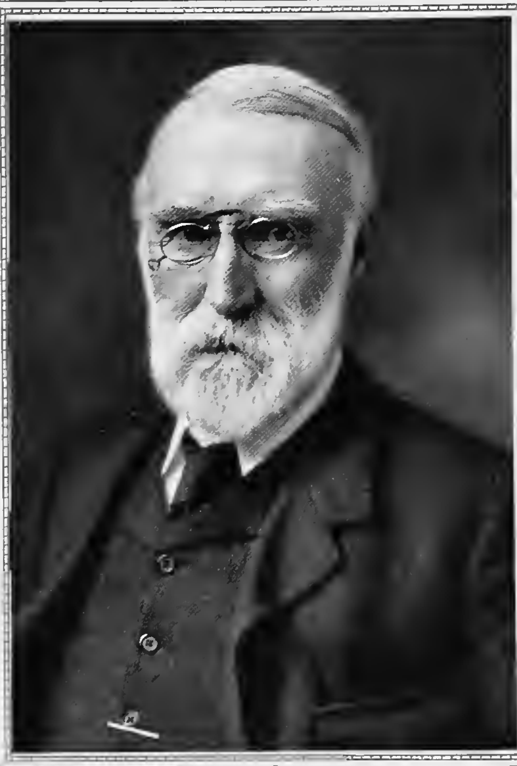
In 1873, he became Professor of Practical Mechanics in the Sibley College of Mechanic Arts at Cornell University, Ithaca, N. Y. This position he held for only six years and a half; but during that period he produced upon his many students a deep impression as a teacher, and won in the engineering profession a high reputation as an inventor and a pioneer reformer in the designing of machinery. His fame is specially connected with the development and introduction of the straight-line high-speed steam engine, involving the formation in 1880 of the Straight-Line Engine Company, of which he became and remained for 35 years the President and Superintendent.

Professor Sweet was one of the early members of the American Institute of Mining Engineers, and one of the founders of the American Society of Mechanical Engineers, of which he was President in 1883 and 1884. In 1893, he was expert for the U. S. Government and Member of the Jury on Machine Tools at the Chicago Exposition. In 1899, he was elected the first President of the Engine Builders' Association of the United States; in 1904, President of the Technology Club of Syracuse, N. Y.; and in 1906, President of the Syracuse Metal Trades Association. In this year he published a suggestive book, entitled "Things That Are Usually Wrong." He had been since 1858 a frequent contributor to technical and scientific journals and to the *Transactions* of the professional societies to which he belonged.

In 1914, the John Fritz Gold Medal was awarded to Professor Sweet "for his achievements in machine design, and for his pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine."

He died at his home in Syracuse, May 8th, 1916, in the 84th year of his age, leaving hehind him the record of an exceptionally long, distinguished and useful life.

JAMES DOUGLAS



JAMES DOUGLAS

JAMES DOUGLAS

JAMES DOUGLAS, LL. D., was born at Quebec in November, 1837, the son of a distinguished physician and surgeon. He studied at the University of Edinburgh and graduated at Queens University, Kingston, Ontario, afterwards traveling extensively in Europe and the Orient. He took post-graduate work at Edinburgh in medicine and surgery, and must have studied theology, for he was afterwards licensed to preach. It was his first intention to follow the practice of medicine or to enter the church, but he early began to occupy his leisure time in the pursuit of literature. Having a fondness for the natural sciences, he studied chemistry and taught this branch of science for three years in Morrin College, Quebec. His father had extensive but unremunerative investments in gold and copper mining in Canada, and the condition of these investments made it imperative that someone should look after them more closely than had been done. Young James Douglas thereupon entered the mining field. He had met the late Dr. T. Sterry Hunt and together they worked out the details of the well-known Hunt & Douglas process for the wet extraction of copper.

Dr. Douglas came to the United States in 1875 to introduce the Hunt & Douglas process in the works of the Chemical Copper Company, at Phoenixville, Pa. He traveled extensively, visiting mining centers. His power of keen observation and his willingness always to give advice wherever needed, bore fruit in many instances to the benefit of his friends, if not in all cases for his own financial advancement. He is credited with having revolutionized the practice of the Arkansas Valley Smelting Company at Leadville, changing their annual deficit into an average profit—this from a casual remark which he made to the superintendent. A mining man, in Butte, Mont., in the early days, testifies that in his opinion Dr. Douglas was the first to suggest the probability of secondary enrichment in that camp.

The greater part of Dr. Douglas' active life has been associated with the development of the metallurgy of copper, and that chiefly in connection with the Clifton and Bisbee deposits in Arizona. He had first refined copper from this district in his works at Phoenixville, and subsequently took charge of the development of the Copper Queen mine in Arizona which the firm of Phelps, Dodge & Company had under option. After its purchase, by his advice, Dr. Douglas was put in charge permanently. When Phelps, Dodge & Company was incorporated, Dr. Douglas became its first President. His foresight and business imagination led this very successful firm into railroad building, coal mining and to the extension of their interests into Mexican and other fields. Many young mining engineers and, indeed, those older in the profession, bear testimony to his broadmindedness and liberality. His mines and works were open at all times to any who had a legitmate reason for visiting them. His lectures before mining institutes, colleges and learned societies have been preserved as records of great permanent value. His charities have been large — in the form of endowment of colleges and research institutions, etc. He has been honored by having the degree of LL. D. conferred on him by both Queens and McGill Universities, has been twice elected to the Presidency of the American Institute of Mining Engineers and, in addition to receiving the John Fritz Medal, has also been the recipient of the Gold Medal of the Institution of Mining and Metallurgy.

In 1916, Dr. Douglas endowed with the sum of $100,000 the Library of the United Engineering Society of New York.

Available space does not permit the listing of Dr. Douglas' many scientific and other writings. A fairly complete list appeared in the Bulletin of the American Institute of Mining Engineers for January, 1916. It is interesting to note that this list covers not only the particular fields of copper mining and metallury, but also touches upon the science of astronomy, the improvements in the manufacture of steel, discussions on the relation of railroads to the mineral industry, and includes among the more important publications, volumes on Canada, on the relations between New England and New France, and a most interesting volume containing the journals and reminiscences of his father, edited by the son.

A list of his writings would be too long for the purposes of this article, but among them may be mentioned:

The Copper Deposits of Harvey Hill, 1870.

Spectroscopic Observations of the Sun, 1870.

The Copper Mines of Chili, 1872.

Copper Mines of Lake Superior, 1874.

Metallurgy of Copper, 1883.

Cupola Smelting of Copper, 1885.

American Methods and Appliances in the Metallurgy of Copper, Lead, Gold and Silver, 1895.

Progress of Metallurgy and Metal Mining in America during the last Half Century, 1897.

Record of Boring in the Sulphur Spring Valley of Arizona, 1898.

Treatment of Copper Mattes in the Bessemer Converter, 1899.

The Characteristics and Conditions of Technical Progress of the 19th Century, 1899.

Gas for use in the Manufacture of Steel, 1902.

Untechnical Addresses on Technical Subjects, 1908.

The Influence of Railroads of the United States and Canada on the Mineral Industry, 1909.

Earthquakes in Mines, 1911.

Development of the Railroads of North America and their Control by the State, 1911.

The Copper Bearing Traps of the Coppermine River, 1913.

Most of the above essays and many others appeared first in the *Transactions* of various technical and other societies, but in addition to these, Dr. Douglas has given us several historical volumes, among them:

Canadian Independence, Annexation and Imperial Federation.

Old France in the New World.

New England and New France.

Journal and Reminiscences of James Douglas, M. D., by his son.

ELIHU THOMSON

Elihu Thomson

ELIHU THOMSON

ELIHU THOMSON was born in 1853 at Manchester, England. His father was Scotch and his mother English, and they came to the United States in 1858, settling in Philadelphia. He was educated in the public schools of that city and graduated from the Central High School early in 1870. He entered a laboratory as analyst, but was appointed Assistant Professor of Chemistry in the High School later in the same year. In 1876, when twenty-three years old, he was given the chair of chemistry in the same school. This position was retained until 1880, when having become deeply interested in the future applications of electricity, he resigned to take up the work which he has continued ever since. He had always been fascinated by physical and chemical studies, and especially by electricity. He had constructed when eleven years old a frictional electrical machine from the traditional wine bottle. This and similar apparatus were followed by batteries, electromagnets, and telegraph instruments in which the bare wire was insulated by the laborious winding of thread around it by hand.

Possessed of a natural aptitude for construction and the use of tools, he gave the time he could spare from other duties to making such apparatus as he needed. In this way, while in his teens, he had built induction coils, electromagnets, cameras, chemical balances, and the like. In his early twenties, he constructed lenses, such as achromatic microscope objectives and oculars, and the microscope stand itself, and also built a pipe organ with electrical action, making pipes, windchest, bellows, keyboard and all other parts. This work, coupled possibly with a hereditary aptitude, gave him insight and skill, and naturally led to invention. He acquired from it also a facility in laying out work for the factory and following it through to completion. In recent years his taste for construction has found an outlet in the preparation of lenses for refracting telescopes, a 10-inch glass being mounted in his private observatory at his home in Swampscott, Mass. By way of contrast to his larger work demanding great care and skill, he has made photographic lens combinations, and even oil-immersion, wide-angle, high-power microscope objectives.

When he left his professorship in 1880, it was to take charge of the commercial development of the Thomson-Houston arc-lighting system based on his patents, some of which were taken jointly with his former colleague at the High School, Prof. E. J. Houston. The business was begun at Philadelphia in 1879, and was removed in 1880 to New Britain, Conn. Mr. E. W. Rice, Jr., now the President of the General Electric Company, accompanied him as assistant. In 1883, the modest works at New Britain were removed to Lynn, Mass., a Lynn syndicate having bought control. Here it was that the great development of the Thomson-Houston Electric Company began, due in large measure to the enterprise of its managing heads, chiefly Mr. C. A. Coffin, afterwards for many years President of the General Electric Company, and to the success of its engineering undertakings and achievements. During these pioneer years, Prof. Thomson was electrician and chief engineer, and many of the fundamentally important inventions upon which the business was based were due to him.

In 1892, the Thomson-Houston Electric Company and the Edison General Electric Company were merged under the title of the General Electric Company, which now possesses extensive works at Schenectady, N. Y.; at Lynn and Pittsfield, Mass.; at Harrison, N. J.; Fort Wayne, Ind.; Erie, Pa.; Cleveland, O.; and offshoots in France, England, Germany, and other countries. In connection with the newer problems arising in this great industry Prof. Thomson is still actively engaged. As a record of his inventive work there are about 600 patents in the United States alone, many of the inventions being of such importance that they have gone into extensive use in lighting, railways, power transmission, etc. The Thomson electric meter, as an example, which received first prize in a meter competition in Paris in 1890, is now numbered by millions in use. His pioneer discoveries and inventions in alternating currents are well known. It is not so well known that he is the inventor of the electric air-drill, as used today.

He was pioneer also in high-frequency work, upon which in later years wireless methods have been based. He was the originator of the art of electric welding by the resistance method, a process which is being more and more extensively applied to metal manufactures, and which in fact is essential to many of them.

As a writer and lecturer on scientific and technical subjects Prof. Thomson has attained an exceptional standing for clearness of statement. This together with his intimate knowledge of the electrical art, gives him unusual power as an expert witness in contested cases. His ripe experience is readily available to the younger men with whom he is associated. His attitude to people generally in need of information which he can give is that of the teacher, a generous giving out of the information he may possess, based on the desire that others may receive and carry further that which he has acquired.

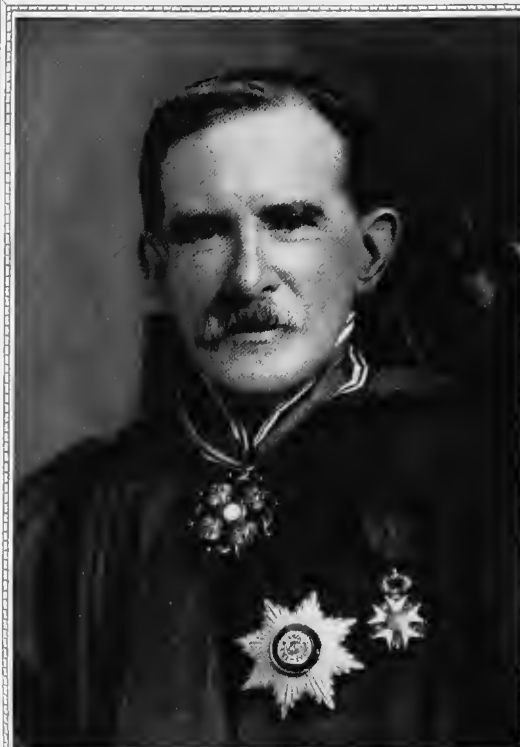
Elihu Thomson, as was natural, has been the recipient of many honors. In 1889, he was decorated by the French Government for electrical inventions, being made Chevalier and Officer of the Legion of Honor. He has received the honorary degrees of A.M. from

Yale and later D.Sc. from Harvard. Tufts College early gave him the degree of Ph.D. He has received the Rumford Medal, and was awarded the Grand Prix at the Paris Exposition of 1889 and of 1900. He is Past-President of the American Institute of Electrical Engineers, Member of the Institute of Civil Engineers (London), Fellow of the American Academy of Arts and Sciences (Boston), Member of American Philosophical Society, of the American Physical Society, Chemical Society and the National Academy of Sciences, and of many other societies here and abroad. He was official U. S. delegate to the Chamber of Delegates, Electrical Congress in Chicago in 1893. He was chosen President of the International Electrical Congress at St. Louis in 1904 and also President of the International Chamber of Official Delegates at said Congress. Also in 1904 he was elected Honorary Member of the Institution of Electrical Engineers of Great Britain and in 1909 was chosen President of the International Electrotechnical Commission, the general meeting being held at Turin, Italy, in 1911.

Elihu Thomson was the first recipient of the Edison Medal and more recently received the award of the Elliott Cresson Gold Medal from the Franklin Institute at Philadelphia, having before that twice received the John Scott Legacy Medal for electrical inventions.

It may be added that, having been always interested in education, he is now, and has been for many years, connected with the governing Corporation of the Massachusetts Institute of Technology.

HENRY M. HOWE



Henry M. Howe

HENRY M. HOWE

HENRY MARION HOWE was born March 2, 1848, at Boston, Mass. His father was Dr. Samuel G. Howe, famous for his service to Greece in her war for independence (1824 to 1830), and later for his labors in the instruction of the blind and the feeble-minded. His mother was Julia Ward Howe, author of the "Battle Hymn of the Republic," and leader in many reforms. He was graduated from the Boston Latin School in 1865, and from Harvard College with the degree of A. B. four years later. He then entered the Massachusetts Institute of Technology, from which he received in 1871 the degree of B. S.; and Harvard made him an A. M. in 1872. He was subsequently engaged at Pittsburgh, Pa., and Troy, N. Y., as an assistant in metallurgical work, and soon became known as a keen observer and investigator. In 1880 and the following years, he designed and built the works of the Oxford Nickel and Copper Company, at Capelton and Eustis, in the province of Quebec, Canada, and at Bergen Point, N. J. From 1883 to 1897, he resided at Boston, and besides his private practice as a consulting metallurgist and expert witness in metallurgical patent suits, was lecturer on metallurgy at the Massachusetts Institute of Technology.

Having become a member of the American Institute of Mining Engineers in 1871, the year of its foundation, Mr. Howe soon distinguished himself by his contributions to the *Transactions* of that society. His first paper, in Vol. 3, on "Blast-furnace Economy," was followed in subsequent volumes by "Thoughts on the Thermic Curves of Blast Furnaces," and "The Nomenclature of Iron"—the latter a brilliant contribution to the discussion inaugurated by Alexander L. Holley, with the famous paper, "What is Steel?" Later, he published valuable essays on the metallurgy of nickel and copper.

In 1885, Professor Howe issued his first book, "Copper Smelting," and in 1891, the first edition of the great work, "The Metallurgy of Steel," which was to constitute the principal foundation of his fame. In this volume he embodied the results of a comprehensive study of the literature of his subject, together with intelligent and fruitful researches of his own. A supplementary work, entitled "Iron, Steel and Other Alloys," issued in 1903, emphasized what his "Metallurgical Laboratory Notes" of 1902 had already indicated—his leadership in the comparatively recent science of metallography, especially that of iron and steel, to which he furnished many fundamental data and several felicitous new terms and hypotheses.

Of these three books, "The Metallurgy of Steel" and "Metallurgical Laboratory Notes" (the latter said to be the first text-book for the metallurgical laboratory ever written) were translated into French, and "Iron, Steel and Other Alloys" has appeared in Russian. The versatility and thoroughness of Professor Howe's learning and knowledge, the acuteness of his observation and the clearness of his statements and arguments are evinced in more than three hundred professional papers read before scientific and technical societies, etc.

The universal recognition of the high quality and value of his work is shown by the numerous honors conferred upon him in America and many other countries. He was a member of the Jury on Mining and Metallurgical Processes at the Paris Expositions of 1888 and 1900, and President of the Jury of Awards on Mines and Mining at the Chicago Exposition of 1893. In that year he was also President of the American Institute of Mining Engineers, which had charge of two departments (Mining and Metallurgy) of the International Engineering Congress, held at Chicago. These sessions were made memorable by the presentation and discussion of Posepny's "Treatise on Ore Deposits" (then published for the first time in any language) and the epoch-making contributions of Hadfield, Osmond, Martins, Sauveur, Howe and others on steel and its alloys; their nature, micro-structure, heat treatment, etc.

In 1895, Professor Howe received the Bessemer Gold Medal of the British Iron and Steel Institute, the Gold Medal of the German *Verein zur Beförderung des Gewerbfleisses* (Society for the Promotion of Technical Industry) and the Elliot Cresson Gold Medal of the Franklin Institute of Philadelphia. In 1906, he was made Chevalier of the Légion d'Honneur of France, and in the same year Knight Commander of the Imperial Russian Order of St. Stanislaus. He has been twice President of the American Society for Testing Materials, has been President and is a life member of the Council of the International Association for Testing Materials, has served three times as President of the Alumni Association of the Massachusetts Institute of Technology, and is an Honorary Member of the Russian Imperial Technical Society, the Russian Metallurgical Society, the French *Société d'Encouragement pour l'Industrie Nationale*, which awarded him also a prize of 2500 francs, the British Institution of Mining and Metallurgy, the Cleveland (England) Institution of Engineers, the Royal Swedish Academy of Science and the Dallas Historical Society. He is a non-resident Fellow of the American Philosophical Society and of the American Academy of Arts and Sciences.

It would be unfair to close this list of Professor Howe's scientific achievements and honors without mention of the great practical service rendered by him to American industry by introducing into this country in 1890 the manufacture of manganese steel and of the Hadfield projectiles made of it. He is still Vice-President of the Taylor-Wharton Iron and Steel Company, which is engaged in that manufacture.

JONAS WALDO SMITH

JONAS WALDO SMITH

JONAS WALDO SMITH

JONAS WALDO SMITH was born on March 9, 1861, at Lincoln, Mass., a small town near Boston. His parents, of English extraction, lived on a farm. Here young Waldo Smith spent his boyhood and attended the public schools. At 19, he went to Phillips Academy, Andover, from which he was graduated from the scientific course in 1881. Soon afterward Mr. Smith went to Lawrence, Mass., to become an assistant in the Engineering Department of the Essex Company, which controls the local water development there. His service in this environment led him to decide to pursue a thorough course of study in civil engineering. This he did at the Massachusetts Institute of Technology, where he was graduated in 1887.

During his college vacations and for some three years after his graduation, he served with the Holyoke (Mass.) Water Power Company, where he had much experience in the testing of turbines, at times assisting in making noteworthy hydraulic experiments.

In 1890, he became resident engineer with the East Jersey Water Company, which had just entered into a contract to build new supply works for the City of Newark, in charge of extensive reservoir construction for two years or more. As principal assistant engineer he had charge later of pipe line extensions, operation and maintenance.

In 1897, Mr. Smith was made Engineer and Superintendent of the Passaic Water Company and affiliated companies which distributed water to numerous communities of north Jersey, including Paterson, Passaic and Montclair, and a few years later was made Chief Engineer of the East Jersey Water Company. His experience during this period as an administrator proved invaluable in later years. He came in contact with the various consumers of this large waterworks system, and was intimately associated with the adjustment of public relations between the Water Company and some of the municipalities. Under his administration the use of meters was advanced, and the Little Falls Filter Plant, practically the first of its type in this country, was installed.

In this work Mr. Smith came actively in contact with a group of men notable for their far-sighted policy and business alertness, and during the later portion of his connection with them he served as Consulting Engineer on the design and construction of the Boonton Reservoir and of the long pipe line supplying water by gravity to Jersey City.

In 1903, Mr. Smith was made Chief Engineer for the Croton Aqueduct Commission which still had in hand the completion of two large storage reservoirs and numerous highways, bridges and other structures connected with the new Croton Reservoir and the Jerome Park Reservoir within the city limits. On account of the dangerous shortage of the water supply of New York City, it was urgent that current construction work should be expedited and additional storage reservoirs provided such as he later created at Cross River and Croton Falls.

The change of service from a large private corporation to the municipality of New York with its charter restrictions and other limitations, opened many new problems which were handled with characteristic energy, foresight, and common sense. Mr. Smith realized the importance of securing an adequate technical staff, and, notwithstanding Civil Service and other restrictions, attached to his engineering organization, experienced designing and constructing experts drawn from the staffs of the Metropolitan Water Board in Boston and from the New Jersey organizations of which he had been in charge.

His record on the Croton project led to his appointment in the summer of 1905 as Chief Engineer of the largest and most important waterworks undertaking the world has ever seen, the additional supply for the City of New York from the Catskill Mountains. This project involved an expenditure up to 1917 of about $175,000,000 for work which was performed on schedule time and at a cost of about $9,000,000 less than the original estimates. This enormous enterprise included the Ashokan Reservoir located in the Catskill Mountains, about 16 miles west of Kingston-on-the-Hudson. This reservoir is 12 miles long, of a maximum depth of 190 feet and has a capacity sufficient to cover the entire Island of Manhattan for a depth of 30 feet, with its contents of 132,000,000,000 gallons. The Catskill Aqueduct is 120 miles in length from this reservoir and extends under the City of New York to a terminal reservoir at Staten Island. The gravity aqueduct is about 17 feet high and 17½ feet wide. There is a tunnel under the Hudson River some 1200 feet below water surface, through which the water flows under pressure. Three miles north of White Plains is a large storage reservoir formed by one of the great masonry dams of the world, 1850 feet long with a maximum height of 307 feet. Beneath the City of New York is a pressure tunnel 18 miles long and from 200 to 750 feet in depth, driven in the rock with shafts through which water is delivered to existing distribution pipes.

Mr. Smith gathered around him a technical staff of unusual competence, insisted that they study the mistakes as well as the successes of similiar enterprises elsewhere and kept his own mind open to pronounce upon the adequacy of conclusions, not allowing himself to become absorbed in a mass of technical detail. The engineering organization, at times exceeding one thousand men, was imbued with a remarkable esprit de corps which resulted in the highest grade of performance. Each man was made to feel that his individual effort and loyalty was an important factor in the success of the work.

The accomplishment of this great enterprise is due chiefly to the rare combination in one man of technical skill of high order, and conspicuous ability as a far-sighted business administrator and as a leader of men.

Mr. Smith was elected to membership in the American Society of Civil Engineers in 1892, and served as Director of that Society from 1906 to 1908 and as Vice-President in 1913 and 1914. In 1918, Stevens Institute of Technology, conferred upon him the honorary degree of Doctor of Engineering and Columbia University the honorary degree of Doctor of Science. He is still Chief Engineer of the New York Board of Water Supply.

GENERAL GEORGE W. GOETHALS

General George W. Goethals

GENERAL GEORGE WASHINGTON GOETHALS

GEORGE WASHINGTON GOETHALS was born June 29, 1858, at Brooklyn, New York, of Dutch parentage. His father came to this country at the age of 21, settling eventually in Brooklyn and engaging in business as a contractor. Here young Goethals attended the Brooklyn public schools until in 1871 the family removed to New York. He entered the College of the City of New York in June, 1872, at the age of 14. After three years in college, where he earned his own way while pursuing his studies, he decided to become a surgeon and was preparing to enter the College of Physicians and Surgeons for a course of practical anatomy when he chanced to learn that "Sunset" Cox, the well-known New York Congressman, was about to nominate a candidate for West Point Military Academy by competition among the public school pupils. The combination of hard study with night work to earn his way had seriously affected young Goethals' health and he decided to try for this appointment. In view of his record in school and college, a competitive examination was waived and he was appointed.

Goethals entered West Point on April 21, 1876, and was graduated June 15, 1880, standing second in scholarship in a class of 54. He was one of the two members of his class selected for the Corps of Engineers, was chosen one of the four captains of the Cadet Corps, and was elected President of his class. He, therefore, in his West Point career, won highest distinction in scholarship, in military skill and in leadership among his associates—a rare trinity.

Notwithstanding these honors he still had ambitions to become a surgeon instead of an engineer and seriously considered resigning his commission after graduation. The reflection that he would be obliged to support himself while he was pursuing his medical studies turned the scale in favor of the Army and he went on with the regular two years' post-graduate course of instruction at the Willets Point Engineer School, given to young engineer officers.

Thenceforward for 25 years Goethals' work was of the usual sort which falls to the lot of the Army engineer, little known and little appreciated. Three times he gave instruction at West Point, first in 1880, immediately after graduation, when he taught astronomy for a a short term, a four-year period from 1885 to 1889 and another tour of duty there ten years later.

In 1882, after leaving Willets Point, he spent two years in the far Northwest as engineer officer on the staff of General Miles, commanding the Department of the Columbia. He had a year on the Ohio River and a longer tour of duty beginning in 1889 on the Tennessee River. Here he completed the Mussel Shoals Canal and began the Colbert Shoals Canal. He recommended a 20-foot lift lock for the latter and it was approved by the Chief of Engineers, although his immediate superior had opposed it. He was next assigned to Washington as Assistant to the Chief of Engineers and was there when the war with Spain began. During this war, he was Chief Engineer of the First Army Corps under General Brooks and took part in the Porto Rican campaign. After the service in West Point, previously noted, he was placed in charge of river and harbor work in New England from Cape Cod to Point Judith.

When the General Staff of the Army was organized in 1903, Goethals was selected as one of the Majors for duty thereon and was serving there when, on March 4, 1907, he was appointed by President Roosevelt a member of the Isthmian Canal Commission and shortly afterward was made its Chairman and Chief Engineer.

Until that time, Goethals had been an unknown Army Engineer. Immediately his name was on the headlines of every newspaper.

The engineering plans had been adopted and the work laid out, and construction work on the canal had been carried on for four years under two eminent civilian Chief Engineers, each of whom had resigned. The successive Commissions in charge of the work had not functioned well.

President Roosevelt and Secretary of War Taft decided to put the work in charge of the Army engineers, and after very careful inquiry as to the Engineer Officer best qualified to carry this great executive responsibility, Goethals was chosen.

The record of his ten years' work at Panama justifies the wisdom of that choice. From a superficial point of view the Panama Canal is a work stupendous in size but comparatively simple in character. To those who know its detail history, the story of the work is one long battle with giant difficulties, from the war against "yellow jack" in the early days to the contest with the slides that at the very completion of the work threatened its success. And the contest with physical difficulties was less arduous than the "human engineering" involved.

There was plenty of it required on the Isthmus to induce the army of workers to exert themselves on the job. There was no small amount needed in the United States, where Congress and a sensational press and suspicious public was always ready to lend ear to sensational rumors about the canal work. Through all these years it was Goethals' leadership that overcame all difficulties and achieved the final success.

Republics are not always ungrateful. On March 4, 1915, a special act of Congress tendered to Goethals the thanks of the Nation for the service on the canal and promoted him to the rank of Major-General.

Previous to this he had been appointed Governor of Panama and the Canal Zone, on April 1, 1914. At his own request he was placed on the retired list of the Army on November 15, 1916, and was released from duty as Governor of the Zone on January 11, 1917.

Relieved thus from the service of the Government, after forty years as an army officer, he returned to New York City, his boyhood home, and began practice as a consulting engineer. The entry of the United States into the World War, only a few months later, brought him back into the Government service with larger responsibilities than ever. His first work was on the U. S. Shipping Board, where his opposition to the wholesale building of wooden vessels—an opposition which later events fully justified—was part of a controversy that lead to his resignation.

In December, 1917, he was appointed Acting Quartermaster-General of the Army. In January, 1918, in addition to the duties of this office, he was made Director of Storage and Traffic, a division having charge of all the storage facilities for the War Department, the movement of all supplies and troops by rail and inland waters within the limits of the United States, together with the Embarkation Service, moving all men, troops and supplies from ports of the United States overseas.

In May, 1918, he undertook the consolidation of the purchase of all standard supplies for the Army, their storage and transportation. To this end, he was relieved from duty as Acting Quartermaster-General and assigned as Assistant Chief of Staff and Director of Purchase, Storage and Traffic. He continued in charge until he was relieved March 4, 1919, at his own request, and returned to the retired list. He then resumed his private practice of engineering at New York City.

General Goethals' war services were recognized on December 27, 1918, by the award of the Distinguished Service Medal "for especially meritorious and conspicuous service in reorganizing the Quartermaster Department and in organizing and administering the Division of Purchase, Storage and Traffic during the War." He was made Commander of the Legion of Honor by the French Government in January, 1919, in recognition of the distinguished service rendered to the cause of France and the Allies in the war against the Central Powers, as "Directeur des Achats, Approvisionnements et Transports." On November 22, 1919, he was made Knight Commander of St. Michael and St. George by the British Government "for distinguished service in the campaign as Chief of the Division of Purchases, etc., General Staff."

General Goethals is a member of the American Society of Civil Engineers, a Fellow of the Academy of Arts and Sciences, and he holds Honorary Membership in the Society of Engineers at Panama, the American Society of Mechanical Engineers, the Institution of Civil Engineers (London), the Dutch Royal Society of Engineers, the American Philosophical Society at Philadelphia, the Northwestern

Society of Engineers, the Engineers Club of Philadelphia, and the Engineers Club of Chicago.

In 1912, he received three honorary degrees: D. Sc. from Columbia, LL. D. from Yale, and LL. D. from Harvard. He has also received the honorary degrees of D. Sc. from Rutgers, LL. D. from Princeton, LL. D. from the University of Pennsylvania, and LL. D. from Johns Hopkins University.

He has received the President's medal of the Architectural League; the Panama Pacific International Exposition Medal and medals from the National Geographical Society, the American Geographical Society, the Geographical Society of Chicago, the National Institute of Social Science, the National Academy of Sciences, and the Civic Forum. On May 22, 1919, he was awarded the John Fritz Medal "for achievement as builder of the Panama Canal."

ORVILLE WRIGHT

Orville Wright

ORVILLE WRIGHT

ORVILLE WRIGHT was born at Dayton, Ohio, August 19, 1871, the fifth son of Bishop Milton Wright and Susan Catharine (Koerner) Wright. As a child he was full of energy, and interested in out-of-door sports. His mechanical bent was shown when, at the age of nine, he made by himself a small wood-turning lathe. At seventeen, while attending high school, he published a weekly paper the "West Side News," of which he was first editor and publisher. Later, his brother Wilbur joined him as editor and the two brought out a four-page, five-column daily paper "The Evening Item," and still later, a weekly magazine entitled "Snap Shots." They made the printing presses on which the papers were printed. These were remarkable contrivances made principally of wood and strings, as it seemed to the curious visitors, some of whom came miles to see the presses run.

From 1890 until the death of Wilbur in 1912, the brothers were always together in all their work and interests; so that during that time the work of one cannot be disassociated from that of the other. It was their practice when one advanced a theory on any subject for the other to take the opposite side, with the idea that if a fallacy existed it would thus be found. This saved much time and money in experiments which would have proved to be failures, and made it possible for them to carry to completion experimental work which otherwise would have been beyond their limited resources.

In 1892, when the safety bicycle was coming into popular use, the brothers formed the "Wright Cycle Company," first to sell bicycles, but later to manufacture them. The output was small but the "Van Cleve" bicycle earned a reputation and is still remembered by Daytonians, though it is twenty years since it was made.

In the early nineties they became interested in flying, through reading articles on the subject in the magazines. They were especially interested in the experiments of the German, Lilienthal, who glided down hills on "wings." In 1896, Lilienthal met with an accident in his gliding experiments and was killed. Shortly after this Octave Chanute, of Chicago, made many experiments in gliding, the results of which were published in 1897.

The following quotations indicate the state of the art at this time. The Aero Club of Washington said:

"Lilienthal, Chanute, Langley, and Maxim are the four names that will ever be inseparably linked with the early stages of flying-machine development, the stages that preceded the successful invention of the first man-carrying machine by the Wright brothers. These four men elevated an inquiry, which for years had been classed with such absurdities as the finding of perpetual motion and the squaring of the circle, to the dignity of a legitimate engineering pursuit"

Wilbur Wright, writing of Chanute in 1911, said:

"If he had not lived, the entire history of progress in flying would have been other than it has been, for not only did he encourage the Wright brothers to persevere in their experiments, but it was due to his missionary trip to France in 1903 that the Voisins, Bleriot, Farman, De Lagrange, and Archdeacon were led to undertake a revival of aviation studies in that country, after the failure of the efforts of Ader and the French Government in 1897 had left everyone in idle despair. Although his experiments in automatic stability did not yield results which the world has yet been able to utilize, his labors had vast influence in bringing about the era of human flight. His 'double-deck' modification of the old Wenham and Stringfellow machines will influence flying-machine design as long as flying machines are made."

When the Wright brothers took up active experiments in 1899, the problem was not one of the motor, for motors lighter per horse power than the one they were soon to use had already been built. The problem was how to build wings of such efficiency that motors already known could propel them, and how to balance these wings when once they were in the air.

In 1899, they built a large kite to test out their first invention, that of warping, or aileron control, and the next year a man-carrying glider to further test this and some other ideas on control. But these experiments, while seeming to demonstrate the value of their ideas, at the same time indicated the inaccuracy of the tables of air pressures from which the machine had been calculated. The first machines were based on tables of air pressures then generally accepted by scientific people. The wings would not support nearly so much as the tables had indicated.

In 1901, a larger machine was built, and hundreds of gliding flights were made with it. But this machine demonstrated conclusively that the then accepted tables of air pressures were not to be relied upon. It was also found in these experiments that the center of pressure on curved surfaces travelled in a direction opposite to that taught in the books. This year marked the turning point in their experiments, the conclusion being reached that nothing published was to be trusted without verification. What was generally accepted had proved to be untrue, and they undertook the establishment of a scientific basis for the calculation of aerodynamic phenomena.

In the fall of 1901, a wind tunnel was set up, and with measuring balances of their own design, measurements of the lift and drift of hundreds of different aerofoils were made. The effect of camber, of aspect ratio, and of superposing were learned. Tables showing the travel of the center of pressure on curved surfaces were made. At this time probably a hundred measurements for every one that had been made by all their predecessors were made; but the importance of these measurements was due more to their accuracy than to their number.

A new glider was then built based upon their own laboratory measurements and tested in more than one thousand gliding flights in the fall of 1902. These demonstrated the accuracy of their measurements. It was during these tests that their system of control was completed, so that at the end of these experiments they felt ready to design a motor-driven man-carrying machine which would fly with an ordinary motor and at the same time would be fully controllable in the air.

But in the designing of a power machine several new problems presented themselves, the most important of which was that of the propeller. A study of marine engineering books disclosed that the water propeller, although in use a hundred years, was still based entirely on experiment. A complete theory of its reactions had never been worked out. The Wrights had neither the time nor the money to carry on experiments to develop an air propeller, and therefore were compelled to find some other way. After months of study and argument a theory was arrived at from which it appeared possible to determine by calculation the properties of a propeller. The propellers of their first machine were built entirely upon calculation, without any previous test, and had an efficiency scarcely exceeded today.

The Wrights took the parts of their machine to Kitty Hawk, North Carolina, in September, 1903. The work of assembling being completed, four successful flights were made on December 17. In these flights the machine raised itself from the ground with its own power and flew without loss of speed. The longest flight was of 59 seconds' duration.

In 1904 and 1905, they continued experimenting near Dayton, Ohio, acquiring skill in the handling of the machine. The longest flights of 1904 were two of five minutes each. In 1905, a number of flights of more than 15 minutes duration were made. The last flight of the year was the longest. A distance of about 24 miles was covered in 38 minutes. The accounts of these flights published in Europe produced much discussion. It was not believed possible that two obscure men unknown to the scientific world could so quietly solve a problem which had baffled man for ages. In 1908 and 1909, flights were made at home and abroad, which attracted universal attention.

For his part in the achievement, Orville Wright has been honored with degrees from universities in the United States and Europe, with honorary membership in scientific and engineering societies of America, England, France, Germany and Austria; and with medals and decorations from the Congress of the United States, the State of Ohio, the Republic of France, the Smithsonian Institution, the John Fritz Medal Board, the Franklin Institute, the French Academy of Sciences, the British Royal Society of Arts, and the leading aeronautical societies of America and Europe.

SIR ROBERT A. HADFIELD

Sir Robert A. Hadfield

SIR ROBERT ABBOTT HADFIELD

SIR ROBERT ABBOTT HADFIELD, the son of Robert Hadfield, was born in Sheffield, England, on November 29th, 1859. The Hadfield family, one of whom fought on Flodden Field in 1513, came originally from Derbyshire.

Sheffield is the center of the manufacture of high-grade steel in England, and it was that business in which the ancestors of Sir Robert were engaged. Two members of the family had been Master Cutlers of Sheffield, namely, Samuel Hadfield, who served as such in 1828 and again in 1837, and Sir John Brown. Various members of the family were also active in National and civic affairs; one George Hadfield, was a Member of Parliament for 22 years, and Sir Robert's father, Robert Hadfield, served as a member of the Sheffield City Council for 14 years and also as Chairman of its Highway Commission.

Sir Robert was educated at the Sheffield Collegiate School where, in 1874, he won two scholarships and prizes in Natural Science and other subjects. In 1911, Sheffield University conferred on him the Honorary Degree of the Faculty of Metallurgy (D. Met.), and in 1912, he received the Honorary Degree of Doctor of Science (D.Sc.) from the University of Leeds.

He had been in business a year before he entered the Laboratory of the Hecla Works, at Sheffield, which works were owned and operated by his father, thus beginning a career of remarkable scientific and technical achievement.

In 1882, when he was 23 years old, Sir Robert discovered and invented manganese steel which combined qualities of great hardness and great ductility hitherto unknown in that metal. He afterward invented a low hysteresis steel which is especially suitable for transformers, dynamos and motors. These inventions have contributed much to the science of metallurgy and have resulted in vast improvements in the properties and manufacture of the better qualities of alloy steels, including protective armor-plate steel, and armor piercing projectiles.

Since 1888, Sir Robert has been Chairman and Managing Director of Hadfield's, Limited, the Hecla and the East Hecla Works at Sheffield. He has also served as Chairman of the Sheffield District Railway, Director of the Sheffield Gas Company, the Mond Nickel Company, and others. Following the family tradition, he was Master Cutler of Sheffield in 1899 and 1900.

In 1908, he was knighted, and in 1917, became a Baronet.

Sir Robert possesses that rare combination of qualities which enables him to be successful as investigator, inventor, author, director of financial and industrial works, and public benefactor.

As an inventor and financial and industrial works director, Sir Robert has built up Hadfield's, Limited, to be the greatest works for the manufacture of high-grade steel, alloy steel, and ordnance steel, in Great Britain. He has also introduced the manufacture of his manganese steel in America and his special cast ordnance steel in Japan and other countries.

In 1891, he introduced the 48-hour week in his works, being the first steel manufacturer to inaugurate this change.

It has been stated that during the World War, more munitions for the British Navy were produced in his works than in those of any other manufacturer, and his manganese steel was found to be the most effective material for helmets and body armor, 9,000,000 helmets made of that steel having been used by the English, Belgian and American armies.

For his invention of manganese steel, Sir Robert has been awarded medals and prizes by a number of scientific societies, among which are the Telford Gold Medal and Premium, awarded in 1888, by the Institution of Civil Engineers; the Gold Medal, awarded in 1890, by the Société d'Encouragement pour l'Industrie Nationale de France; the John Scott Medal and Premium, awarded in 1891, by the Franklin Institute; and the Bessemer Gold Medal, awarded in 1904, by the Iron and Steel Institute. He has also received medals and prizes for his work in alloys of iron and steel, and for his advancement of the science of metallurgy, from the Institution of Civil Engineers, the Institution of Electrical Engineers, the Franklin Institute, and the Société d'Encouragement pour l'Industrie Nationale de France.

As an author, Sir Robert has published more than one hundred monographs, many of which describe important investigations and discoveries made by himself and others in connection with metallurgical work.

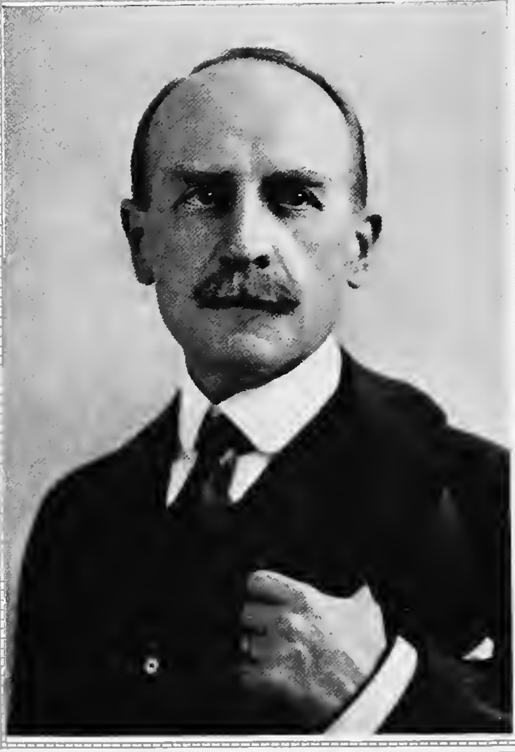
He is a member of many scientific societies in Great Britain and other countries and has done much to increase their usefulness to the technical world by his support and writings. He has served as President of the Iron and Steel Institute and the Faraday Society, and as Vice-President of the Institution of Mechanical Engineers, the Institution of Mining and Metallurgy, and the Royal Society of Arts. He is a Fellow of the Royal Society, Institute of Chemistry, Chemical Society, Royal Aeronautical Society, Institute of Physics, and the Physical Society, and an Honorary Member of the K. Venska Vetensk Akademie (Stockholm), American Institute of Mining and Metallurgical Engineers, American Iron and Steel Institute, American Steel Treaters' Association, British Foundrymen's Association, Sheffield Association of Metallurgical Chemists, Société des Ingenieurs Civils de France, and the Athenaeum Club of London.

His public services have included those of Justice of the Peace for Sheffield since 1896, Chairman of the Ferrous Section of the Advisory Council for Scientific and Industrial Research, member of the Arbitration Panel, of the Senate and Court of Governors of the University of Sheffield, member of the Board, and Executive, of the National Physical Laboratory, and member of the Advisory Panel of the Munitions Inventions Department. In 1917, he was elected a Freeman of the City of London.

During the World War, Sir Robert supported, from November, 1914, to January, 1919, the Hadfield Hospital at Wimereux, France, at which approximately 16,000 cases were treated. For this service to the nation, he received special letters of thanks from the Prime Minister and others. He was also awarded a bronze medal by the city authorities of Boulogne, France, for aid rendered the St. Louis Hospital at that place.

The John Fritz Gold Medal was awarded Sir Robert in 1921 for the "invention of manganese steel."

CHARLES PROSPER EUGÈNE SCHNEIDER



Charles Prosper E. Schneider

CHARLES PROSPER EUGÈNE SCHNEIDER

CHARLES PROSPER EUGÈNE SCHNEIDER, ironmaster, was born at Le Creusot, France, October 29, 1868, the descendant from a family of Lorraine. His forbears had been in the iron business for several generations. Joseph Eugène Schneider created the firm of Schneider & Cie., which purchased the ancient works at Le Creusot. His son, Henri, succeeded him as head of the firm. Eugène, the subject of the present sketch, grew up in the business and succeeded his father, Henri, in 1898.

In speaking of the metallurgical works at Le Creusot it helps to visualize them by mentioning Essen and Bethlehem. These are the great metallurgical plants of the world wherein armaments and ordnance have become the specialties. As such establishments they played predominant parts in the Great War. In the cause of the allied and associated powers Le Creusot was pre-eminent. It was mainly through the foresight of Eugène Schneider that his ancestral business was put in a position to play this important part and become not only a national, but also an international, asset. As early as 1895, the Schneider establishments made special efforts to improve heavy and light field ordnance, and created the quick-firing type, the appearance of which produced a revolution in the tactics of modern artillery.

While giving to peace industries all the attention necessitated by the progress in science and the continual improvement in industrial methods and products, Eugène Schneider, with a discernment that subsequent events amply justified, especially directed his efforts toward the creation in France of a war industry able to counterbalance the enormous power which the German war industry had established. The task was rendered difficult inasmuch as the French government, supplied by its own arsenals, placed few orders with private concerns; and moreover the Krupp works had known how to establish a pre-eminence throughout the world, helped toward that by the now familiar commercial methods of Germany and through the fact that a French law, abrogated only in 1882, had prohibited the export to foreign countries of war materials.

After comparative trials, made in numerous countries between Krupp and Schneider guns, the latter were adopted (in spite of the Krupp influence and prestige) by virtue of their superiority, duly ascertained by military commissions. By the time of the Great War, most of the nations that did not do their own manufacturing had replaced Krupp artillery by that of Schneider. This led to a development in the manufacture of war materials that proved immensely helpful to the French government. In the Schneider works, not only were units of various calibers found completed, or in the course of manufacture, for foreign governments, but also there were shops ready immediately to undertake artillery and ammunition manufacture and a competent staff trained for those difficult tasks, which was able to assist in starting numerous other shops that had not previously been used for this kind of work.

The artillery and munitions, delivered in very large quantities during the war to the French and Allied governments, were of widely varied types: field guns and howitzers (heavy and light types), siege guns, guns of large caliber on railway mounts, tanks, shells, fuses, explosives, torpedoes, sights, submarine and airplane engines, and armor plate.

Not only in France, but also in Russia, Italy, and England, the Schneider engineers initiated numerous works for war manufacture especially in the preparation of special gun and shell steels. The American Government adopted for its ordnance the 155 and 240 mm. howitzers and railway mounts for large caliber guns, according to the Schneider models. This ordnance, which brilliantly proved its superiority on European battlefields, was manufactured in American arsenals, with the technical help of agents from the Schneider works.

Under the enlightened management of Eugène Schneider the establishments of his firm were largely extended previous to the war, their activity being not only directed to increasing production, but also to spreading more and more their scope for action in all branches of industry—in metallurgy, mechanical and electrical construction, shipbuilding, artillery and ammunition, and in public works. During the ten years immediately preceding the war, the number of employees in these establishments, and without counting those of the more and more numerous subsidiaries, increased by approximately 50 per cent. In 1918 they were employing 150,000 workmen.

Besides the technical and industrial development of the works, Eugène Schneider gave steadily his attention to social economics for the welfare of his employees, following the traditions from his ancestors. All questions pertaining to the happiness and scale of living of his workmen commanded his enthusiastic attention and often received solutions that were much in anticipation of laws. Among these subjects were schools, technical instructions, evolution of salaries, inducements to saving, old age pensions, allowances for the sick and the wounded, medical attention, hospitals, hygiene and safety conditions, and mutual aid societies, etc.

Eugène Schneider has received many honors and has performed many duties besides those directly associated with his business. From the death of his father in 1898 until 1910, he served as a member of the Chamber of Deputies. He was elected to the Presidency of the British Iron and Steel Institute in 1918 and served in that capacity until 1920. At the same time he was honorary chairman of the Comité des Forges de France.

In 1919, the Mining and Metallurgical Society of America awarded to him the gold medal for "distinguished service in the metallurgy of iron and steel." This medal was presented to him during a visit to the United States in 1919. During the same visit he was elected to honorary membership in the American Iron and Steel Institute and the degrees of Doctor of Science were conferred upon him by the University of Pittsburgh and Western Reserve University, and Doctor of Engineering by the Stevens Institute of Technology; and he was given the freedom of the City of Pittsburgh. On July 8, 1921, at Paris, M. Schneider received the John Fritz gold medal at the hands of a deputation of American engineers sent there for the purpose.