Ferranti married the second daughter of Mr. Francis Ince, a solicitor who gave a great impetus to the electrical industry in its early days. One of Ferranti's sons, Basil, was killed in the War, after distinguishing himself as a major and gaining the military cross; another son, Vincent, is a director of Ferranti's. Ferranti's home at The Hall, Baslow, Derbyshire, was fitted up with every electrical convenience, including even artificial sunshine. His seaside house in Wales was also 'all-electric'.

He was a great motorist, and for his summer holiday he often went for a motoring tour abroad. In the winter he and some of his family went to Switzerland for the winter sports. On Dec. 19 last he attended the meeting of the Institution of Electrical Engineers, at which Mr. Haldane read a paper on a heat pump which reversed the Carnot cycle of operations. Ferranti was enthusiastic over it, and reminded me that Prof. Perry as well as Kelvin had advocated reversing the Carnot cycle. He was just starting for his winter holiday, and was looking forward to skating and to seeing his children and grandchildren taking part in more active sports. His death at Zurich on Jan. 13, following an operation, came as a great shock to his many friends all over the world.

Ferranti, through his father-in-law Mr. Ince, was closely connected with Faraday House Electrical Engineering College. At the old students' dinner on Oct. 25, in proposing the toast of the College, he encouraged the students by reminding them of his own strenuous struggle during the days of his youth. He missed in his student days, by a hairbreadth, the invention of the tungsten filament lamp and the induction motor. He attributed these failures to lack of technical knowledge, and urged the students to use every endeavour to widen their knowledge. One could never tell what scientific fact would give the key to an invention.

Ferranti was a great inventor and engineer, one of the greatest the world has ever seen. We need merely mention the mercury meter, the Ferranti alternator, the Ferranti rectifier, the Ferranti concentric cable, Ferranti switchgear, the Ferranti steam engine, the Ferranti steam valve, his system of earthing, his induction furnace, his high temperature improvements of the steam turbine, his systems of electric welding, and his high-speed spinning machinery for cotton mills. There are many more. Electricity supply as we know it to-day was largely fashioned by him. In England, in America, and practically all over the world, his name is a household word in engineering circles. Yet he was a singularly modest and retiring man. He never stood in the limelight or pushed himself forward for public recognition. Foreigners after meeting him sometimes asked, wonderingly, "Was that the great Ferranti?"

He was a fellow of the Royal Society, an honorary member and Faraday medallist of the Institution of Electrical Engineers, an honorary member of the American Institute of Electrical Engineers, and an honorary D.Sc. of the University of Manchester.

A. RUSSELL.

PROF. H. L. CALLENDAR, C.B.E., F.R.S.

IT is with deepest regret that we record the death of Hugh Longbourne Callendar, professor of physics at the Imperial College of Science and Technology. He was born in 1863, and died after a brief illness on Jan. 21 last. He leaves a widow and three sons.

Callendar received his early education at Marlborough at a time when little encouragement was given to a brilliant scholar to take up any form of experimental science, and he passed through the school on the classical side. In his first year at Trinity College, Cambridge, he received college prizes for classics and mathematics, obtained a first class in Part I. of the Classical Tripos of 1884, and was bracketed sixteenth Wrangler in the Mathematical Tripos of 1885. Afterwards, however, his whole career was devoted to the experimental branches of physical science, in which he developed a degree of skill and a *flair* for accurate work that left him without a rival.

Callendar's first work, on the platinum resistance thermometer, was communicated to the Royal Society in 1886, during which year he became a fellow of Trinity College, and his researches on temperature measurement were continued at the Cavendish Laboratory until 1893. After a brief interlude at the Royal Holloway College, Egham, he accepted appointment to a professorship of physics at McGill University, Montreal, remaining there for five years. During this period he developed his method of continuous electrical calorimetry, the first application being the measurements by his assistant Barnes on the specific heat of water. It was also at McGill that he first brought his knowledge to bear directly on the problems of engineering science, and in conjunction with Nicolson he made many valuable discoveries on the heat transmission and leakage losses from steam engine cylinders.

In 1898, Callendar returned to England as Quain professor of physics at University College, London, and in 1900 he first put forward his characteristic equation for an imperfect gas which has been so useful and satisfactory in representing the properties of steam. He accepted appointment as professor of physics at the Royal College of Science, now incorporated in the Imperial College of Science and Technology, in 1902, and still filled the chair at the time of his death. His long occupancy of this post has been crowded with work representing not only the developments of his early researches but also brilliant and vital investigations on many new lines to which he turned his attention.

Of the many services which Callendar has rendered to pure and applied science, it is difficult to say which should be placed first, but undoubtedly the most widespread utilisation of his researches lies in the applications of the platinum resistance thermometer. In this instrument, Callendar not only gave to the research worker a method of the highest order of accuracy for the measurement of temperature, but also gave to the engineer and metallurgist a convenient and

practicable method of heat regulation in industrial operations. To the perfection of the thermometer itself Callendar added the design of his automatic recorders and put the combination to many and varied uses. His equation for an imperfect gas with his measurements of the properties of steam are similarly of universal importance. It now seems so obvious that the values of the various properties of a vapour must be thermodynamically consistent with each other, yet of the many systems of steam tables in use throughout the world none possessed that vital attribute until Callendar showed the way. He was spared to put the crowning touch to the edifice which he had erected, and last year saw the publication of his experimental values for steam up to and beyond the critical pressure. He had long been dissatisfied with the usual presentation of conditions in the neighbourhood of the critical point, and his revelation of a differentiation in density and a latent heat beyond the temperature at which the meniscus vanishes came after a prolonged series of experiments which only he could have brought to a successful conclusion.

Space does not permit of a detailed reference to Callendar's work on the gas thermometer, the radio-balance, the re-determination of the specific heat of water, and the many other physical problems which he successfully attacked during his tenure in London. Concurrently with these researches, he conducted a series of investigations on engineering problems connected with steam turbines and internal combustion engines, and in 1925 and 1926 he published papers on dopes and detonation, in conjunction with the staff of the Air Ministry Laboratory, which represented most valuable advances in the elucidation of that important but obscure phenomenon. In all the major works which bear his name, he alone was responsible for every detail and every determination, and it may be that his most valuable contribution to science of the present day was the introduction of a new standard of accuracy for physical and engineering measurements. The elimination of every possible source of error and the very highest degree of consistency alone would satisfy him.

In his college lectures, Callendar was clear and concise, presenting his subject with logical sequence and perfect illustration. He took few holidays, and was most happy when allowed to pursue his individual research steadily and without interruption, yet no interrupter was ever received with anything but perfect courtesy. He was a good tennis player, and had won the Prince of Wales' Cup at Bisley for rifle-shooting. He had been interested in motoring from its earliest days. He was the inventor of a system of shorthand which is in fairly general use in some parts of the Colonies where older systems had not become firmly established prior to its advent. He had no great liking for public lectures or for committee work, but accepted in his course such duties as they called. He was for some years treasurer of the Physical Society of London, and was president in 1910–12. He was also president of Section A (Mathematical and Physical Science) of the British Association at the Dundee meeting in 1912. He was elected a fellow of the Royal Society in 1894, when only thirty years of age, and received the Rumford Medal in 1906. When the Physical Society of London established the Duddell Memorial Medal, to be awarded for the advancement of knowledge by the invention or design of scientific instruments, the name of the first recipient was a foregone conclusion and the medal was unanimously awarded to Callendar in 1924. He was a Hon. LL.D. of McGill University, and at least one British university was desirous to bestow the same honour upon him, but he declined to leave his college duties during the examination period.

It is pleasing to record that in the industrial world the work that Callendar did was valued, accepted, and used. His steam tables were officially adopted by the turbine manufacturers of Great Britain through the British and Electrical Allied Manufacturers' Association, and used for turbine tests and contracts, and his later work on high-pressure steam was supported and financed by the manufacturers' research association. He was awarded a Watt Medal by the Institution of Civil Engineers in 1898 for his work with Nicolson on the laws of condensation of steam, and received the Hawksley gold medal of the Institution of Mechanical Engineers in 1915 for his investigations into the flow of steam through nozzles and throttles, while in 1929 he was invited to deliver the Hawksley memorial lecture. He was made a C.B.E. in 1920 for his work for the Air Ministry and the Anti-Submarine Department of the Admiralty, but his most lasting memorial is the mark he has made on the science of accurate measurement. H. M.

WE regret to announce the following deaths:

Dr. A. J. Bigney, professor of zoology in Evansville College, Indiana, and president in 1915 of the Indiana Academy of Science, on Nov. 13, aged sixty-five years.

Prof. Ralph H. Curtiss, of Detroit Observatory and professor of astronomy at the University of Michigan, who was known for his work on stellar spectroscopy, on Dec. 25, aged forty-nine years.

Dr. Henry Wilson Hake, lecturer on chemistry and toxicology at Westminster Hospital Medical School, and consulting chemist, on Jan. 18, aged seventy-two years.

Prof. F. Neher, professor of organic chemistry since 1914 at Princeton University, who was known for work on the derivatives of halogenated ethers and esters, on Dec. 11, aged sixty-two years.

Prof. T. Brailsford Robertson, professor of biochemistry and general physiology in the University of Adelaide since 1920 and officer in charge of investigations on the nutrition of animals for the Commonwealth Council for Scientific and Industrial Research, on Jan. 25, aged forty-five years.

Rev. F. A. Tondorf, director of the seismological observatory and professor of physics at Georgetown University, Washington, on Nov. 29, aged fifty-nine years.

Sir Frank Warner, K.B.E., president in 1918–20 of the Textile Institute and a leading man in the silk industry of Great Britain, on Jan. 23, aged sixty-seven years.