

though the figures obtained during a two years' trial on a section of the Birmingham tramways were not encouraging to the cause in England ; but, as was acknowledged afterwards in the discussion of a paper on the subject of electric traction at the Institution of Electrical Engineers by Mr. Epstein, the fault lay not with the accumulators but with the installation of the system.

Mr. Epstein had set himself a high ideal for an accumulator, and towards this he continued to press. Experiments were constantly carried on in his private laboratory at Richmond. The application of accumulators to launches, torpedoes, and traction work generally occupied the whole of his time, and to the last he was at work on an improved form of traction cell. His early death was caused by the worry of litigation affecting an impetuous mind concentrated upon arriving at perfection. His great experience of accumulators made him a valuable authority on the subject, and though an enthusiast in his special line he always recognised the limitations of the lead accumulator, and was ready to try any substitute which showed promise of success.

He was a great admirer of all things English ; if he had lived he had intended to become a naturalised British subject. He leaves a widow and one boy.

He became an Associate of the Institution on the 24th of November, 1892, and was transferred to the class of Members on the 25th of February, 1897. His paper on "Accumulator Traction on Rails and Ordinary Roads" was read at the Ordinary General Meeting on the 11th of November, 1897.

W. S. R.

DAVID EDWARD HUGHES, F.R.S.—On the 22nd of January in the present year death deprived the world of Science and this Institution of one of the most brilliant experimental discoverers and inventors of the century ; and at the same time a large circle of friends lost one of their number whom they loved and greatly admired.

David Edward Hughes was a Welshman by parentage, a Londoner by birth, and for some twenty years an American by adoption, returning in 1857 to this country, where he settled and remained until his death. Born in London on the 16th of May, 1830, he, with his parents, migrated to Virginia when he was barely seven years old. From a very early age the boy displayed a remarkable talent for music, and this developed to such an extent that at the age of nineteen he was appointed Professor of Music in the Bardstown College in Kentucky ; but side by side with his love of music was, at the same time, developing a love for experimental science, chiefly in the domain of Physics. After holding his musical professorship for a short time he was appointed to the Chair of Natural Philosophy in the same college, and for a time taught both Music and Physics. It was during this period that he first conceived the idea of the Printing Telegraph with which his name must ever be associated. The Hughes Type Printer is so well known to the readers of this Journal that it would be superfluous to describe it ; but one of its essential characteristics is the wonderfully

perfect synchronism of the transmitting and receiving instruments, which is attained by the substitution of circularly vibrating springs for tuning-forks, an invention that has been applied for similar purposes very often since he introduced it. Another organ of his instrument, and a valuable invention in itself, is the Hughes Magnet, in which the armature is released when a current passes through its coils ; it consists of a permanent magnet that is strong enough to hold up, by its own magnetic attraction, an armature, but which can be weakened at will by transmitting through coils that surround it an electric current in a direction whose tendency is to reverse its polarity. This again has had many applications since, notably in connection with railway signalling.

In 1857, Professor Hughes brought his invention to this country, but, being unsuccessful in interesting the Electric Telegraph Company of that date to take it up, he went over to the Continent, where he met with a very different reception. The Emperor Louis Napoleon received him with distinction, and conferred upon him the decoration of the Imperial Order of the Legion of Honour, of which he ultimately became a Commander, and from this period successes and honours followed him in rapid succession. In 1862 he received from the King of Italy the Order of St. Maurice and St. Lazare ; in 1865 the Czar, whose guest he was, conferred upon him the Order of St. Anne. The Emperor of Austria, in 1867, gave him the Iron Crown, which carried with it the title of Baron, and at the same time the Sultan conferred upon him the Commandership of the Imperial Order of the Grand Cross of the Medjidieh ; Holland followed in 1868, and during the next year he received from the King of Bavaria the Noble Order of St. Michael. Switzerland followed in 1870, and five years later he was made by Spain a Commander of the Royal and Distinguished Order of Carlos III. He had also the Grand Officer's Star and Collar of the Servian Royal Order of Takovo, and was an Officer of the Royal Order of Leopold of Belgium. He was also, at the Paris Exhibition of 1867, awarded one of ten Grand Gold Medals granted to mark the highest achievements in Science. All these honours and decorations were given in recognition of the importance which the several rulers and administrations attached to the type printing telegraph, which came into very general use in all those countries, with great financial advantage to the inventor, and which was adopted by the New York Associated Press and by the Western Union Telegraph Company of the United States. Thus Professor Hughes was for this invention rewarded and honoured by well nigh every civilised country in the world except his own.

From the time that the development of the type printer no longer required the personal attention of its inventor, he, although in receipt of a splendid income, settled in modest quarters in London and devoted himself to experimental research, chiefly in connection with Electricity and Magnetism, and his discoveries, some of which were nothing short of epoch-making, were made with the very simplest of home-made apparatus. With the help of a few match boxes and pill boxes, needles, copper wire, and sealing wax, Professor Hughes built up most of the instruments he required for an elaborate research, and obtained the most accurate results. His constant batteries were constructed of

gallipots and lamp chimneys, copper bell wire, sheet zinc and pipe-clay, and it was always the delight and admiration of all who had the privilege of seeing him at work to observe the spirit of the true philosopher who, with such apparently rough apparatus, attained such accurate and important results.

In the month of May, 1878, a few friends assembled at his rooms in Great Portland Street to witness some demonstrations of what was then thought to be the discovery by Professor Hughes of "a material which bore an analogous relation to sound that selenium bore to light," but which was the first demonstration of the epoch-making Microphone; this little gathering consisted of the late Professor Huxley, Mr. (now Sir) William Preece, Mr. (now Sir) Norman Lockyer, Mr. Conrad Cooke, and Mr. Perry Nursey. The experiments were repeated at the Meeting of the Royal Society in the following week; and an illustrated description, in which the now accepted theory of the action of the Microphone was given for the first time, appeared in the columns of *Engineering* the next day.

It is not too much to say that, but for the discovery by Professor Hughes of the variation of electrical resistance by the variation of surface contact between two or more conductors touching lightly together in exact proportion to sonorous waves impinging upon them, whereby they are set into sympathetic vibration, the telephone could never have been made the practical instrument that we know to-day; and although Professor Hughes fully appreciated the future there was before the microphone, he refused all suggestions of converting it to commercial use for his own benefit, and gave the invention and discovery freely to the world as the true man of Science that he was.

The microphone was almost immediately followed by his Induction Balance, by which the presence of an inductive mass may be detected at a distance, and it will be within the memory of many who read this notice that it was successfully applied to locating the bullet in the body of President Garfield, who died by the hand of an assassin in the year 1881. It is also applicable to the tracing of metallic ores in the earth, and, by a simple modification, it becomes an instrument for measuring the sensitiveness of the sense of hearing.

The subject of transmitting telegraphic signals from one station to another without a metallic conductor between them engaged the attention of Professor Hughes between 1879 and 1886, and there is no doubt that he discovered at that time the fact that poor conductors, such as finely-divided metals or carbon, become good conductors under the influence of electric waves, a discovery which was subsequently made by M. Branly, and which we now know as the phenomenon of cohesion by the impact of etheric or Hertzian waves. With such a coherer, Professor Hughes, some twenty years ago, in the presence of Professor Huxley, Professor Stokes, and Mr. Spottiswoode (then President of the Royal Society), transmitted electric signals without connecting wires to a distance of five hundred yards, and attributed the action of the combination to the results of electric waves produced by the extra current from an induction coil beating upon a microphone consisting of a semi-metallic powder.

Professor Hughes was elected a foreign member of this institution, then the Society of Telegraph Engineers, in November, 1872, being transferred to the class of Members in 1879. In the following year he was elected a Member of Council ; in 1882 he became a Vice-President ; and, in 1886, he was selected for, and unanimously elected to, the office of President of the Society.

In addition to his Presidential Address on "Self-induction of an Electric Current in Relation to the Nature and Form of its Conductor," he read before the Institution the following papers :—

- "Experimental Researches into Means of Preventing Induction upon Lateral Wires."
- "Note on some Effects produced by the Immersion of Steel and Iron Wire in Acidulated Water."
- "The Cause of Evident Magnetism in Iron, Steel, and other Magnetic Bodies."
- "The Physical Action of the Microphone."
- "Oil as an Insulator."

He also, in the Journal, published a "Communication" in reference to Standard of Light, and, in conjunction with Sir Charles Bright, contributed the Report upon the International Exhibition of Electricity in Paris, 1881.

In the year 1880 he was elected a Fellow of the Royal Society, and five years later he received the Royal Society's Gold Medal, which was awarded "for Experimental Research in Electricity and Magnetism, and for the Invention of the Microphone, Induction Balance, and Sonometer." He was a Life Member of the Society of Arts, and two years ago he was awarded the Albert Medal of the Society for his distinguished services to the cause of Science and "in recognition of the service he has rendered to Arts, Manufactures, and Commerce by his numerous inventions in Electricity and Magnetism, especially the Printing Telegraph and the Microphone."

He was in the year 1889 elected one of the Managers of the Royal Institution, becoming Vice-President in 1891.

Professor Hughes, besides being an enthusiastic worker in Science and a great inventor, had another side to his character which will render him none the less missed in the world. He was simple in his tastes and modest as to his exceptional genius ; he was one of the best and most genial of companions, with a keen sense of the ridiculous, thoroughly appreciative of fun in others, and those who were privileged to belong to the little coterie that used to meet at luncheon three times a week, first at the Horseshoe, Tottenham Court Road, afterwards at the Société Nationale Française, and ultimately at Frascati's Restaurant; will ever recall with pride and happy remembrance his genial comradeship, his merry and contagious laugh, his inexhaustible fund of information or story, and simple and lovable disposition. His memory will be revered by the world at large, but by that inner circle of his intimate friends that memory will be cherished with a loving tenderness.

C. W. C.